


A COMPARISON OF  
GROWTH TRAJECTORIES  
IN IMMATURE MALE,  
FEMALE, AND  
PRECOCIOUSLY MATURING  
MINIJACK SPRING  
CHINOOK SALMON



Lea R. Medeiros  
Andrew L. Pierce  
Curtis M. Knudsen  
Chad Stockton  
Illana Koch  
Sean Narum  
Peter F. Galbreath

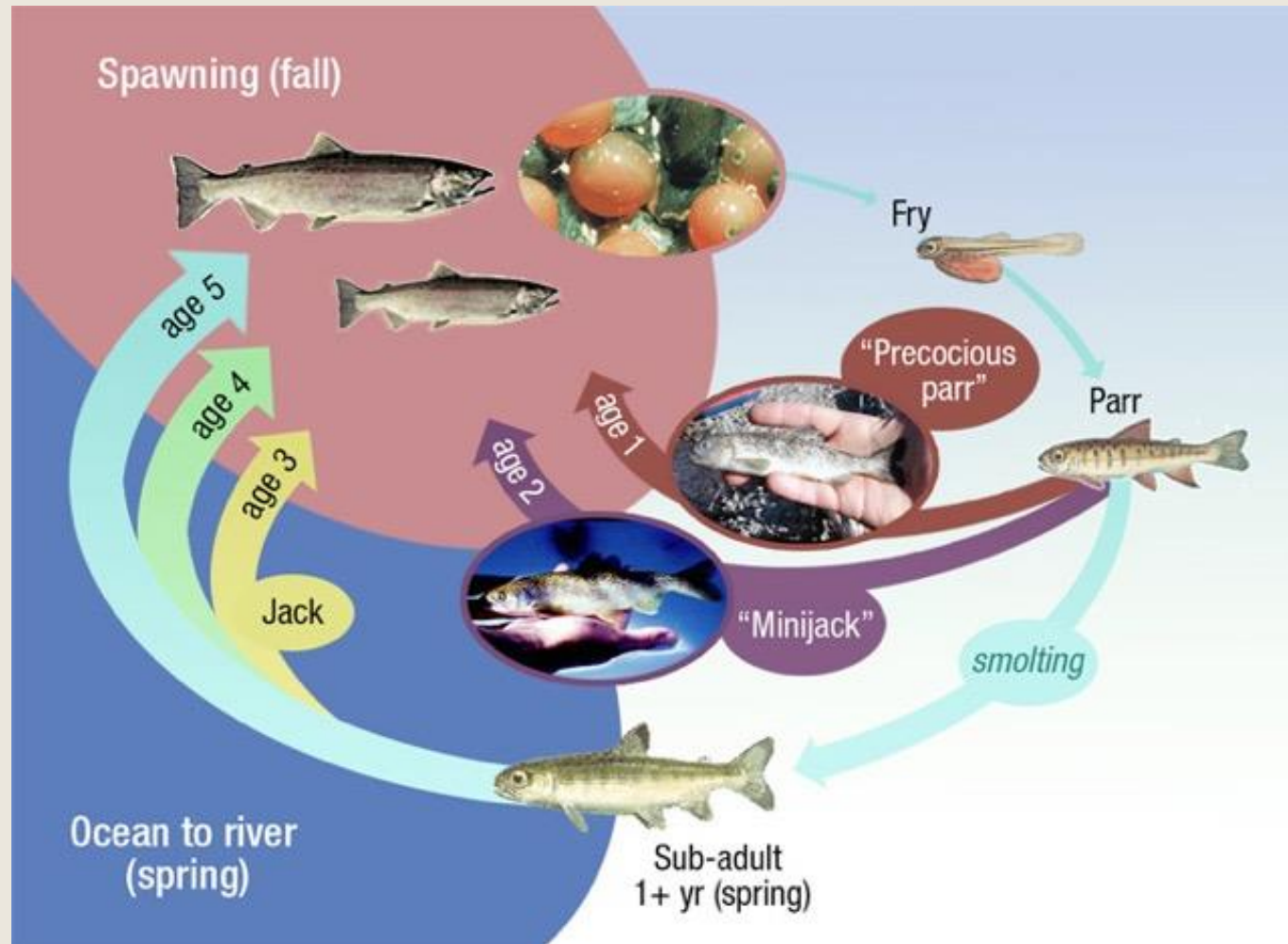




# RATIONALE & STUDY DESIGN

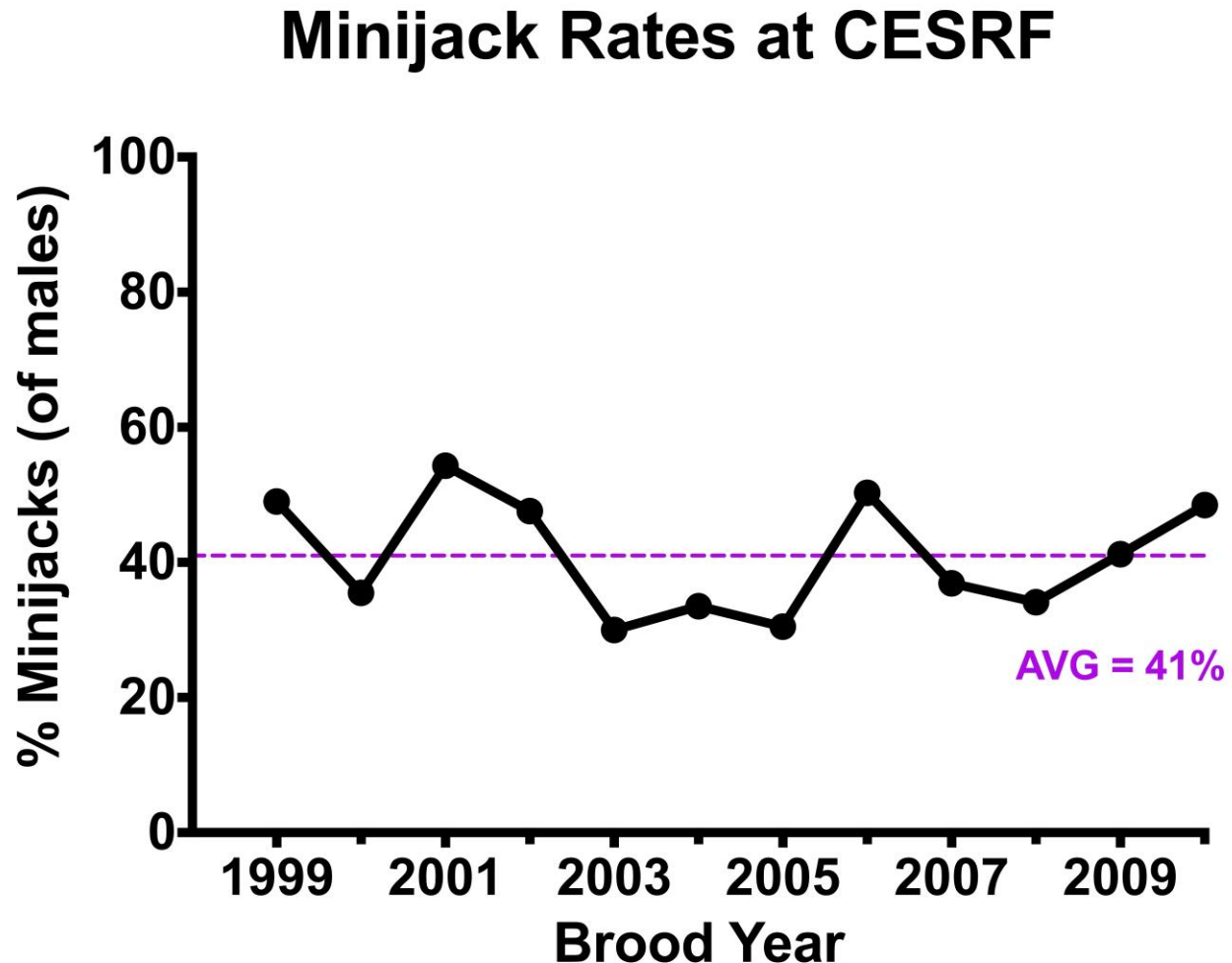


# Hatchery Spring Chinook Life History



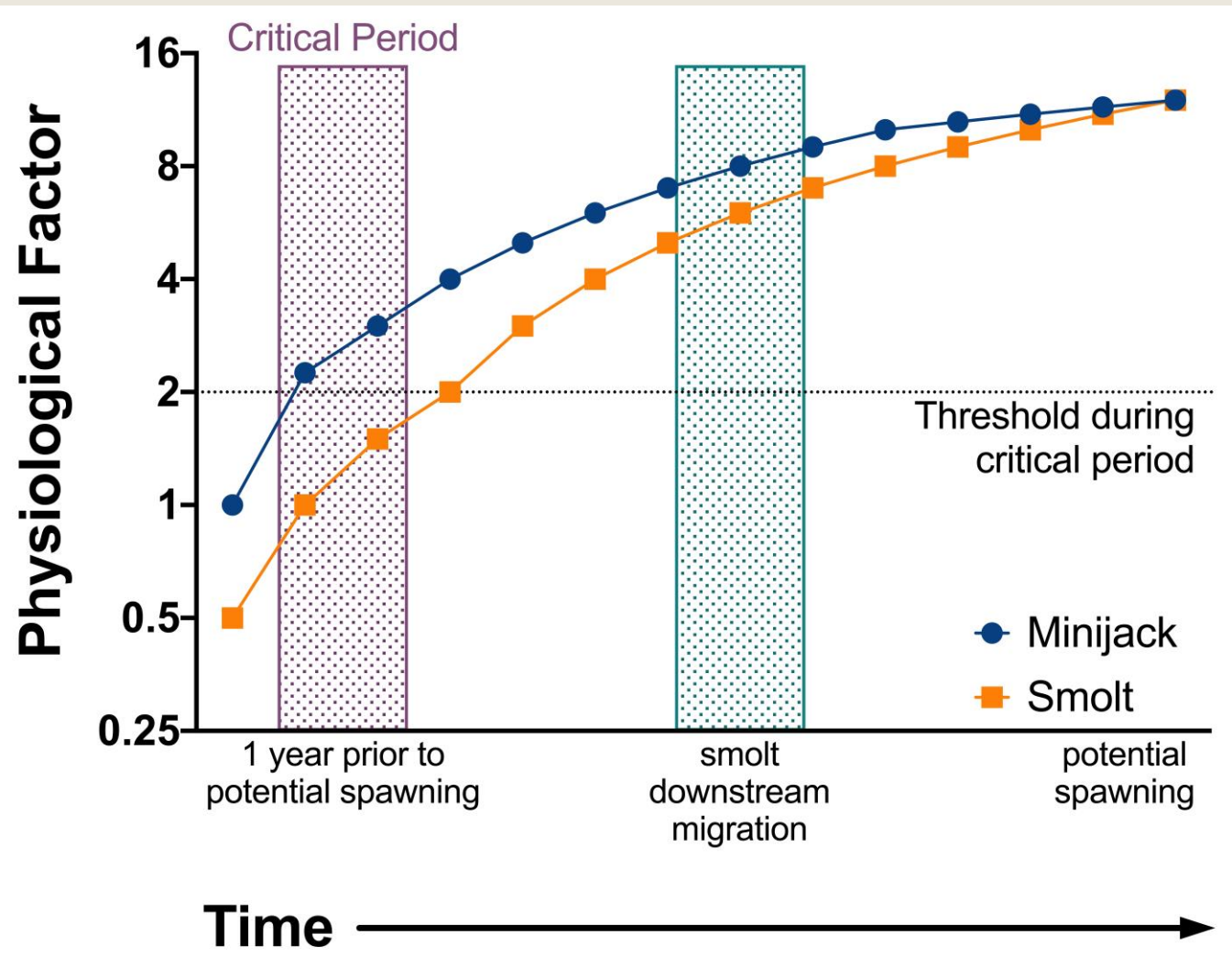
- Normal life history is similar to other salmonids
- Alternative life history strategies involve precociously maturing males
  - *Jacks mature 3 years post-fertilization*
  - *Precocious parr mature 1 year post-fertilization*
  - *Minijacks mature 2 years post-fertilization*

# Nature versus nurture



- CESRF wants to produce fish that are as similar to wild fish as possible
- Use WN x WN broodstock
- Rearing practices produce large, fat smolts to increase adult returns
- Raising WN x WN progeny in the hatchery setting seems to result in a larger proportion of minijacks than is seen in the wild

# Precocious Maturation: Growth & Energy Reserves



- The initiation of maturation occurs during seasonally defined critical period
- Still under debate what factor(s) control the decision to mature
  - *Growth rate?*
  - *Energy reserves (e.g., lipids)?*
- How do genetics factor in?

