Hypoxia Tolerance in Four Strains of Diploid and Triploid Rainbow Trout

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Outline

Introduction

- Background
- Goal
- Research questions

Current work

- Oxygen transport
- Energy metabolism

Experiments

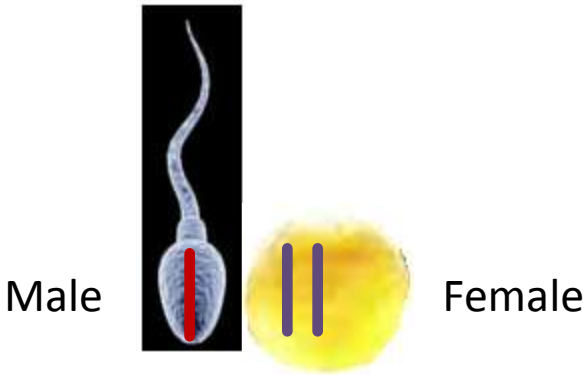
- Swimming performance
- Thermal tolerance
- Hypoxia tolerance

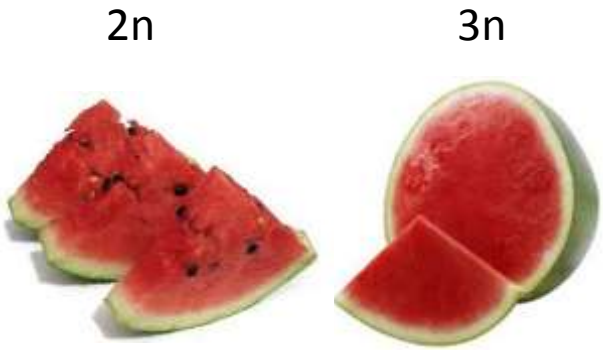
Background

- Rainbow trout are a species of salmonid native to Asia and North America
- Introduced to over 45 countries
- In British Columbia, more than 1,000 lakes are stocked with more than 8 million fish

Background

- Triploid (3n) Induction





- Sterile
- Impaired gonadal development

Background

- Triploid (3n) sterile rainbow trout are preferred for lake stocking programs:
    1. To prevent gene flow
    2. Better flesh quality

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    1. To prevent gene flow
    2. Better flesh quality

- Greater mortalities with triploids

Goal

1. To determine why 3n rainbow trout exhibit higher mortalities in the wild compared with their 2n counterparts

Research Questions

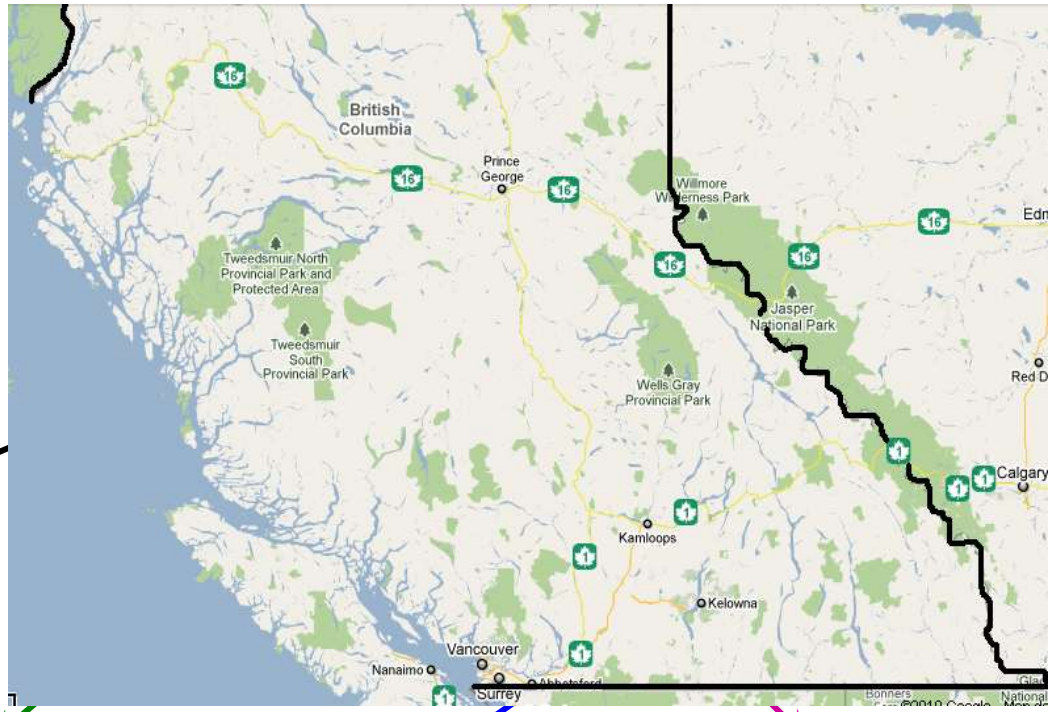
1. Do 2n and 3n rainbow trout differ in physiological performance or environmental tolerance?

2. Can we elucidate the underlying physiological and/or biochemical reasons for any differences in performance or tolerance?

3. Do the results from laboratory studies on juvenile hatchery-reared trout match those from lake stocked trout?

Research System

Four strains:
(BW) Blackwater
(TZ) Tzenzaicuit
(PN) Pennask
(FV) Fraser Valley domestic



Blackwater River

Tzenzaicut Lake

Fraser Valley Trout Hatchery

Pennask Lake

Experiments

Swimming performance

- Swimming required for resource acquisition and predator avoidance

Thermal tolerance

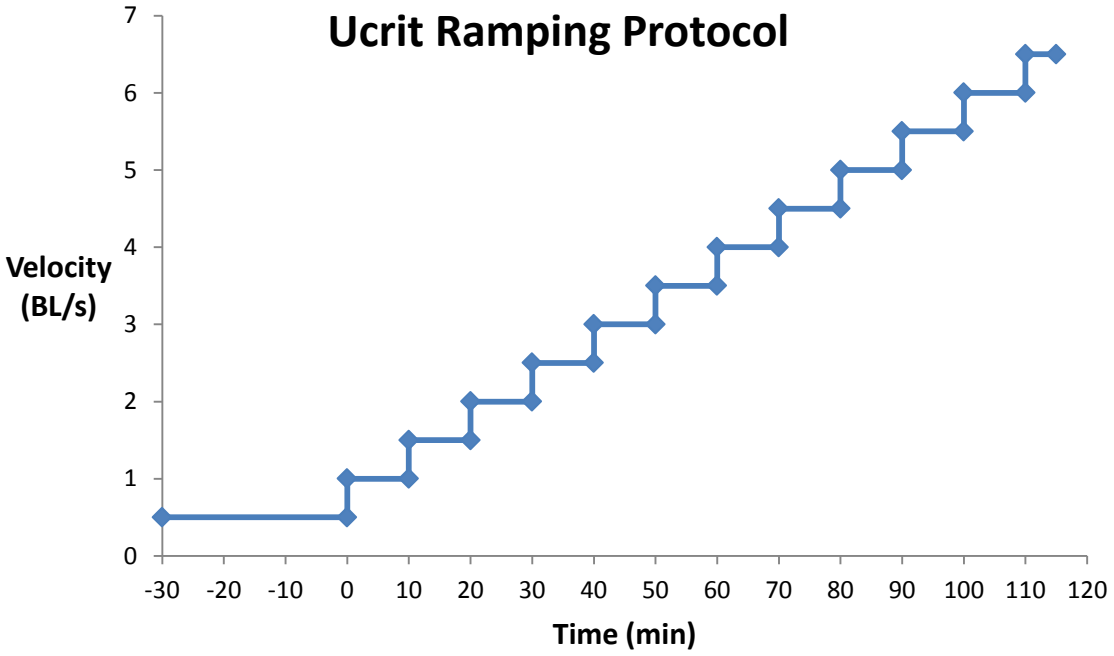
- “Summer kills” are known to occur in stocked lakes

