

# **Physiological Measures of Smolt Quality at Time of Release Successfully Predict Relative Smolt to Adult Performance in Hood River Spring Chinook Salmon**

**D. Spangenberg<sup>1</sup>, D. Larsen<sup>1</sup>, R. Gerstenberger<sup>2</sup>,  
C. Brun<sup>2</sup>, S. Nance<sup>3</sup>, D. Harstad<sup>1</sup>, B. Beckman<sup>1</sup>**

**<sup>1</sup> NOAA**



**<sup>2</sup> CTWS**



**<sup>3</sup> UW**



**BPA**



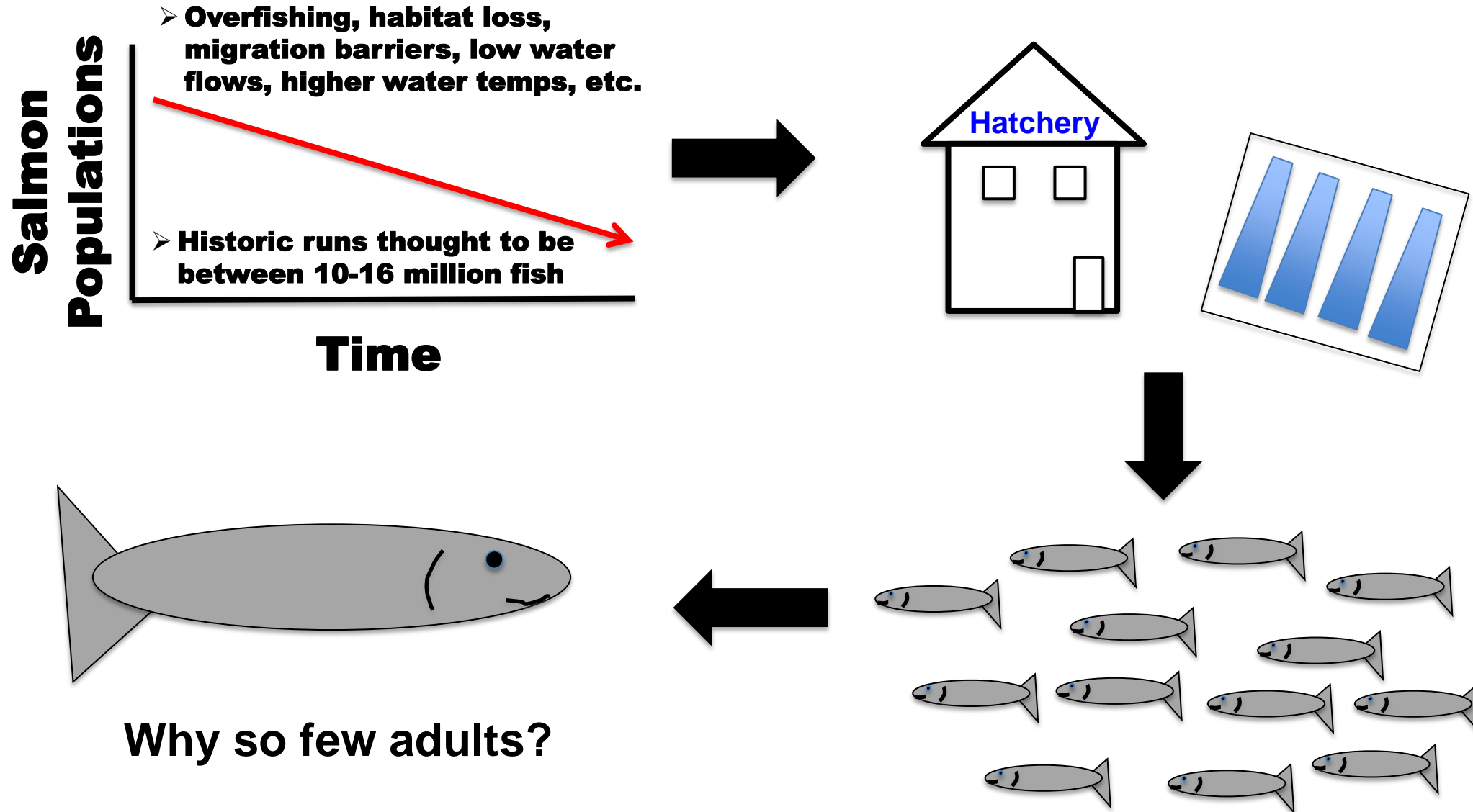
# Talk Outline

- **Background & Goals**
- **Study Design & Methods**
  - **Sampling**
  - **PIT tagging**
  - **PIT tag monitoring**
- **Data**
  - **Physiology**
  - **Adult returns**
- **Conclusions**
  - **References & Acknowledgements**



# Background & Importance

**Salmon Are Important - Culturally, Economically, Ecologically**



# Program Background

- **Hood River spring Chinook went extinct in the late 1960's**
- **Hood River Production Program (CWTWSRO, ODFW, BPA).**
  - **One of the primary goals was to reintroduce spring Chinook salmon to found a natural reproducing population**
- **Production Goal of 150,000 smolts**
  - **Parkdale Hatchery (in basin) ~75,000 & Round Butte & Carson (out of basin) ~75,000 fish**
- **Success???**
  - **Independent program review (Underwood et al 2003)**
  - **Poor SAR's, high stray rates, potentially high production of minijacks**

**As part of BPA Fish Accords in 2008 embarked on a comparative hatchery rearing study to see if different rearing sites/strategies could address such issues**

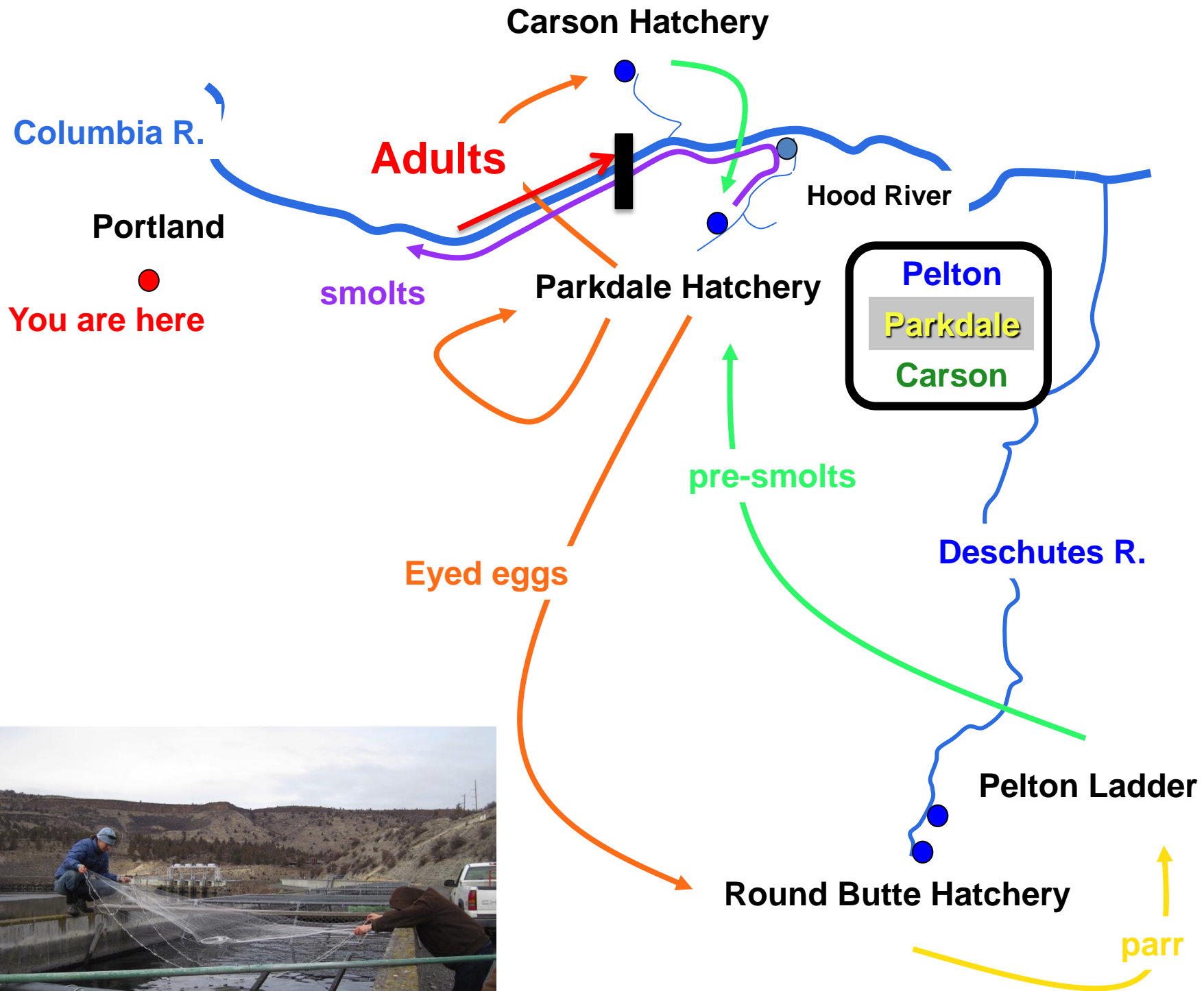




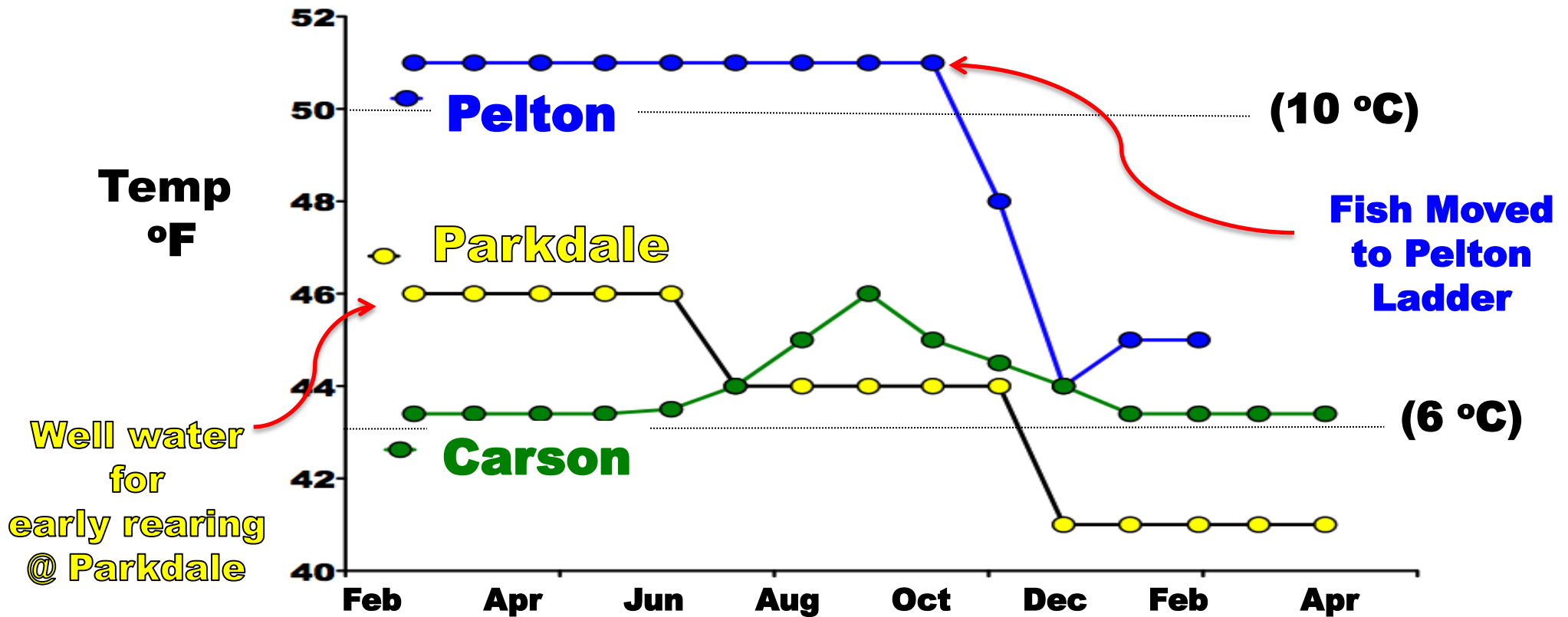
# Study Design

- Raise Hood River stock fish at:
  - Parkdale – **Parkdale**
  - Round Butte/Pelton – **Pelton**
  - Carson – **Carson**
- Assess & compare smolt quality
  - Size, lipid, ATPase, early male maturation, seasonal growth patterns
- **Attempt to predict relative SARs**
- See if predictions were correct





# Hatchery Rearing Conditions Differ



**RB/Pelton Ladder**  
**Mean 50 ° F**



**Parkdale**  
**Mean 44 ° F**



**Carson**  
**Mean 44 ° F**





# Methods - Physiology

**Sampled fish monthly  
from Oct – April**

- **Lengths and weights**
- **Whole Body Lipid**
- **Gender**
- **Gill ATPase (smolt development)**
- **11-Ketotestosterone in blood plasma (minijacks)**





