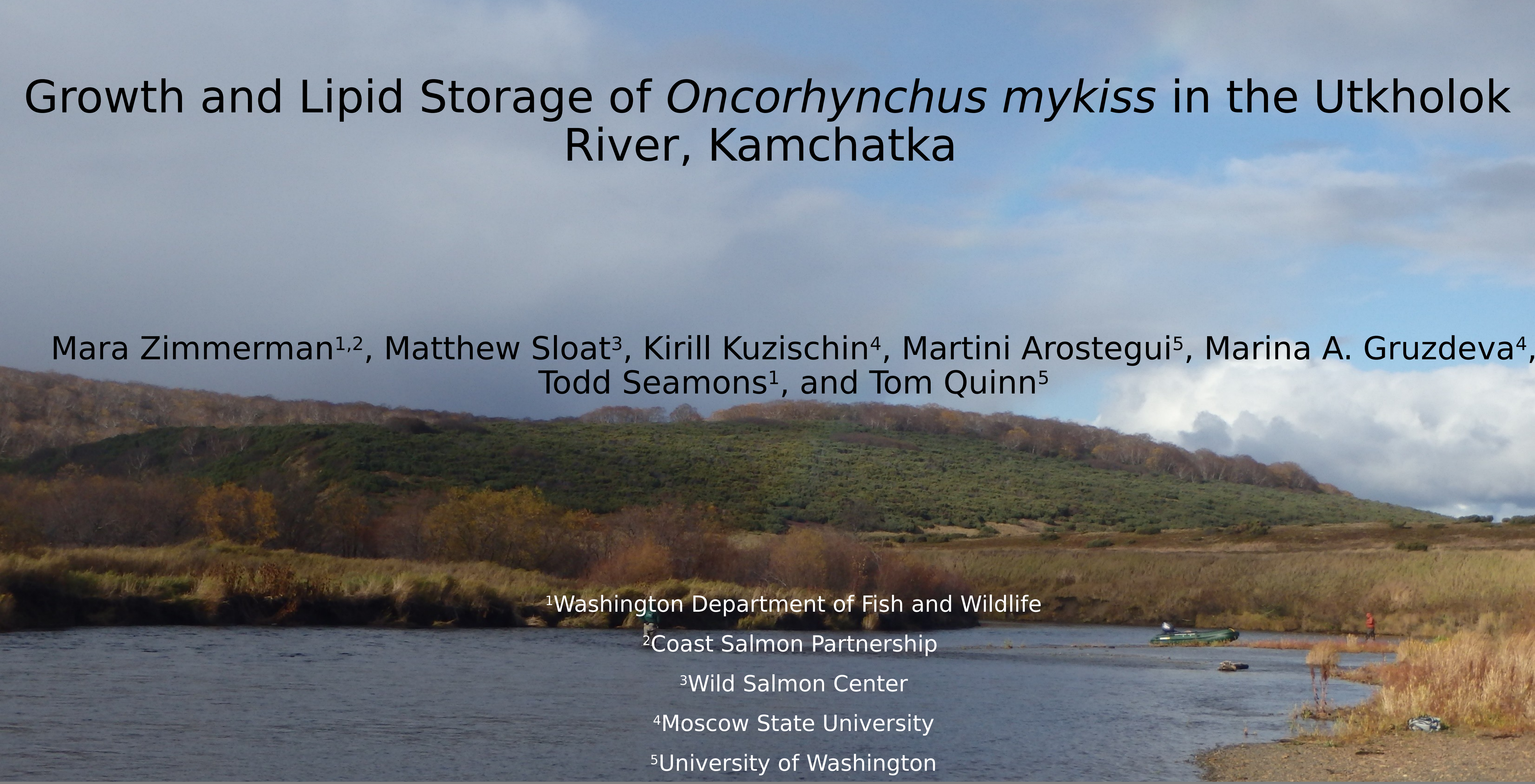
# Growth and Lipid Storage of *Oncorhynchus mykiss* in the Utkholok River, Kamchatka



