Egg size and growth in wild broodstock steelhead (*Oncorhynchus mykiss*)

KATE E. SELF, KAREN M. COGLIATI, DAVID L.G. NOAKES, CARL B.SCHRECK

OREGON STATE UNIVERSITY
DEPARTMENT OF FISHERIES AND WILDLIFE

2016 PACIFIC COAST STEELHEAD MANAGEMENT MEETING
ASILOMAR, PACIFIC GROVE, CA

OREGON Fish & Wildlife

OREGON HATCHERY RESEARCH CENTER

US Army Corps of Engineers

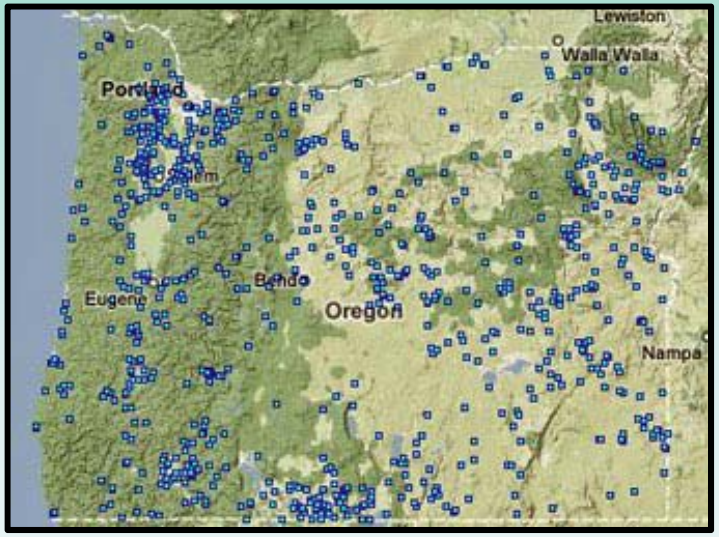
Oregon State UNIVERSITY OSU

Outline

- Surrogate project introduction
- Egg size growth study
  - Methods
  - Results
- Summary of findings

The complex issue of dams

- Dams matter in Oregon
- Impair anadromous fish passage
  - Hatchery fish added to system
  - Decline of wild runs has led to projects like ours



The Wild Fish Surrogate Project

Project Goal:

Develop rearing strategies for wild juvenile surrogates for use in dam passage studies