# Methods: Experimental Design

Evaluate growth rate over time for each individual to (1) identify if growth differs between smolts and minijacks and (2) identify/narrow down critical period

- BY17 SH progeny – fertilized in September/October 2017
  - *Known parentage*
- Fish were raised common garden
- Implanted with PIT tag in July 2018 (N = 737)





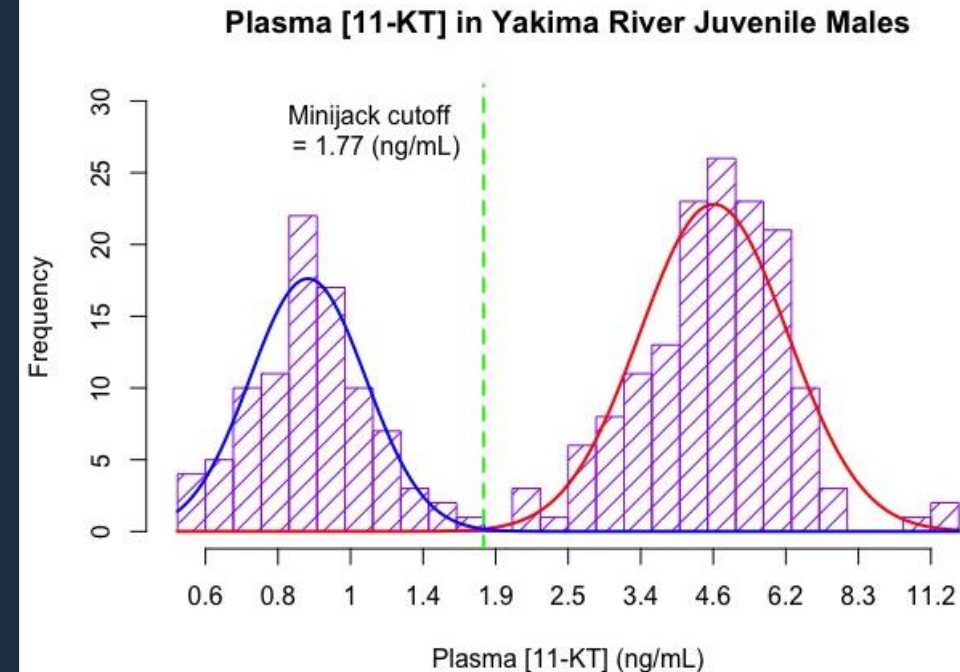
# Methods: Sampling and Processing

- Fish were lightly anesthetized every 3 weeks, and a fork length and body weight recorded
- Terminal samplings occurred on 9/12/18 (N = 194) and 4/10-4/11/19 (remaining fish, N = 467)
- Terminal samplings included:
  - *Fork length and body weight measurements*
  - *Blood sample*
  - *Liver sample*
  - *Pituitary sample*



# Methods: Statistics

- Maturity status was assigned based on 11-KT values
  - *Used finite mixture model to determine cutoff value*
  - *High maturation rate: 62.1%*
- Compared physiological factors between groups over time
  - *Body weight*
  - *Length*
  - *Condition factor*
- We do have parentage information, but the results presented here do not address that variable