# Methods – PIT Tagging & Detections

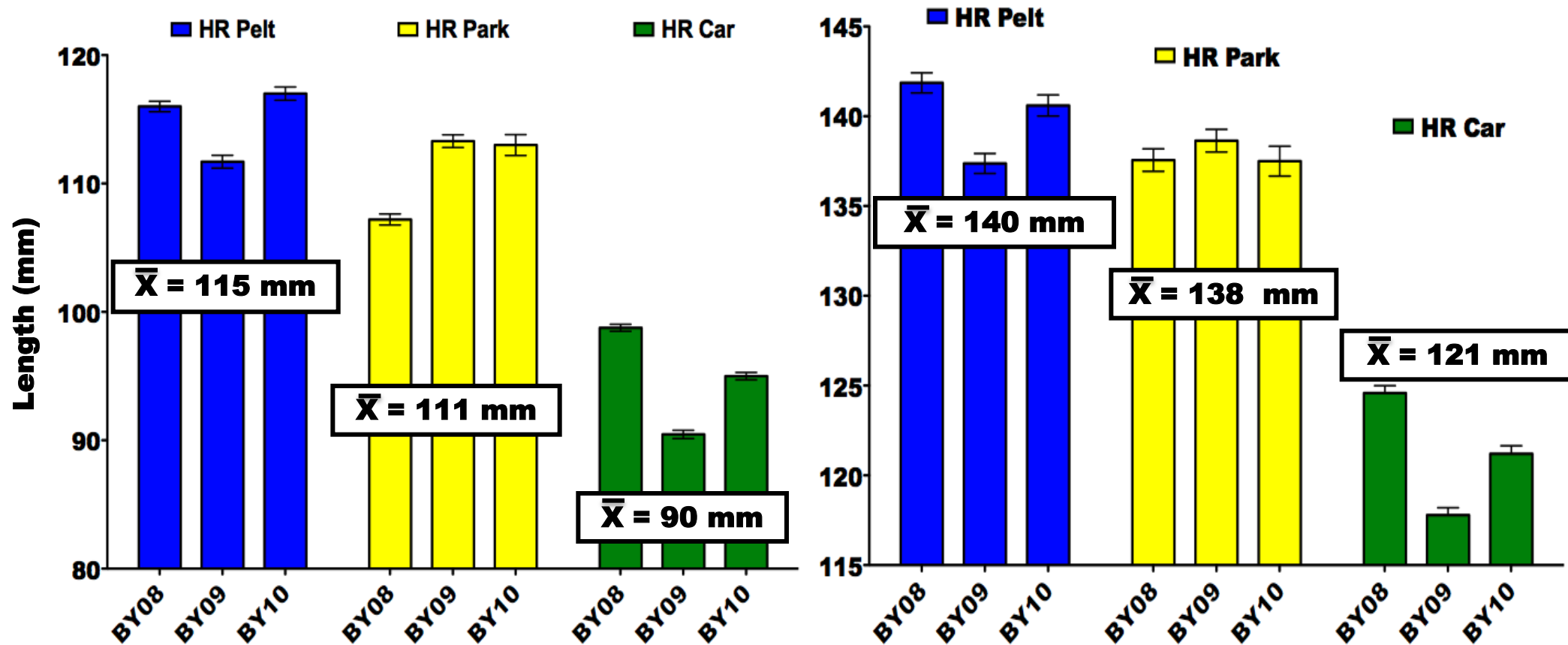
- **12mm full-duplex tags**
- **Tagged at hatchery or acclimation site several weeks to several months before release**
- **2,900-5,300 tags per rearing group annually (7-12% of the population)**
- **All groups released within the same 3 day period to experience similar outmigration conditions**
- **Used PTAGIS database and Columbia River DART websites to query detection data at juvenile and adult detection facilities**
- **SARs calculated as survival from release site to Bonneville dam adult ladders (41 km downstream of Hood River)**



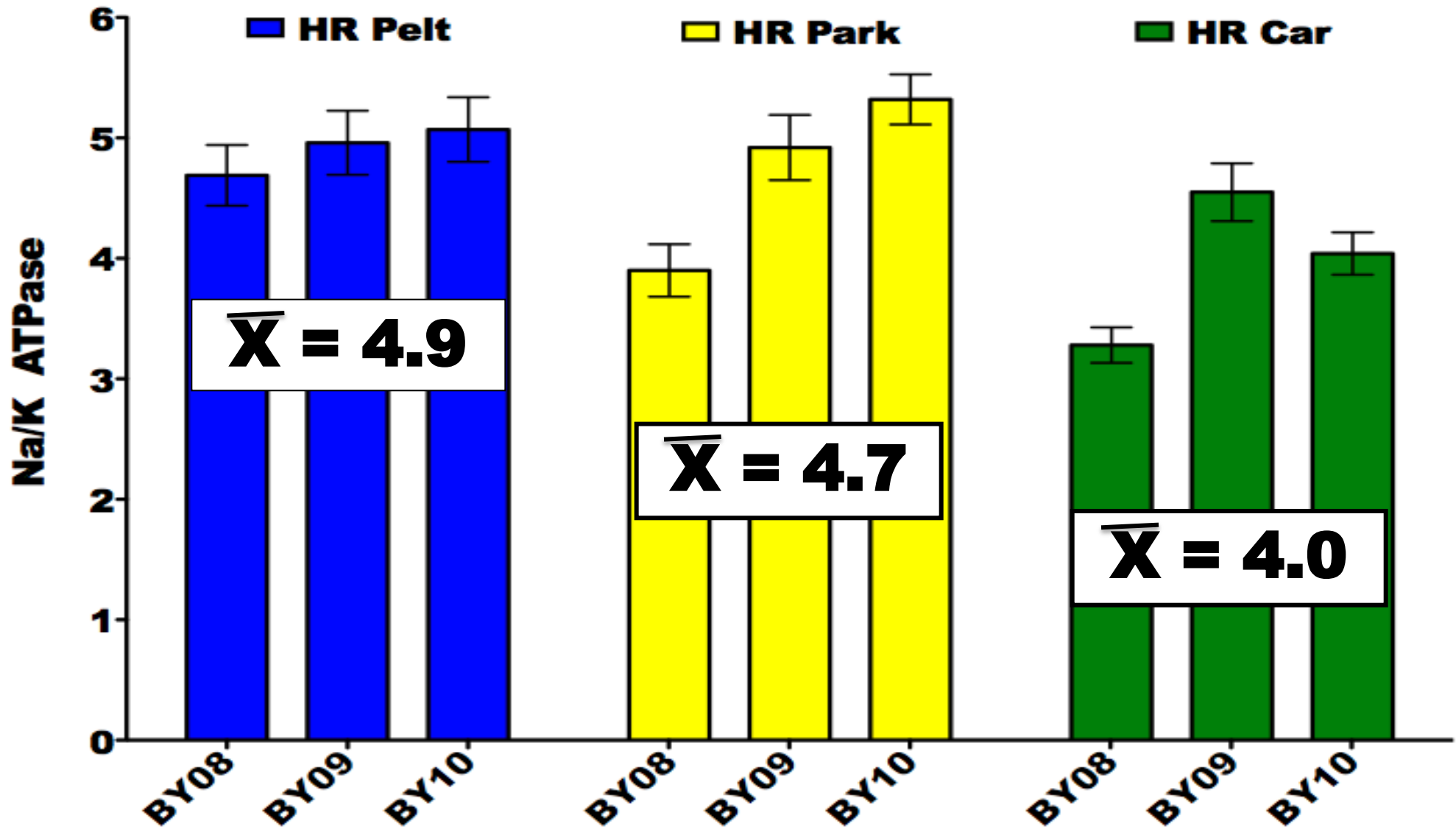
# Pelton Fish Are Generally Larger In Both Fall and Spring

