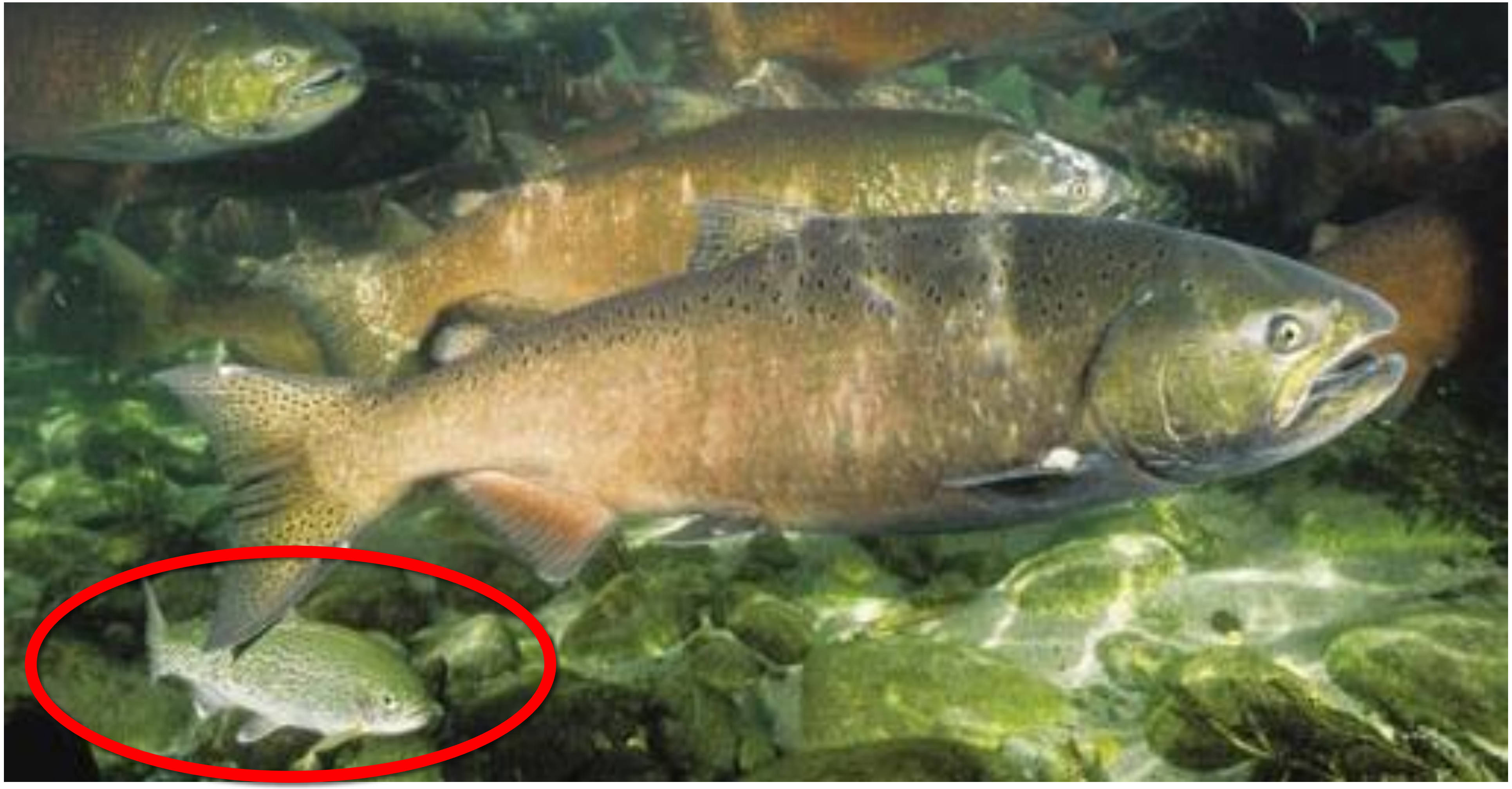
Evaluating minijack rates in spring Chinook Salmon