Hypoxia tolerance

- “Winter kills” occurs when lakes freeze-over
- Algal blooms

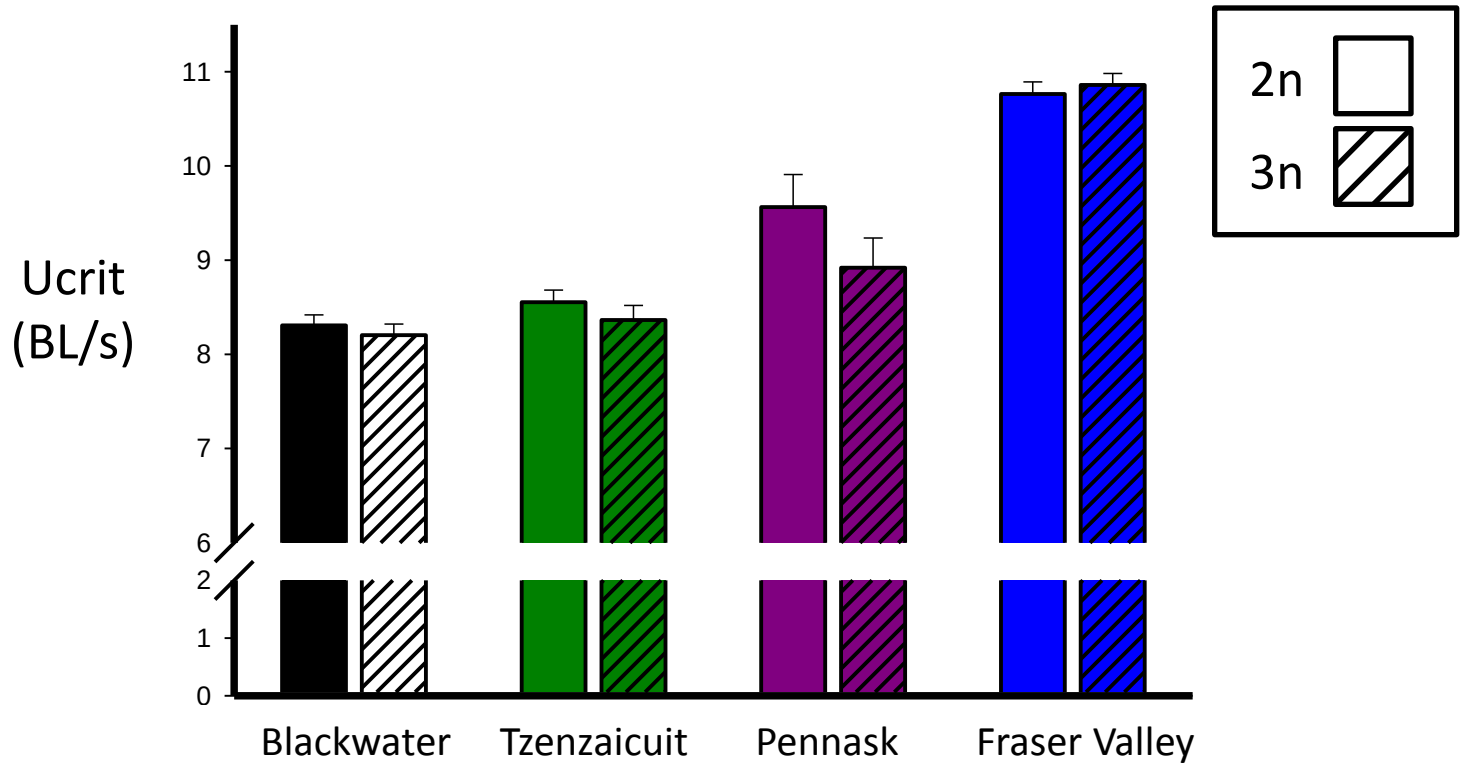
Swimming Performance

Ucrit – Critical swimming speed



Swimming Performance

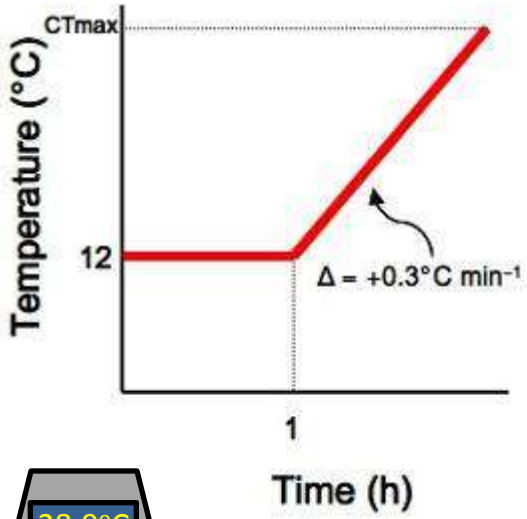
Ucrit – Critical swimming speed