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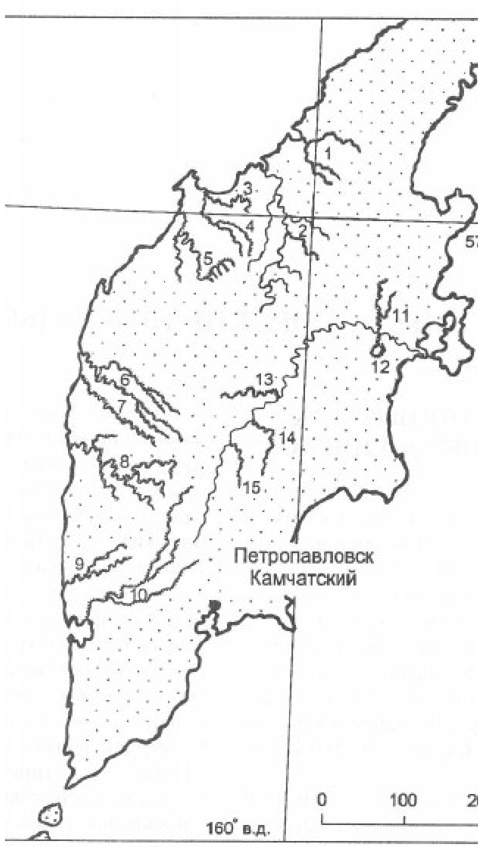
[2]Coast Salmon Partnership

[3]Wild Salmon Center

[4]Moscow State University

[5]University of Washington

2021 Pacific Coast Steelhead Management On-Line Meeting
March 16-18, 2021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# Kamchatka Steelhead Project

Photos provided by P. Soverel

# Partial migration in *O. mykiss* (mykizha)

- Migratory and resident individuals coexisting in the same population

**Anadromous** ⟷ **Resident**

**Typical anadromous**

**Half-pounder/Anadromous B**
Kesner & Barnhardt 192, Savvaitova et al 2005, Hodge et al. 2014

**Estuarine**
Pavlov & Savvaitova 2008, Roloson et al. 2020, Kuzishchin et al. 2020

**Riverine-Estuarine**
Pavlov et al. 2007, Kuzishchin et al. 2020

Slide provided by K. Kuzishchin

Typical anadromous

Riverine

Anadromous B (Half pounder)

Estuarine

Riverine-estuarine

Our primary objective was to examine energy allocation into growth and somatic lipid content among the *O. mykiss* life histories.

- Growth: Life histories with access to more prey resources will grow faster and to a larger size, variation expected among anadromous life histories

- Lipid Storage: Life histories with greater energy needs will store more lipids

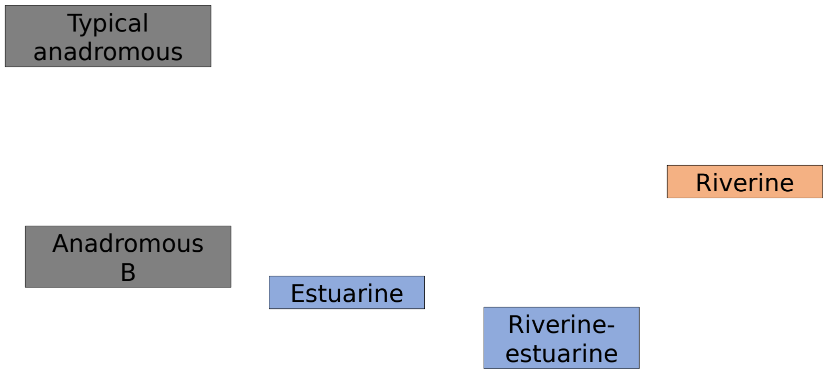
- Lipid Storage: Within each life history, individuals with greater energy needs will store more lipids

# Resources for growth and energy storage vary among *O. mykiss* life histories

| | Ocean<br>Typical anadromous, Anadromous B | Coastal<br>Estuarine, Riverine-estuarine | Freshwater<br>Riverine |
|---|---|---|---|
| Prey resources | ⬆ | ⬆ | ⬆ |