Detroit Dam, N. Santiam

Cougar Dam, SF McKenzie

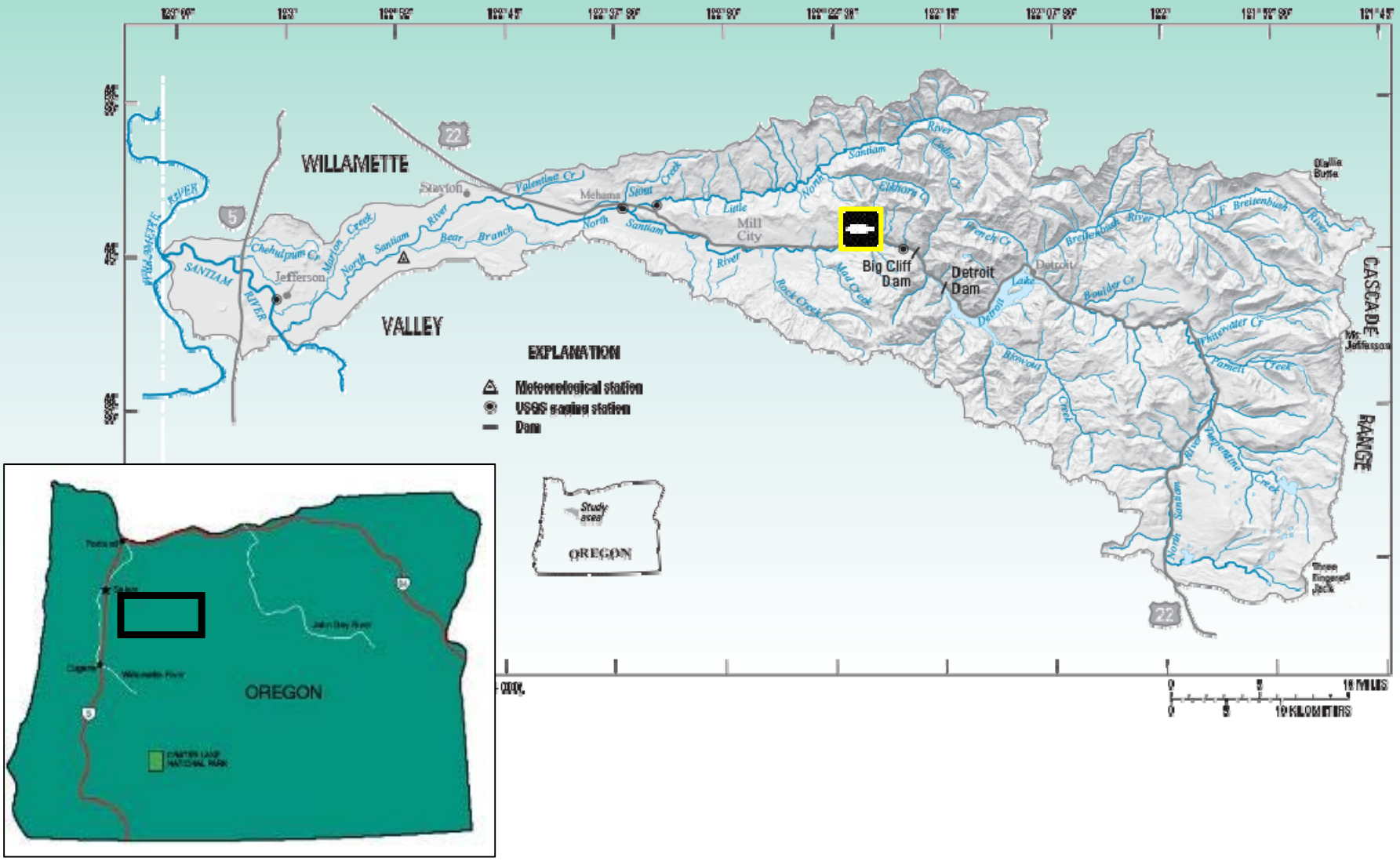
Specific project goals

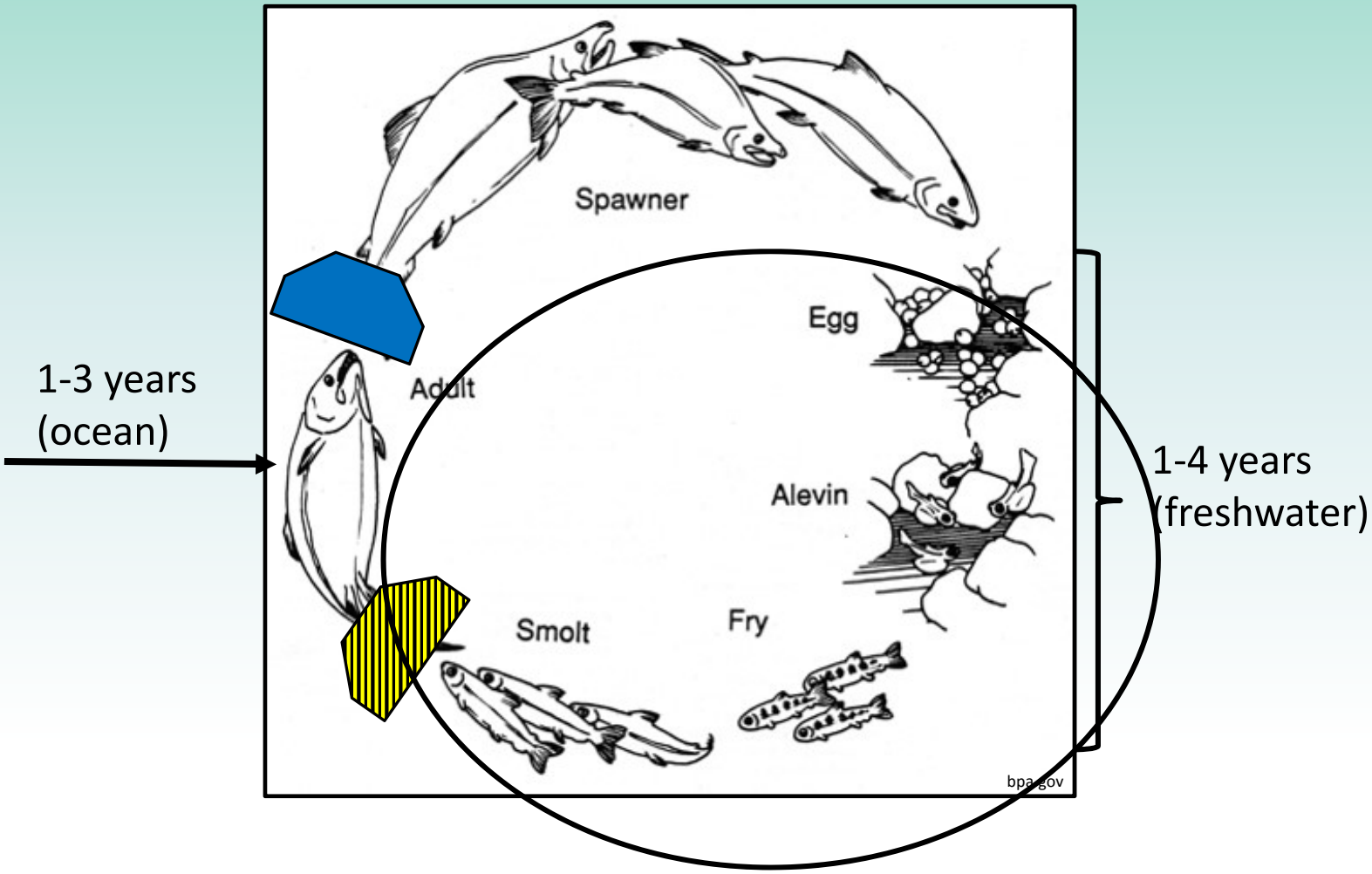
A) Produce fish for field collaborators

B) Aim for “Wild Phenotype” target

C) Investigate methods in hatchery circumstances that result in a fish that resembles a wild phenotype

Study Area


WILLAMETTE
VALLEY
CASCADE RANGE
Big Cliff Dam
Detroit Dam
Mill City
Jefferson
Stayton
Mehama
Detroit
Detroit Lake
EXPLANATION
Meteorological station
USGS gaging station
Dam
Study area
OREGON
OREGON
0 5 10 MILES
0 5 10 KILOMETERS


1-3 years
(ocean)
Spawner
Egg
Adult
Alevin
Smolt
Fry
1-4 years
(freshwater)
bpa.gov

Egg size growth study

1. Life history implications for steelhead trout

2. Important for surrogate project

Why egg size?

Salmonid egg size investigation

Effects of egg size on offspring development and fitness in brown trout, *Salmo trutta* L.

A.F. Ojanguren *, F.G. Reyes-Gavilán, F. Braña

Departamento de Biología de Organismos y Sistemas, Universidad de Oviedo, 33071Oviedo, Spain

Accepted 9 July 1996

Bigger is not always better: egg size influences survival throughout incubation in brown trout (*Salmo trutta*)

Thomas Régnier[1,2], Valérie Bolliet[1,2], Philippe Gaudin[1,2], Jacques Labonne[1,2]

[1]INRA-UMR ECOBIOP, Pôle d'Hydrobiologie INRA, Saint Pée sur Nivelle, France

[2]UPPA-UMR ECOBIOP, Pôle d'Hydrobiologie INRA, Saint Pée sur Nivelle, France

Accepted for publication October 24, 2012

Effect of Female Size, Egg Size, and Water Temperature on Developmental Biology of Chum Salmon (*Oncorhynchus keta*) from the Nitinat River, British Columbia

Terry D. Beacham and Clyde B. Murray

Department of Fisheries and Oceans, Fisheries Research Branch, Pacific Biological Station, Nanaimo, B.C. V9T 5K6

Effect of maternal growth history on egg number and size in wild white-spotted char (*Salvelinus leucomaenis*)

Kentaro Morita, Shoichiro Yamamoto, Yoshinobu Takashima, Takashi Matsuishi, Yasuji Kanno, and Kinya Nishimura

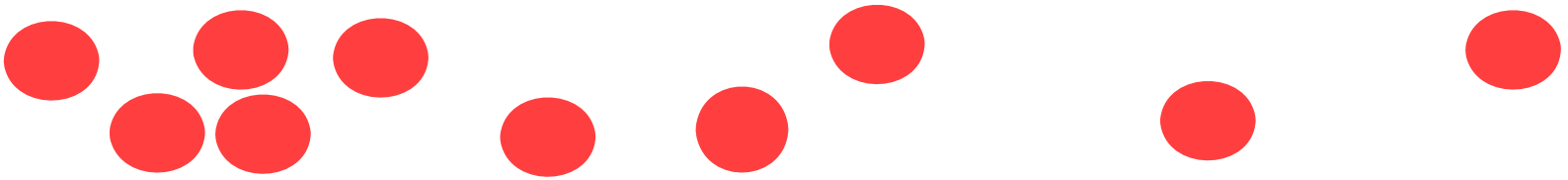
Study Questions

1. Does the growth rate of juvenile steelhead trout differ in offspring from eggs of different sizes?

H_1: Small-egg origin offspring will grow more quickly than large-egg origin offspring over time.

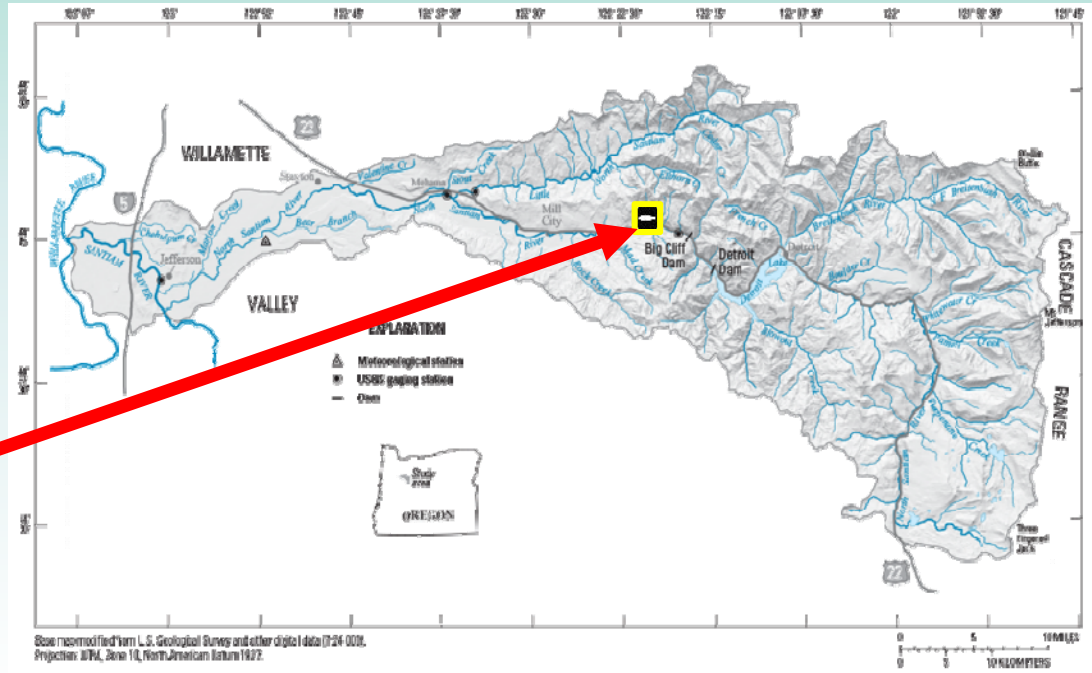
2. Is the growth rate of juvenile steelhead trout affected by rearing group?

H_2: The growth rates of small and large-egg origin fish will differ between small, large, and mixed rearing groups.