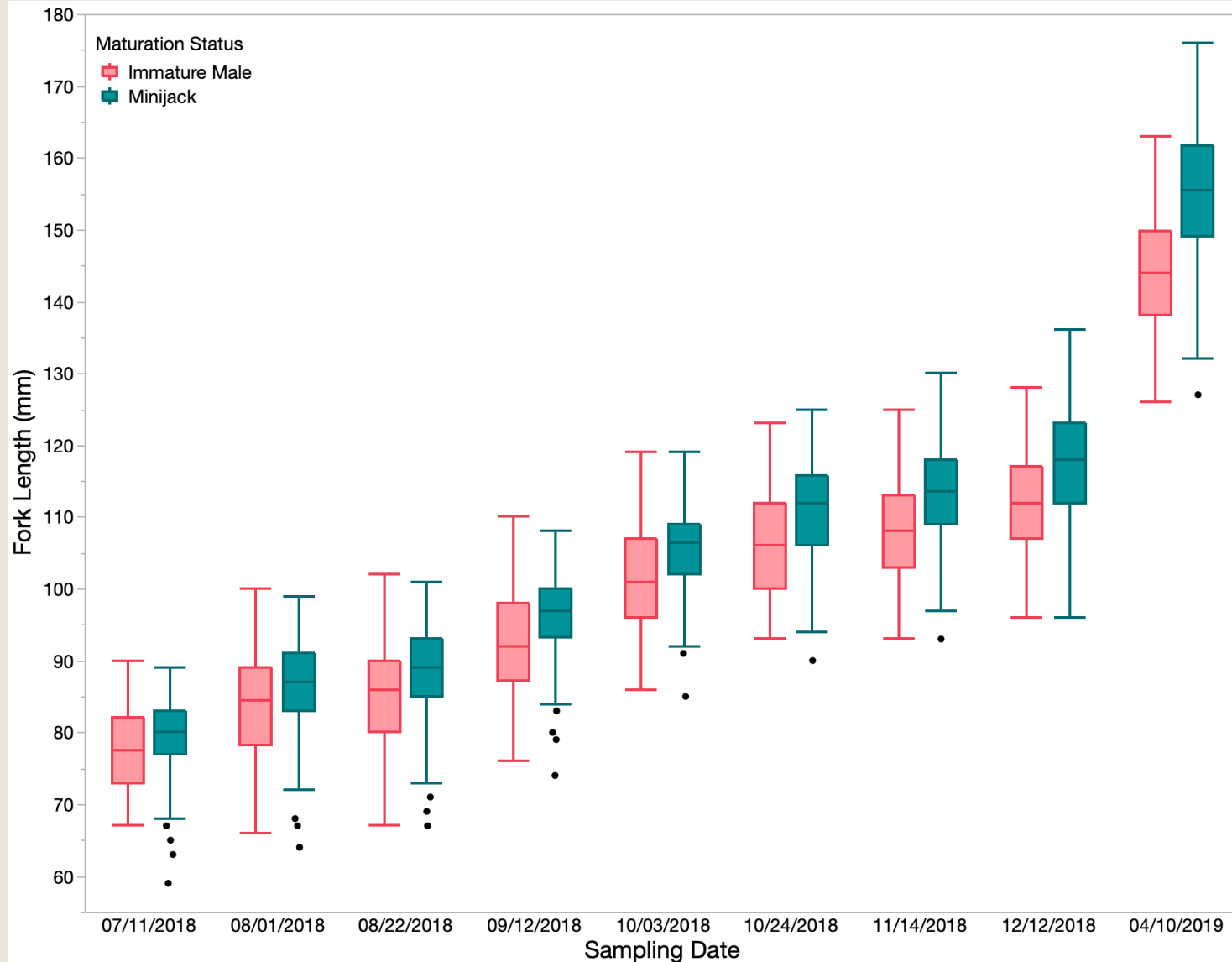






# RESULTS

Preliminary analysis of growth and maturation



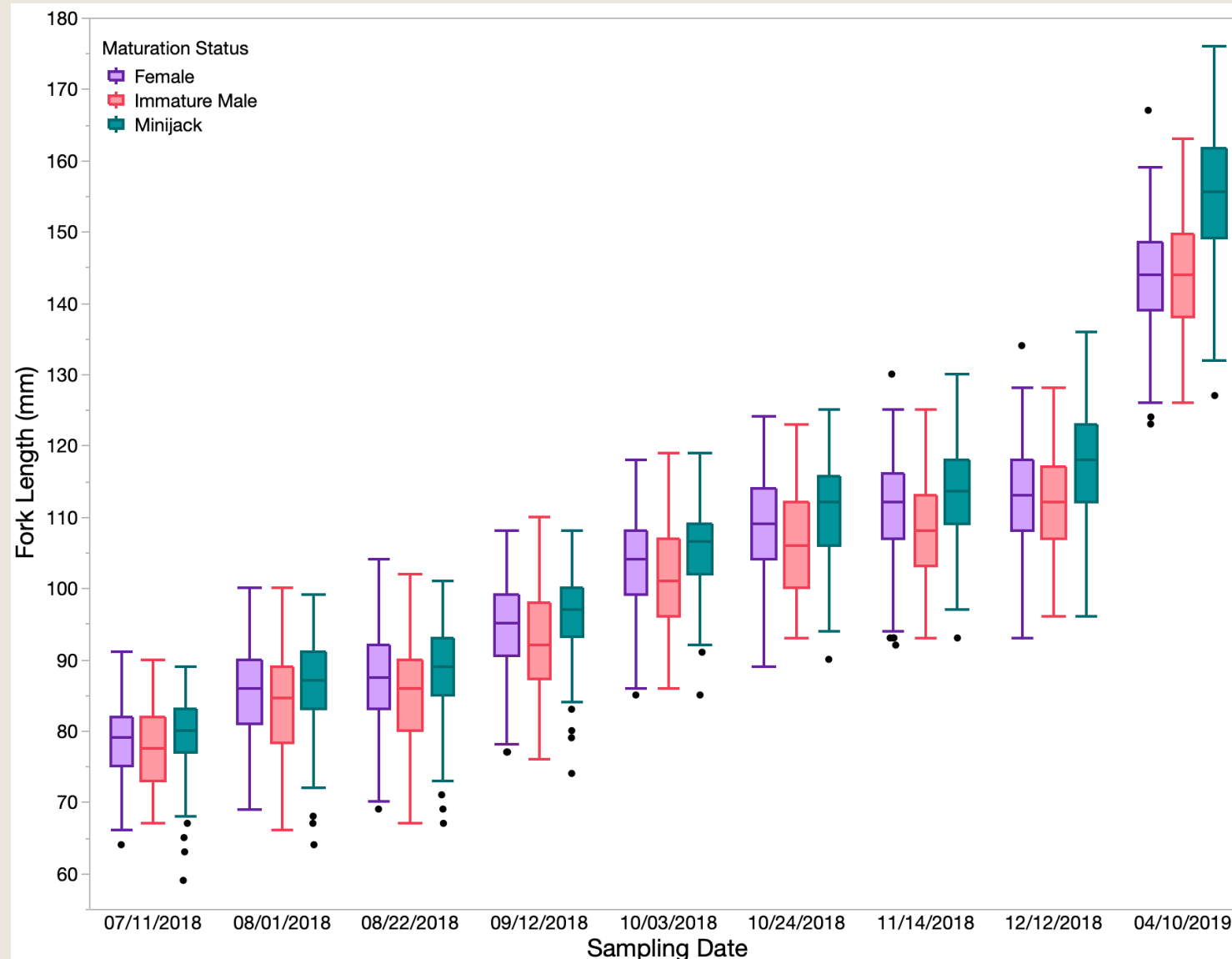
# Immature Males vs MJs Fork Length

- Significant difference in fork length exists by 7/11/18 sampling
- Remained different between immature males and minijacks throughout the experiment
- Preliminary logistic regressions suggest fork length may be important in determining maturation status

