# Size Matters: Small Deschutes River Smolts Out Perform Big Smolts

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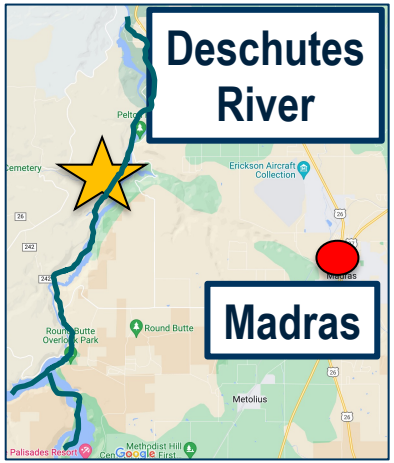
Funding – BPA
Project # 1988-053-03

# Overview

- Background - Dina
- Methods - Dina
- Results - Dina
  - Juvenile – Dina/Deb
  - Adult - Deb
- Conclusions - Deb

# Round Butte Hatchery & Pelton Ladder

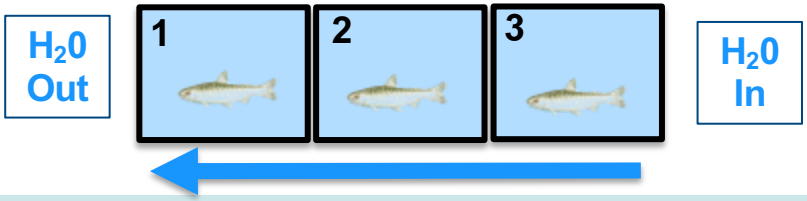
## Location




## Deschutes Spring Chinook

## Round Butte Hatchery

## Pelton Ladder



# Spring Chinook Program Challenges

- Declining returns
- High minijack rates
- Skewed age class (jacks)
- Disease
- Water quality/quantity
- Aging infrastructure

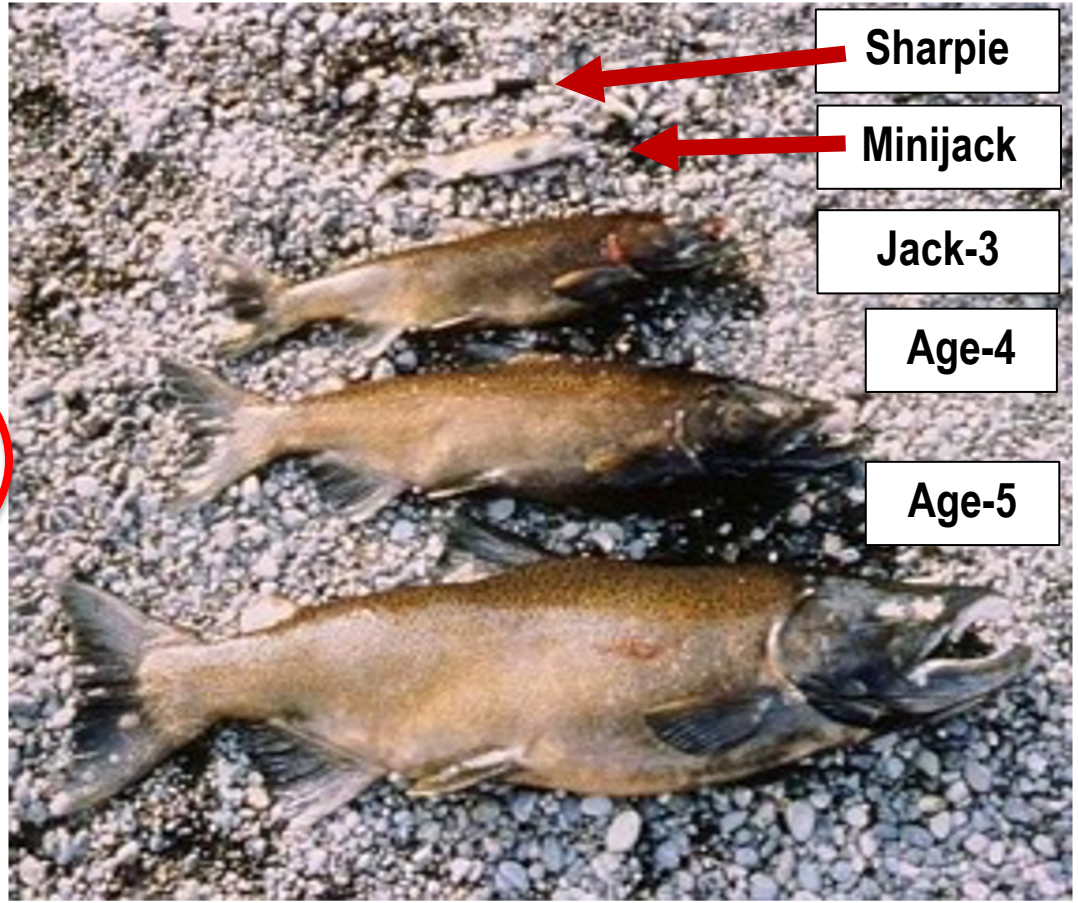
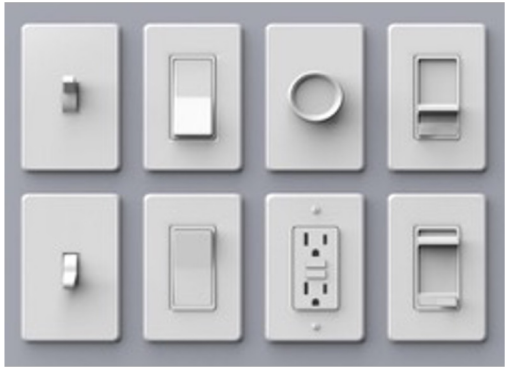



Photo: Andy Dittman

# Reducing Size at Release to Decrease Minijack Production & Improve Adult Returns



Transactions of the American Fisheries Society

Article

The Effects of Variation in Rearing Conditions on Growth, Smolt Development, and Minijack Rate in Yearling Chinook Salmon: a Hatchery Scale Experiment

Dina Spangenberg, Donald A. Larsen ✉, Ryan Gerstenberger, Chris Brun, Brian R. Beckman

First published: 20 August 2014 | https://doi.org/10.1080/00028487.2014.931304 | Citations: 14

Transactions of the American Fisheries Society

ARTICLE

The effect of reducing dietary lipid and food availability on precocious male maturation in Chinook Salmon: A production-scale hatchery experiment

Deborah L. Harstad ✉, Donald A. Larsen, Lance Clarke, Dina K. Spangenberg, Robert Hogg, Brett Requa, Brian R. Beckman