CONFIRMING THAT SPRING PLASMA 11-KETOTESTOSTERONE LEVEL ACCURATELY PREDICTS FALL MATURATION STATUS

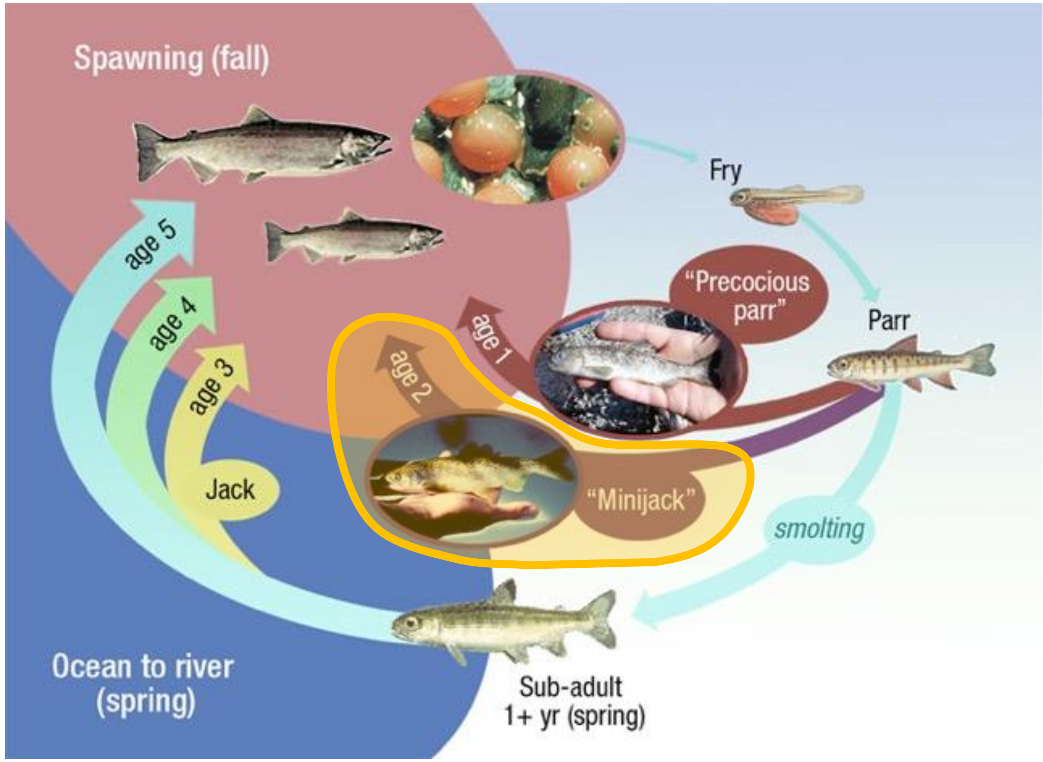


Background information

What are minijacks and why do we care about them?

Photo credit: NOAA

Hatchery Spring Chinook Life History



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

Never enter ocean

Variation in age at Maturity

Several factors are involved in determining a fish's age at maturity:

- Genetics
- Environment
- Interactions between genetics and the environment

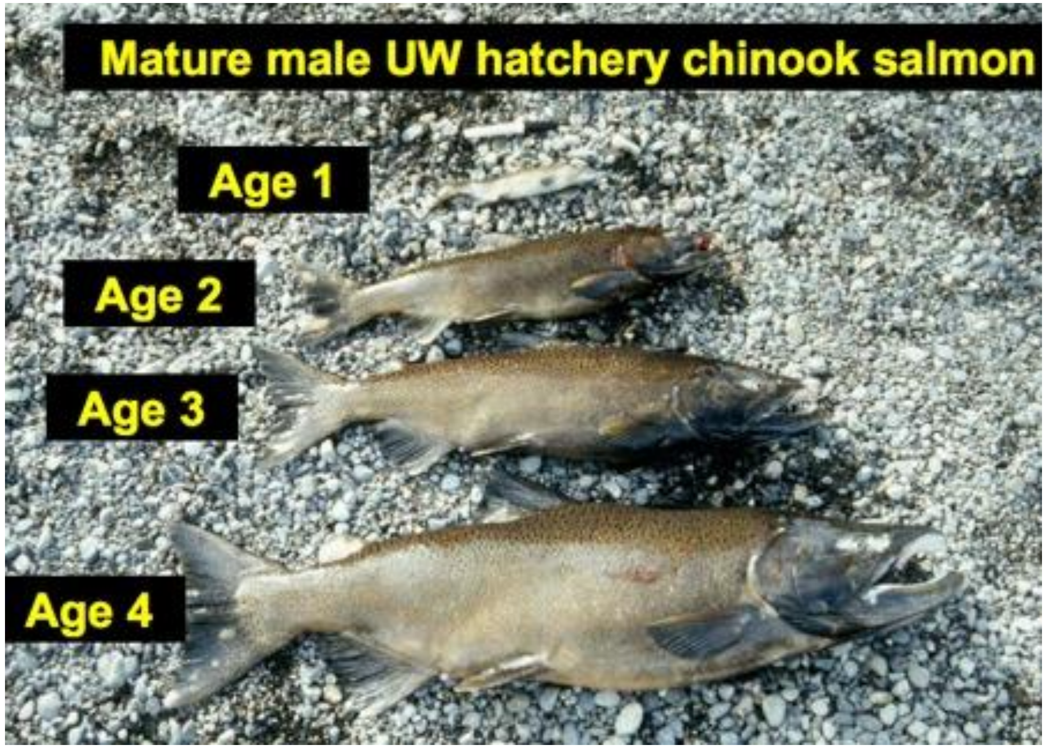


Photo credit: https://www.nwfsc.noaa.gov/news/features/minijacks/ (Tom Quinn)

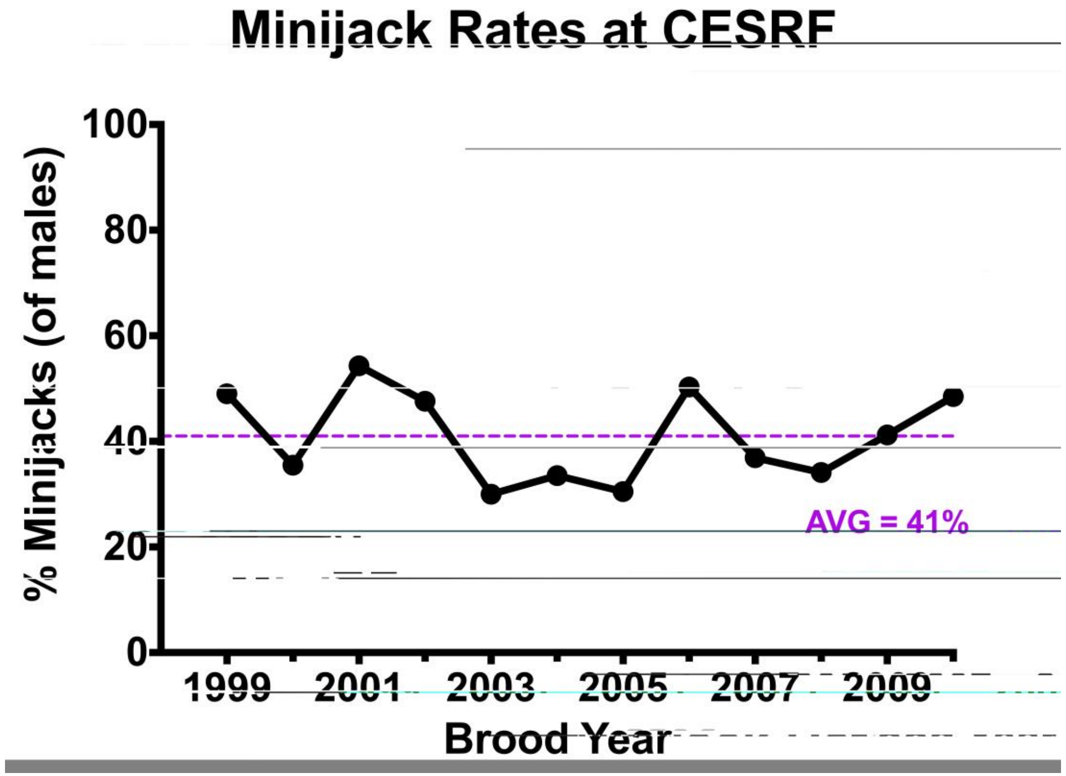
Conservation in a hatchery setting

Cle Elum Supplemental Research Facility (CESRF) endeavors to produce fish that are as similar to wild fish as possible

Use WxW broodstock

Current rearing practices are aimed at producing large, fat smolts

Raising WxW progeny in the hatchery appears to result in a large proportion of minijacks



Adapted from Harstad *et al*, 2014

Are minijacks an issue?