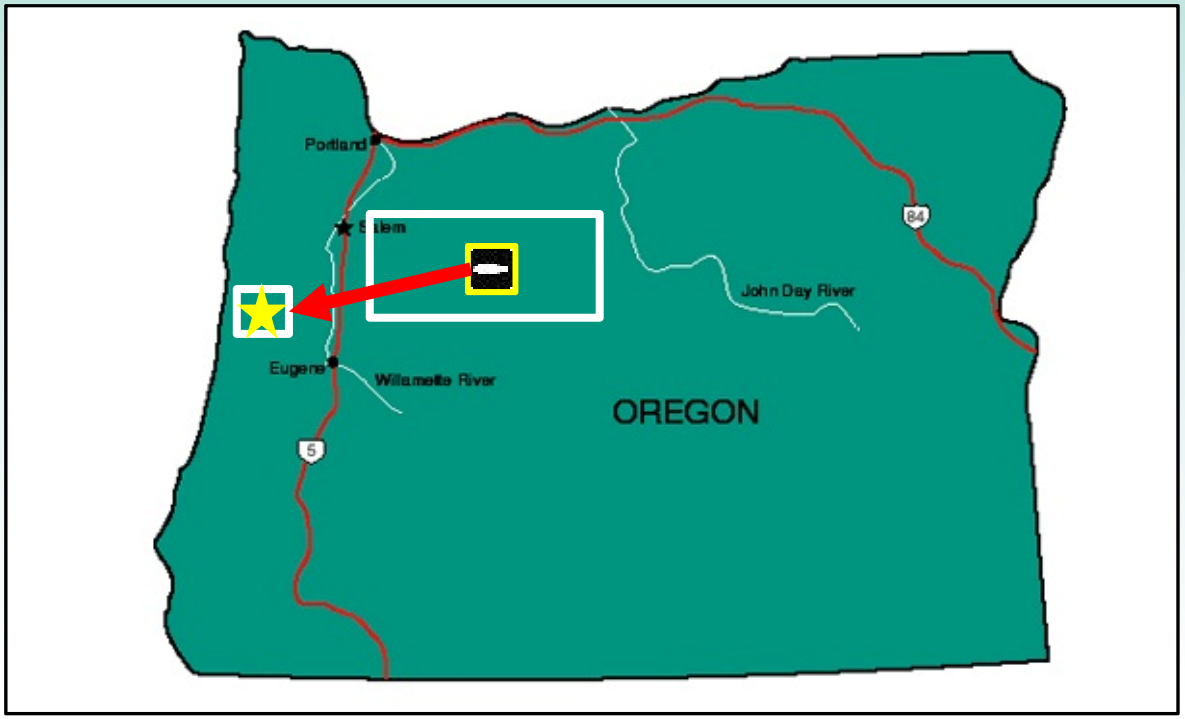


Fish spawned April 2014

Minto Fish Collection Facility



Fish spawned April 2014

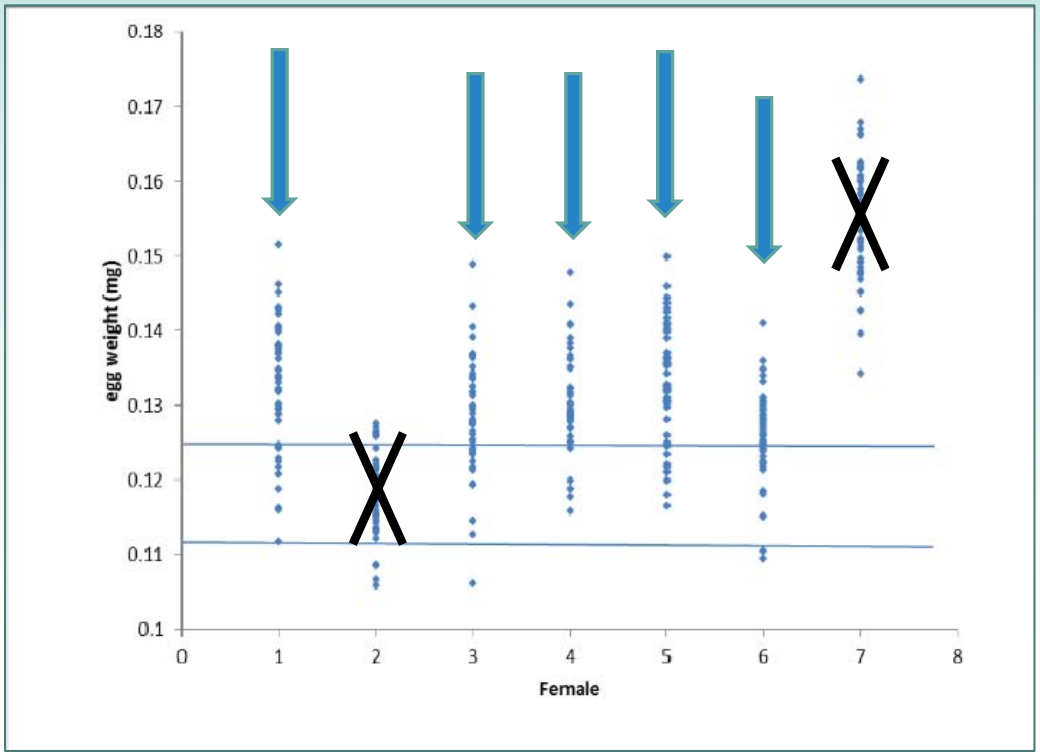


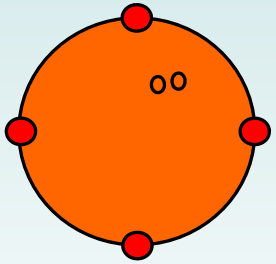
Transported to OHRC

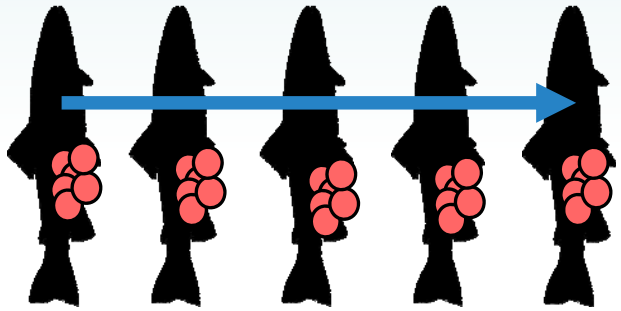
Methods

- Each female's eggs kept in separate isolet(s) within heath trays
- Incubated until eyed egg stage
- Sorted within female by weight at eyed egg stage

Egg size determination

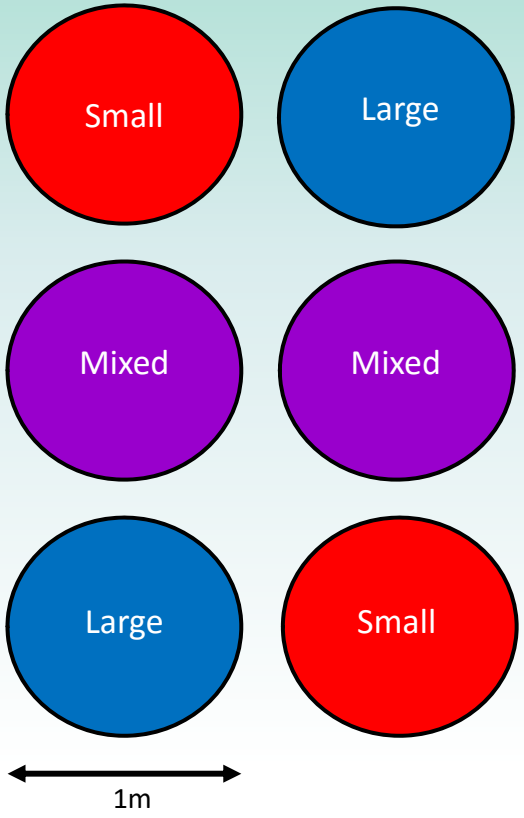






Study design

- VIE tags and pelvic fin clips
- Monthly sampling
  - Subset (30/tank)