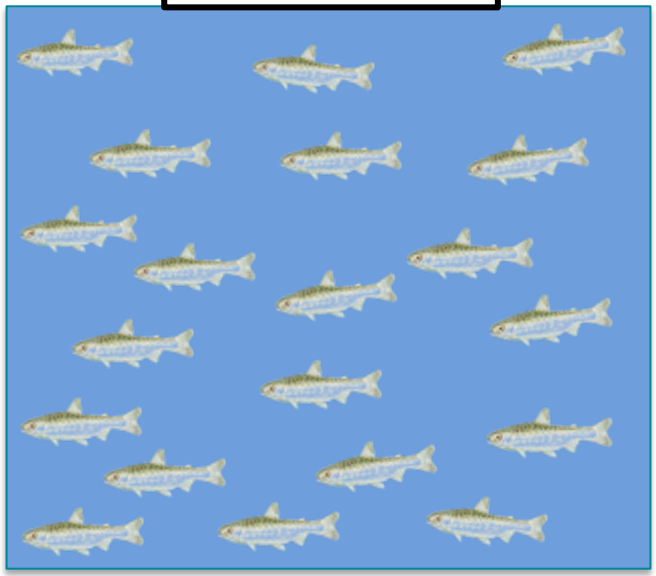
# Experimental Design

| Standard Rearing Protocol | Two Treatment Groups: ‘Bigs’ 1 Group | | ‘Smalls’ 2 Groups |
|---|---|---|---|
| Fish Size Fish per pound | 8 FPP (56.7 g) | > | 15 FPP (30.2 g) |
| Fish/Raceway | ~80-90 K | < | ~130-150 K |
| Fish Density (total biomass) | ~10,000 lbs | = | ~10,000 lbs |

# Visualizing the Experiment

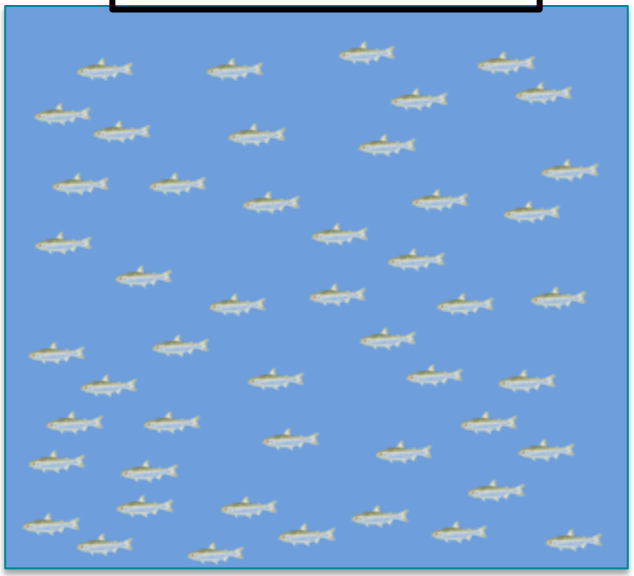
**biomass/densities = biomass/densities**

**Bigs/Less**



**?**

**Smalls/More**



# Sampling Protocol and Data Collection

## Sampling Time Points

- Multiple brood years 2015-2020 (RY2017-2022)
- Multiple sampling points (Oct-April)

## Size & Energetic Indices:

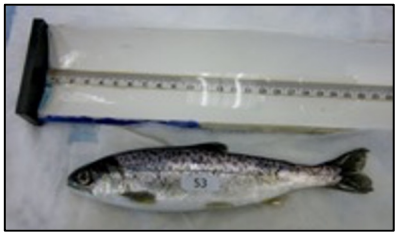
- Size (length & weight)
- Condition Factor
- "% Lipid" – (wet/dry weights)

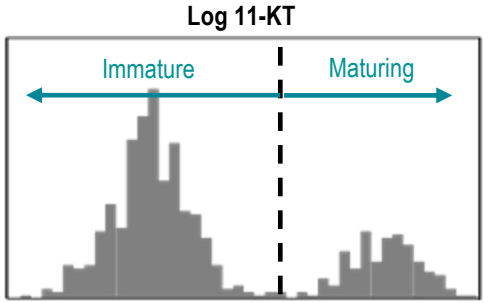
## Smoltification:

- Gill Na+/K+ ATPase

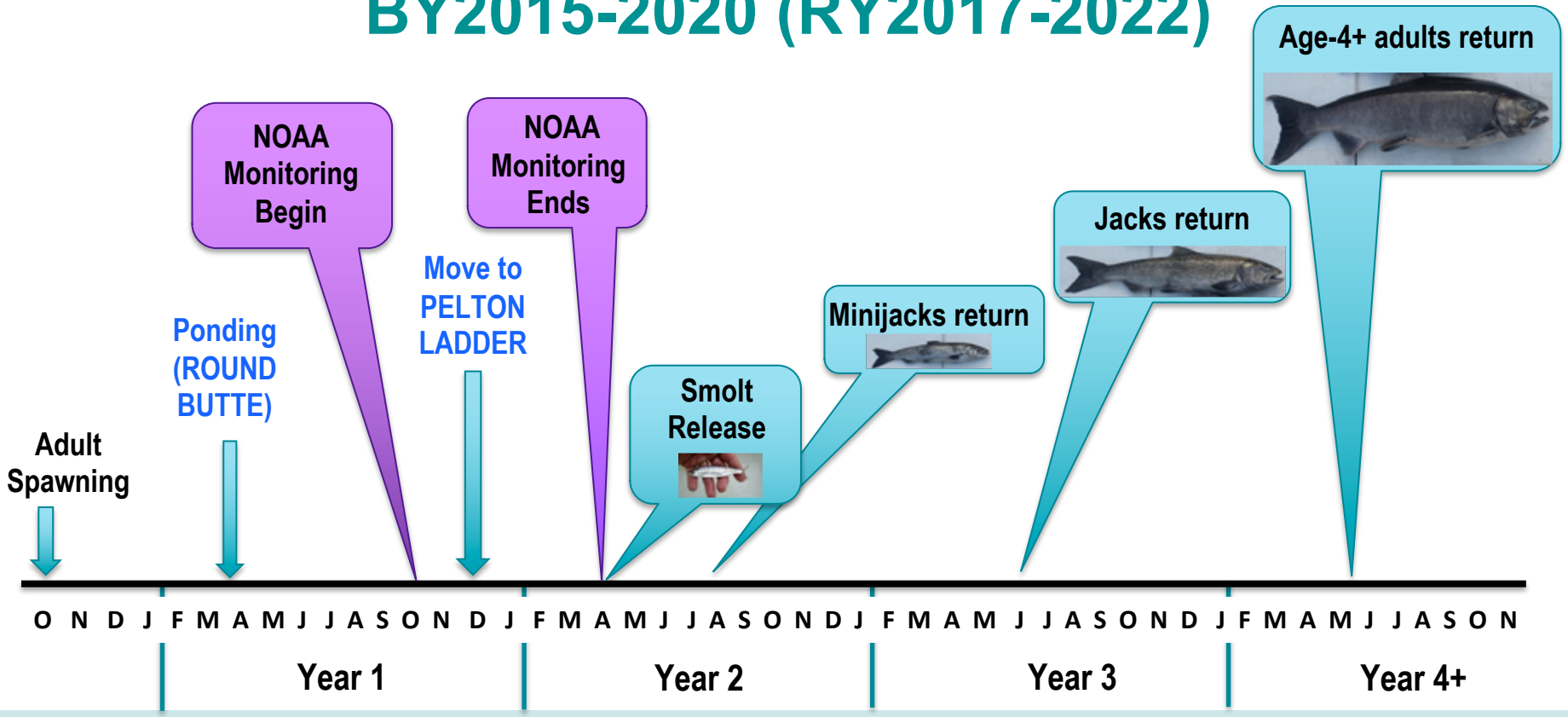
## Male Maturation:

- 11-Ketotestosterone (11-KT) – hormone; indicator of maturation (N=~150)





# Review: Experiment Timeline
# BY2015-2020 (RY2017-2022)



# Overview

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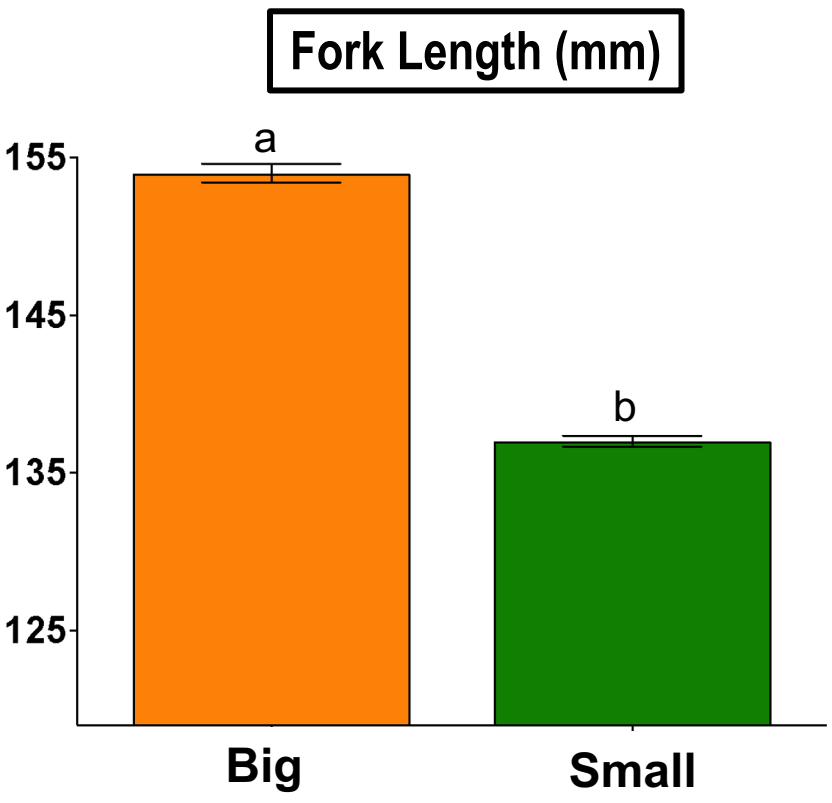
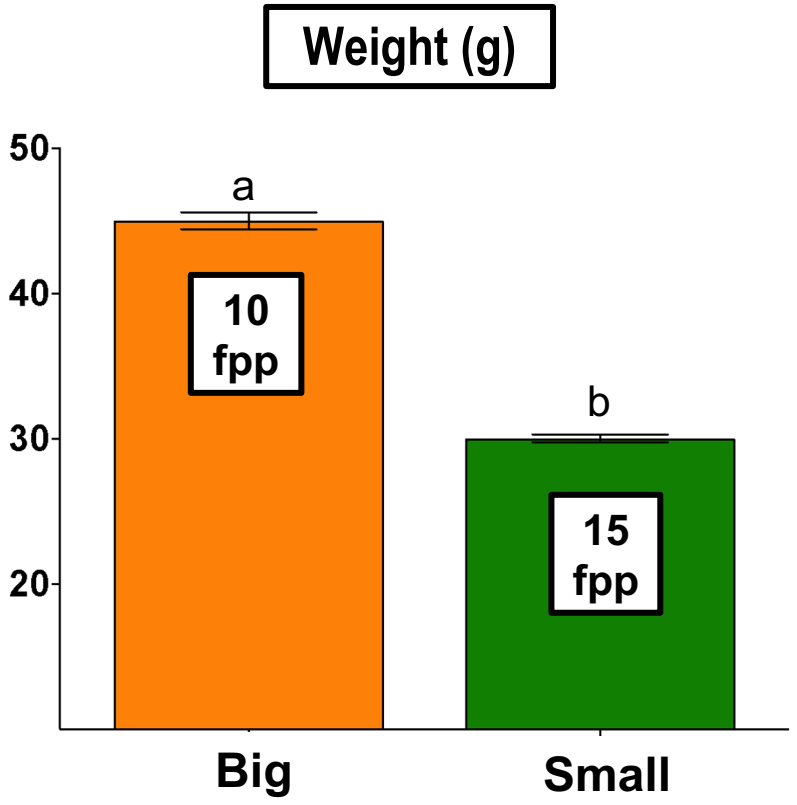
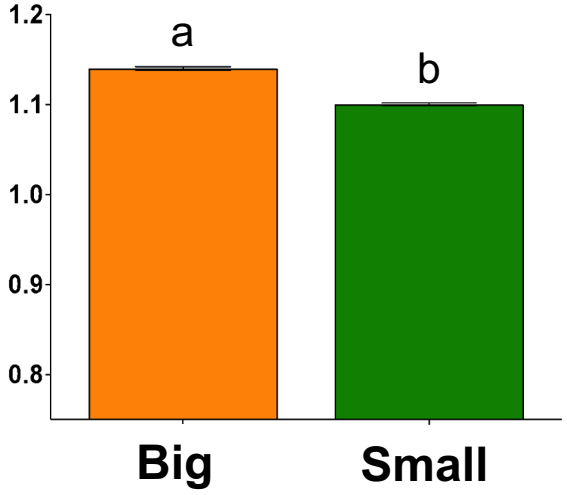
# At Release, Smalls Are Smaller than Bigs