Should we care that the hatchery environment is driving the proportion of minijacks up?

- Decreased adult production
- Deviates from wild population
- Skewed gender ratio in returning adults, which lowers genetic diversity
- Increased straying in minijacks

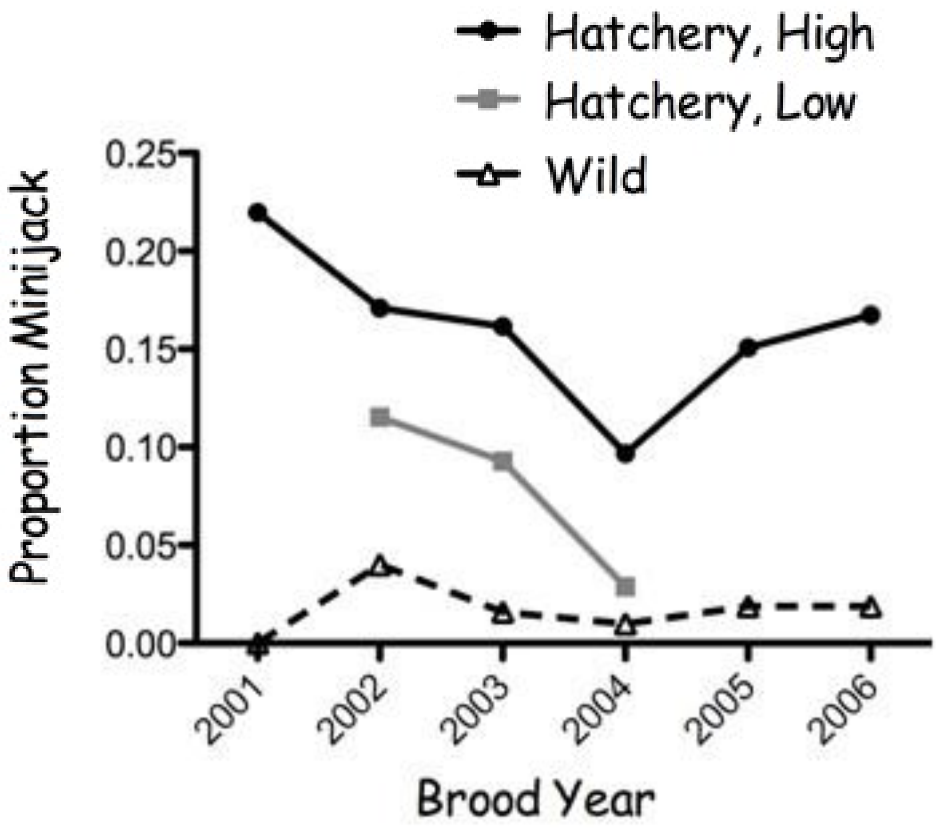


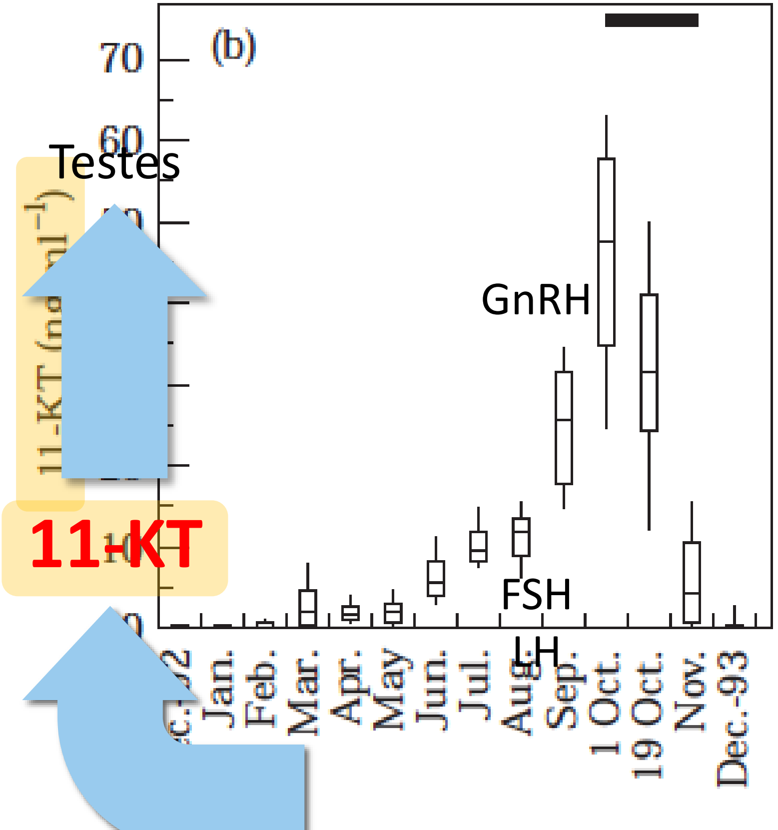
Figure adapted from Larsen *et al*, 2013