⬆ Resource rich

⬆ Resource limited



# Need to store energy (lipids) varies among life histories (environment) and individuals (state)

Small energy need

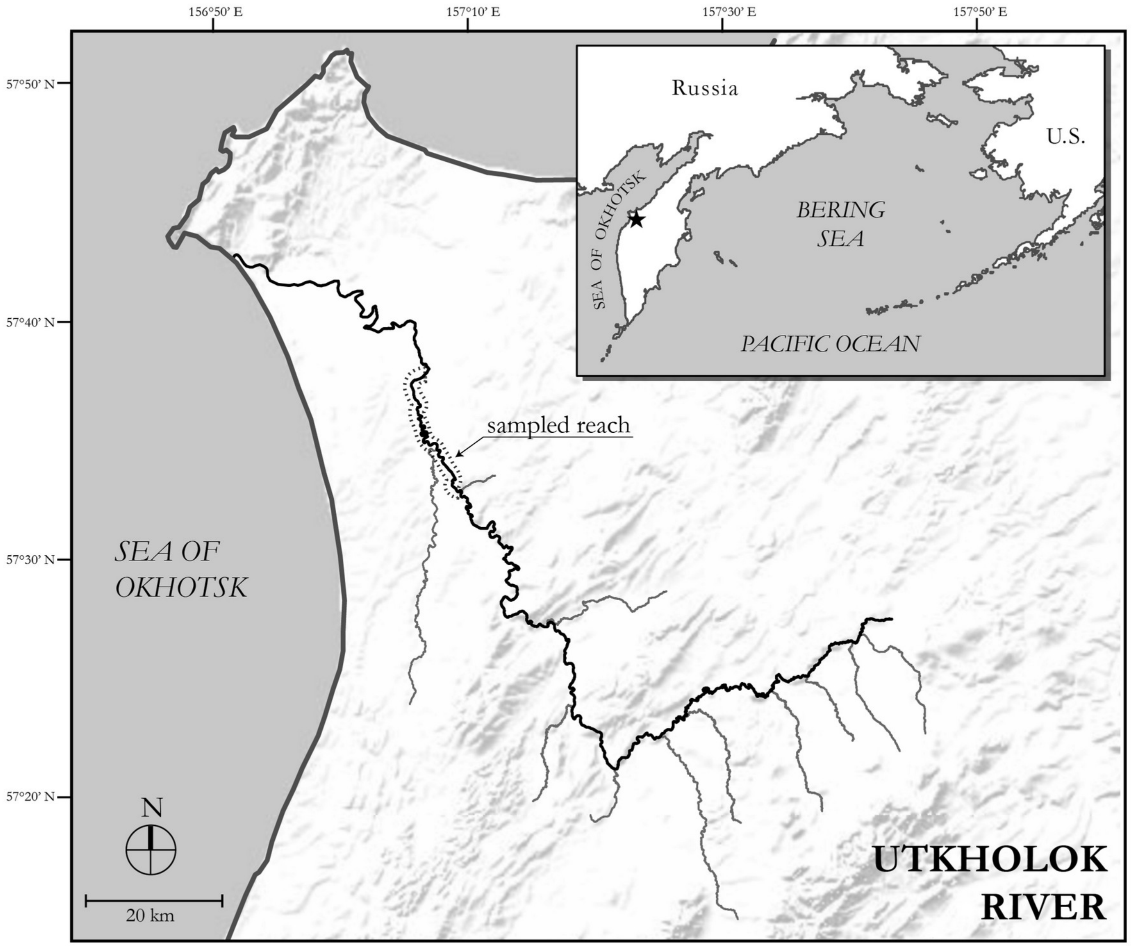
Large energy need

**Environment**

**State**

| | Ocean<br>Typical anadromous, Anadromous B | Coastal<br>Estuarine, Riverine-estuarine | Freshwater<br>Riverine |
|---|---|---|---|
| Migration distance<br>Gilhousen 1980, Crossin et al. 2004 | | | |
| Fasting duration<br>Hearsey & Kinsiger 2014, Lamperth et al. 2017 | **F M** | **F M** | **F M** |
| Reproduction<br>Hendry & Berg 1999, Lamperth et al. 2017 | **S Lg** | **S Lg** | **S Lg** |
| Body size | | | |

# Study area




Map provided by Haley Wagoner, PC Trask & Associates, Inc.

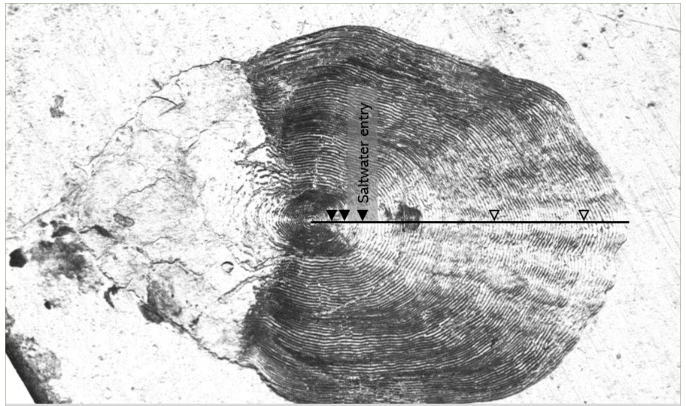
- 1350 $km^2$ basin
- Low gradient (5 m/km)
- Ice covered November – April
- Maximum water temps ~ 0°C in winter, ~ 19°C in summer