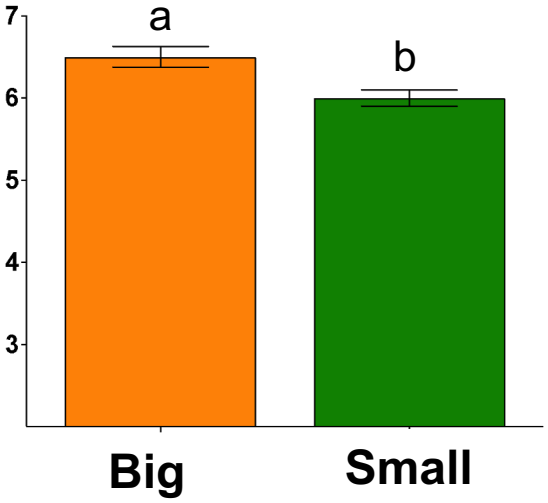



# Smalls Have Similar Energetics and Smolt Development to Bigs

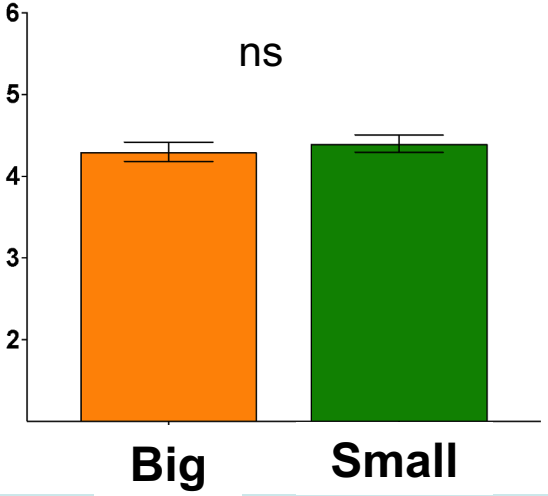
**Condition Factor**



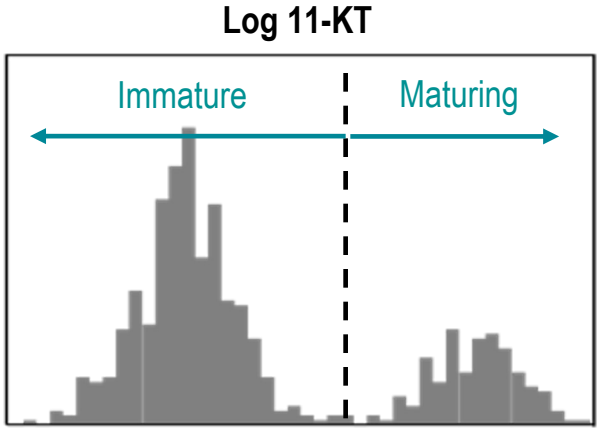

**% Lipid**

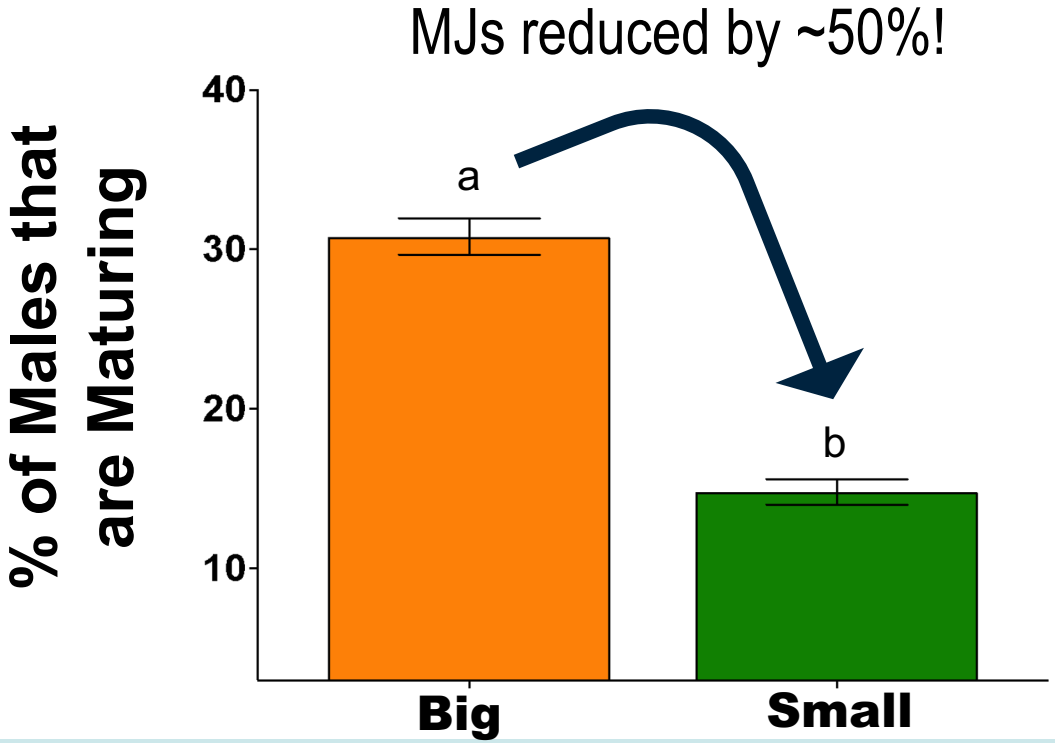



**Smolt Development**



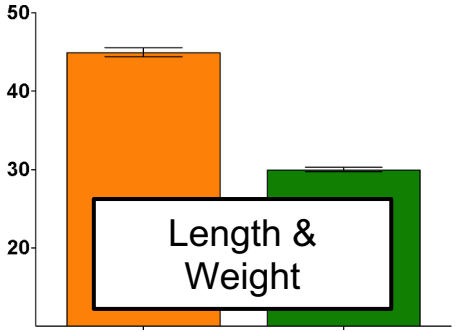
# At Release, Small Group Has Fewer Minijacks



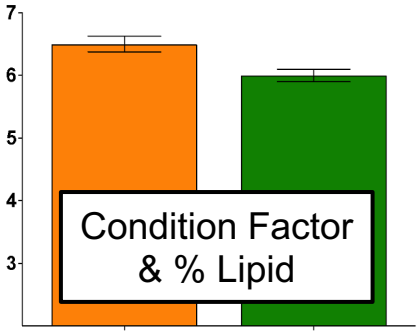



# Smaller Smolts Reared at a Higher Abundance Do Not Appear to be Physiologically Compromised

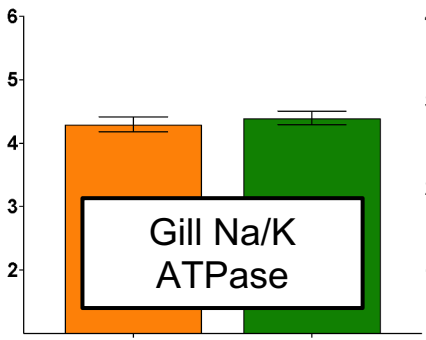
**Size**
**Bigs > Smalls**



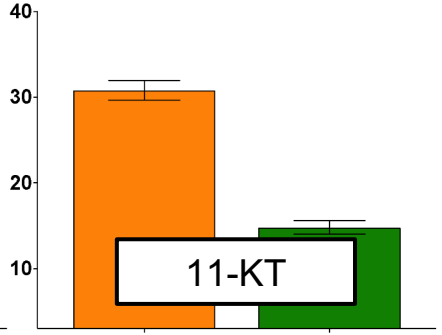

**Energetics**
**Bigs = Smalls**




**Smolt Development**
**Bigs = Smalls**




**Minijacks**
**Bigs > Smalls**



# What Does This Mean Once Fish Are Released?

# Post Smolt Release

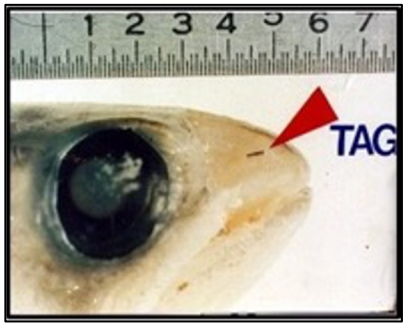
## 1. Passive Integrated Transponder (PIT)