**October**

**April**

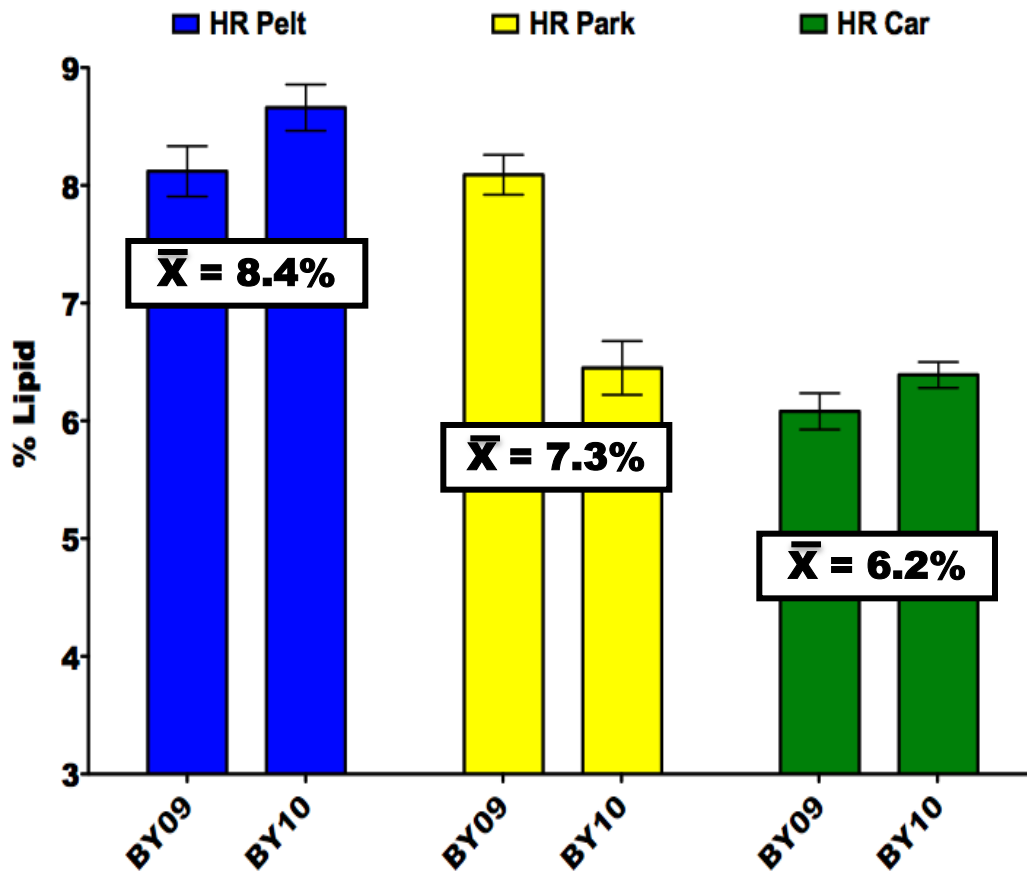


# HR Pelt ATPase is Higher than HR Car ATPase at release

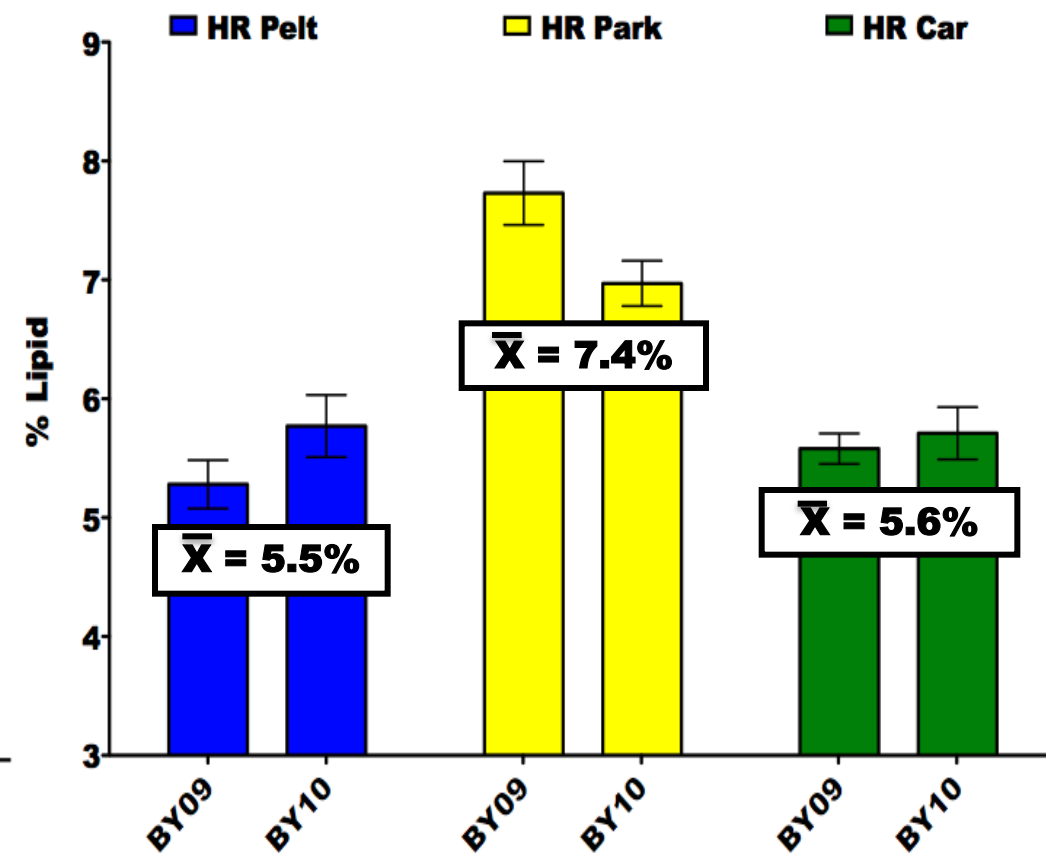


# Whole Body Lipid Levels Show a Marked Decline Over the Winter in HR Pelton Fish

## October

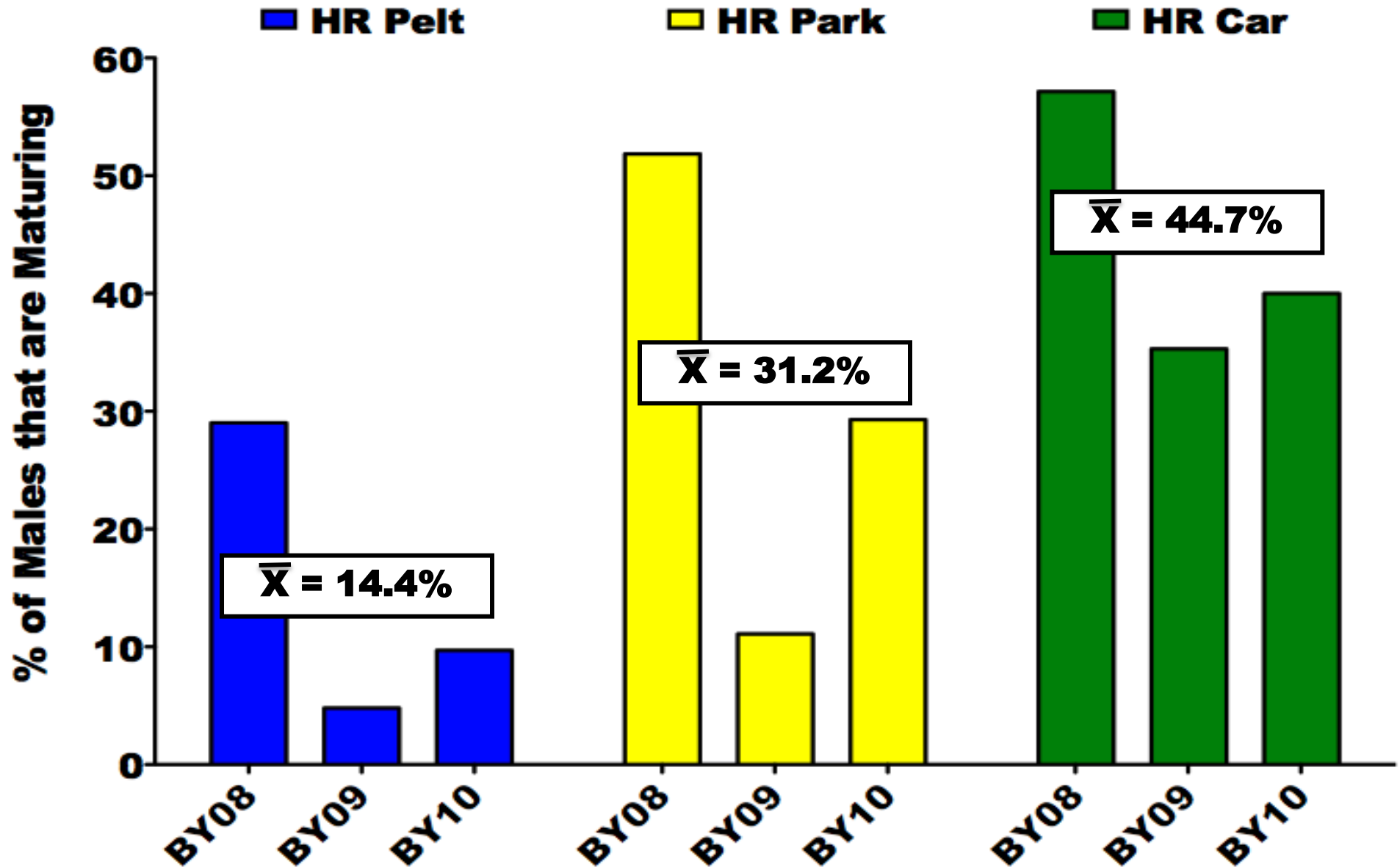


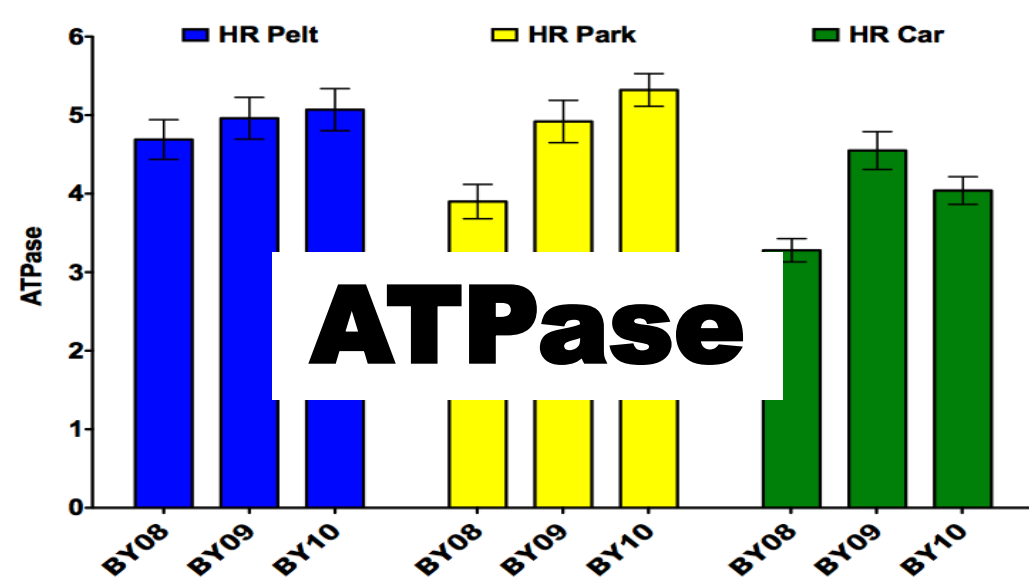
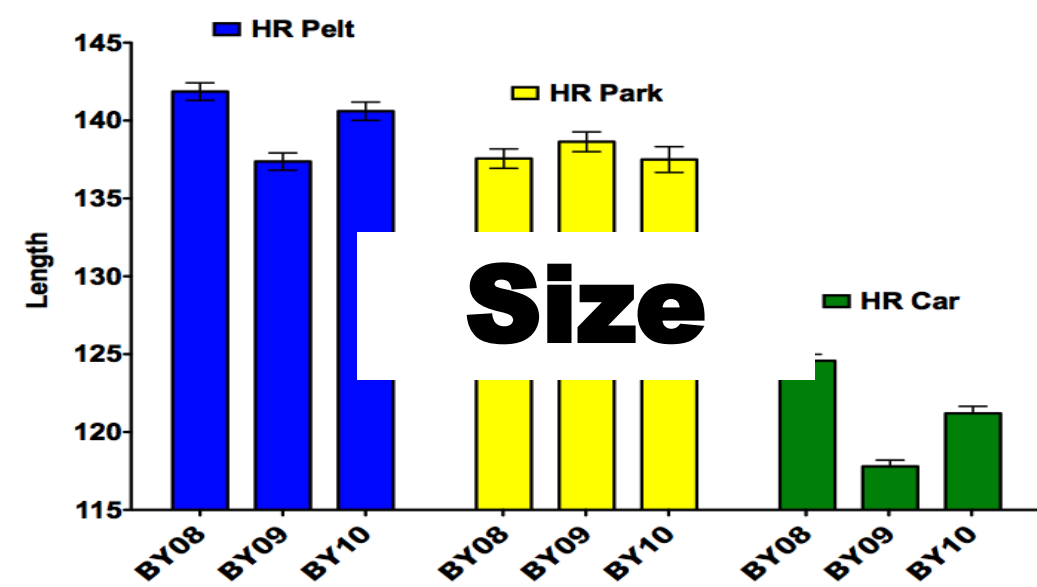
## April



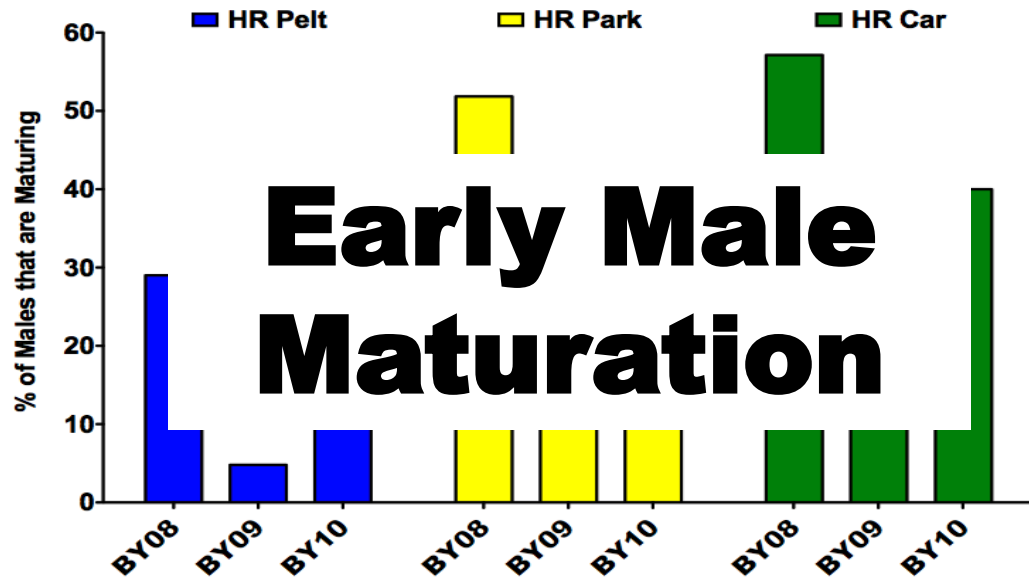
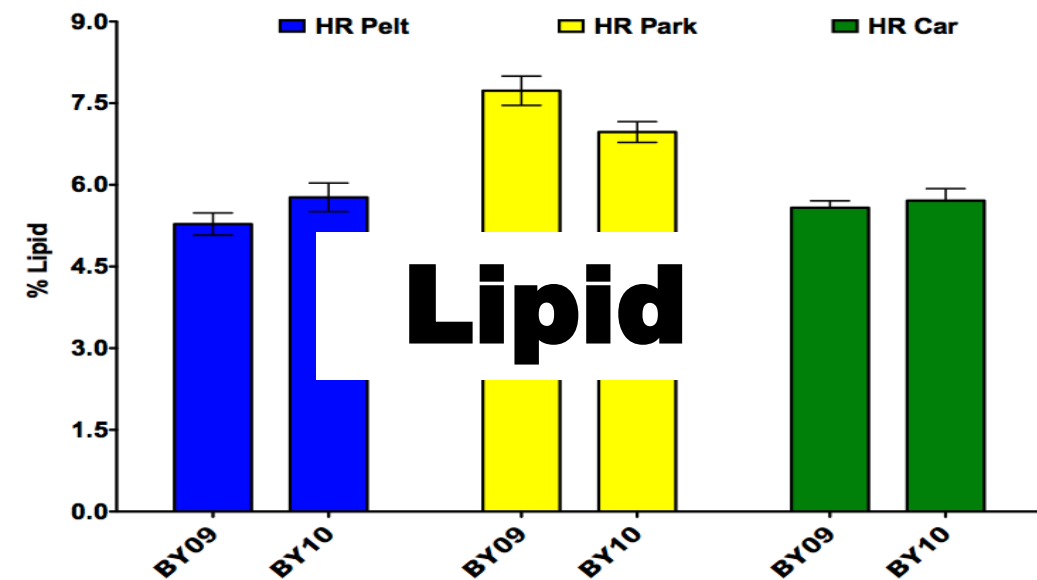


# HR Pelt Fish have Lower Rates of Early Male Maturation

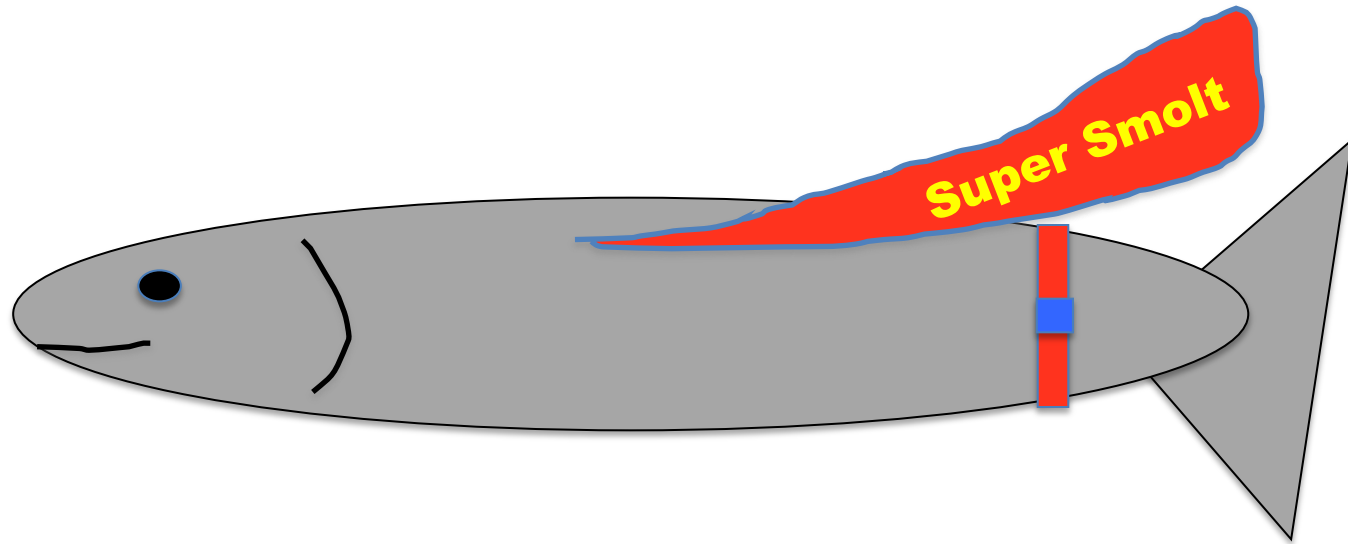




**Need to Predict Relative SARs**



# What makes a good smolt?

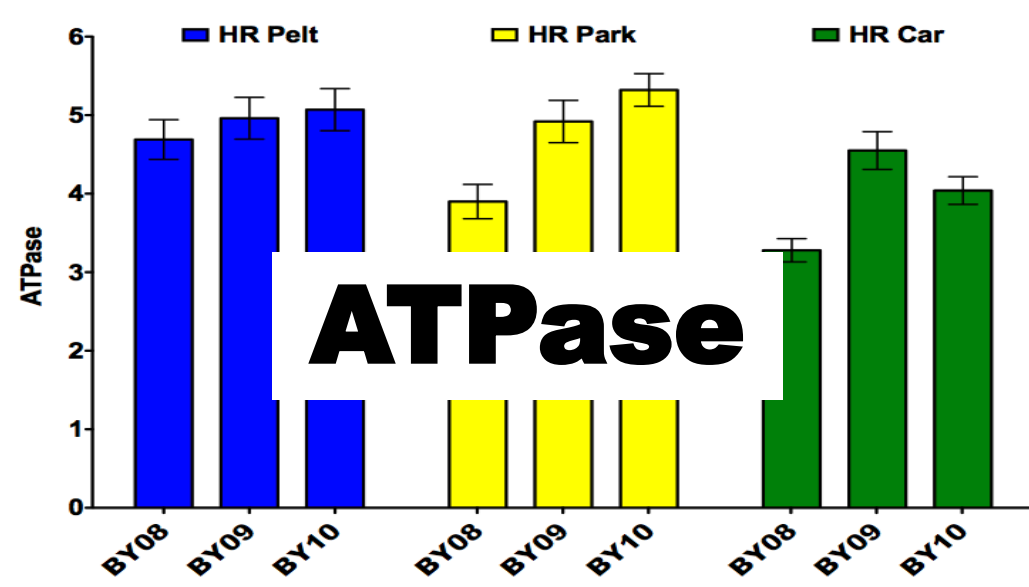
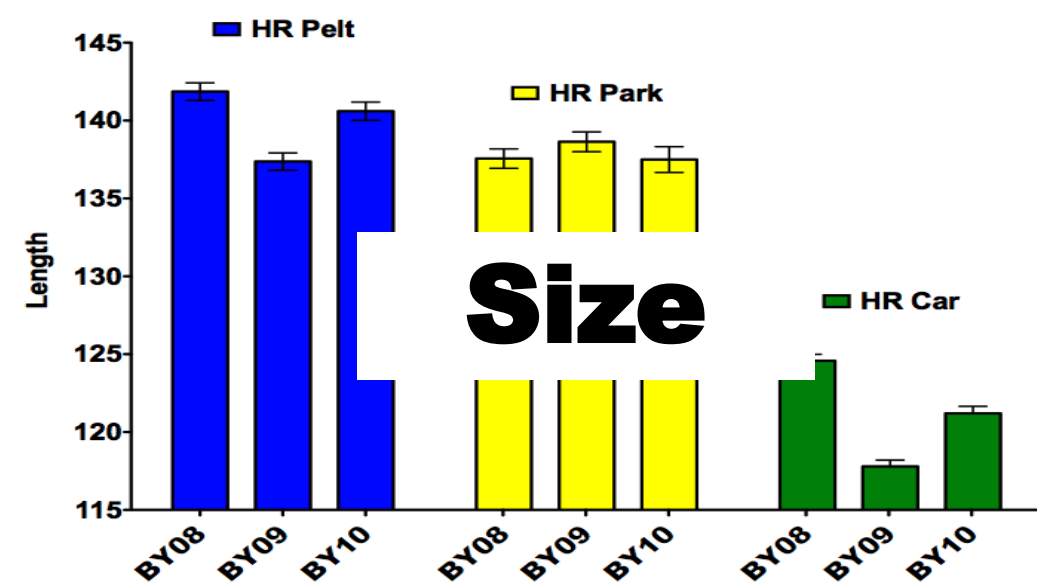