# Utkholok River

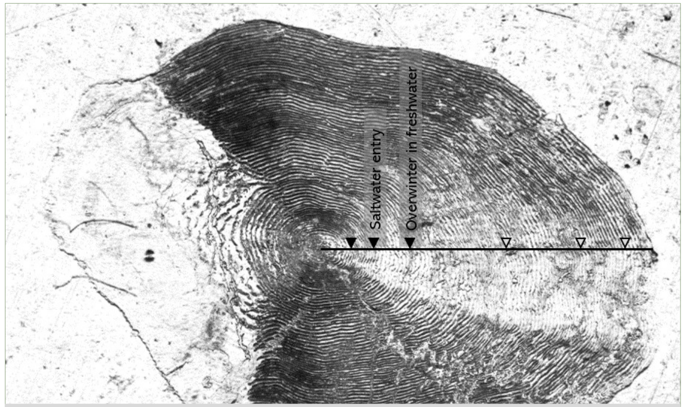
# Sampling

- ❑ Fork length, girth
- ❑ Sex
- ❑ Scales
  - ❑ Age
  - ❑ Life History
  - ❑ Genetics (sex ID)
- ❑ Somatic Lipid Content
- ❑ Photograph

# Age and life history determined from scales

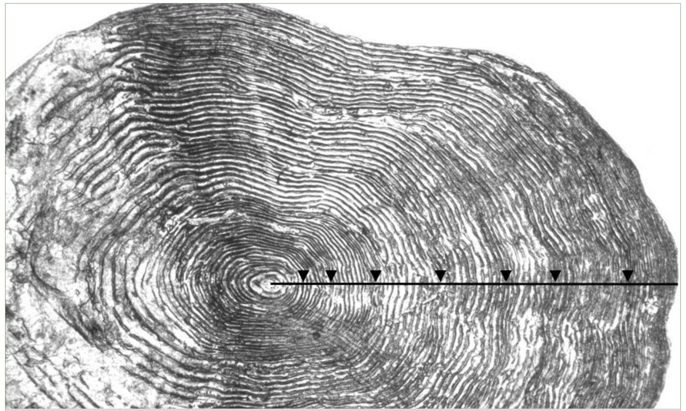


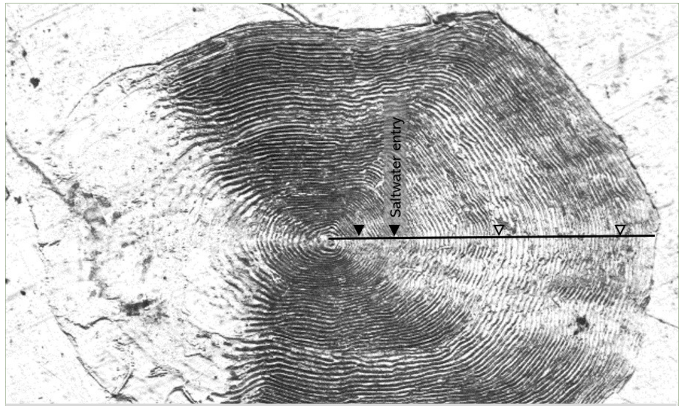
Typical anadromous 3.2+



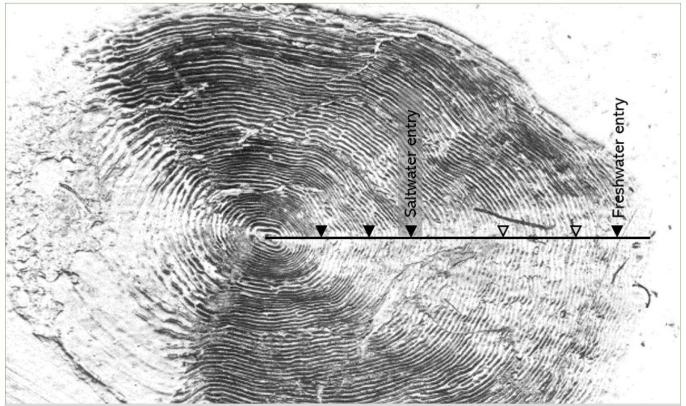
Anadromous B 2.4+

Methodology described in Savvaitova et al. 1999 and Pavlov et al. 2001


Riverine 7+



Estuarine 2.2+



Riverine-Estuarine 3.2.1+

# Analysis

**Growth**

- VonBertalanffy model fit to length-at-age data, estimated growth rate (k) and asymptotic length ($L_\infty$ ), AIC to compare pooled vs. life history specific coefficients