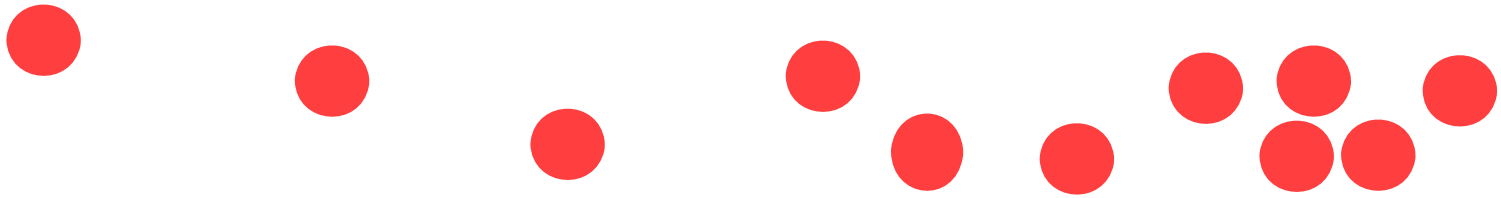


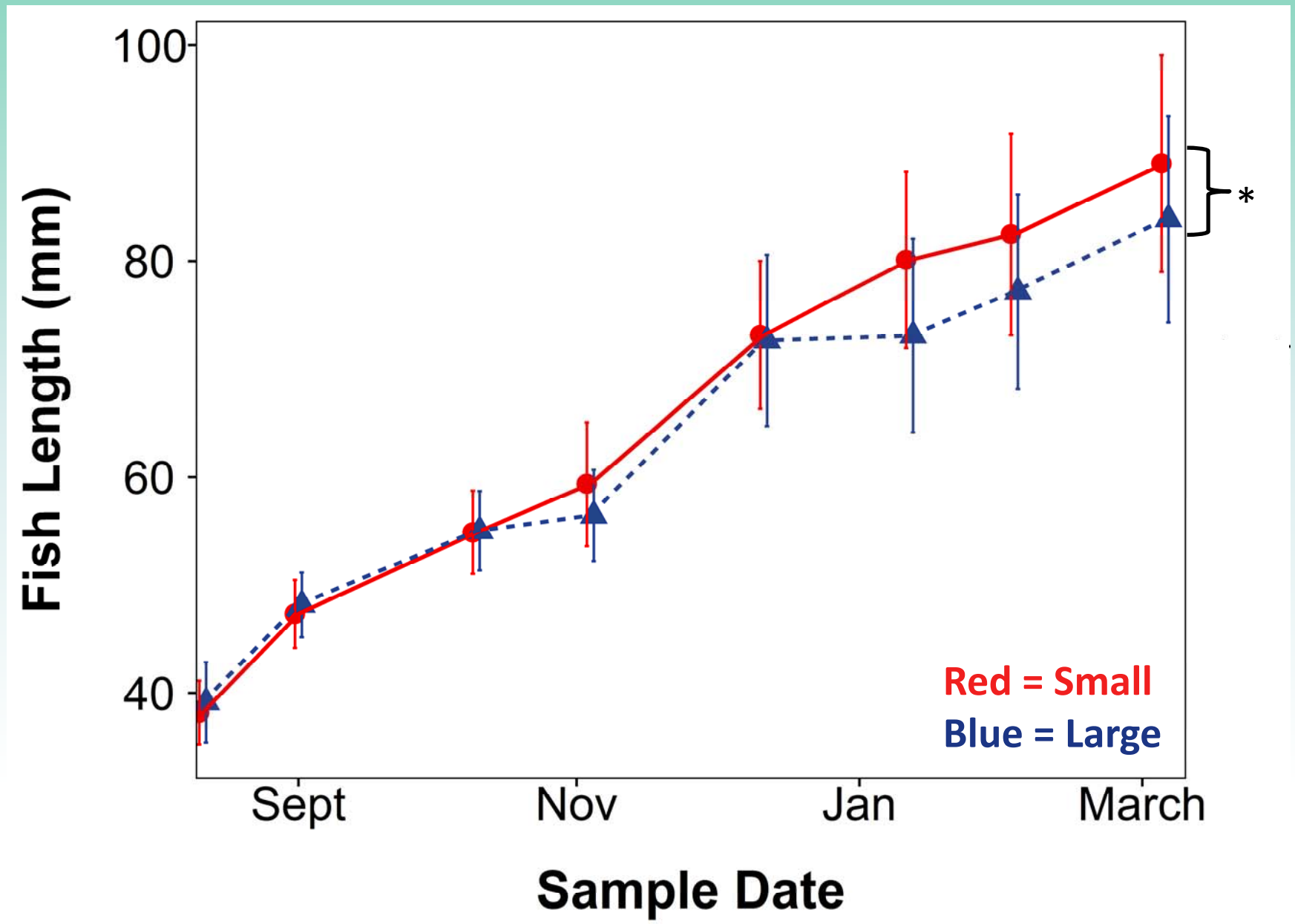
N = 100 fish/tank

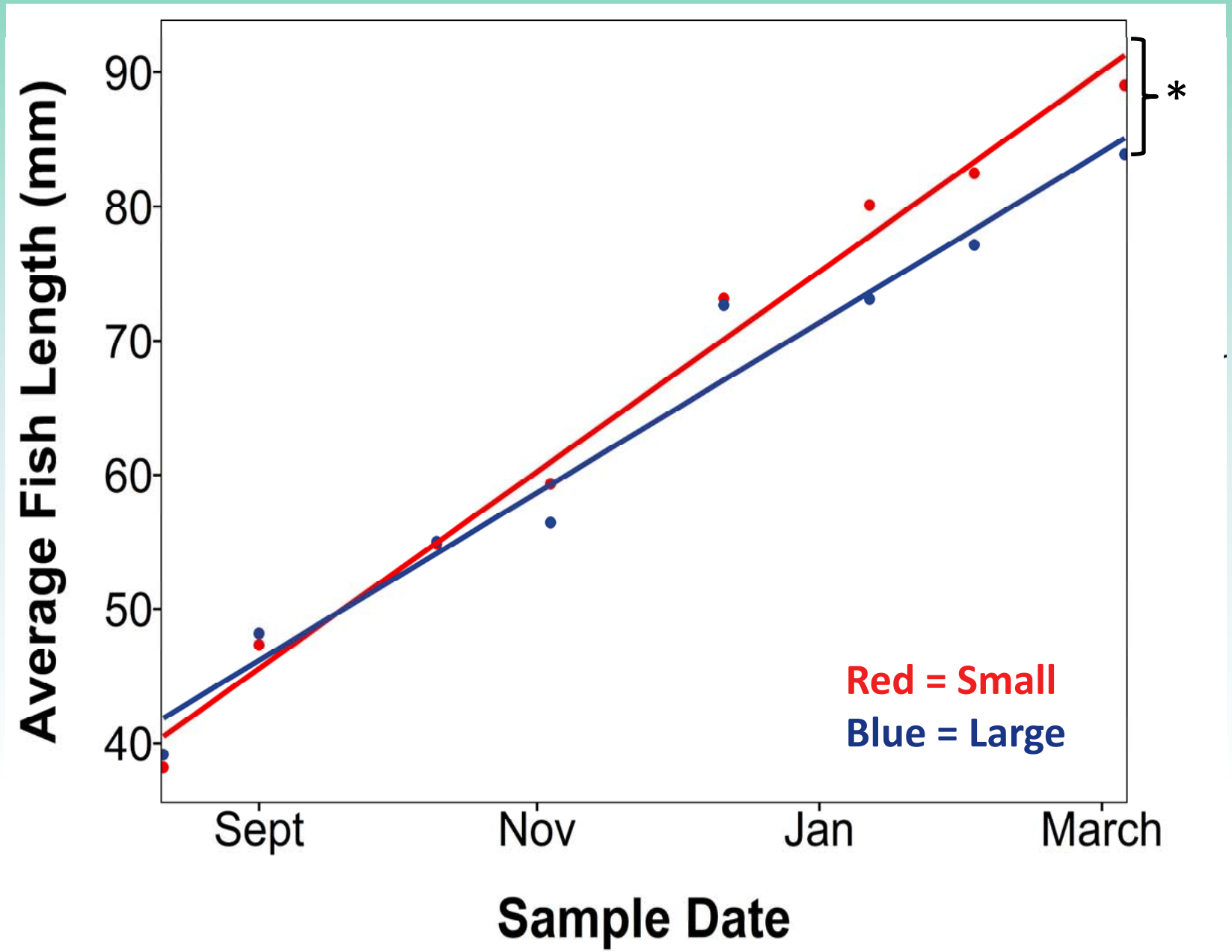
Linear Model 1

Length ~ treatment + date + treatment*date + (1|tank)