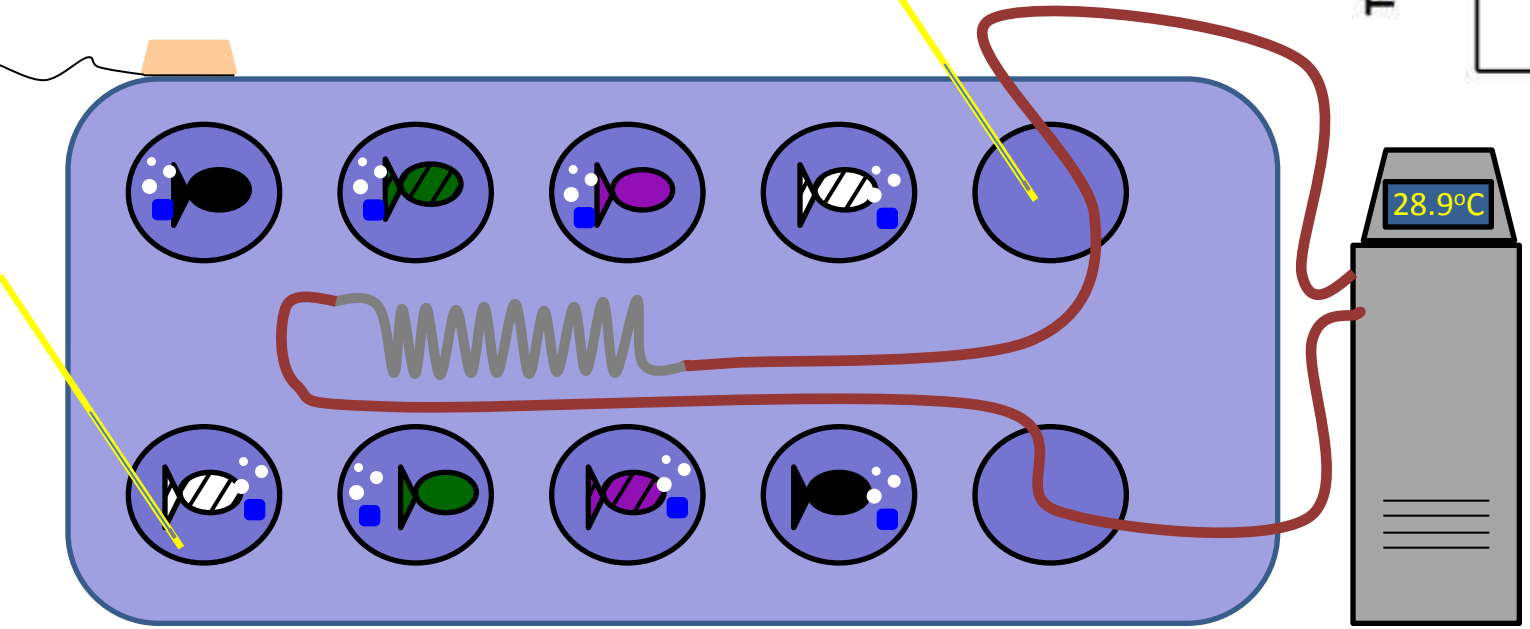


Strain P<0.0001
Ploidy P=0.096
SxP P=0.25

Thermal Tolerance

CTMax – Critical thermal maximum





Thermal Tolerance

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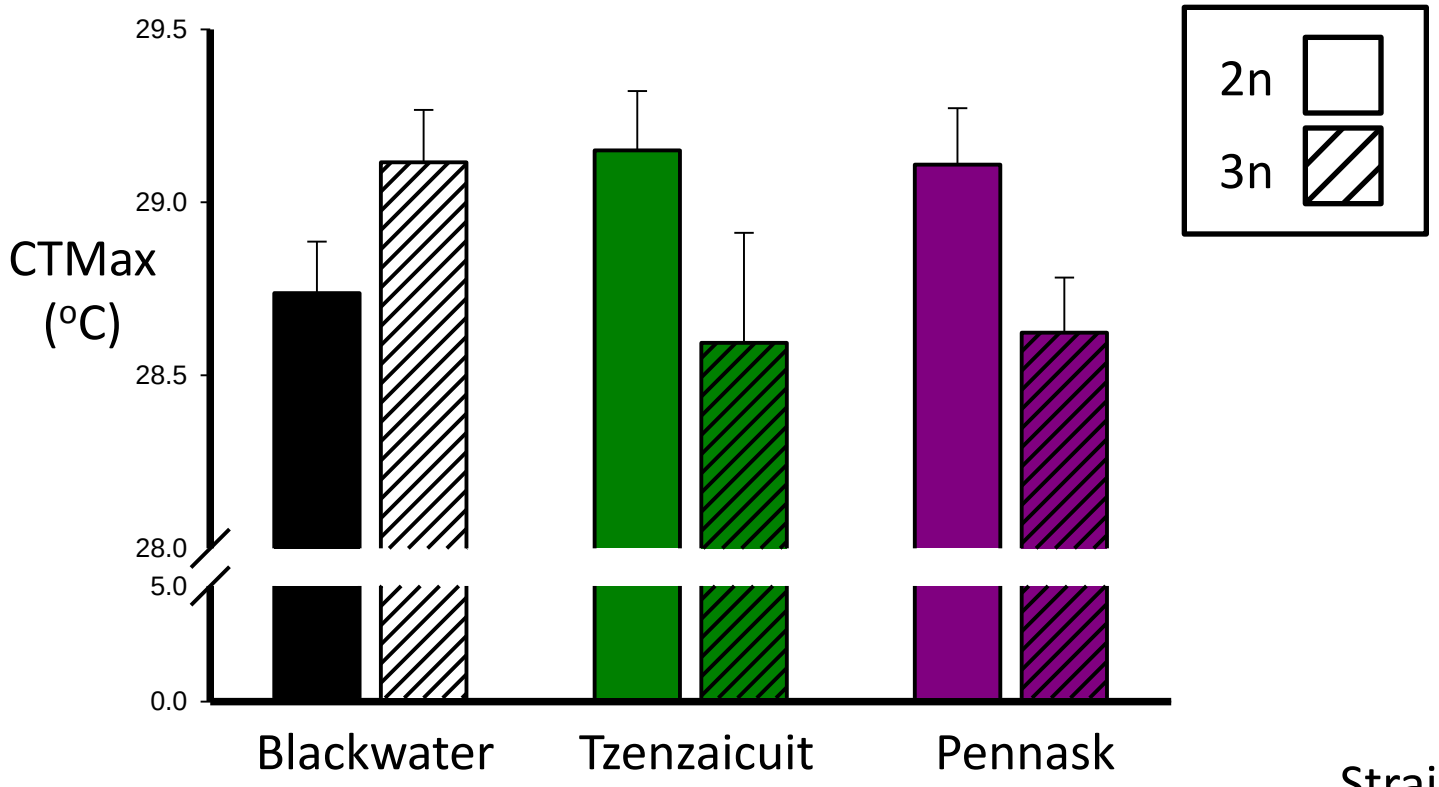