**Size = Large**

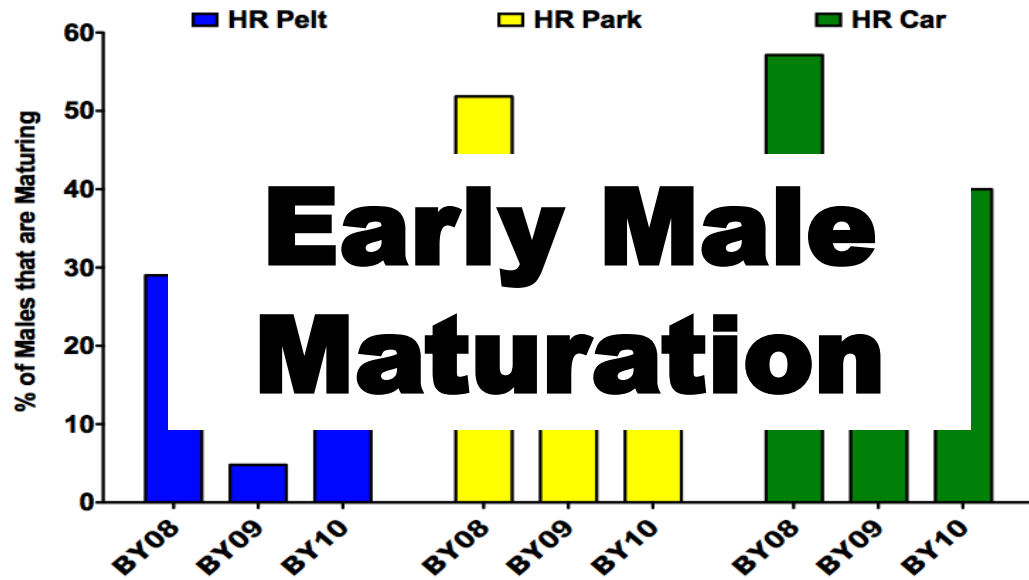
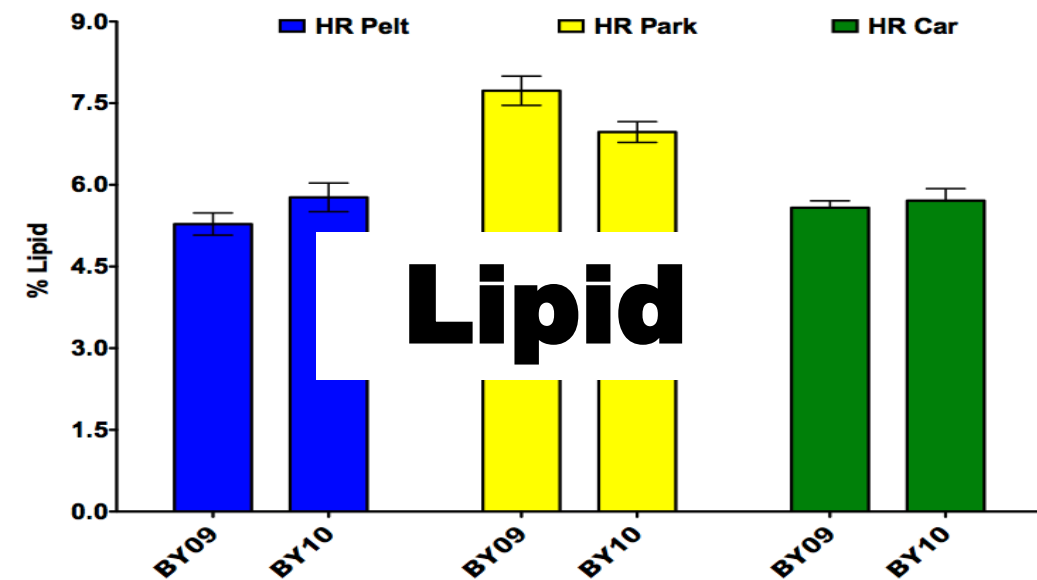
**ATPase = High**