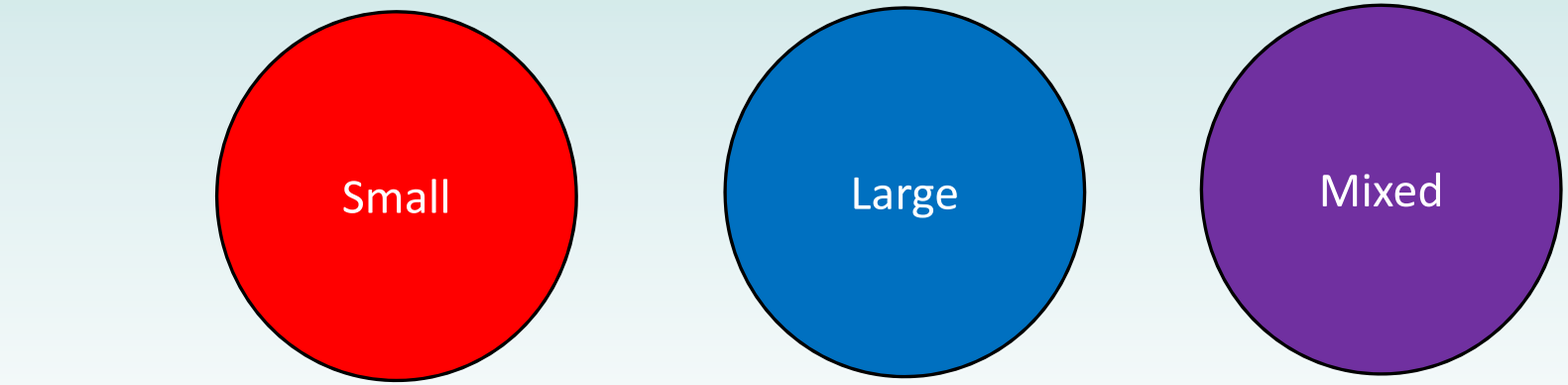
Q1. Does the growth rate of juvenile steelhead differ in offspring from eggs of different sizes?

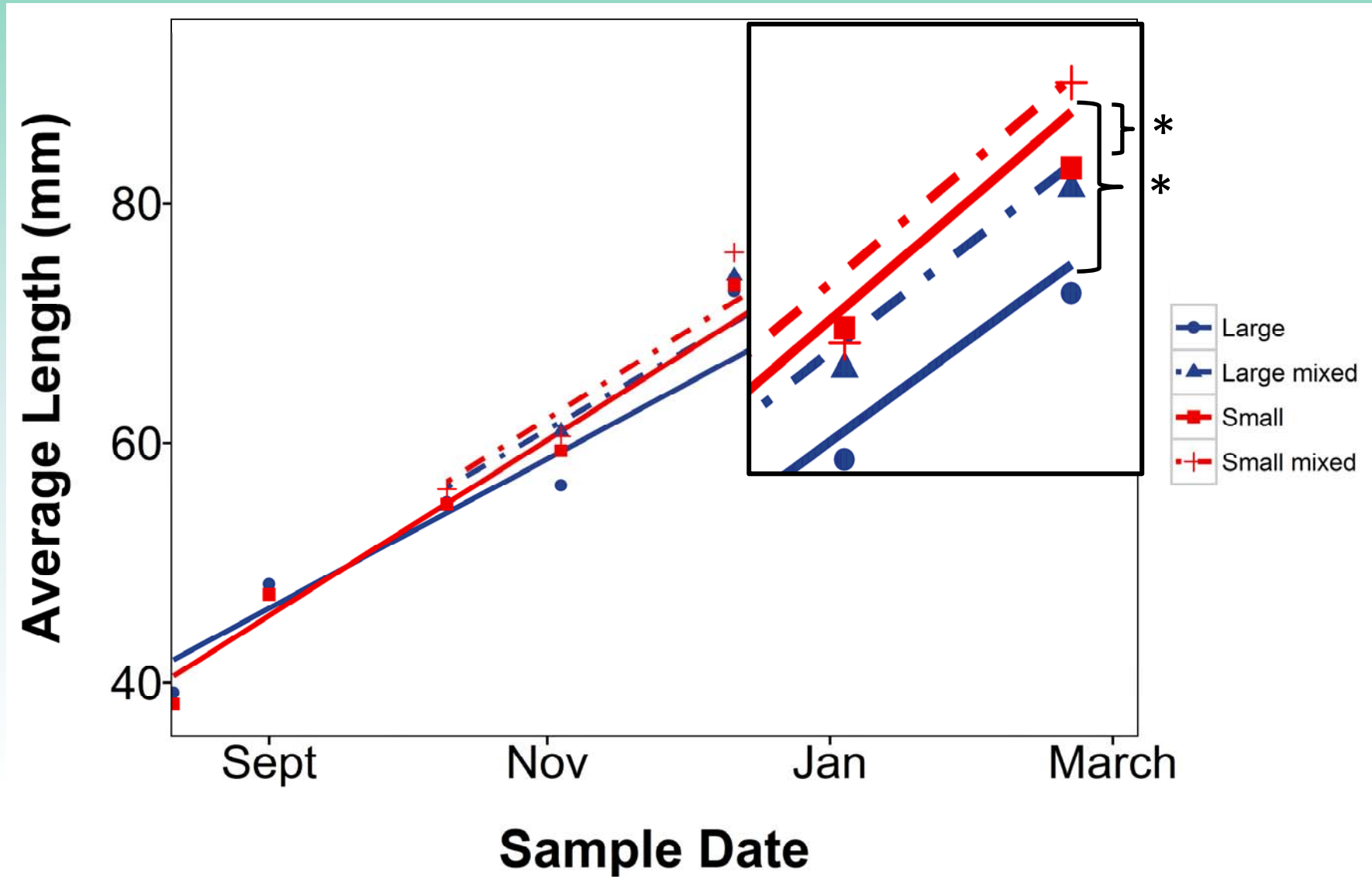



100
80
60
40
Fish Length (mm)
Sept
Nov
Jan
March
Sample Date
*
Red = Small
Blue = Large


Average Fish Length (mm)
90
80
70
60
50
40
*
Red = Small
Blue = Large
Sept
Nov
Jan
March
Sample Date

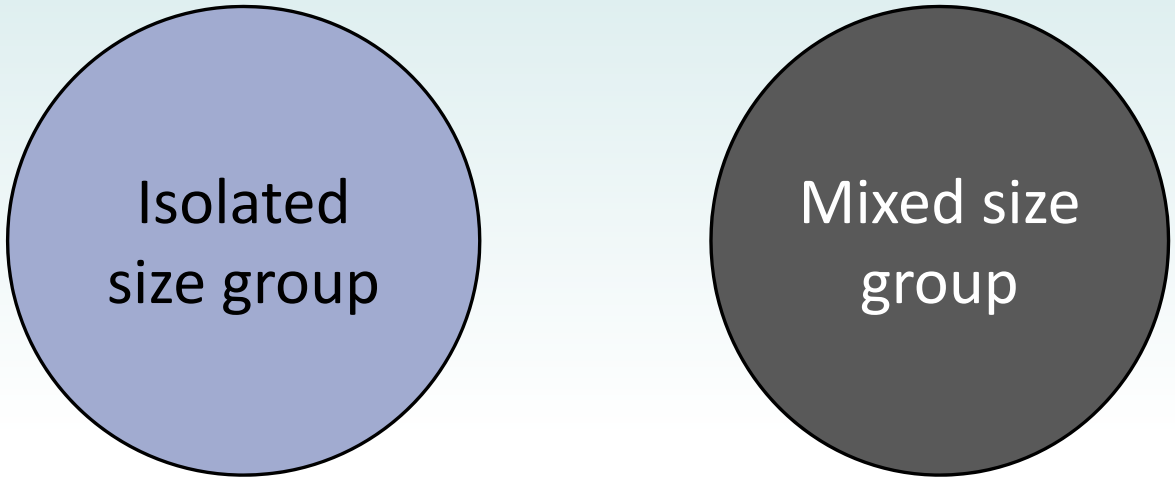
Q2. Is the growth rate of juvenile steelhead trout affected by rearing group?