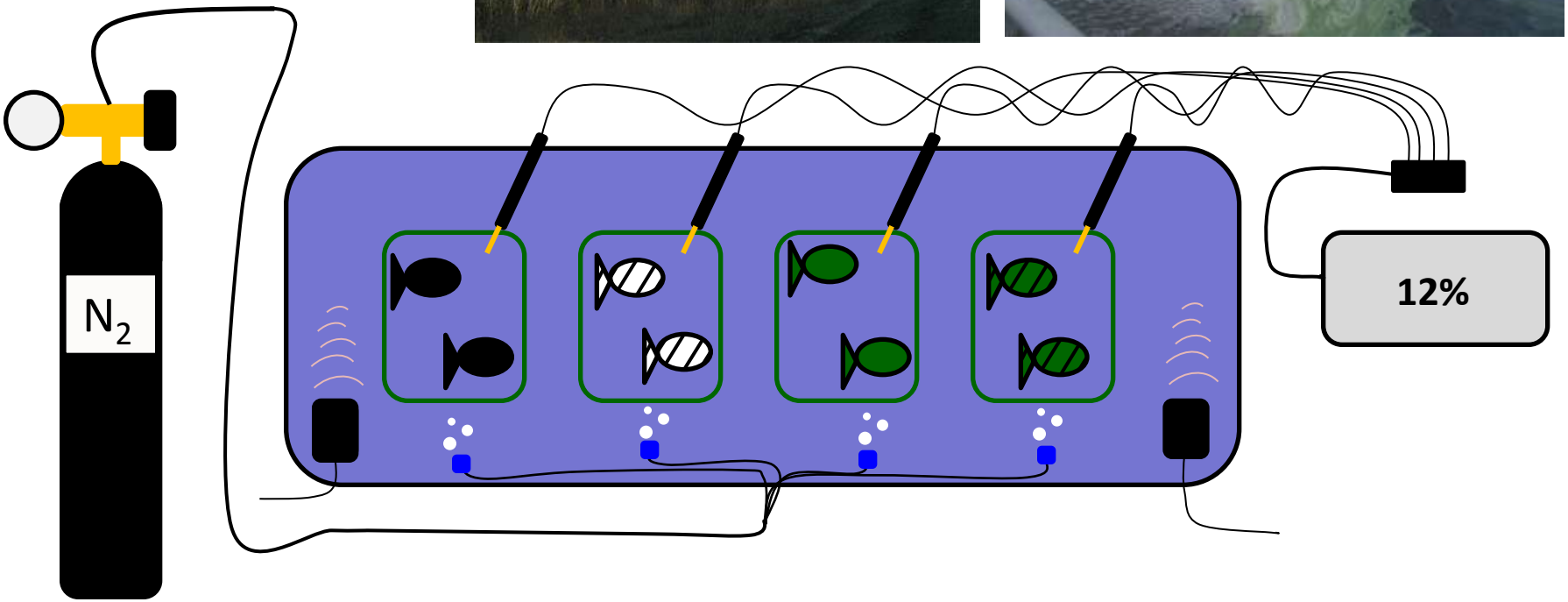
Strain P=0.76

Ploidy P=0.004

SxP P<0.0001

Hypoxia Tolerance

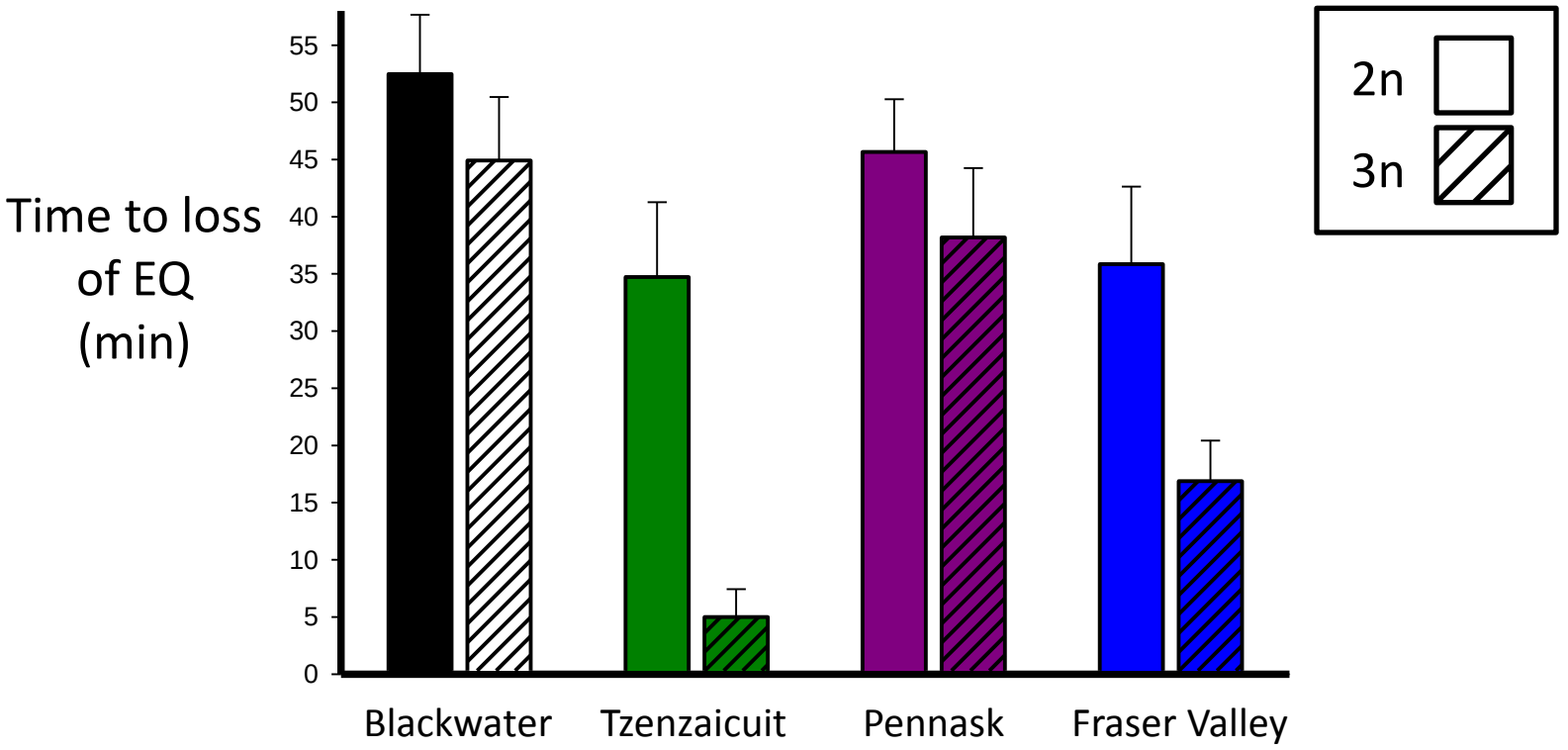
LOE – Loss of equilibrium



Hypoxia Tolerance

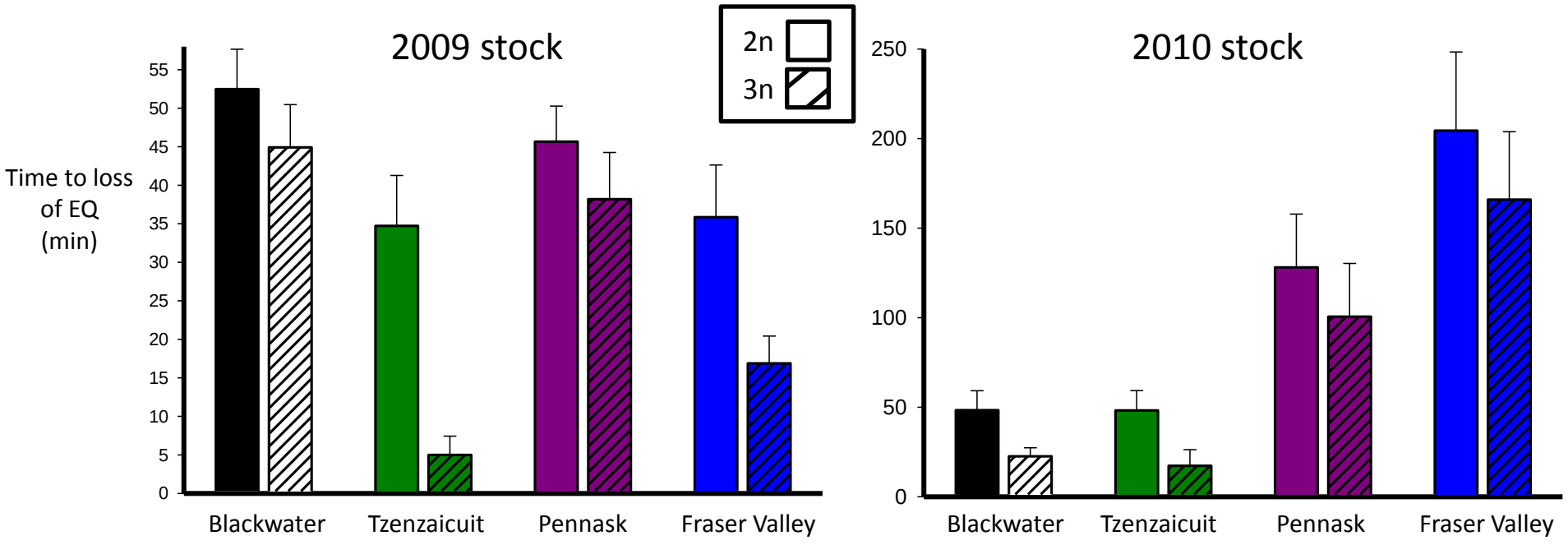
LOE – Loss of equilibrium

Time to loss of equilibrium of juveniles at 12% air saturation (~18 torr)