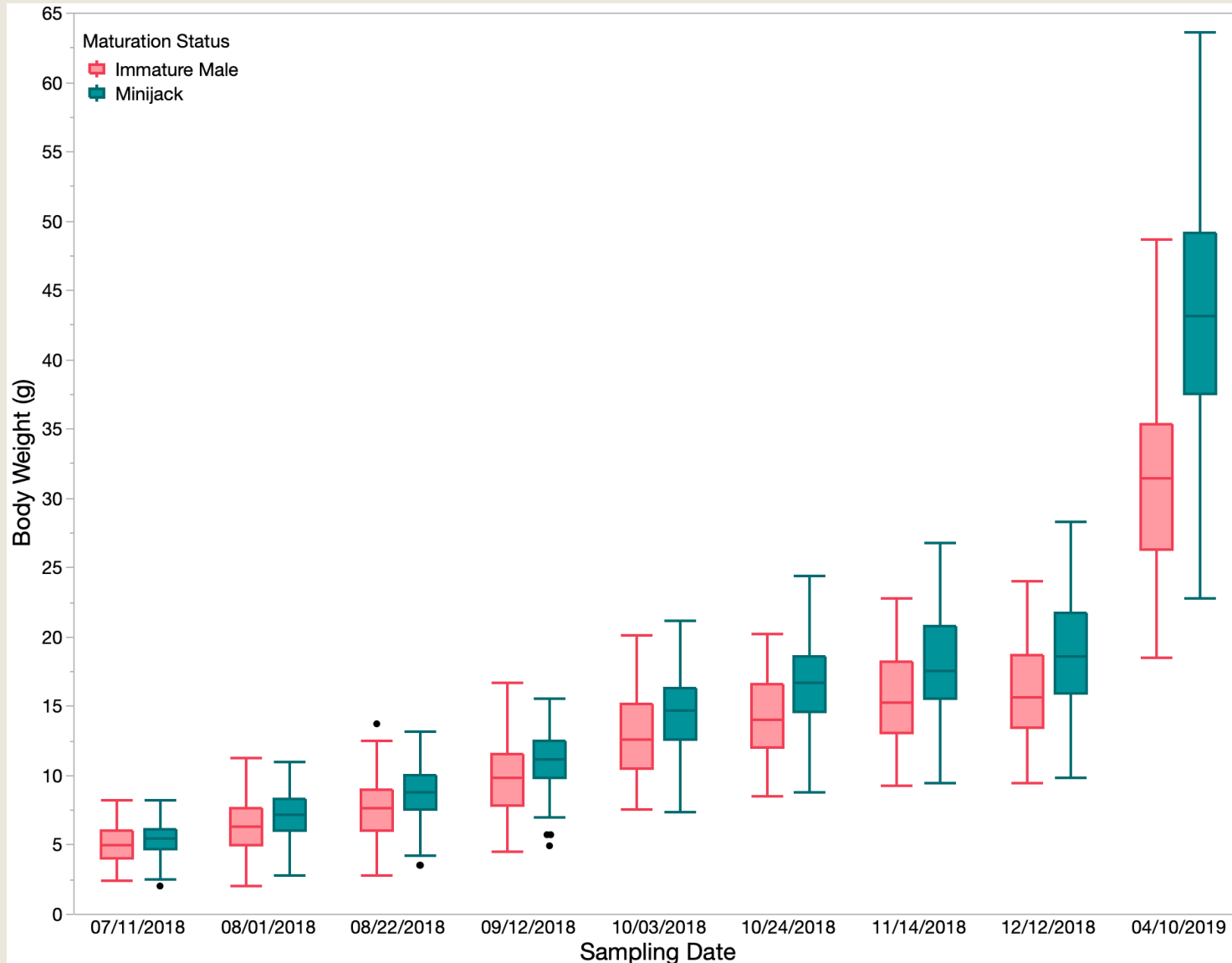
# All age 1+ Fish

## Fork Length

- Up until the final two samplings, immature males were significantly smaller than either females or minijacks
- Would have expected females and immature males to be more similar than females and minijacks







# Immature Males vs MJs

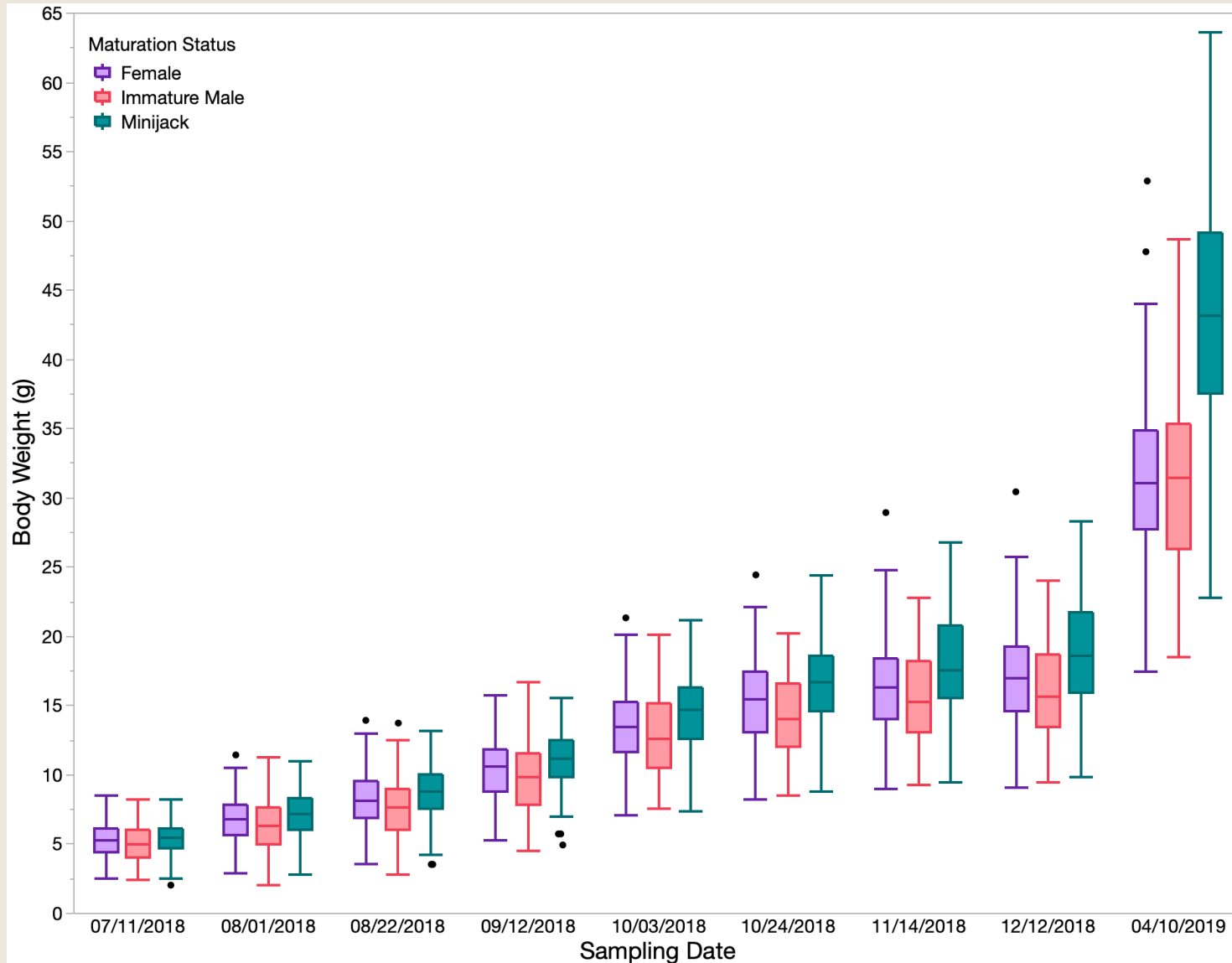
## Body Weight

- Significant difference between groups already exists by 7/11/18
- Remained significantly different throughout experiment
- Preliminary logistic regressions suggest that body weight may be important in determining maturation status