**Lipid = High w/ some Seasonal  
Variation**

**Minijack = Rate Low**



**Pelton > Parkdale > Carson**



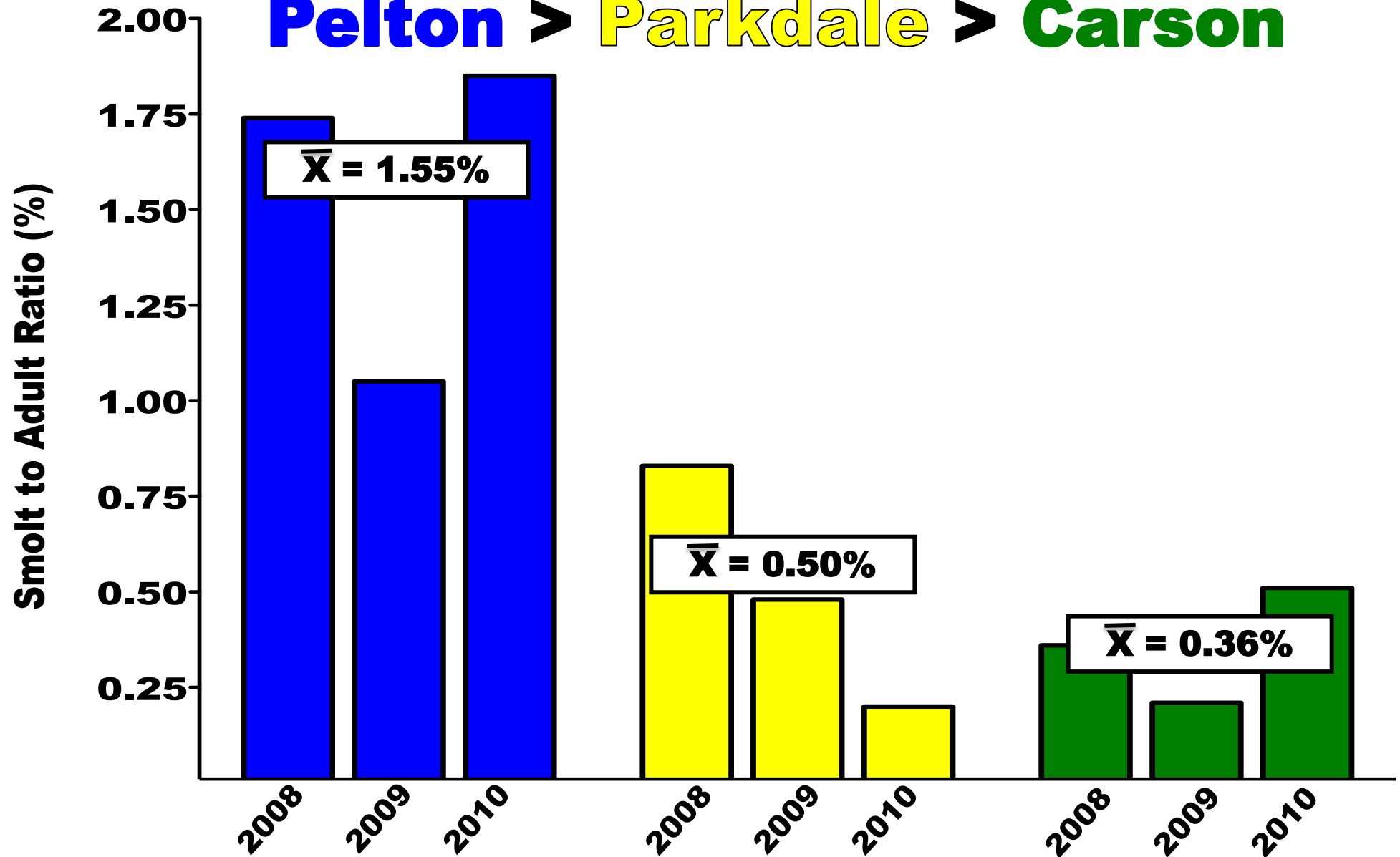


**Were our  
predictions  
correct?**

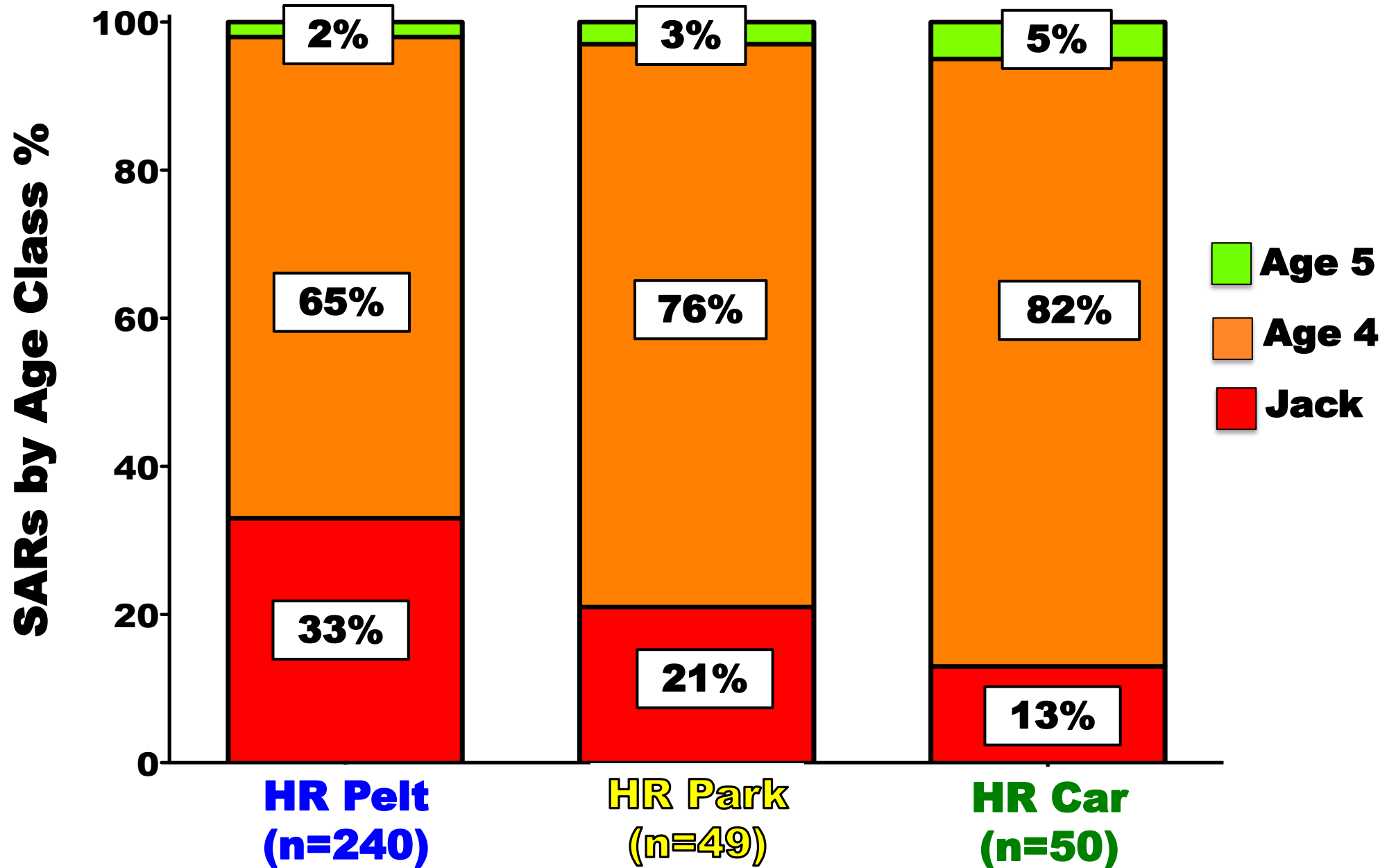


# Smolt Quality Ranking Did Predict Relative SARs Accurately

**Pelton** > **Parkdale** > **Carson**

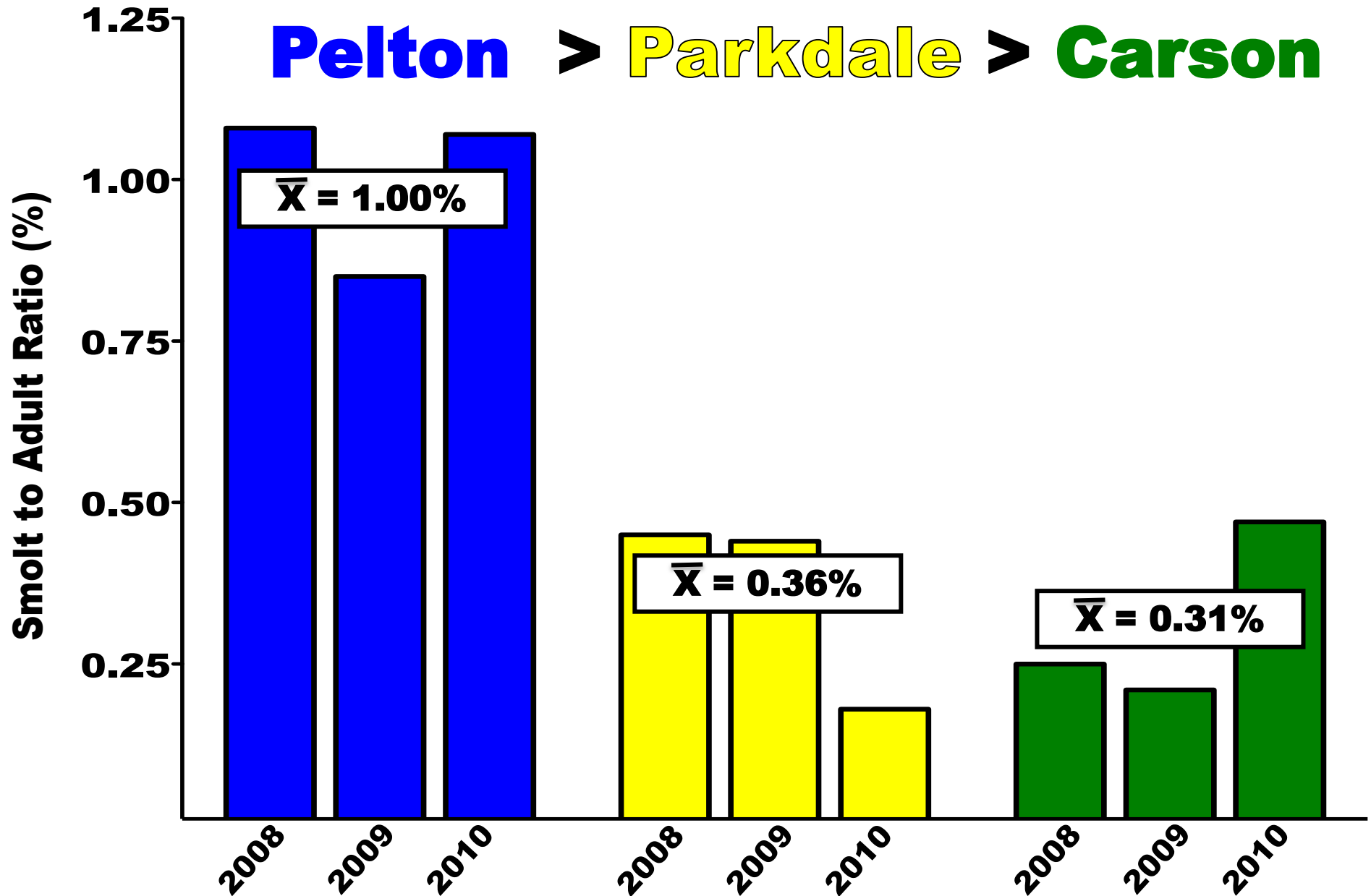


# Age Ratios Varied Between the Groups



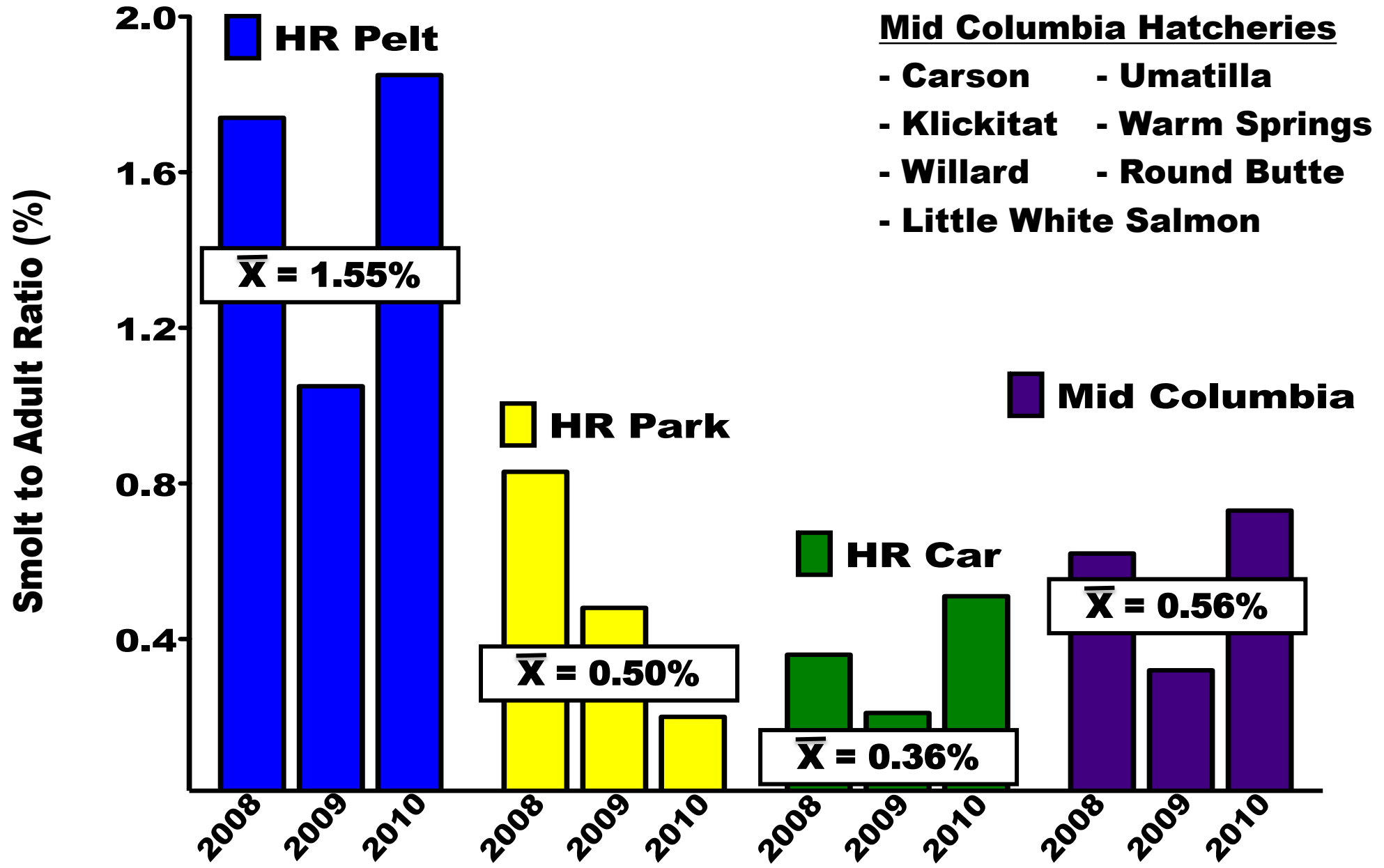
# Even Without the Jacks, Ranking Remains the Same