~ 5000

**Smolt Outmigration:**

- Travel time
- Smolt survival

## 2. Coded Wire (CWT)

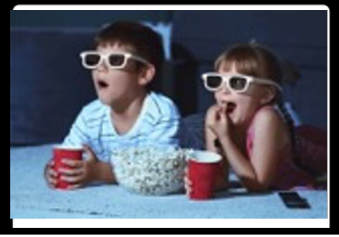



55K – 95K

**Adult Returns:**

- Estimate survival
- Age at recovery

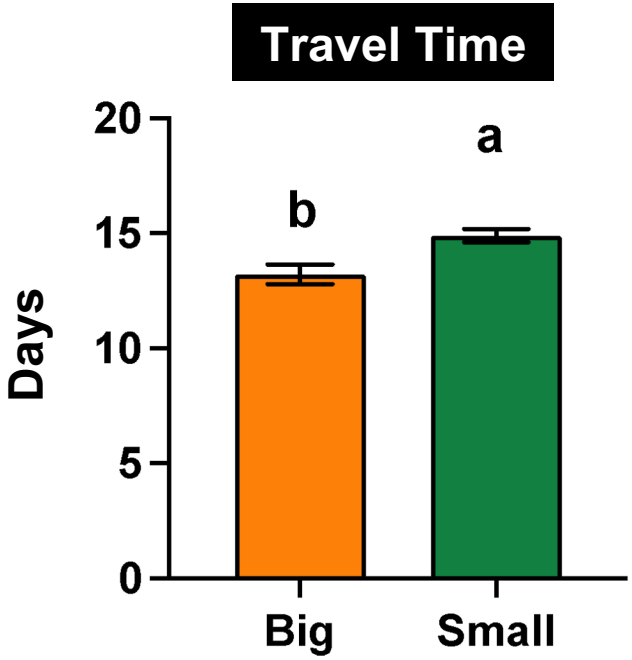
# Smolt Outmigration

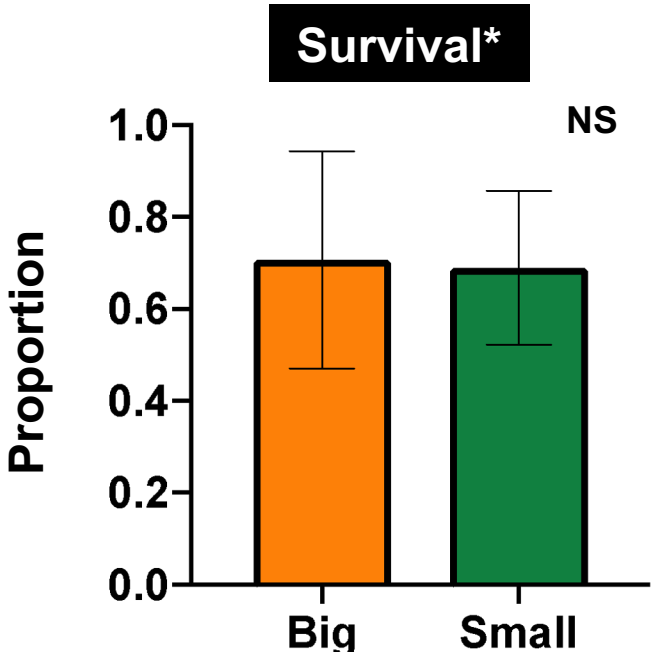


Deschutes River

Bonneville Dam

# Smolt Outmigration to Bonneville: Does size matter?




*Cormack Jolly Seber

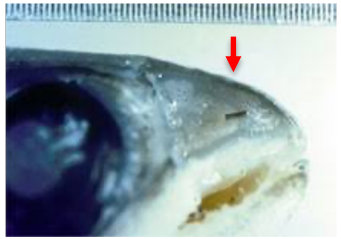
Data presented is model output from linear regression models

# Adult Returns*

*Data presented are through Release Year (RY) 2021

# CWT data is **incomplete.**
# So far it correlates with PIT tag returns.

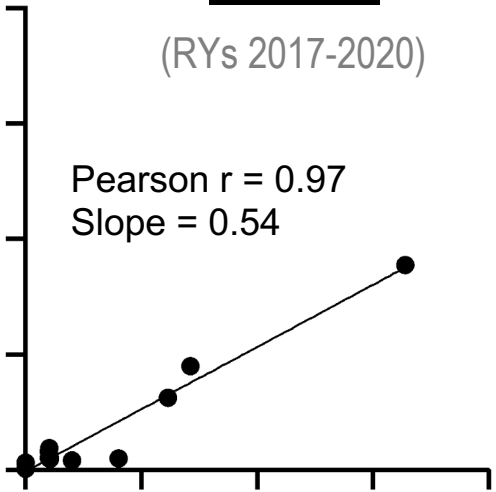
**CWT**



**Age 3**

(RYs 2017-2020)