# All age 1+ Fish

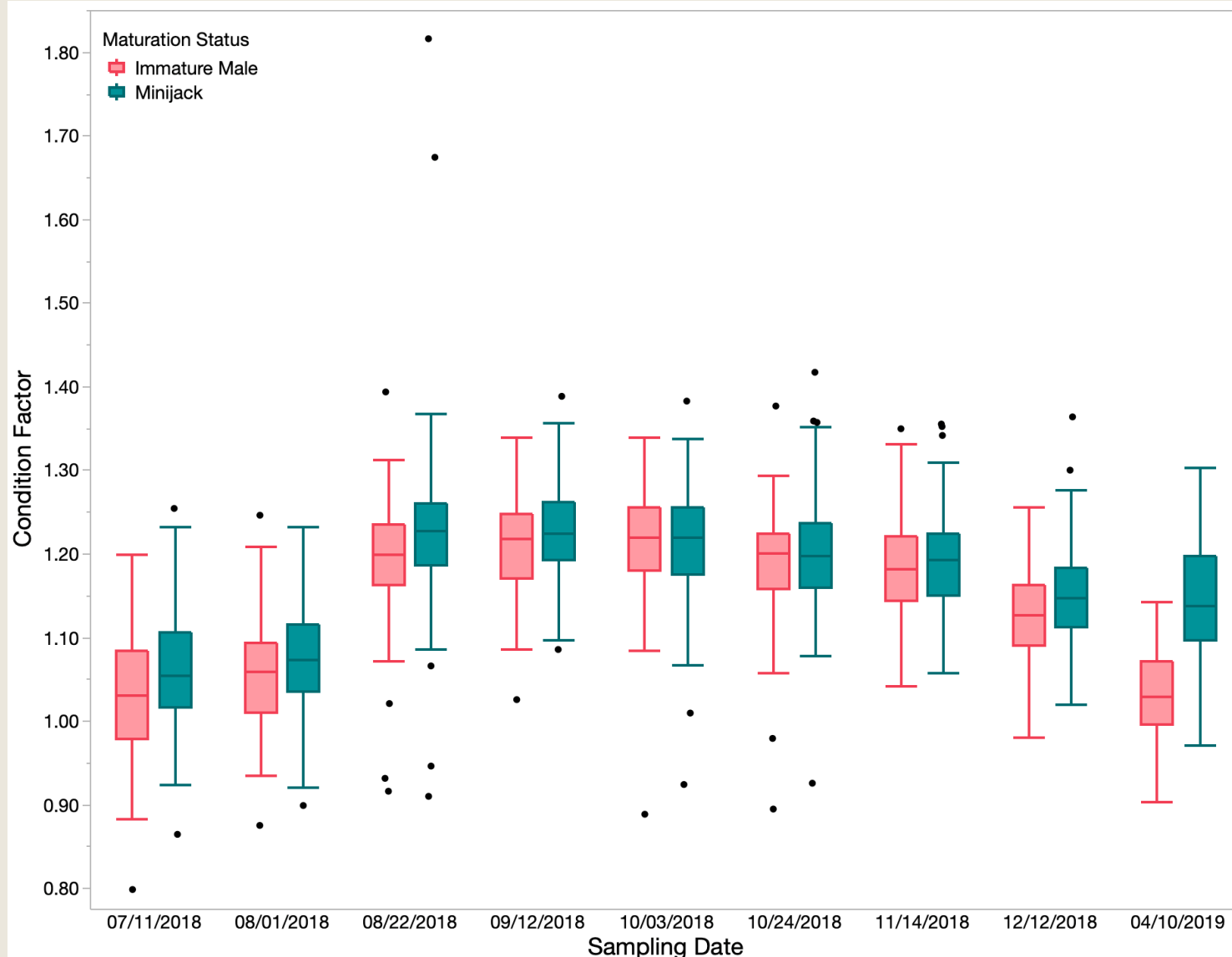
## Body Weight

- Minijacks tended to be heavier than females, which tended to be heavier than immature males (until final sampling)
- Surprising that immature males and females were different



# Immature Males vs MJs Condition Factor

- Significant differences in condition factor varied over time
  - *Different 7/11/18 through 8/22/18 and 12/12/18 through 4/10/19*
  - *Not different 9/12/18-11/14/18*
- MJ condition factor decreased less over the winter
  - *Probably due to developing gonads rather than true maintenance of weight*