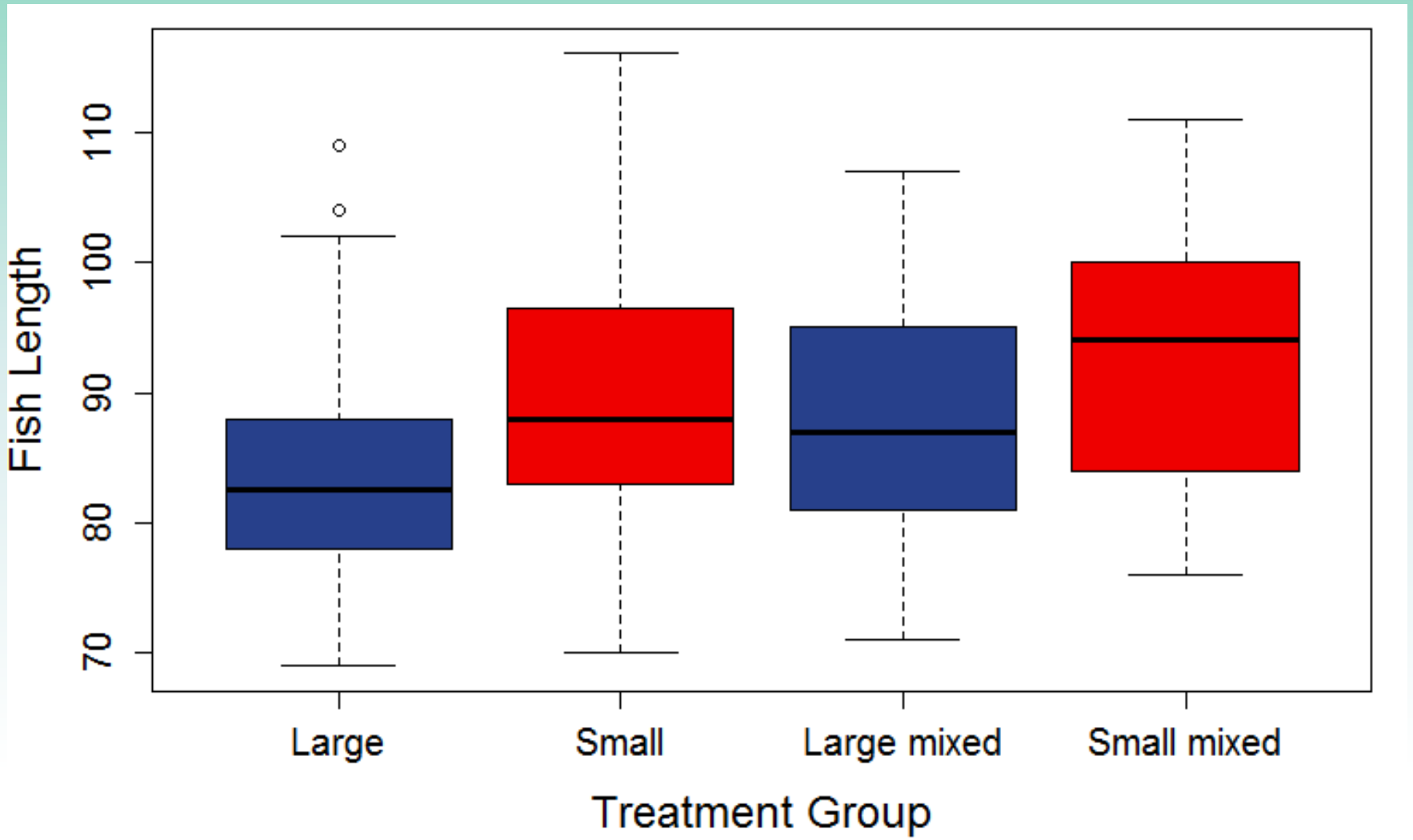

Average Length (mm)
80
60
40
Sept
Nov
Jan
March
Sample Date
*
*
Large
Large mixed
Small
Small mixed