$$L_a = L_\infty * (1 – \exp(-k*(a – t_o)))$$

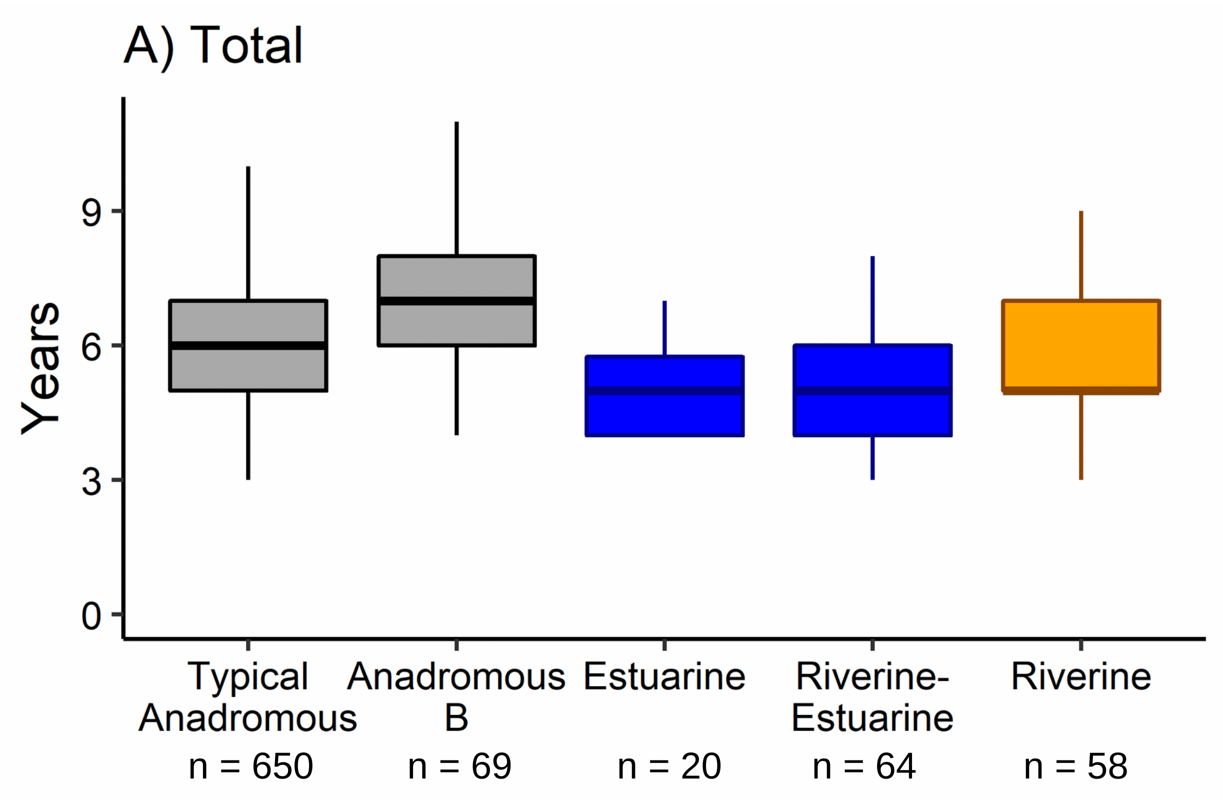
*explored sex and year as random effects, dropped*