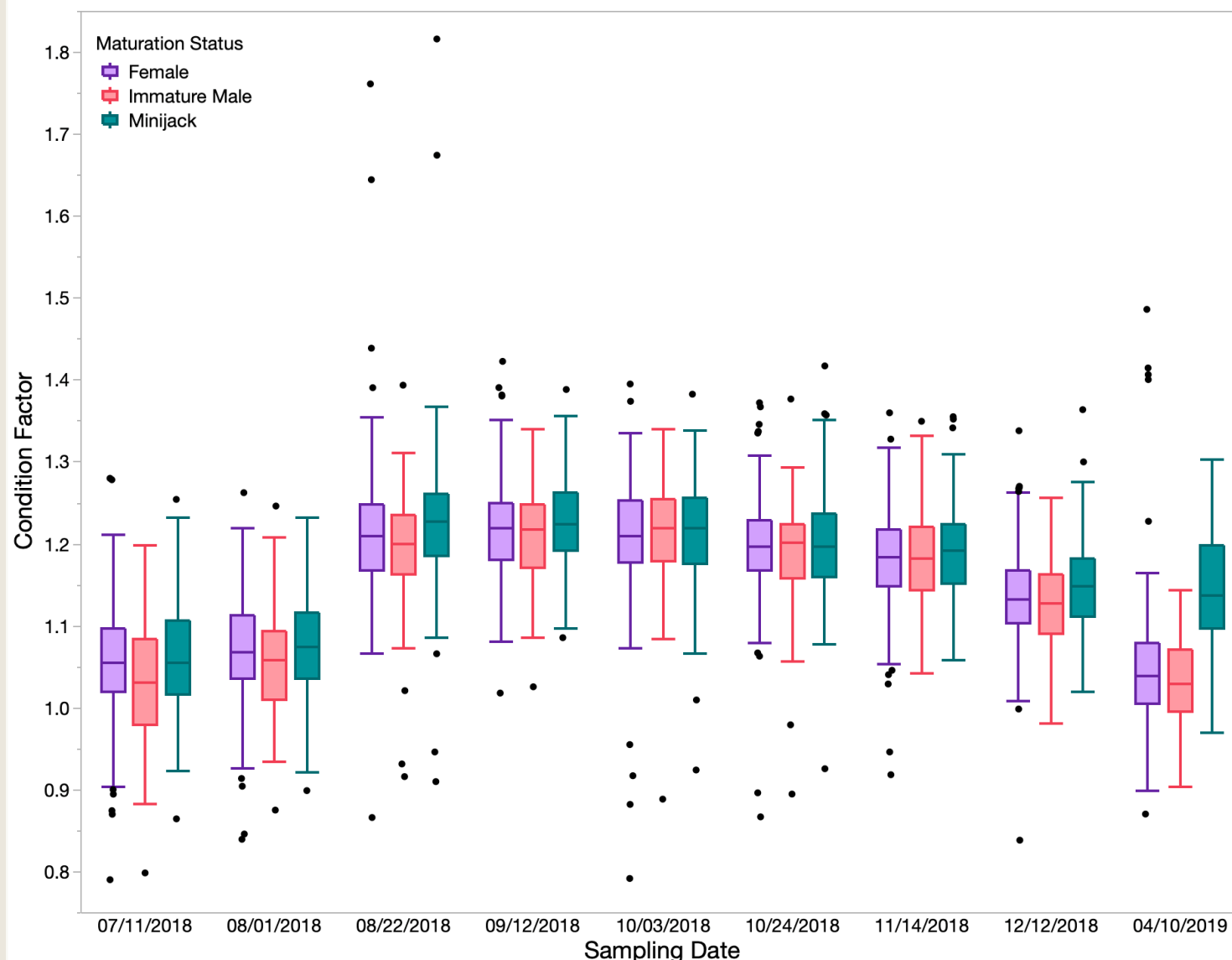




# All age 1+ Fish

## Condition Factor

- Immature males significantly lower than MJ's and females at first two samplings
- Minijacks significantly higher than immature males and females at 8/22/18
- Minijacks significantly higher than immature males and females 12/12/18-4/10/19
- Could indicate that having an abnormally low condition factor is what prevents males from maturing





# CONCLUSIONS

Preliminary conclusions



# Based on morphometrics alone...

- Significant differences between immatures males and minijacks already exist for both fork length and body weight at the first sampling (7/11/18)
  - *Can be “evaluated” during the theoretical critical period*
  - *Implies that somatic growth does not increase as a result of maturation*
- Still need more information to determine when the critical period occurs
  - *Theoretically, this should be around the autumn equinox*
  - *Took pituitary samples at 9/12/18 sampling to evaluate reproductive indices that occur prior to gonad development. Currently being processed.*
- Will continue to analyze the data to determine if one metric is more important than the others... will need Curt's help



# Is absolute size more important than genetics?

- Each fish in this study is of known parentage
  - *Know that size varies significantly between families*
  - *Know that maturation rate varies IMMENSELY between families*
  - *Haven't yet analyzed the data enough to really answer this question... BUT*
- All of the results presented in this talk do not incorporate family
  - *Seems that size (either fork length, weight, or weight at a particular fork length) is still important regardless of family*
  - *Implies that size outweighs the genetic component*

# Future Studies

**Goal: Reduce precocious maturation without changing CESRF's mission statement**

1. Food deprivation (at CESRF)
  - *Fast a group of fish prior to and following critical period to evaluate the effects of food deprivation on maturation rate*
2. Photoperiod manipulation (at ARI)
  - *Prevent fish from perceiving decrease in daylight in hopes that this will deter them from assessing their ability to mature until it's too late*



# Thank you

Bonneville  
POWER ADMINISTRATION



Wouldn't be possible without the help of a  
large crew of people!

Chad Stockton and the rest of the WDFW guys that  
help out

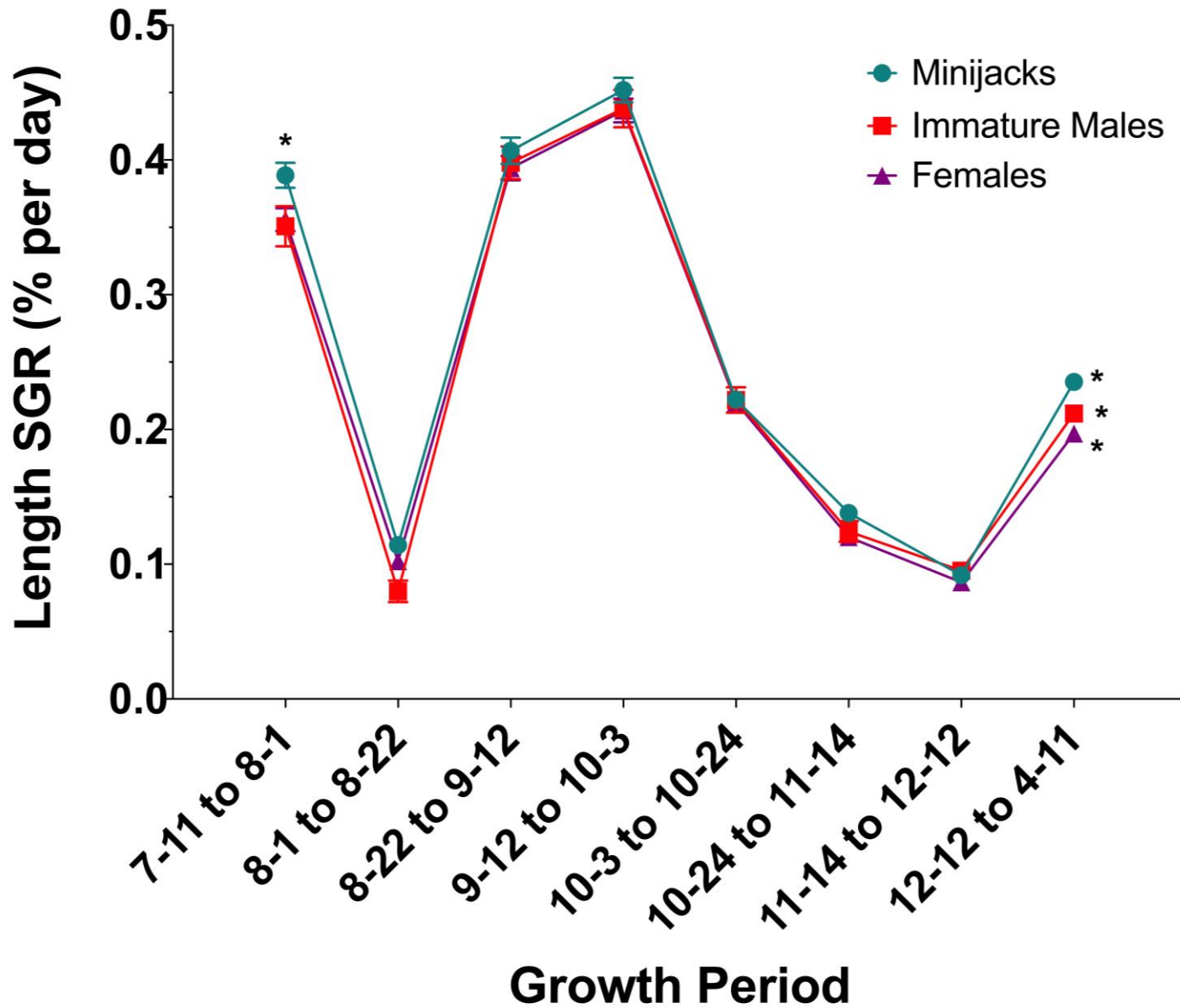
CRITFC techs that make the drive to help out