Linear Model 2

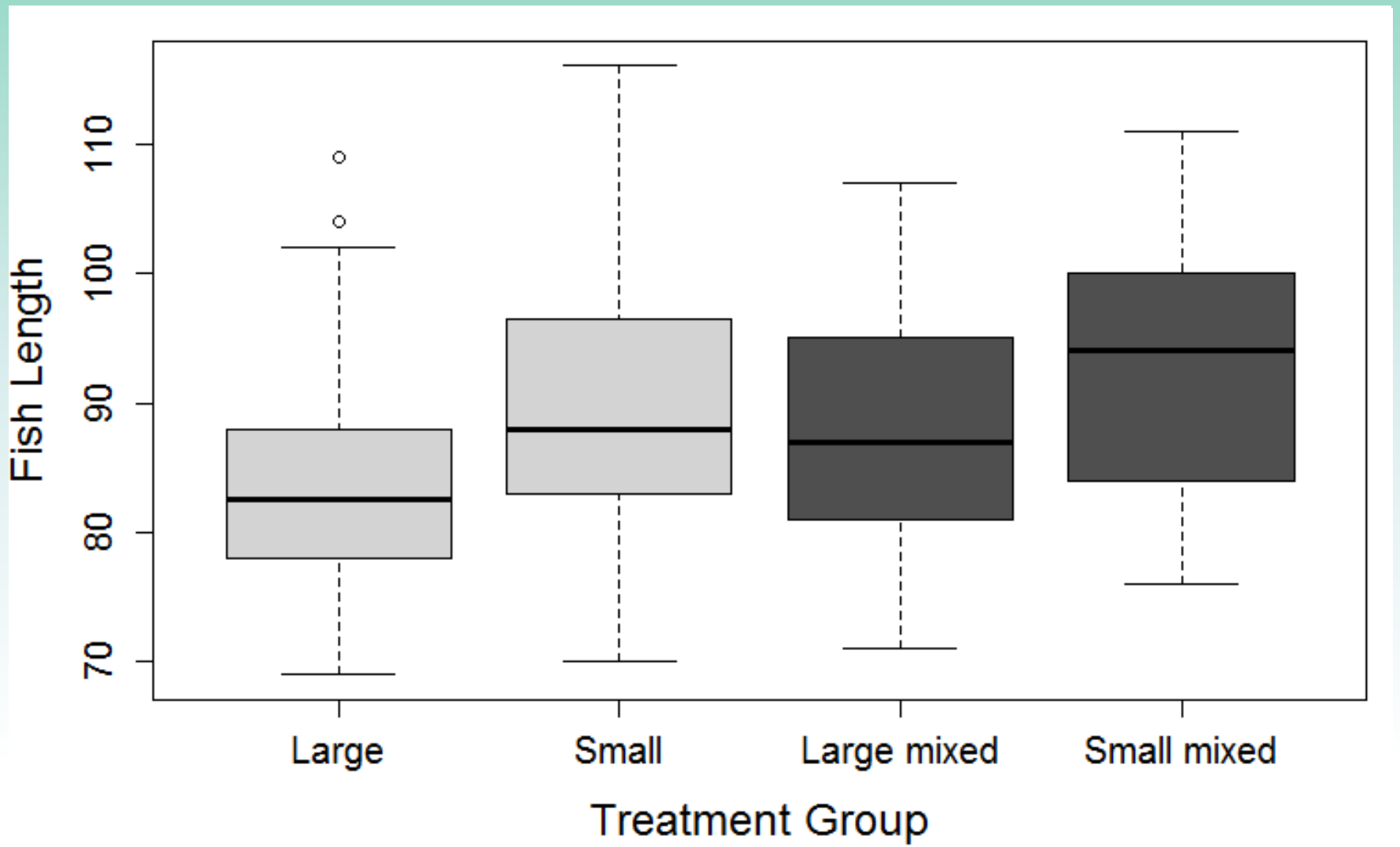
Length ~ treatment + mixed + date



Day 212

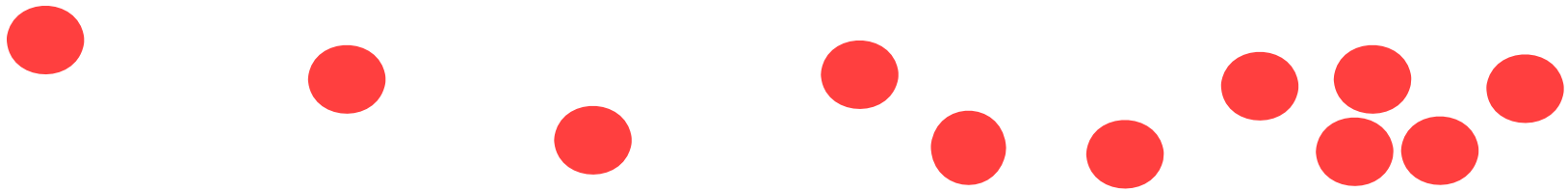

Fish Length
70
80
90
100
110
Large
Small
Large mixed
Small mixed
Treatment Group

Day 212


Fish Length
70
80
90
100
110
Large
Small
Large mixed
Small mixed
Treatment Group

Summary

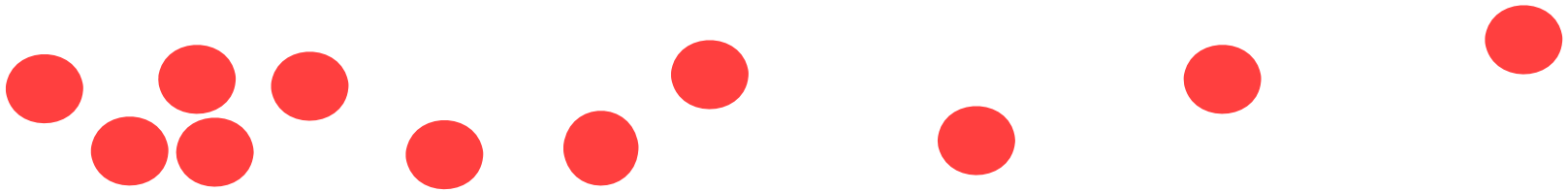
- In all cases, within female variation in egg size was significant
- Fish from the smallest eggs had longer final lengths than fish from the largest eggs
- Fish reared in a mixed treatment grew longer than fish reared in uniform groups



So what?

- Wild Fishes Surrogate Project
  - Implications for rearing
  - Counter-intuitive information for hatchery managers

- Life history
  - May be an indicator for future life history tactic choices
  - Possible reflection of a bet-hedging tactic on the part of the female to increase the diversity of her offspring?

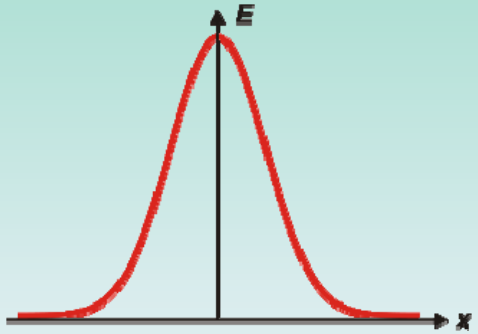


Acknowledgments

Cameron Sharpe
Alix Gitelman
Ryan Couture
Joyce Mahr
Joseph O'Neil
Julia Unrein
Olivia Hakanson
Heather Stewart
Rob Chitwood
Courtney Danley
Bill Brignon
Parr Group
Oregon Cooperative FW Unit