Strain P <0.0001
Ploidy P <0.0001
SxP P =0.0018

Hypoxia Tolerance



Statistical significance: $P < 0.0001$ $P = 0.0002$

Research Questions

1. Do 2n and 3n rainbow trout differ in physiological performance or environmental tolerance?

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2n and 3n rainbow trout differ in hypoxia tolerance

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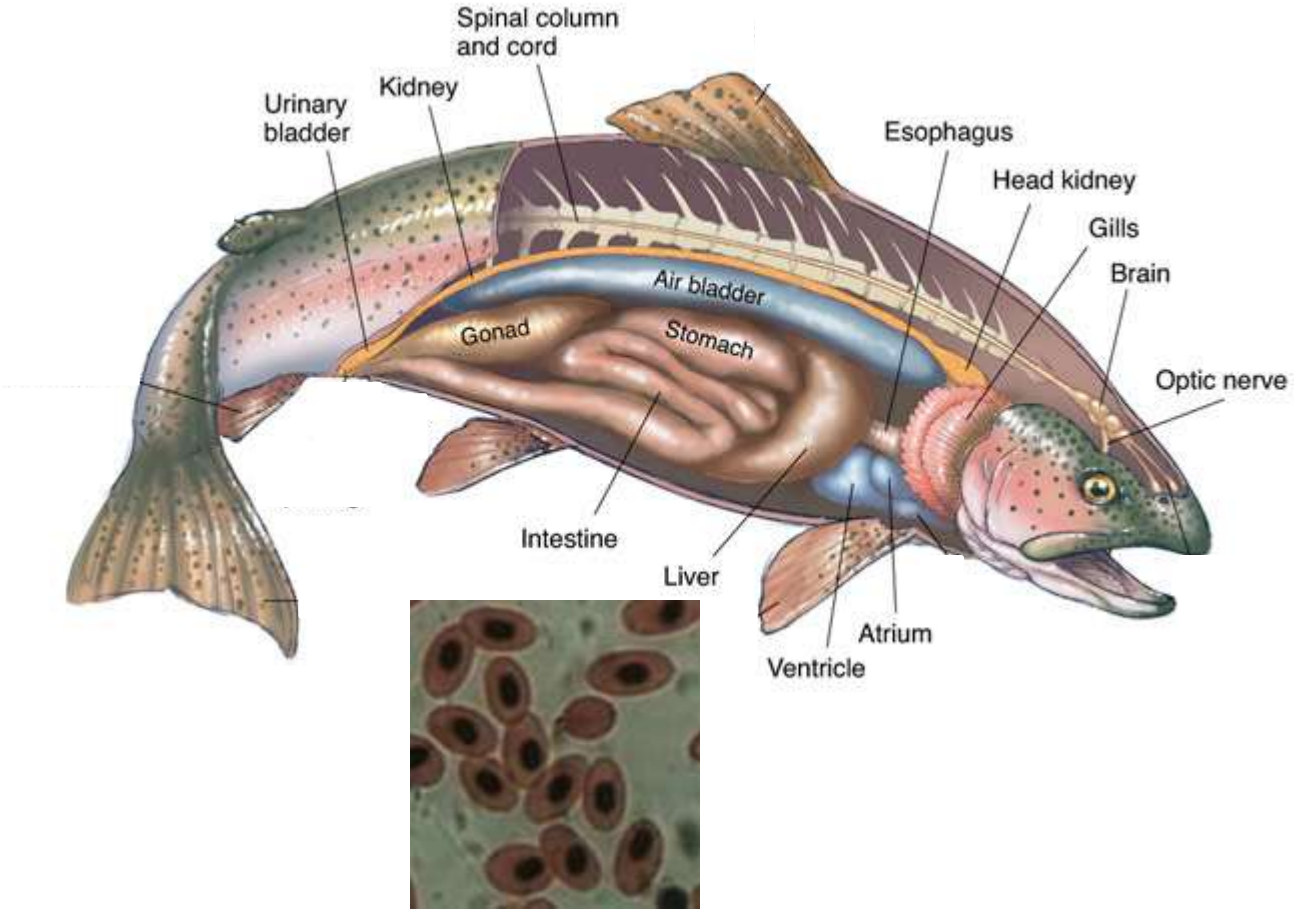
2. **Can we elucidate the underlying physiological and/or biochemical reasons for any differences in performance or tolerance?**