**Pelton** > **Parkdale** > **Carson**

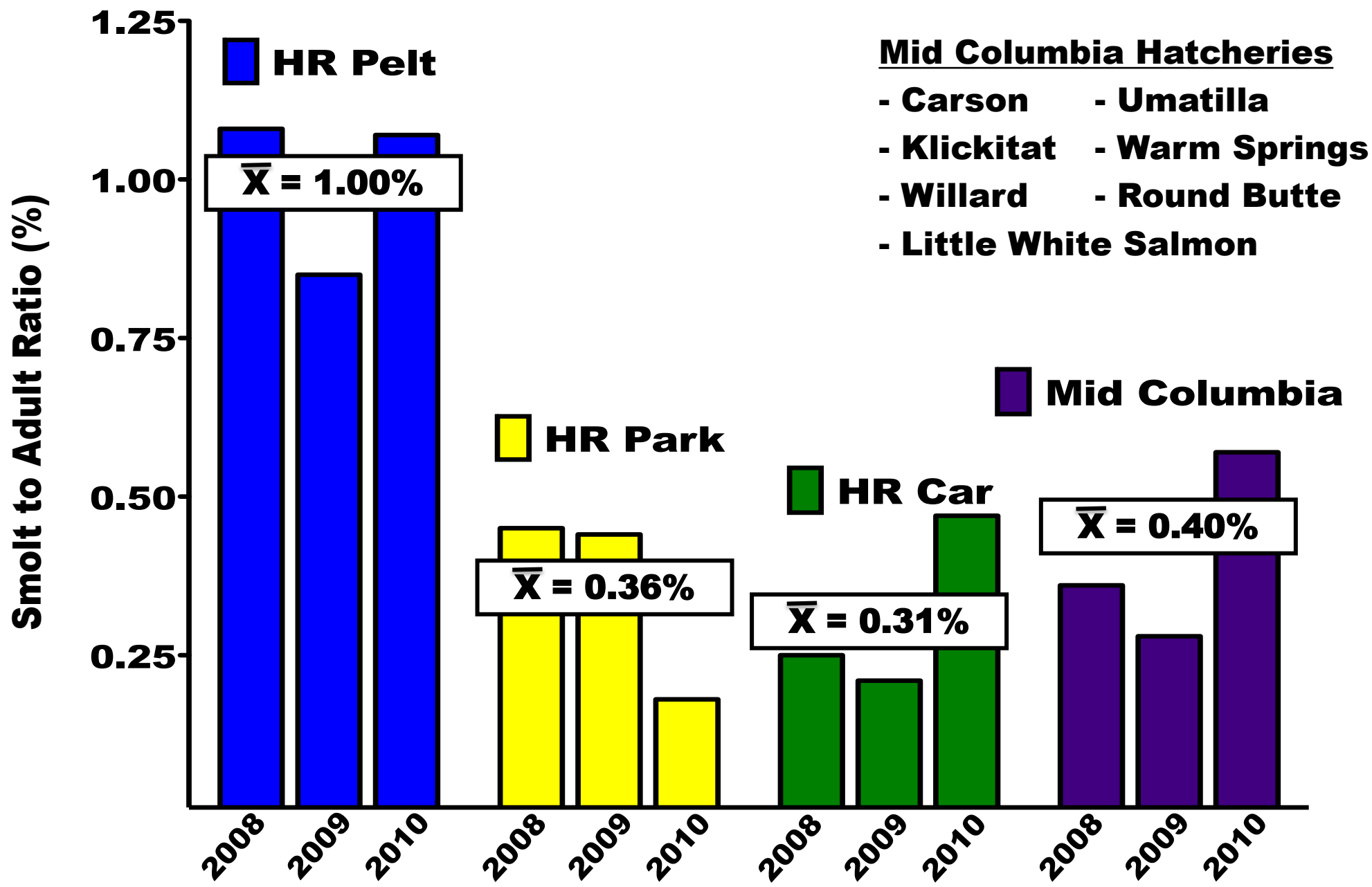




# HR Pelton Fish Outperform Other Mid Columbia Spring Chinook Hatcheries



# Without Jacks, the Trend Remains the Same



# Hatchery Scale Experiment

**same population (Hood River Stock) reared under different conditions**

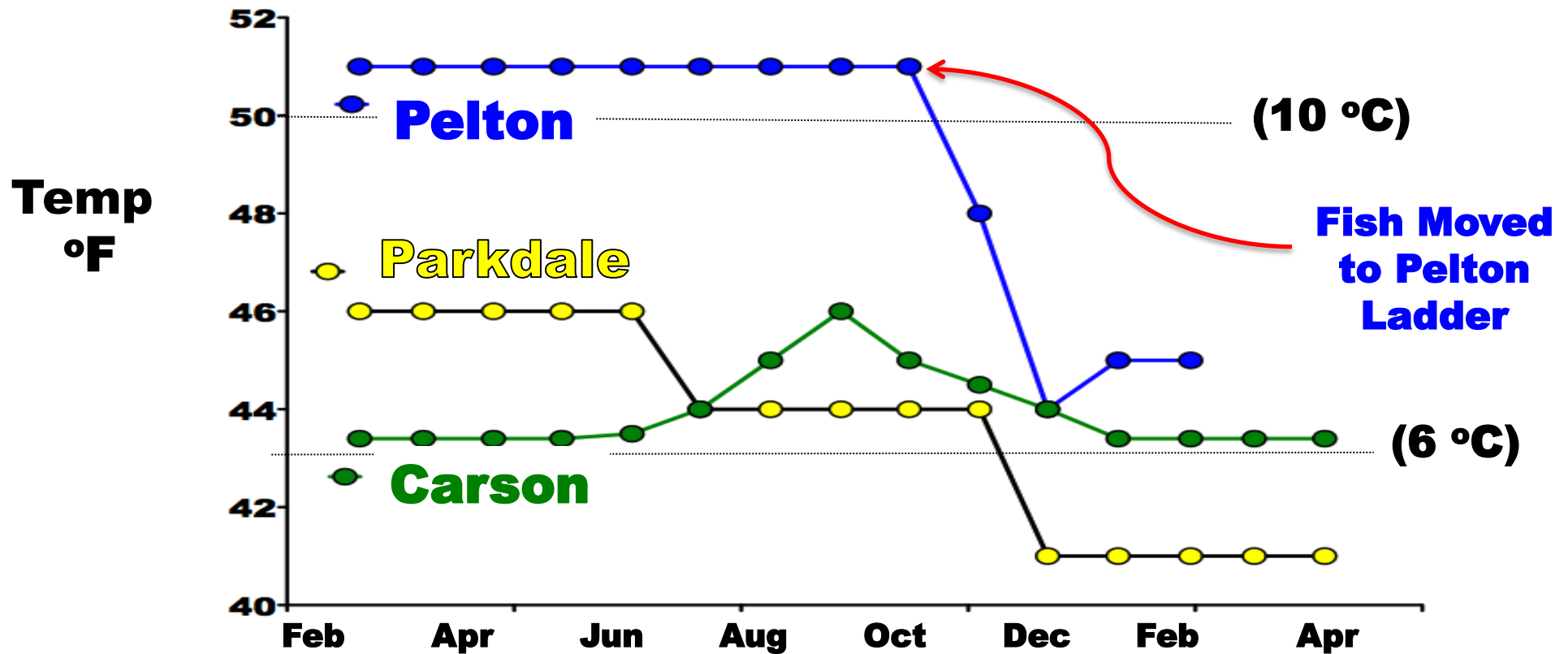


**Use physiological data to predict SARS –  
Predictions were correct**

**Why the Differences?**

**Pelton > Parkdale > Carson**

# Pelton Has Unique Rearing Conditions



**Pelton = Higher water temps**

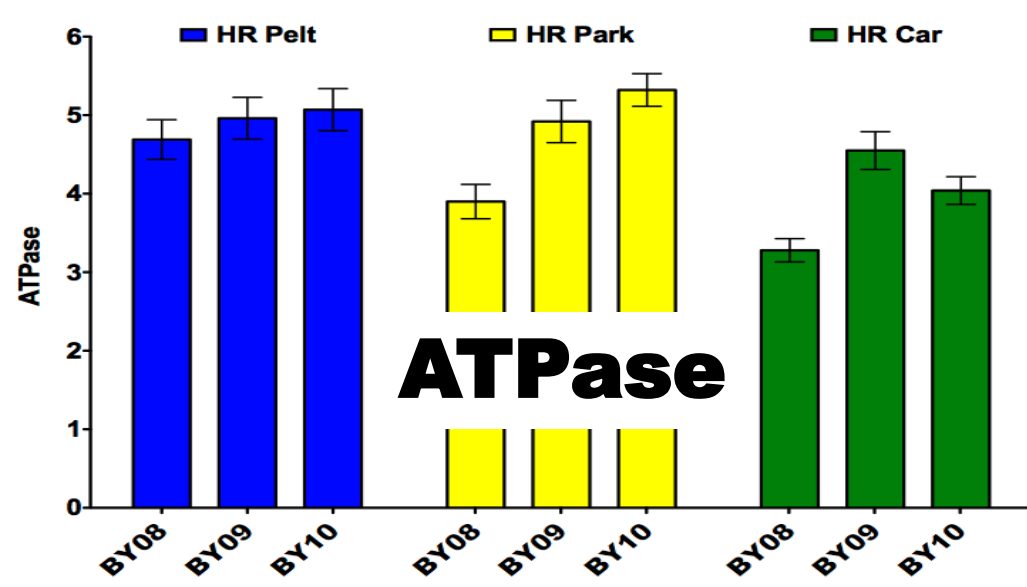
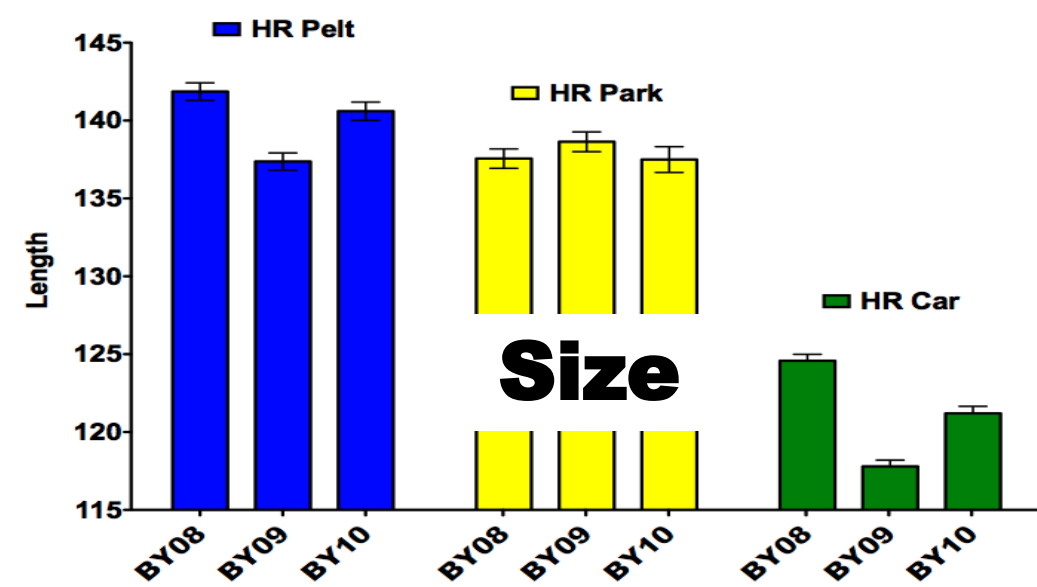
**→ Larger fish**

**Decrease SARs**

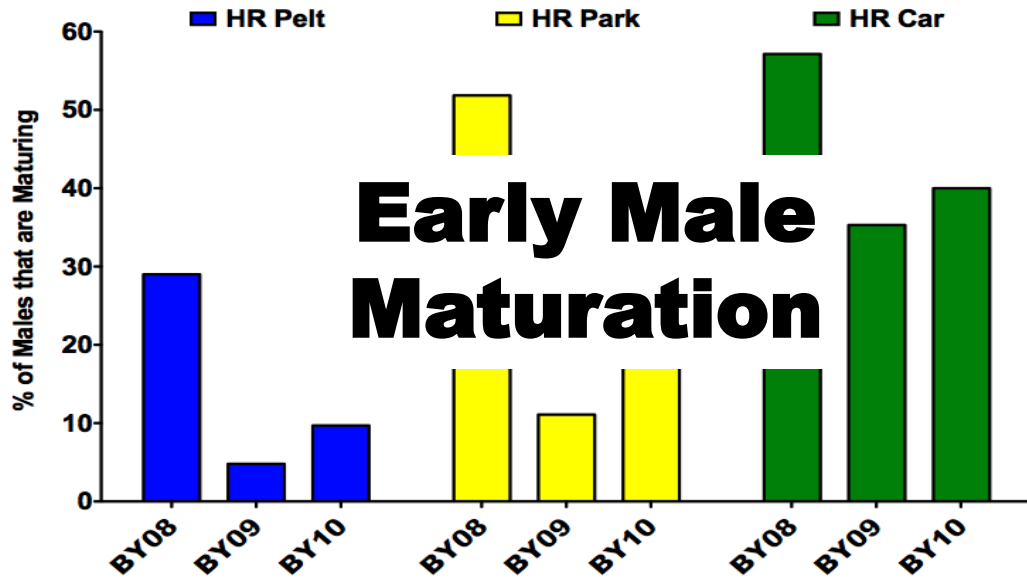
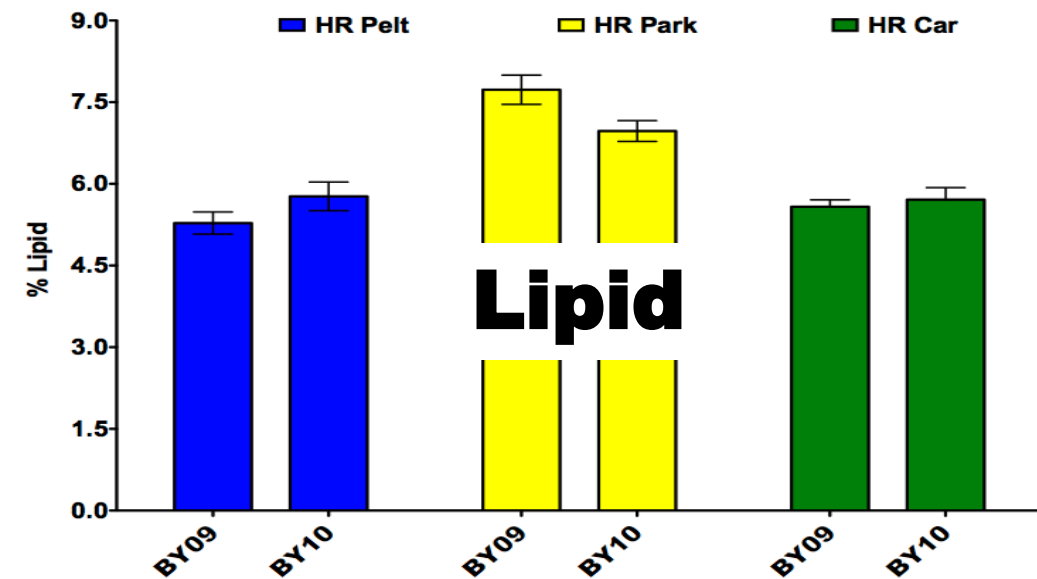
**Higher Rates of Minijacks**

**Increased survival  
Increase SARs**





# Pelton Biggest Fish w/Lowest Rates of Early Male Maturation

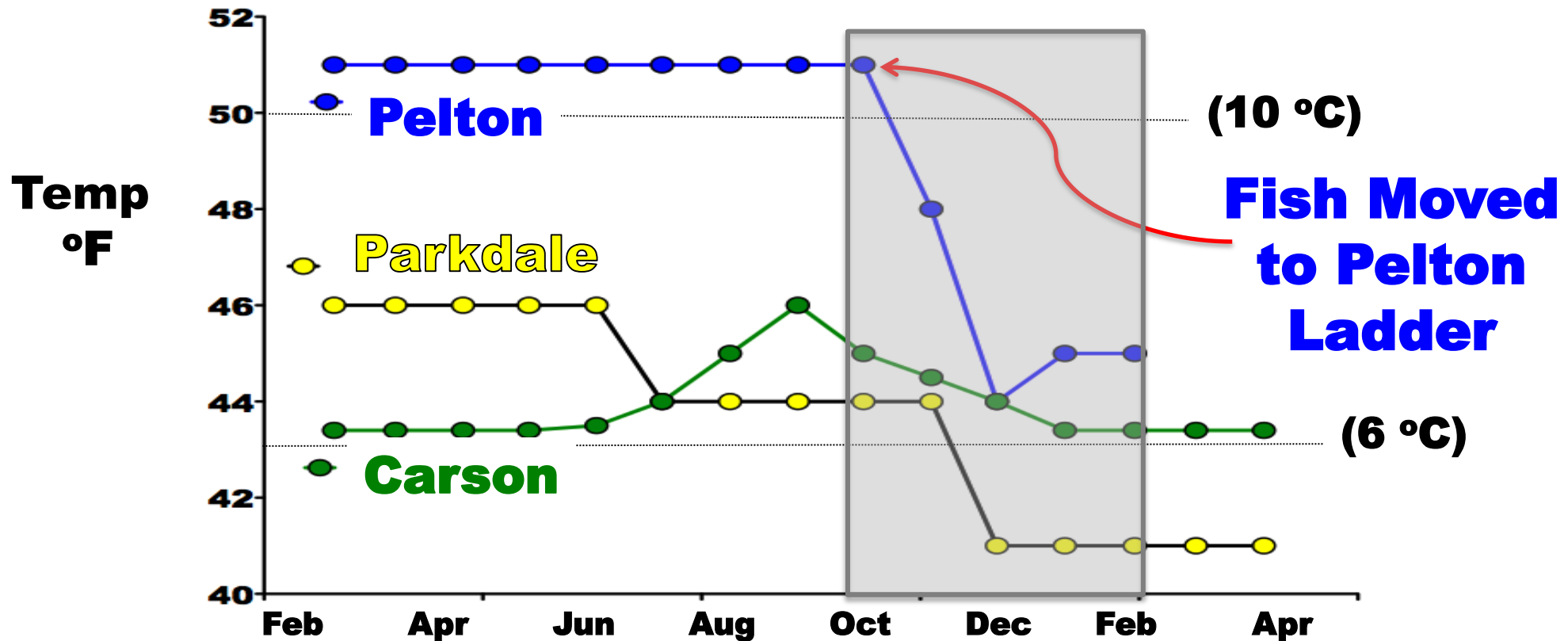


# Window of Opportunity

Endocrine Changes During Onset of Puberty in Male Spring Chinook Salmon,  
*Oncorhynchus tshawytscha*

B. Campbell, J.T. Dickey, P. Swanson

Biology of Reproduction, 69, 2109–2117 (2003)

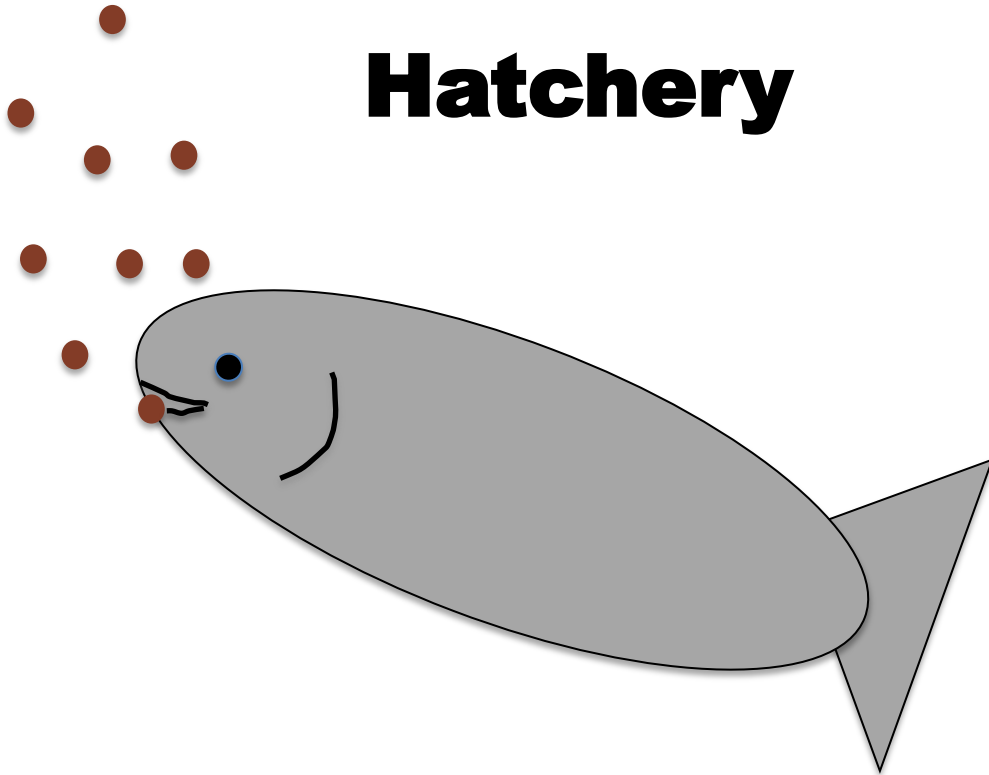


**Bigger/sufficient energy reserves=Mature**  
**Smaller/less energy reserves=Wait**

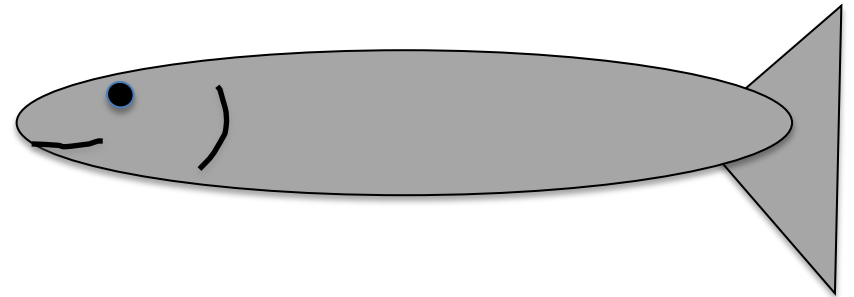
# **There Can Be Differences In Behavior Between Hatchery and Wild Fish In the Fall and Winter**