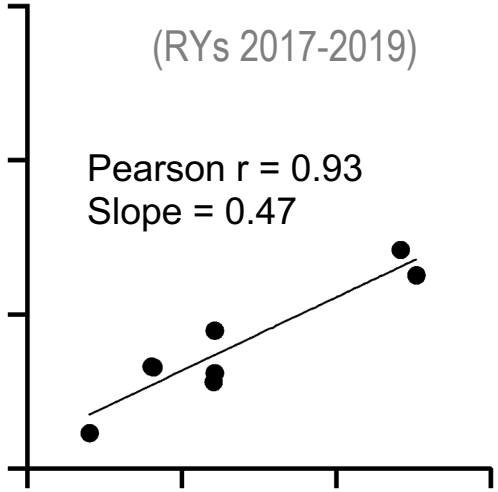
Pearson r = 0.97
Slope = 0.54



**Age 4**

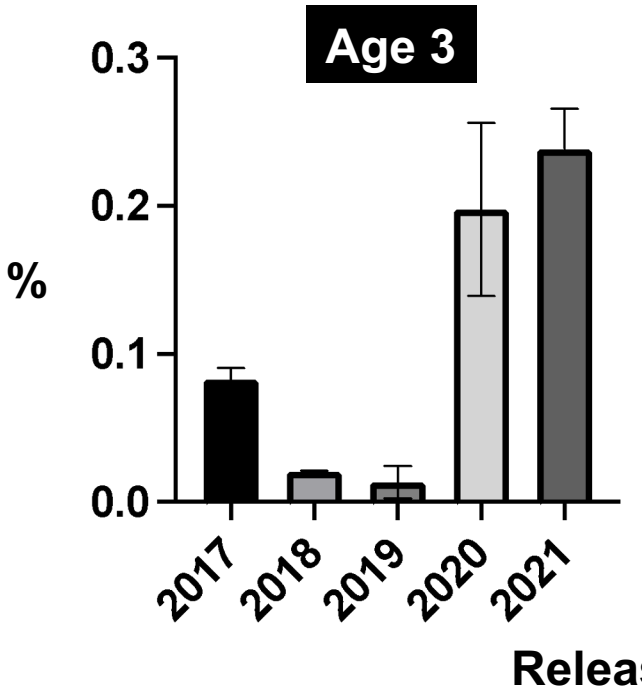
(RYs 2017-2019)

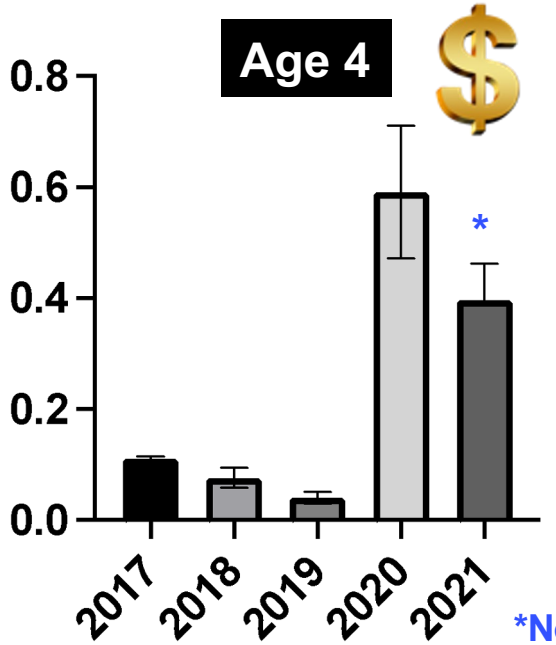
Pearson r = 0.93
Slope = 0.47



**PIT**

# **Release Year** had a strong effect on adult returns




Age 5

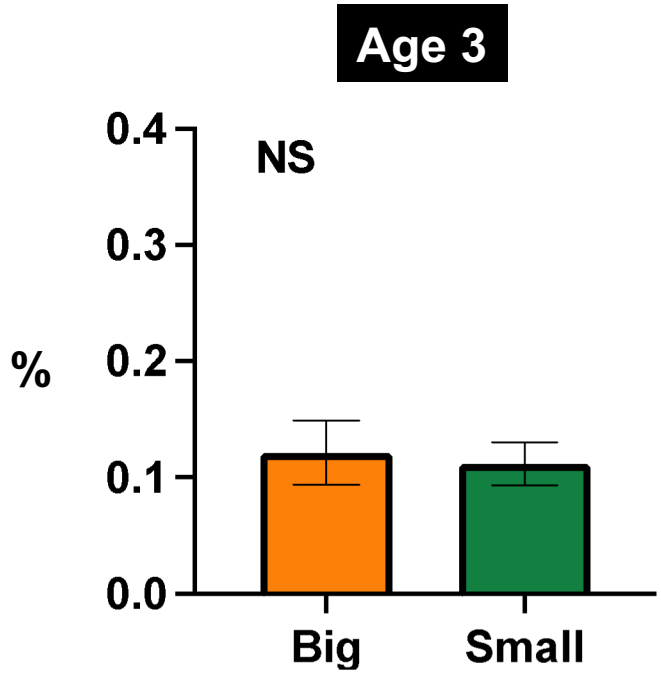
**We did not have ANY Age 5 returns !!**

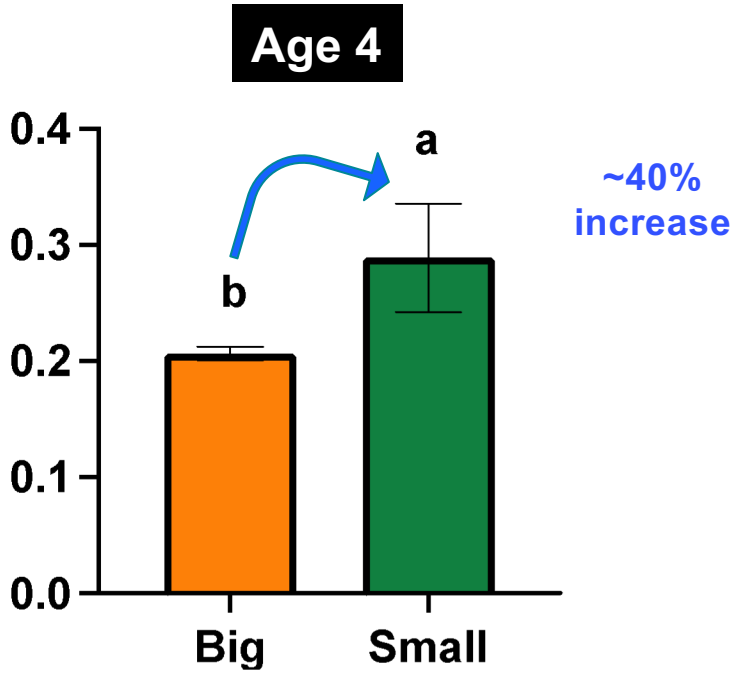
(RYs 2017-2020)