Current Work

Oxygen transport

Energy metabolism



Blood

Current Work

Oxygen transport

Gills

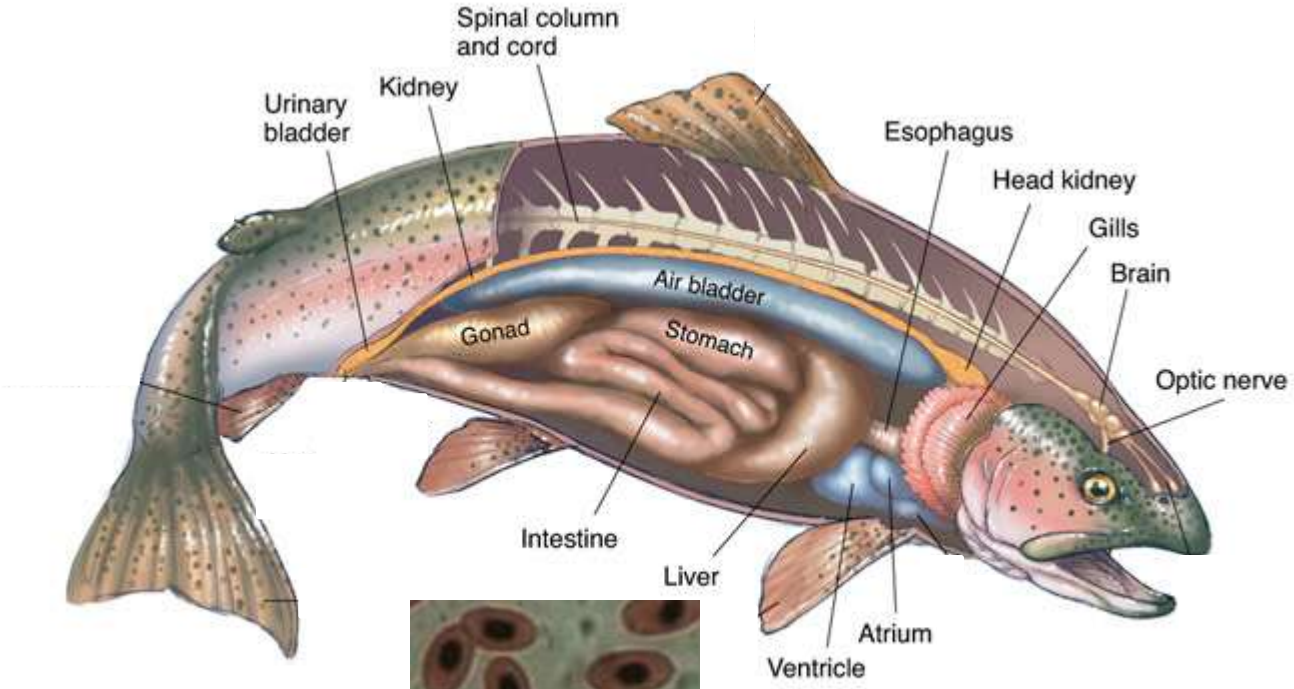
↓

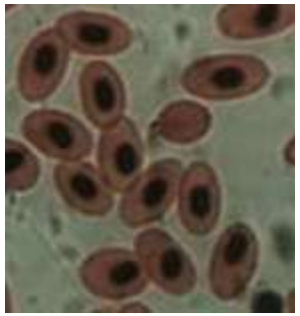
RBCs

↓

Tissues

Energy metabolism





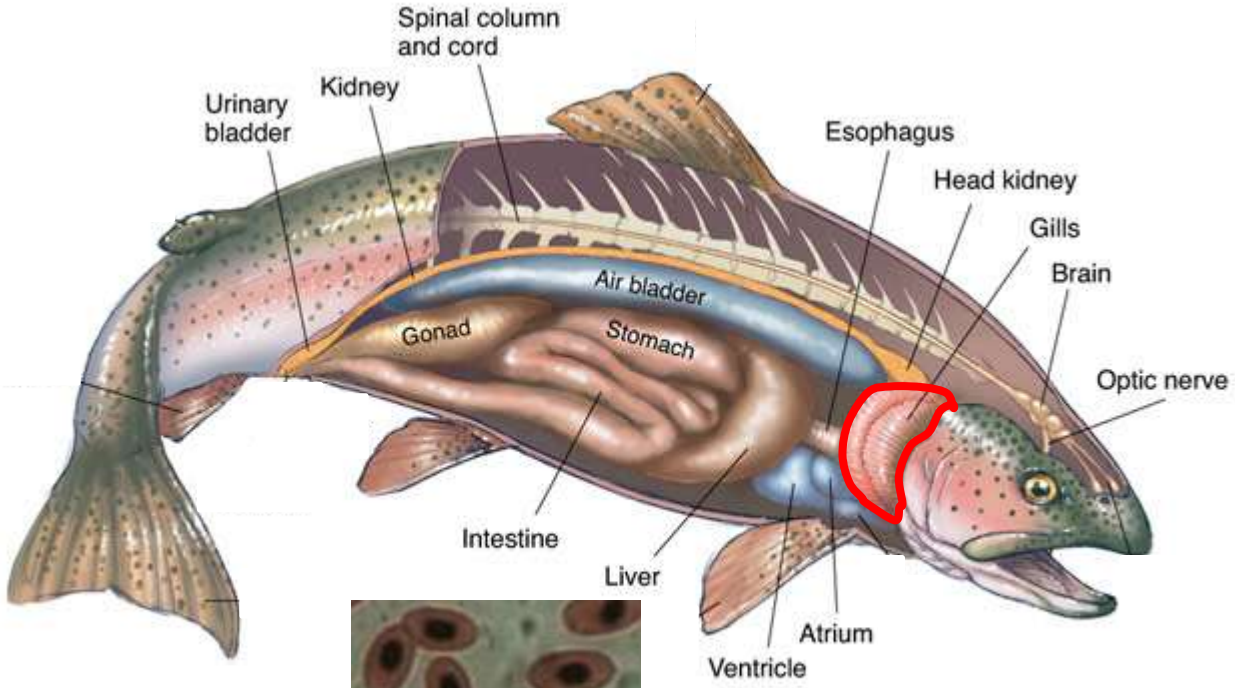
Blood

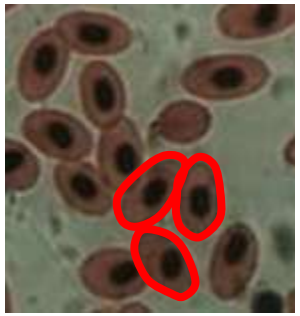
Current Work

Oxygen transport

Gills → RBCs → Tissues

Energy metabolism





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Tissues

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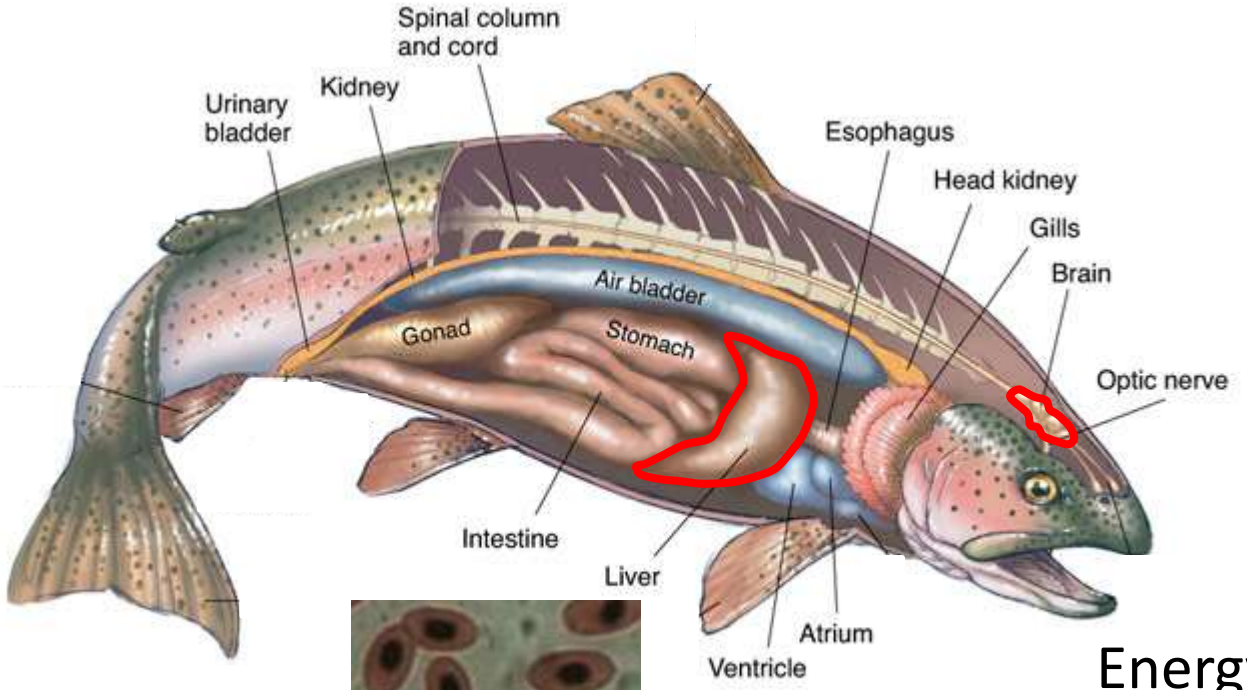

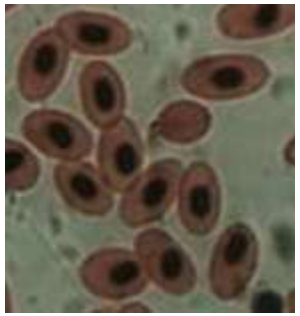

Blood

Energy Stores

Ie/ Glycogen

Energy production

Ie/ ATP

Waste removal

Ie/ Lactate

Research Questions

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2n and 3n rainbow trout differ in hypoxia tolerance

2. Can we elucidate the underlying physiological and/or biochemical reasons for any differences in performance or tolerance?