**Somatic Lipid Content**

- Beta regression, AIC to forward select covariates and interactions

Lipids ~ LifeHistory*Sex*TotalAge

# Age composition among *O. mykiss* life histories



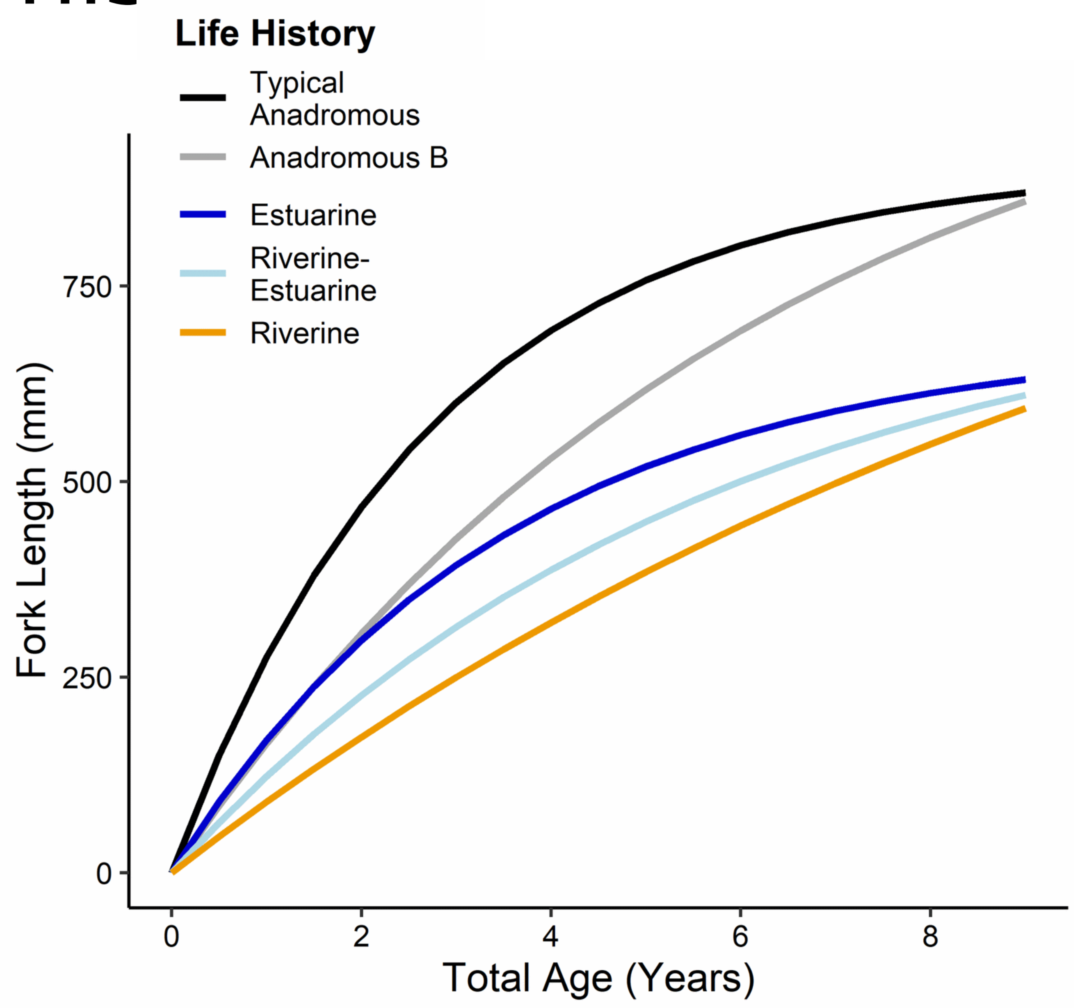

55 combinations (fresh & saltwater ages)

Total age 3 – 11 years

Freshwater
- 2 – 5 years (anadromous)
- 3 – 9 years (riverine)