***Not yet complete**
**(6 June 2023 query)**

Data presented is model output from fractional regression models

# Does rearing smaller fish change adult returns?

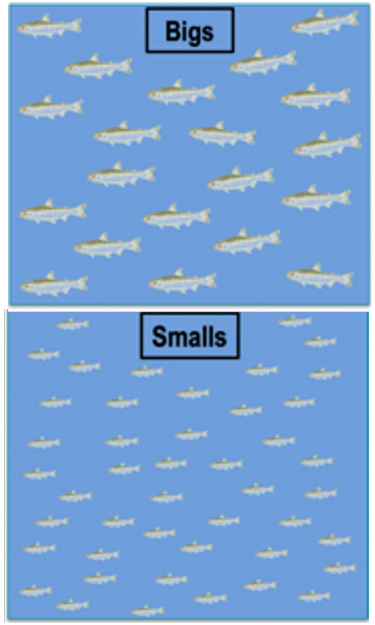


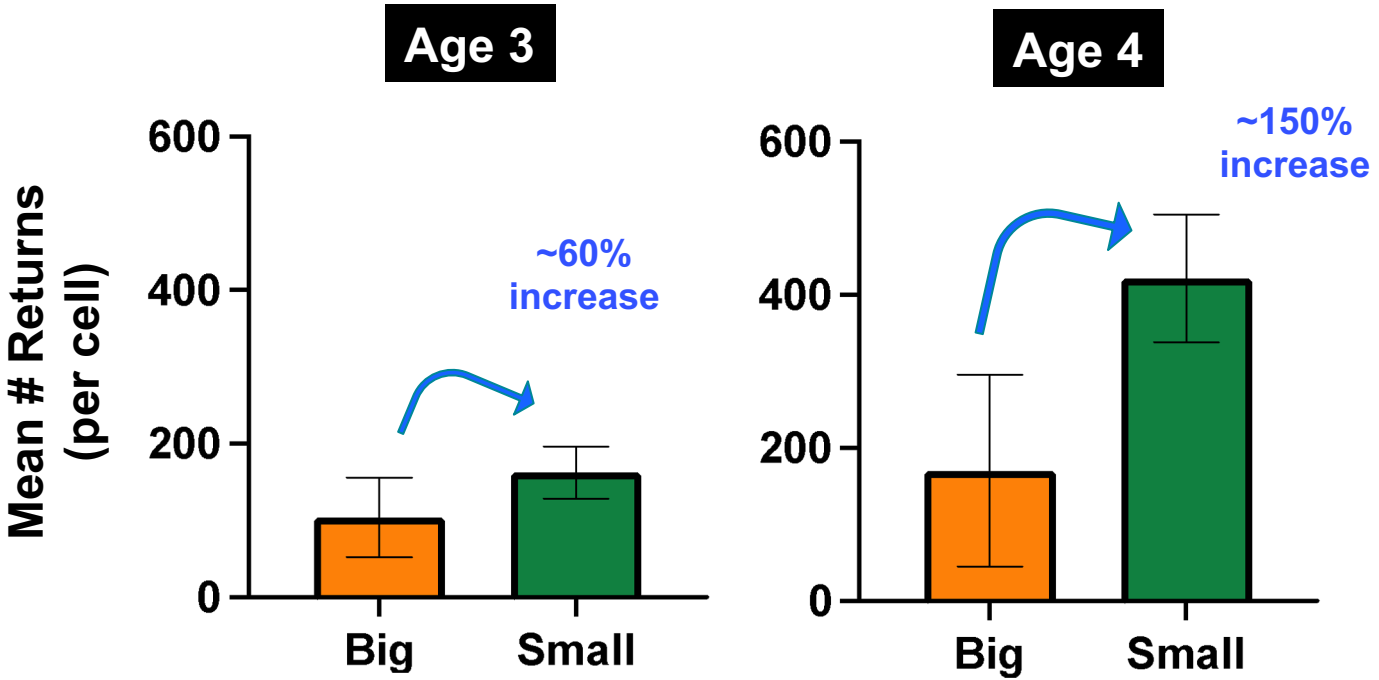

Data presented is model output from fractional regression models

# How does this translate to returns for each ladder cell?

**Expanded return numbers =** Proportion returns * total fish released per cell

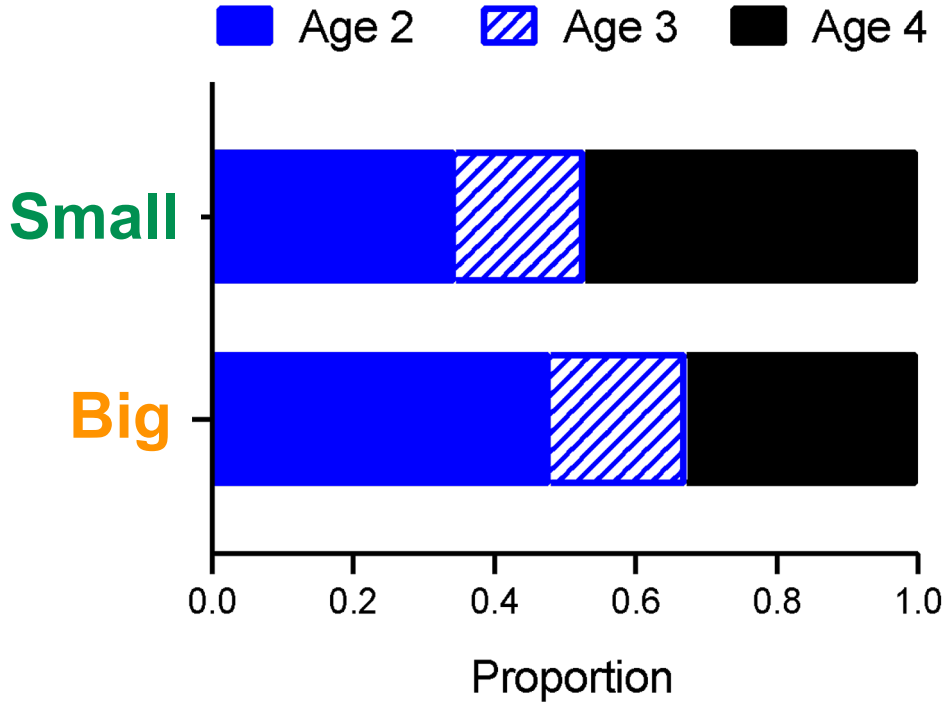



= biomass, but more fish in 'small' cells




Data presented is model output from linear regression models

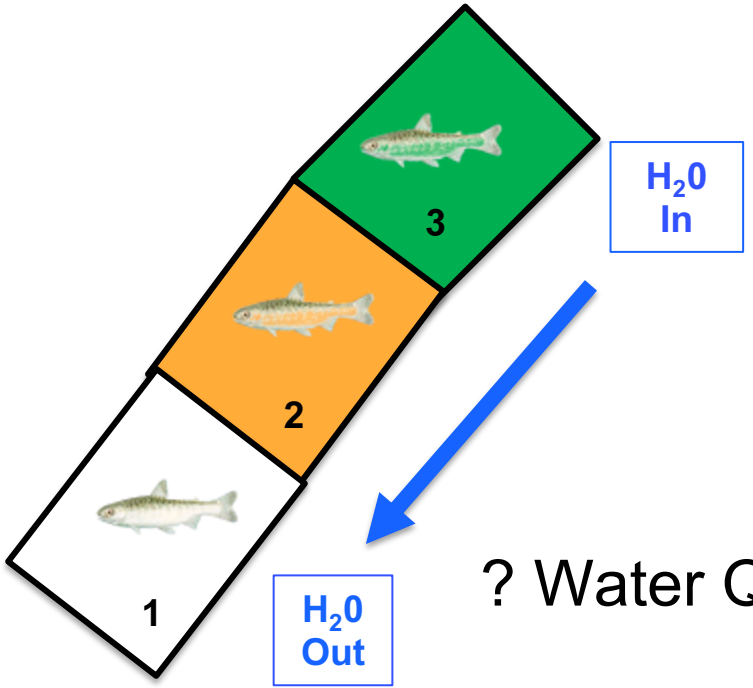
# Shift in Age at Return



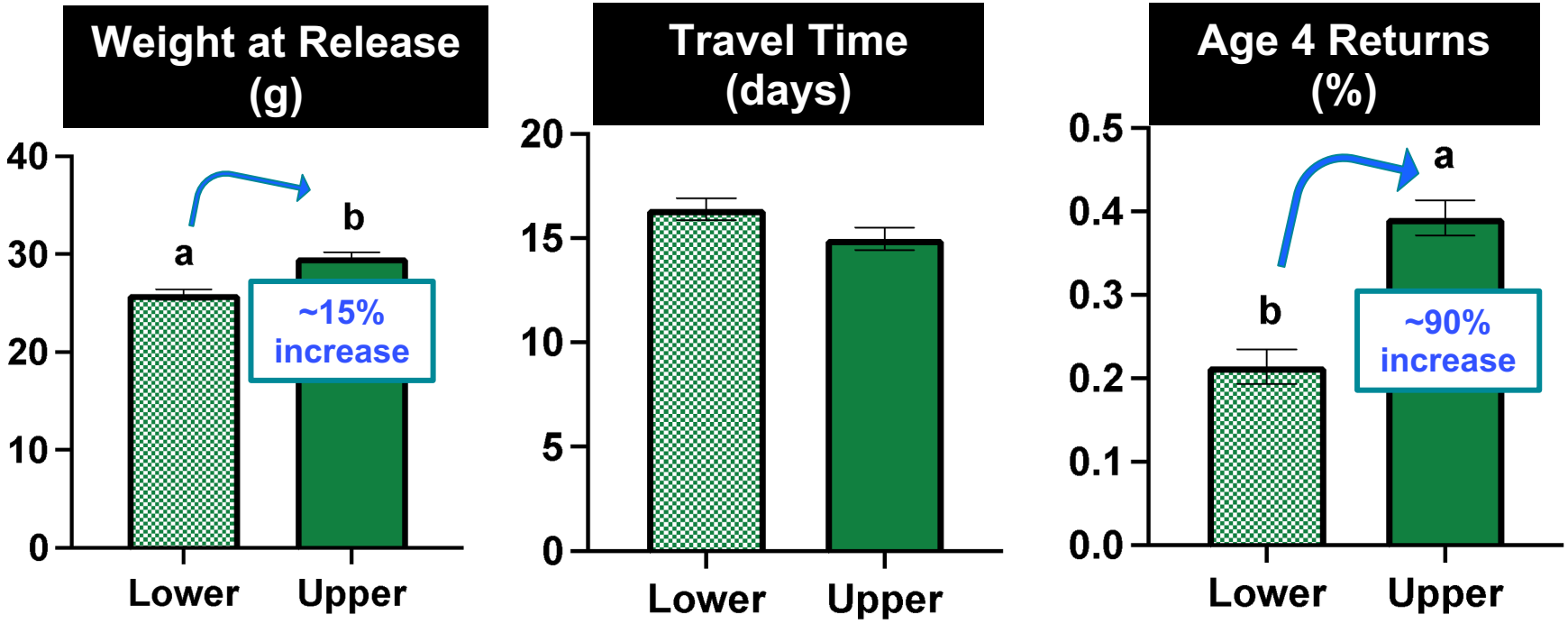

| Mean Age at Return |
| --- |
| Small: 3.13 |
| Big: 2.85 |

# Because water flows in at Cell 3 and exits after Cell 1, decreasing water quality in lower cell positions may have an affect

**Pelton Ladder**



# Comparison of “Smalls” upstream vs. downstream: Does cell position matter?

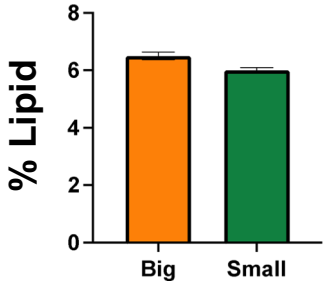