**Days are getting shorter  
Temperatures are declining**

**Hatchery**



**Wild**



# **Previous Studies Linking Size, Seasonal Growth Rates, & Lipid to Early Male Maturation**

- **Growth modulation alters the incidence of early male maturation and physiological development of hatchery reared spring Chinook salmon: a comparison with wild fish.**

D. A. Larsen, B.R. Beckman, et. al.

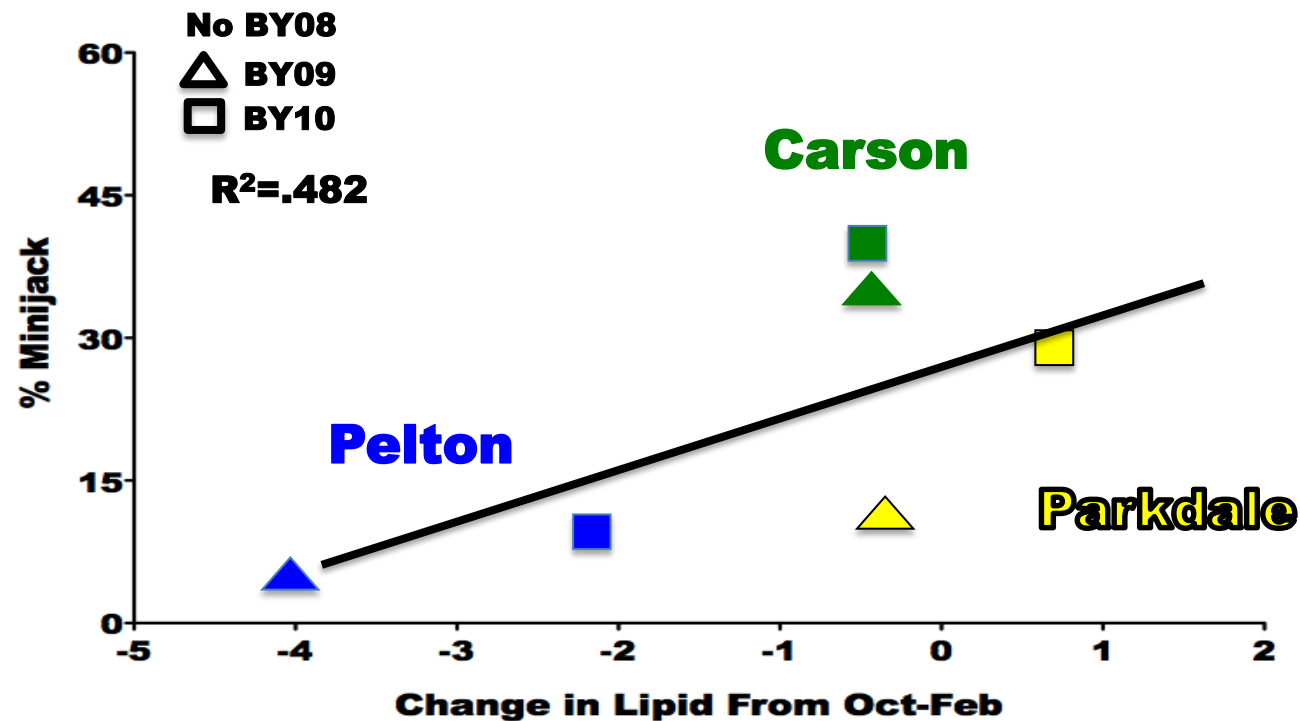
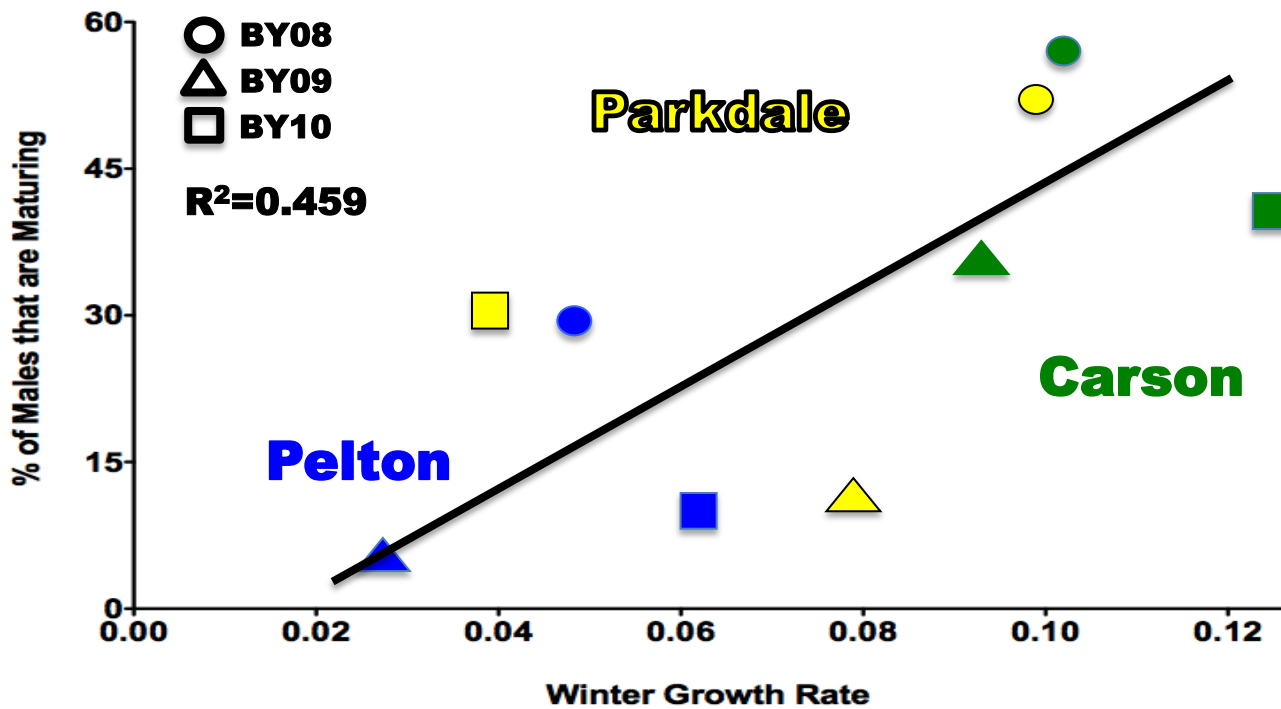
Transactions of the American Fisheries Society, 2006, 135:1017-1032

- **The Effect of Whole Body Lipid on Early Sexual Maturation of 1+ Age Male Chinook Salmon (*Onchohynchus tshawytscha*)**

Karl D. Shearer & Penny Swanson

Aquaculture, Volume 190, Issue 3-4, 1 November 2000, Pages 343–367

**Pelton  
Fish Are  
Doing  
What Wild  
Fish Do!**



# What We Learned

- **Smolt quality varied among HR stock fish reared at different sites**
- **The rearing environment does affect smolt quality even if fish are genetically similar**
- **Smolt quality did in fact predict which rearing groups would perform better or worse**
- **Rearing appears to affect age ratio of returns**
- **Following a wild type template may lead to increased smolt quality**



- **Science & data can be useful**





# Applying The Science

- **Focus on rearing at Round Butte/Pelton and Parkdale**
- **New feeding strategy at Parkdale Hatchery with seasonal growth and size targets**
- **Upgrading an acclimation site on the West Fork Hood River to facilitate longer term rearing on a natural thermal regime**



# **Publications**

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

Transactions of the American Fisheries Society  
(2014) 143:5 1220-1230

D. Spangenberg, D.A. Larsen, R. Gerstenberger, C. Brun, B. R. Beckman

## **Stock Differences in Growth, Smolting, and Early Male Maturation in Hatchery Spring Chinook Salmon: a Common-Garden Experiment**

North American Journal of Fisheries Management  
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# **Acknowledgements**

**Parkdale Staff (CTWS) - Albert Santos**

**Round Butte Staff (ODFW) - Jack Palmer**

**Carson Staff (USFWS) - Larry Zeigenfuss**

**NOAA - Deb Harstad, Abby Tillotson**

**UW - Shelly Nance, Meredith Journey**

**CTWS- Blaine Eichenhorn, Chuck, Megan  
McKim**

**USFWS - Jesse Rivera and marking crew**

**BPA- Funding & Richard Golden COTR**



# Questions?

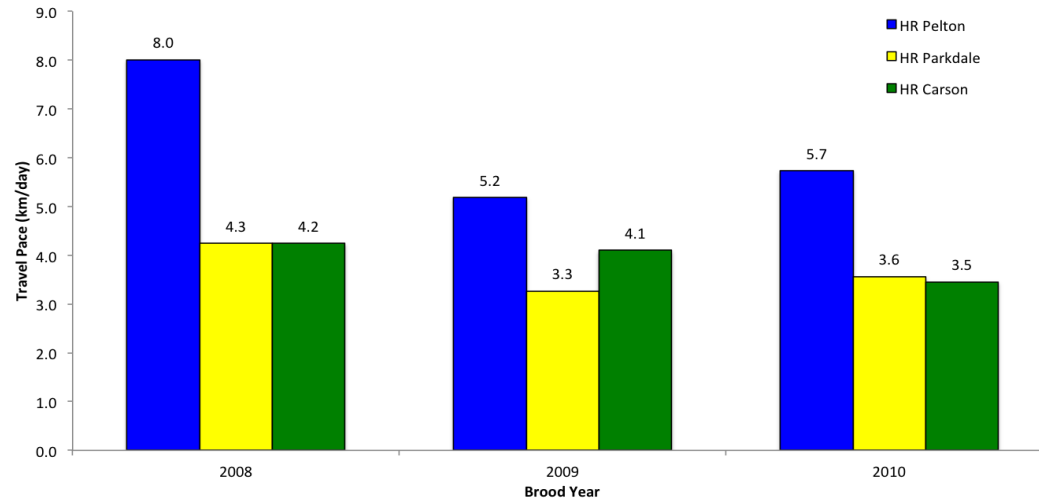


03/14/2012

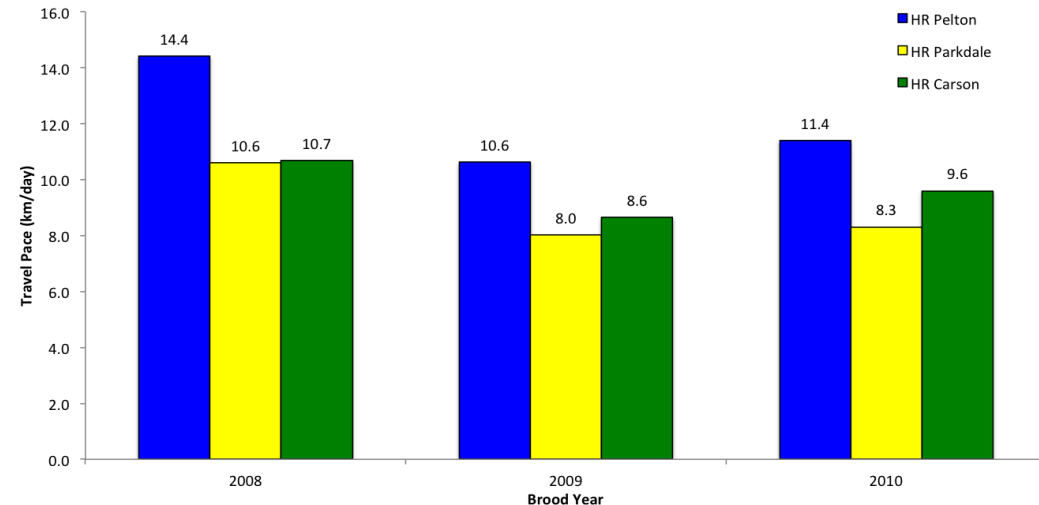
# Results – Migration Pace

- Pelton fish consistently and substantially had a faster migration pace than the other 2 rearing groups
- Parkdale and Pelton fish did not appear to differentiate from each other in migration pace
- Faster pace should lead to higher survival (lower exposure to predators, earlier access to productive ocean feeding grounds)

Travel pace (km/day) from release site to Bonneville Dam (rkm 234)



Travel pace (km/day) from release site to estuary trawl (rkm 75)