Saltwater 1 – 8 years

# Growth rates differ among *O. mykiss* life histories




## Oceanic
- TA: fast growth, large body
- AB: moderate growth, large body
- High proportion female (~60%)

## Coastal
- E: fast growth, small body
- RE: moderate growth, small body
- High proportion male (~56-78%)

## Freshwater
- R: slow growth, small body
- High proportion male (78%)

# Somatic Lipid Content

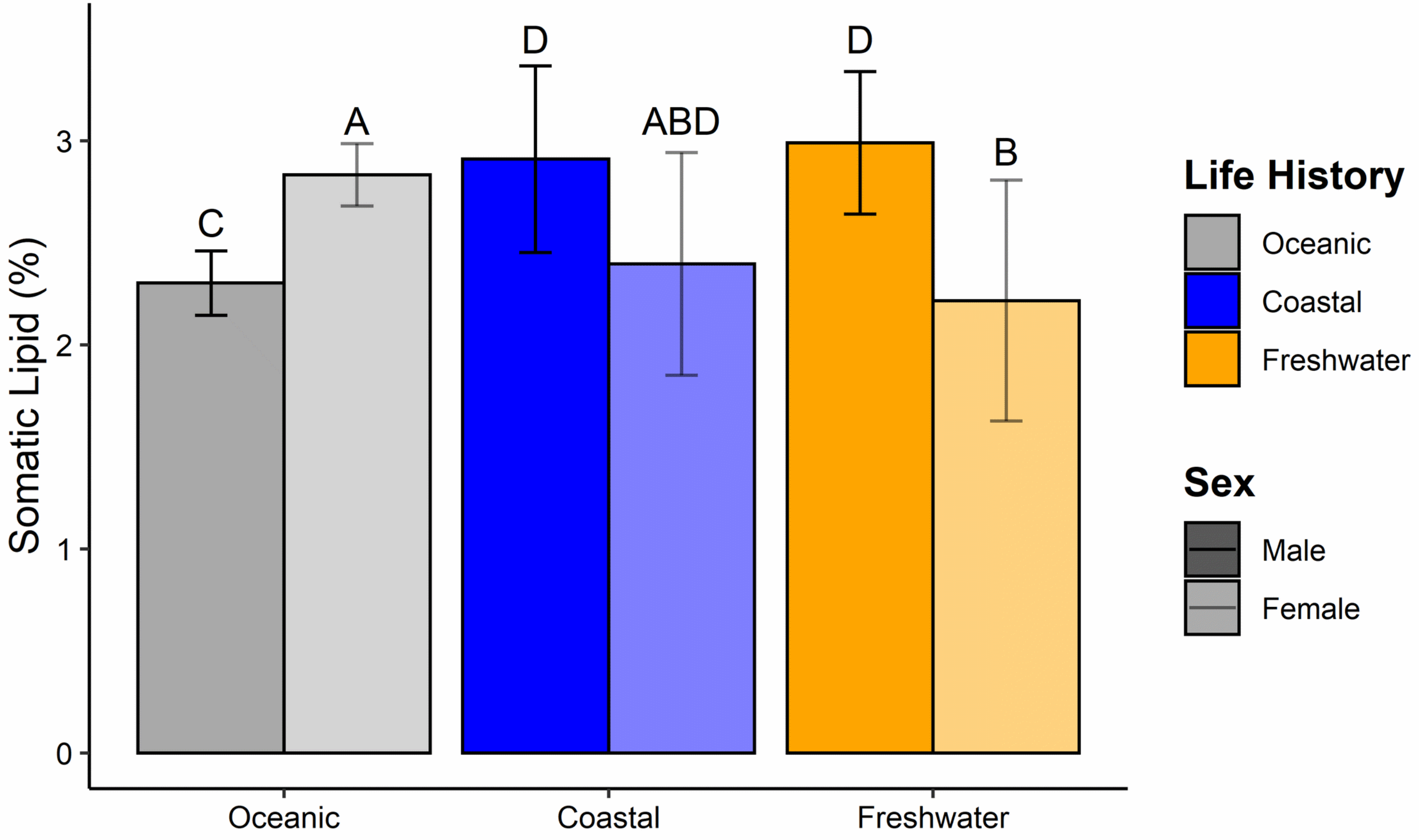
2.5% ± 0.78 one SE (range 0.66 - 4.9%)

Data grouped into oceanic, coastal, freshwater due to low sample sizes

Lipids ~ Intercept + Life History + Sex + Age + Life History*Sex + Life History*A