**Water quality considerations will be important to new rearing facilities**

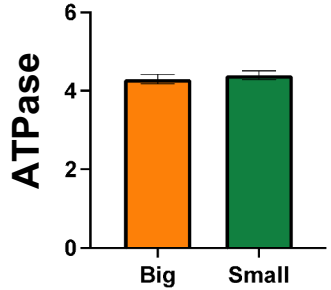
# Conclusions

## Rearing smaller fish:

- Produced similar **body condition/energetics**

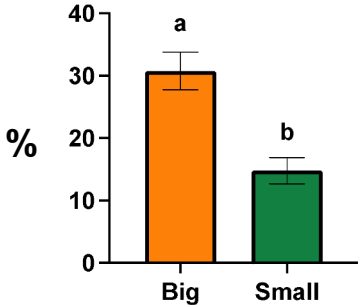



- Produced similar **smoltification**

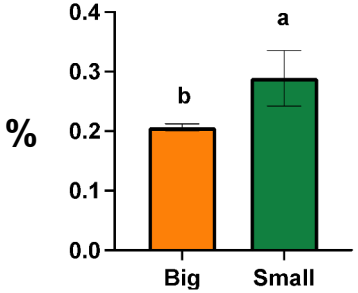



## Rearing smaller fish:

- Decreased **minijacks**

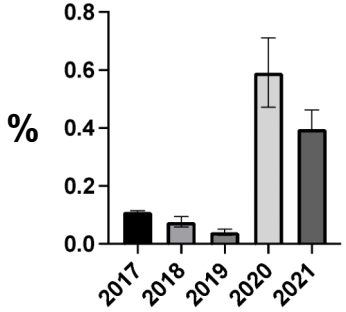



- Increased **age 4 returns**

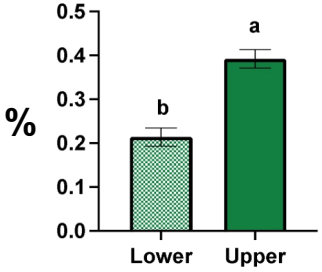



## Other factors:

- Year effect on **age 4 returns**

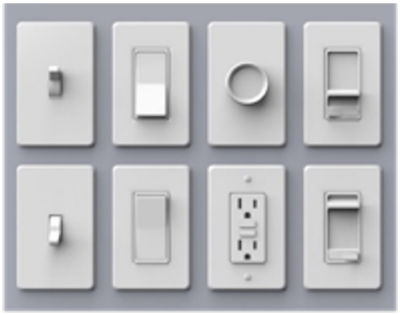



- Lower cell position decreased **age 4 returns**



# Take Home

- If smaller fish are no worse than big fish……
- Opportunity to dial in tradeoffs between smolt size and age at return
- Plus you can rear more fish!



# Acknowledgements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Mollie Middleton, Abby Fuhrman, Meredith Journey

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# Age 4 returns by release year and cell position