Thank you

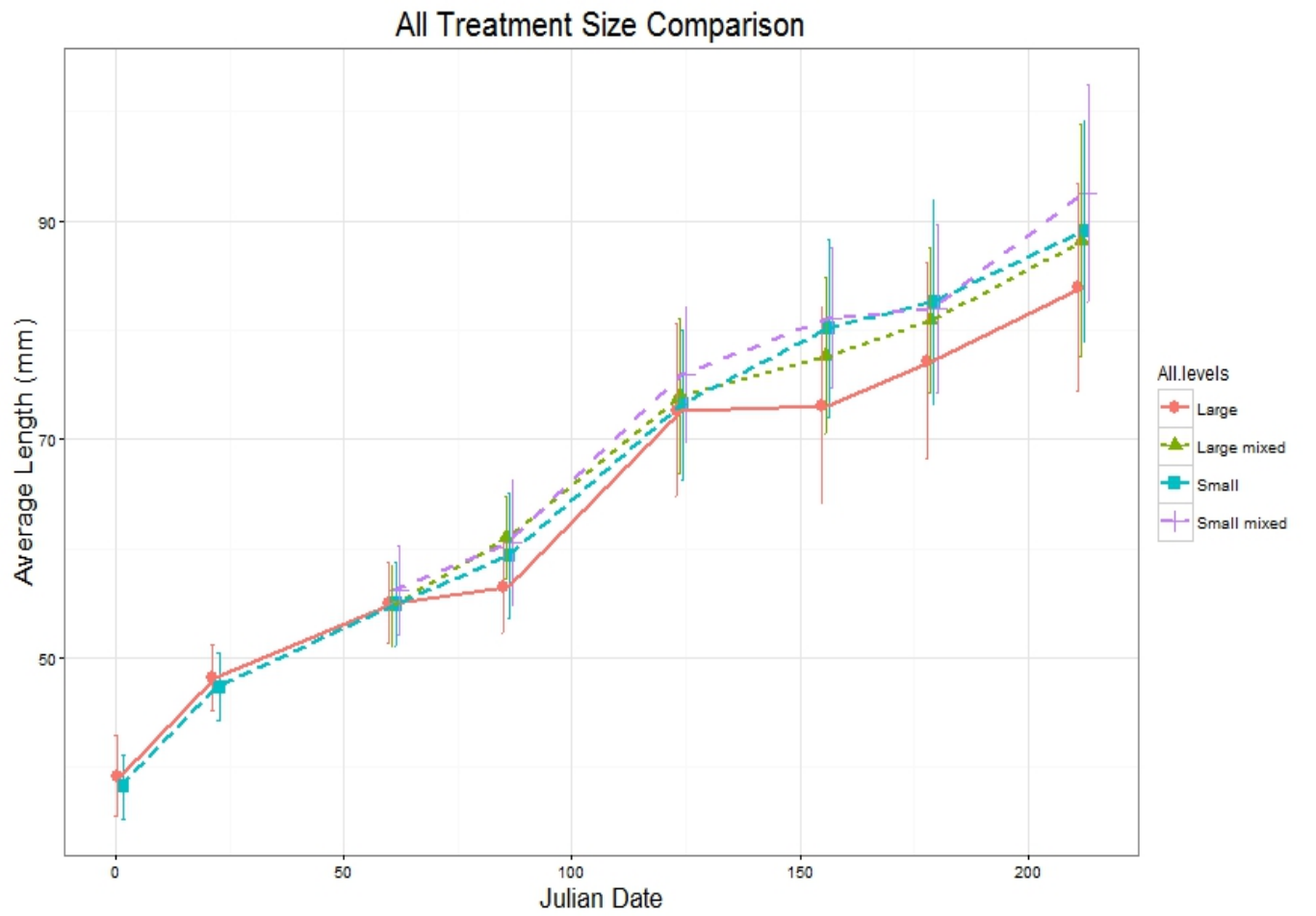
Statistics



Normal distribution observed

Tested with small and large treatments as reference levels

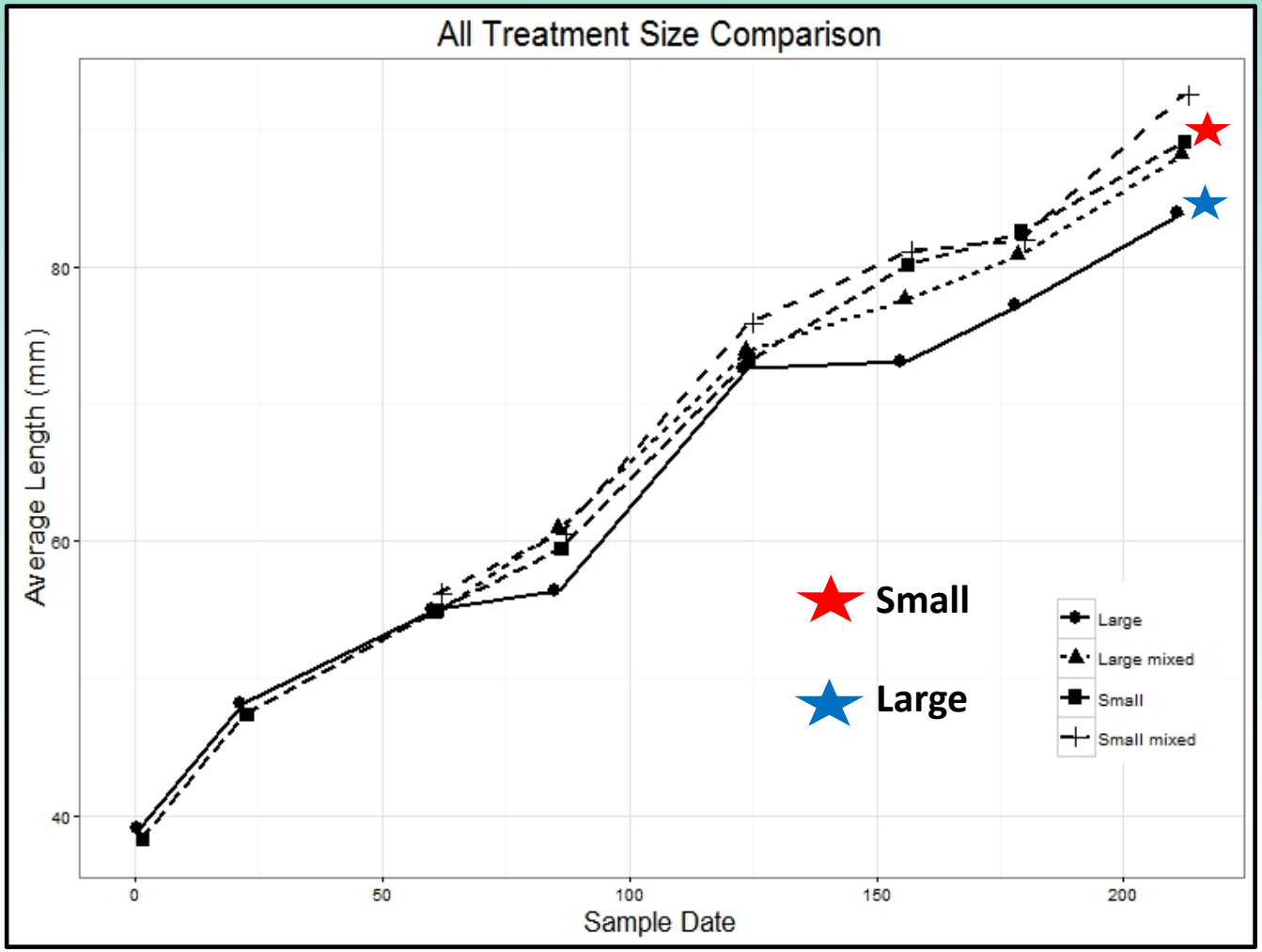
Figures show log-transformed data



Significant Interaction
$F_{1,242.3} = 0.0327$

Pairwise:
Small to Large
P = 0.006

Large Mixed to Small
P = 0.06



Significant Interaction
$F_{1,242.3} = 0.0327$

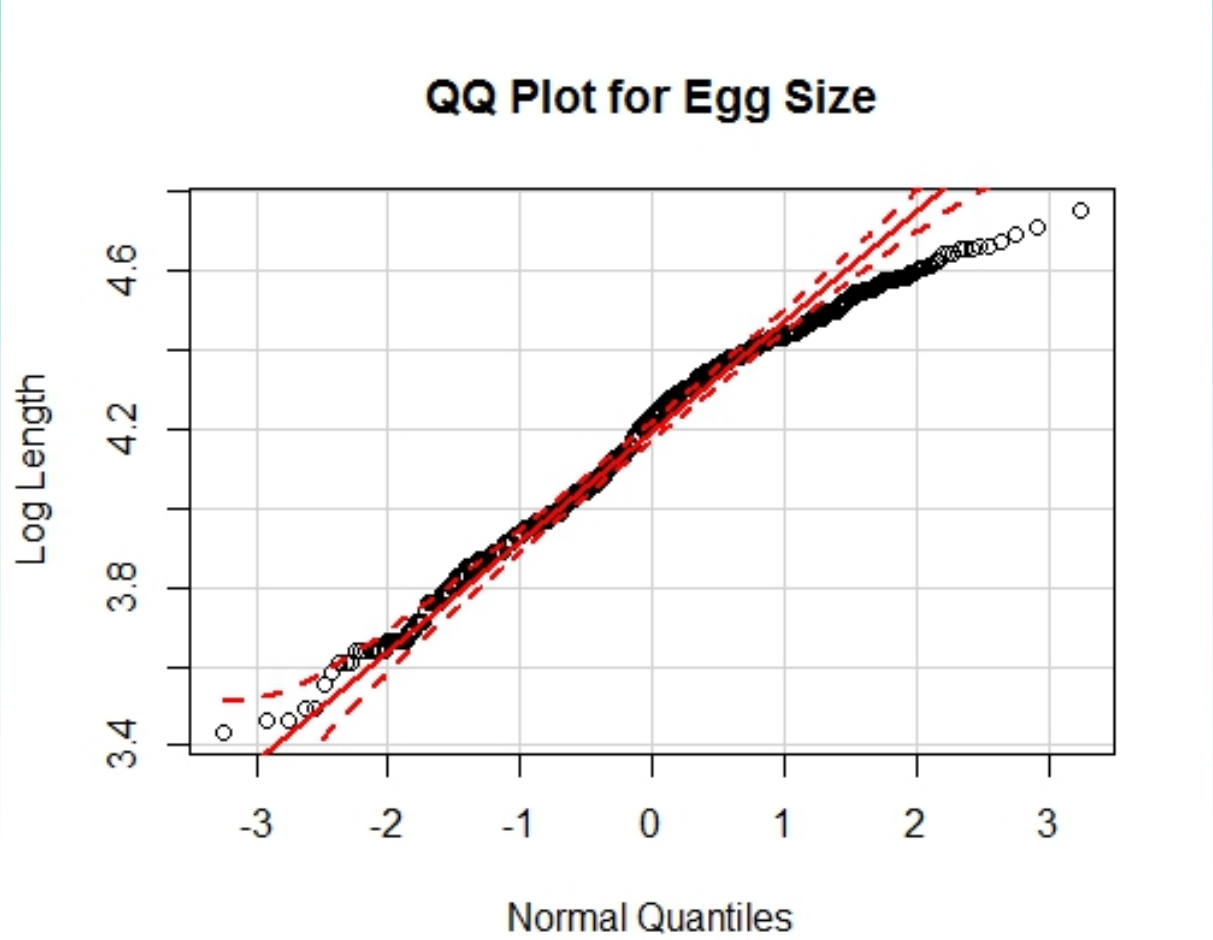
Pairwise:
Small to Large
P = 0.006

Large Mixed to Small
P = 0.06

Objectives of egg size growth study

1) Assess morphometric differences between two distinct egg size groups

2) Assess short-term and long-term effects on growth and development when the two size groups are reared together versus alone


QQ Plot for Egg Size
Log Length
3.4
3.8
4.2
4.6
-3
-2
-1
0
1
2
3
Normal Quantiles

Variation in fish length