AICc weight 0.90

# Somatic Lipid Content: Life History * Sex

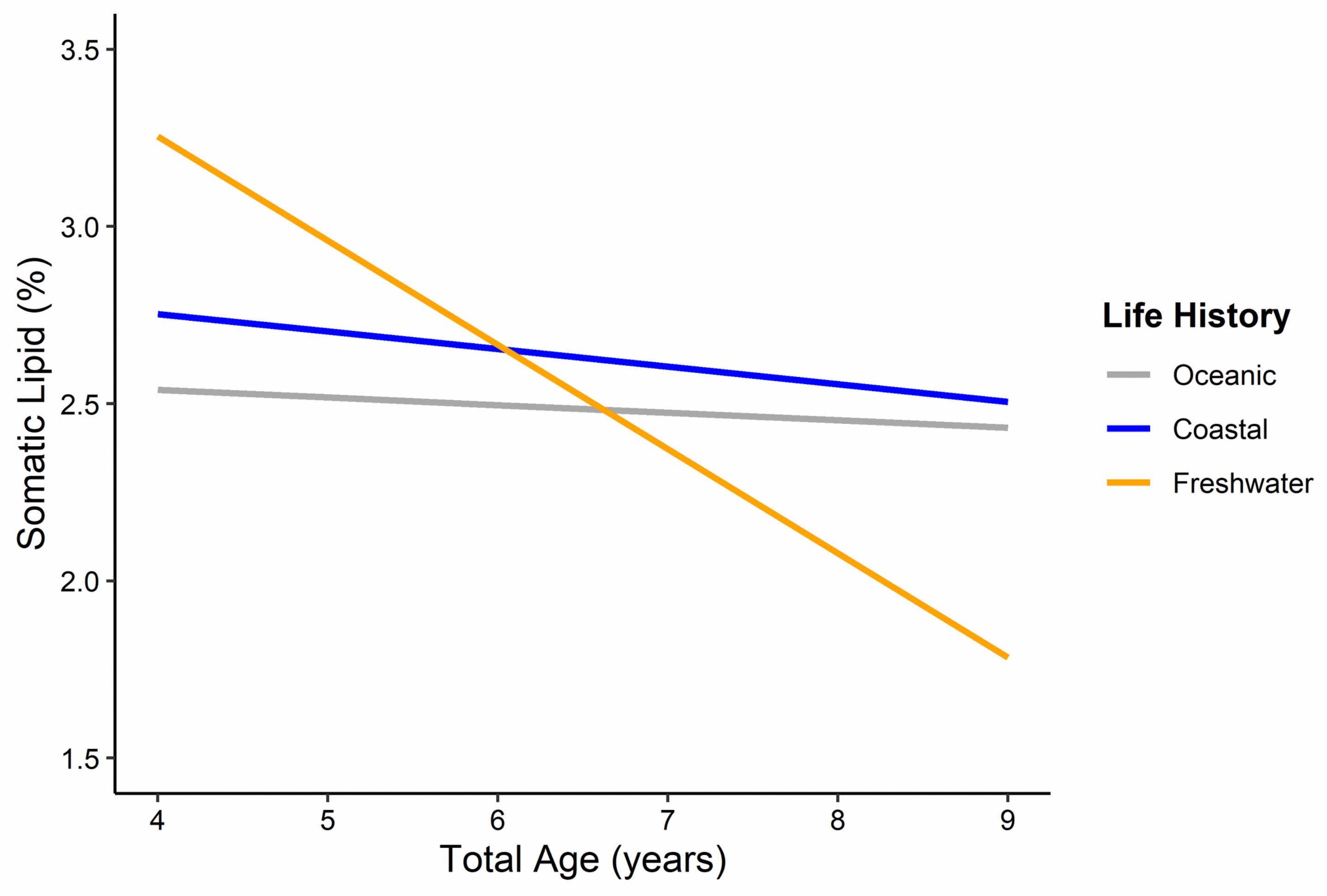



**Oceanic**
Female > Male

**Coastal**
Male > Female (n.s.)

**Freshwater**
Male > Female

# Somatic Lipid Content: Life History * Age




**Oceanic**
Young ~ Old

**Coastal**
Young ~ Old

**Freshwater**
Young > Old

# Summary #1

- Growth rate can be explained by the (assumed) resource richness of growth environments associated with each life history.
- Large body size associated with the ocean growth environment.
- Growth rates were distinct to each life histories and results in a wide range of sizes in the younger age classes.
  - Perhaps related to the amount of time spent feeding in more resource rich (saltwater) environments.

# Summary #2

- Lipid storage can not be explained by future energy needs alone.

- Females store more lipids in resource-rich environments.
  - *Why not in resource-limited environments?* Perhaps not enough energy intake to provide for storage.

- Males store more lipids in the resource-moderate or limited environments.
  - *Why not in resource-rich environments?* Lipids are expensive! Perhaps larger body size in resource-rich environment reduces lipid storage needed to meet energetic demands.

# What does this have to do with steelhead management?

- Numbers…
- Abundance and diversity are connected
- Understanding what maintains diversity and how this changes over time helps us look at management in a new light.
- Every population is different. Understand what is possible in an environment that has been minimally altered.

# Many thanks to…

- The Conservation Angler
- Russian Academy of Sciences
- Moscow State University
- WA Dept of Fish and Wildlife
- Wild Salmon Center
- The Fly Shop (Redding, CA)
- Angler sponsors
- Haley Wagoner, PC Trask & Associates, Inc.

Photo provided by S. Pettit

Since 1994, The Conservation Angler has supported the study and conservation of the richest diversity of salmon, trout, steelhead and char in the world, all on Russia's Kamchatka Peninsula. This work is done in cooperation with A.N. Severtsov Institute of Ecology and Evolution of the Russian Academy of Science and Moscow State University.
Samples were collected with a scientific research permit obtained under the US-Russia Agreement on the Environment.


Questions? Comments?
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