CESRF staff that keep the fish alive and safe from  
kingfishers

Funding from BPA



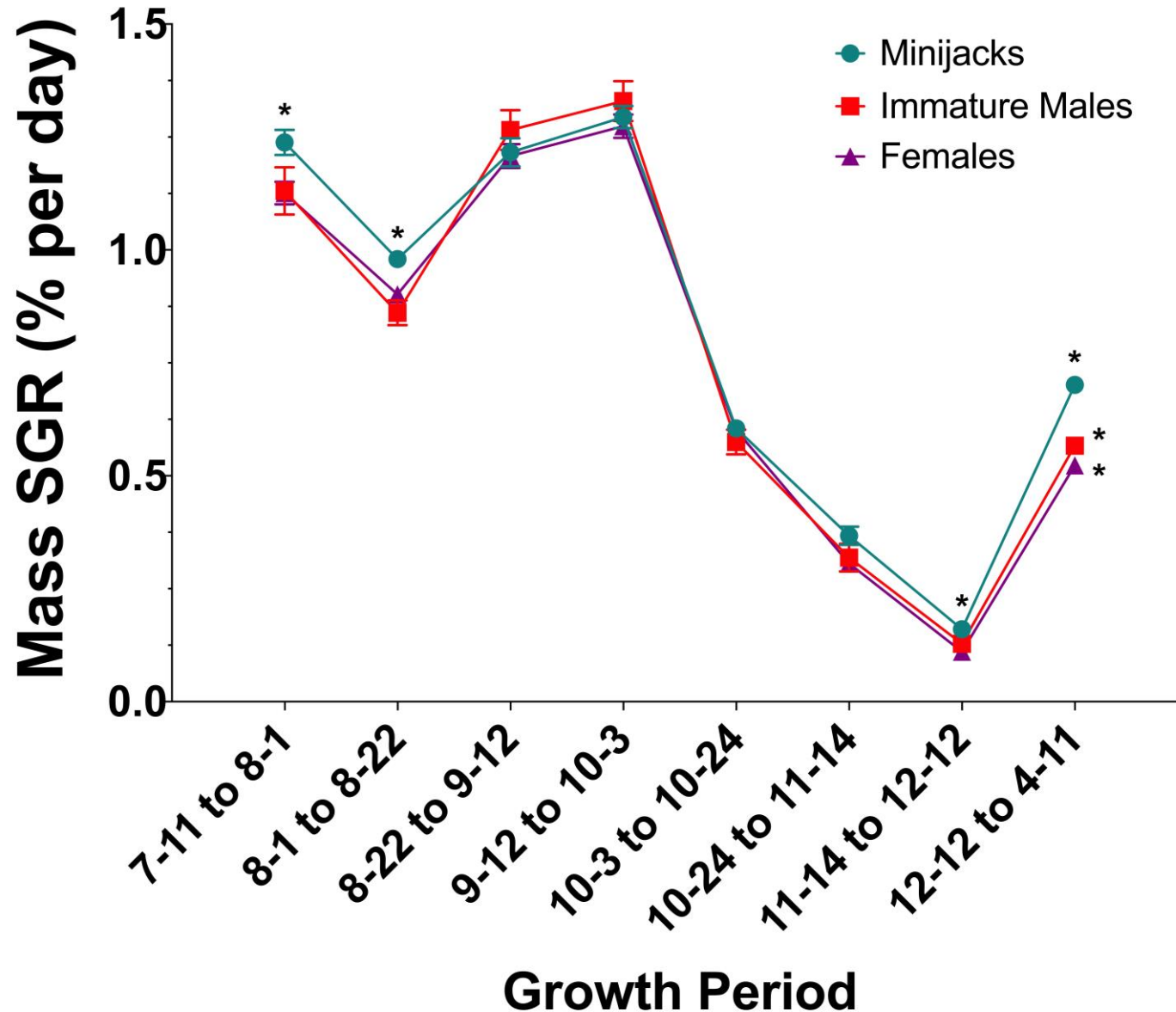




# All age 1+ Fish

## Length SGR

- Minijacks had higher length SGR over first 3 weeks of experiment
- All groups were different from each other at last sampling
  - *MJs probably higher due to gonadal development*



# All age 1+ Fish

## Mass SGR

- Minijacks had higher mass SGR over first 6 weeks of experiment
- All groups were different from each other at last sampling
  - *MJs highest at last two samplings*
  - *MJs probably higher due to gonadal development*