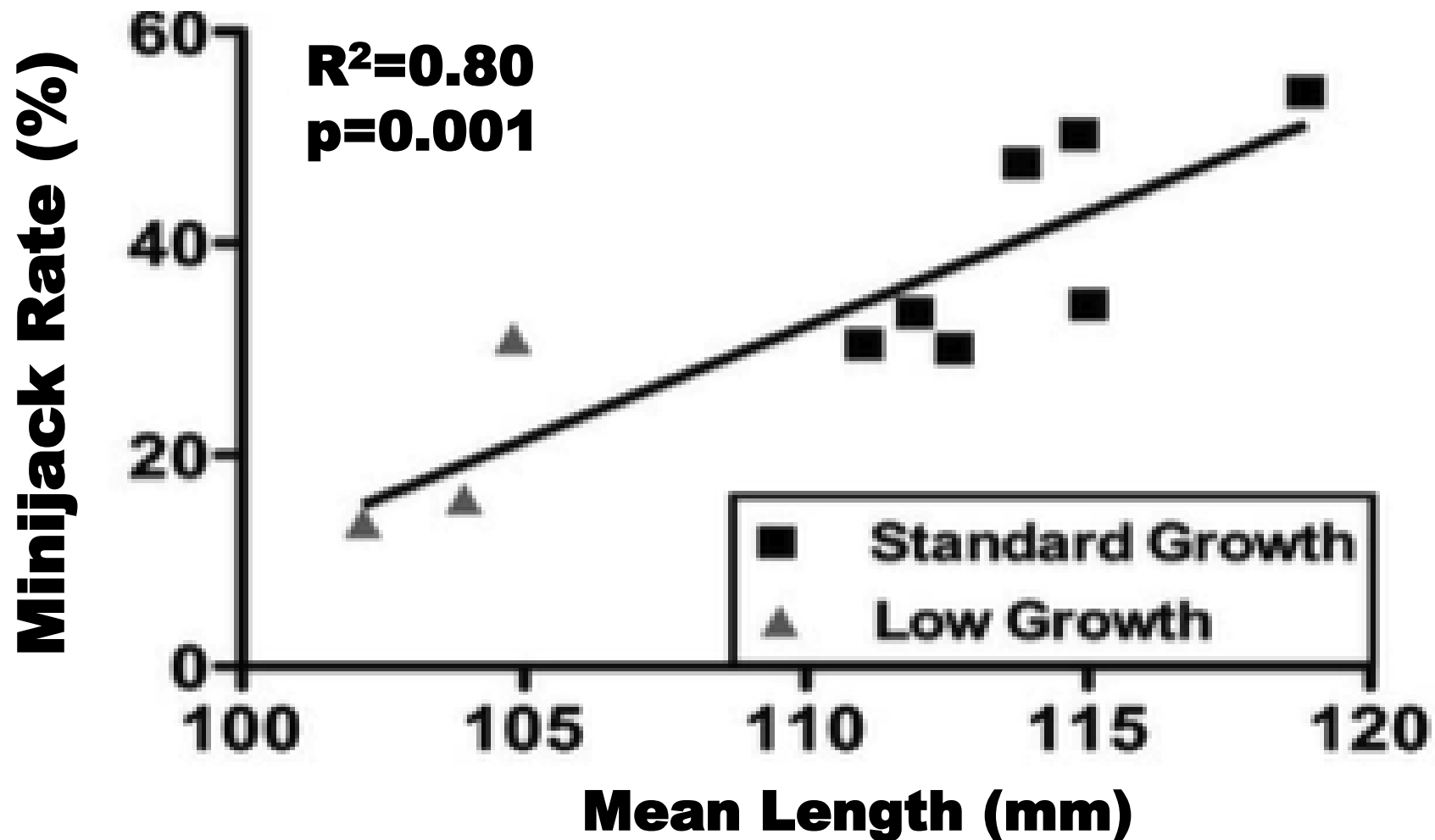




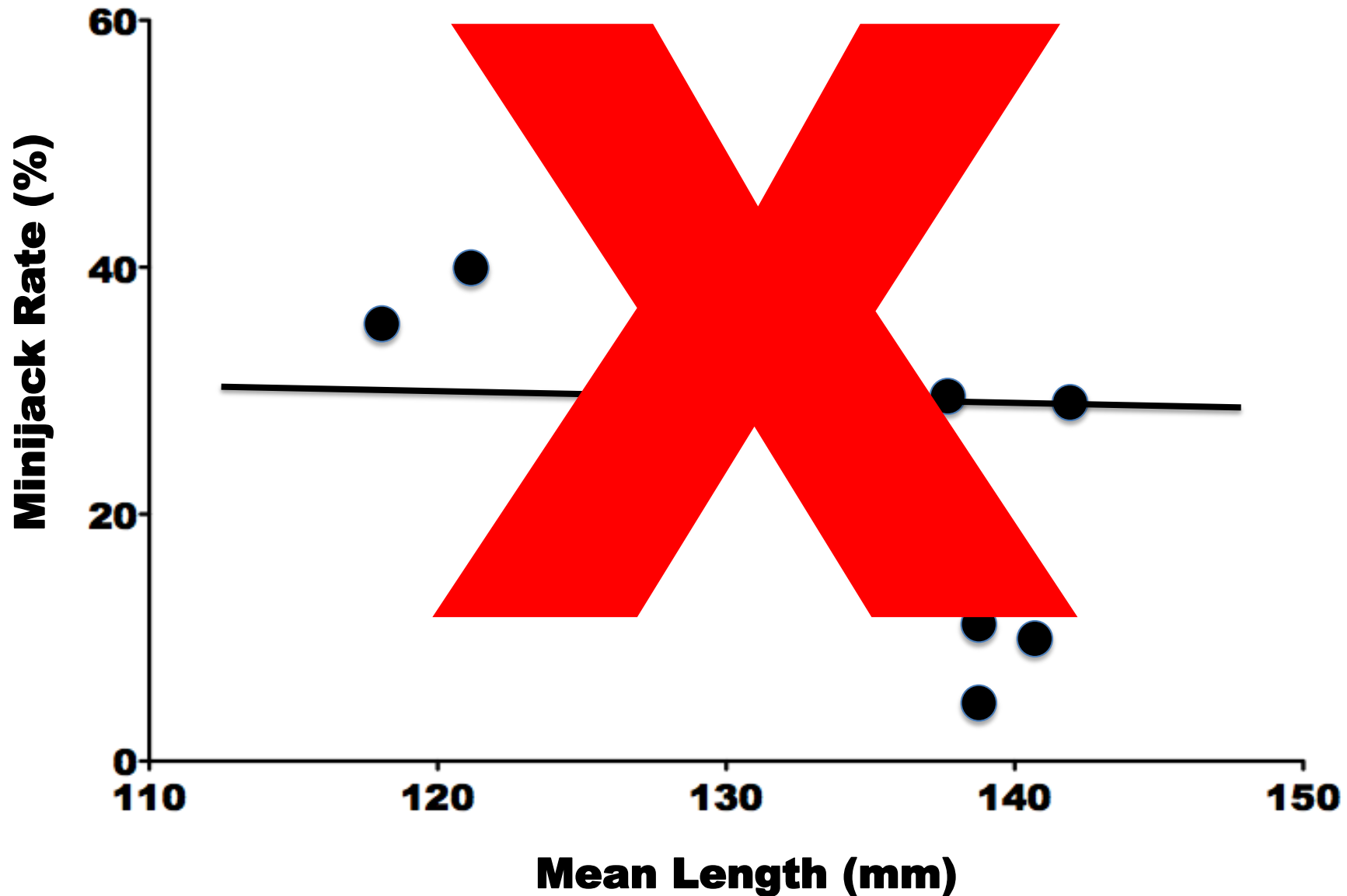
# Strong Positive Relation Between Release Length and % MiniJack

Early Life History Variation in Hatchery- and Natural-Origin Spring Chinook Salmon in the Yakima River, Washington.

Larsen et. al., Transactions of the American Fisheries Society, 2013, 142:2, 540-555.

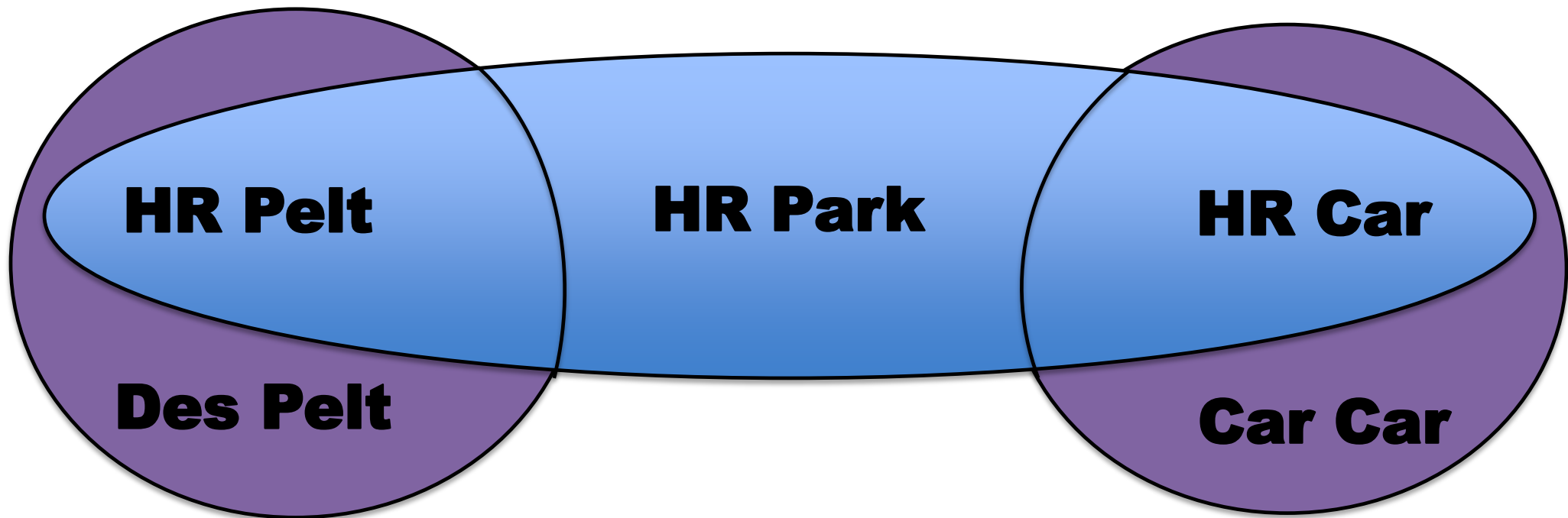


# Hood River Not Following This Size/Minijack Trend



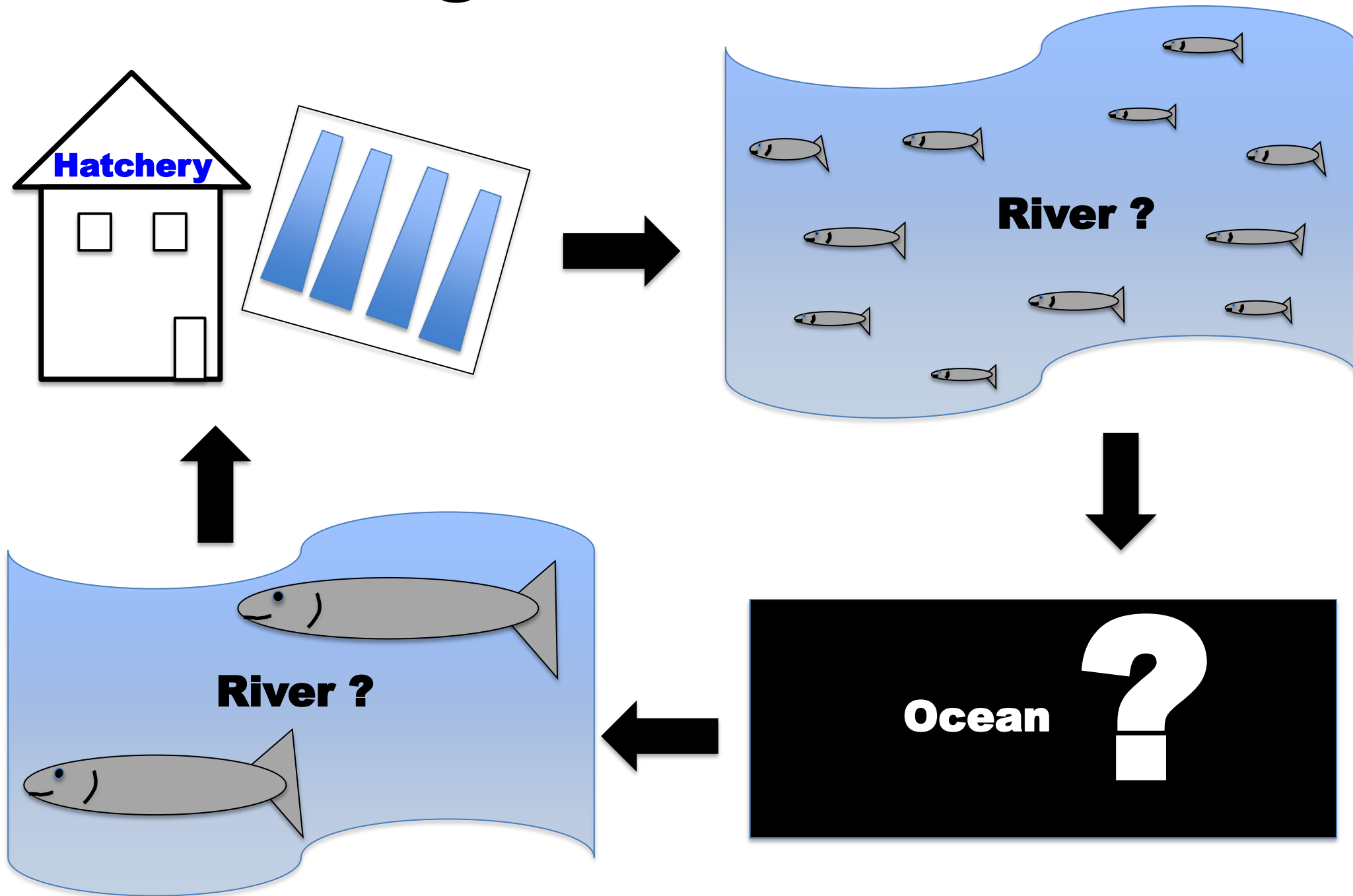
# Unique Hatchery Scale Experiment

**same population reared under different conditions**



**different populations raised under similar conditions**

# Challenge #1- Limited Data



# Challenge #2 - Time



**Overall Goal - Bring Chinook Salmon  
Back to the Hood River**

**Experimental Goal - Develop a Tool to  
Predict Relative Adult Return Rates**