3. **Do the results from laboratory studies on juvenile hatchery-reared trout match those from lake stocked trout?**

Research Questions

- Swimming
- Temperature
- **Hypoxia**

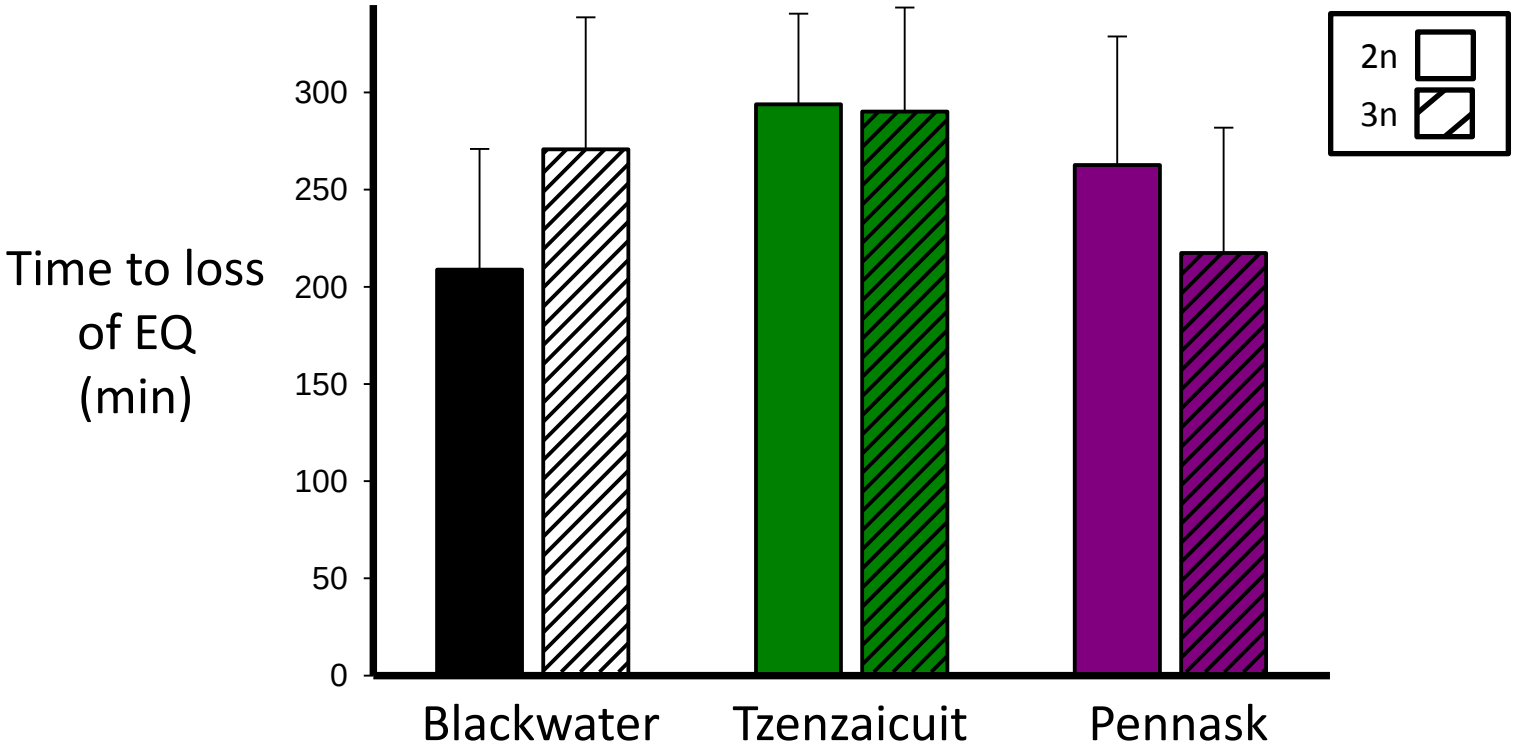
- **Hypoxia**

3. **Do the results from laboratory studies on juvenile hatchery-reared trout match those from lake stocked trout?**

Hypoxia Tolerance (Lake Fish)

LOE – Loss of equilibrium

Time to loss of equilibrium of adults at 12% air saturation (~18 torr)



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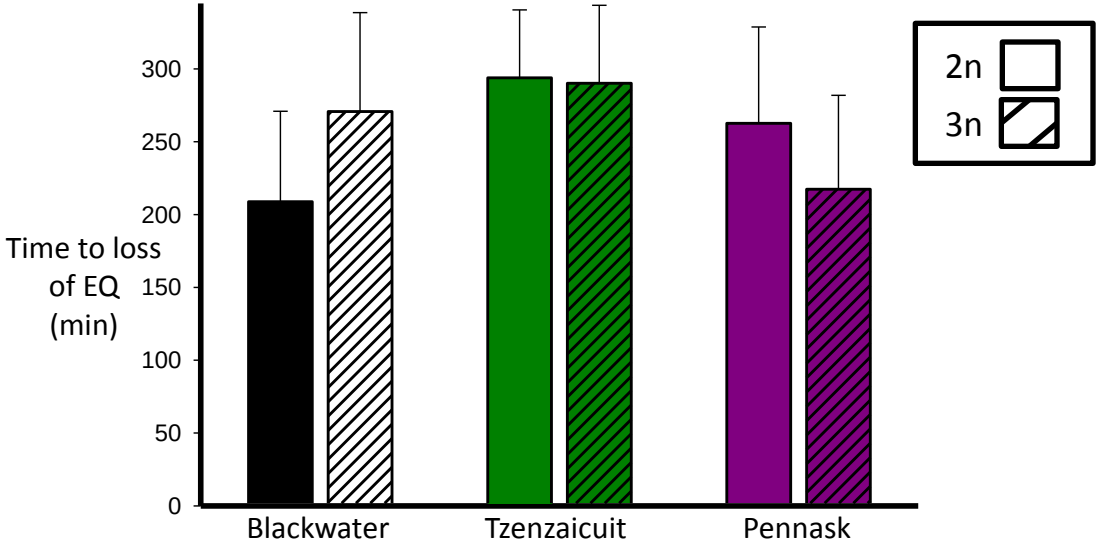

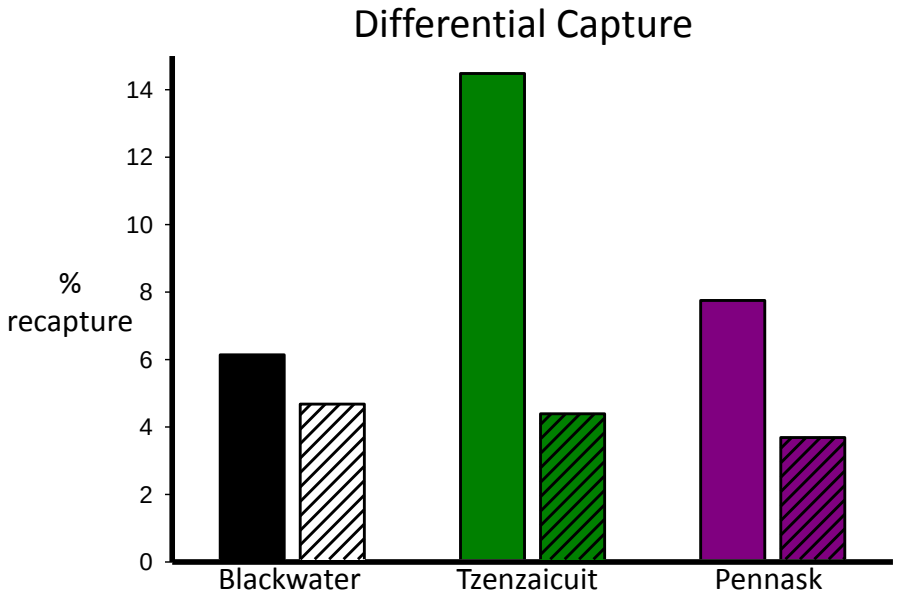

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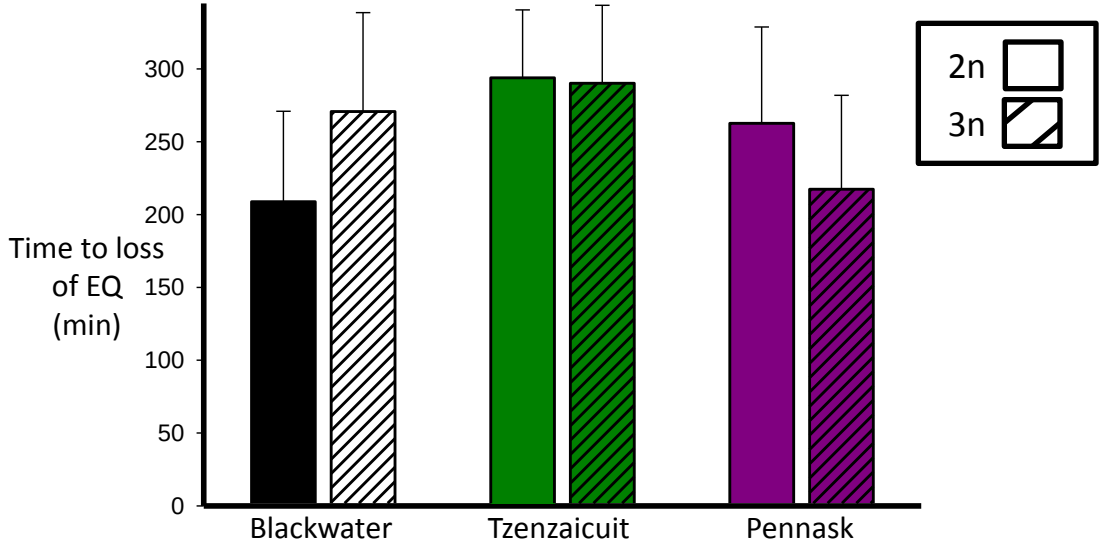

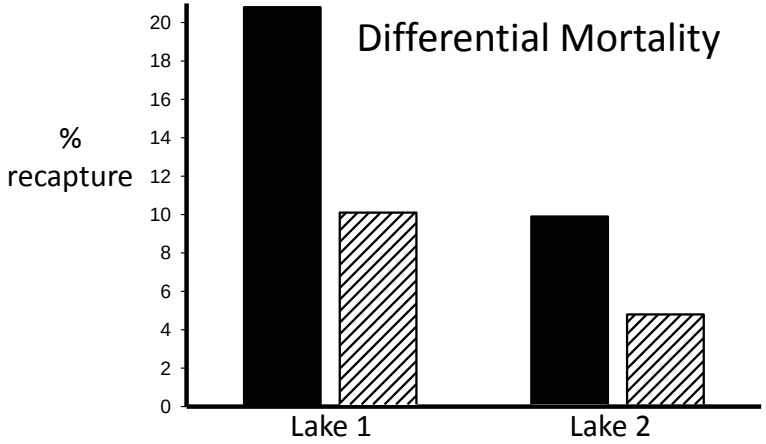

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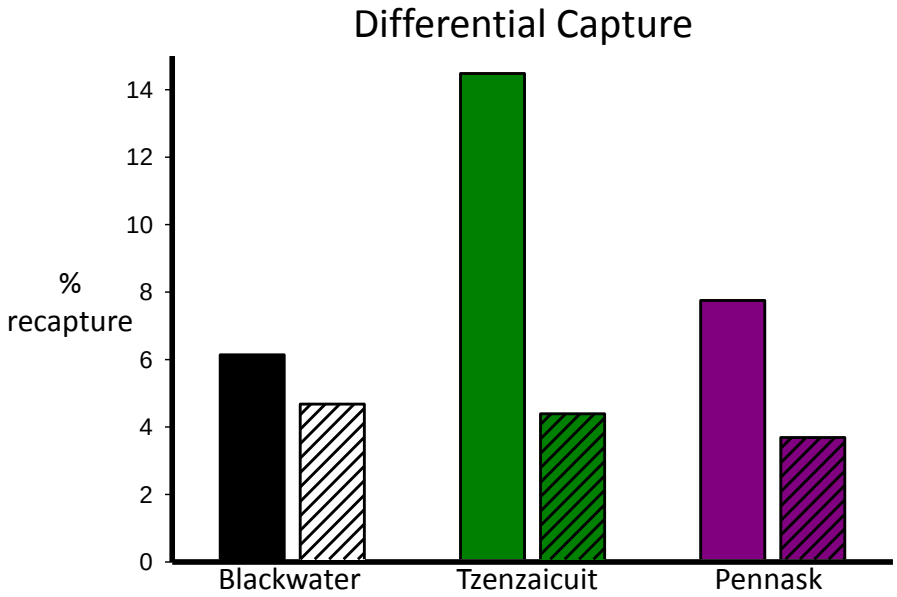


Summary

1. Do 2n and 3n rainbow trout differ in physiological performance or environmental tolerance?

2n and 3n rainbow trout differ in hypoxia tolerance

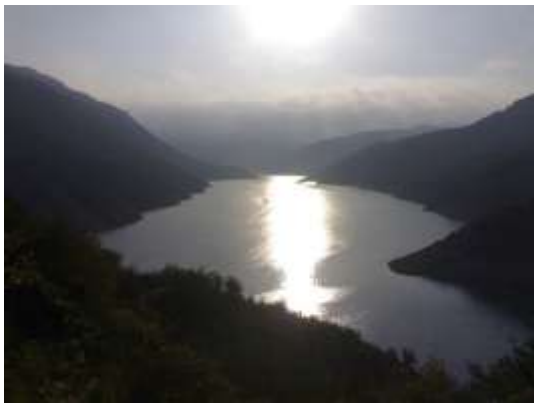
2. Can we elucidate the underlying physiological and/or biochemical reasons for any differences in performance or tolerance?

3. Do the results from laboratory studies on juvenile hatchery-reared trout match those from lake stocked trout?

2n and 3n hatchery-reared trout in the wild do not differ in their hypoxia tolerance

Conclusion

Differential 2n/3n tolerance of hypoxia suggests that environmental oxygen challenges contributes to poorer 3n performance.



Acknowledgements

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Questions?