How do we determine who is a minijack?

The earliest reliable time point is the spring prior spawning

- This is when environmental stimuli prompt the production of 11-KT, which in turn stimulates spermatogenesis
- 11-KT is separated before late stage spermatogenesis is apparent

Visual inspection of the gonads along with calculating a GSI also works, but isn't reliable until the fall (just prior to spawning)



Plasma 11-KT Profile for Arctic Charr

Adapted from Tveiten *et al.*, 1998

Plasma 11-KT and Minijack Rates

Previous studies have used springtime plasma 11-KT to estimate minijack rates

Examined springtime plasma 11-KT levels and compared to GSI to predict minijack rates the following fall

While it is a safe assumption, to our knowledge, no studies have provided confirmation that individual males with elevated springtime plasma 11-KT levels do in fact complete maturation and are prepared to spawn the next fall

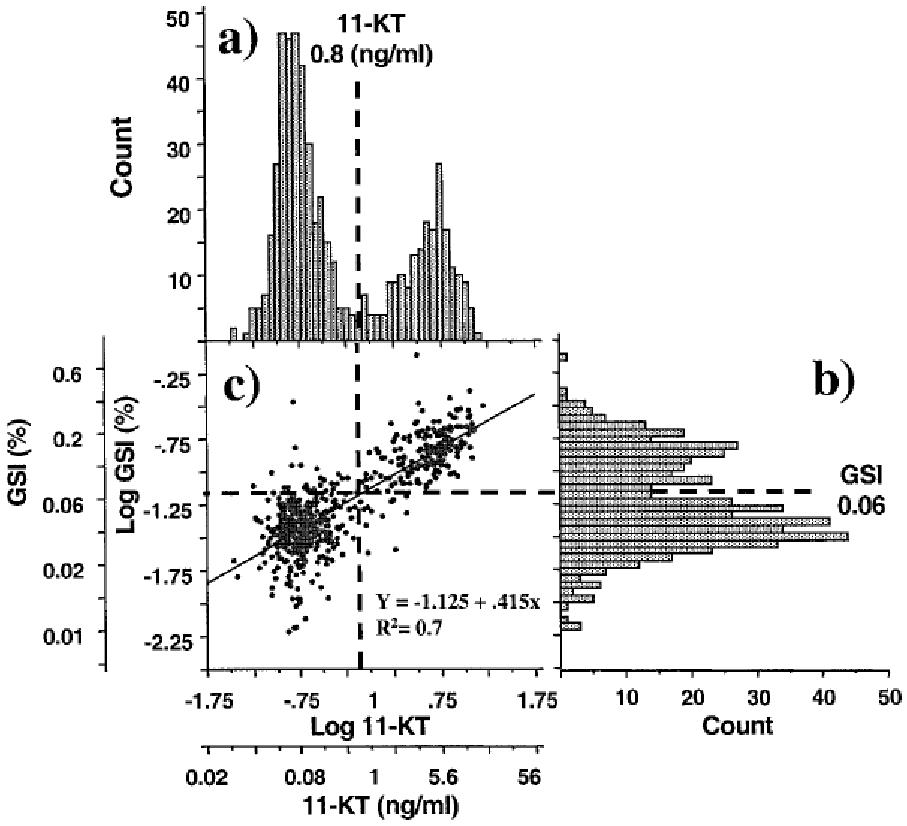
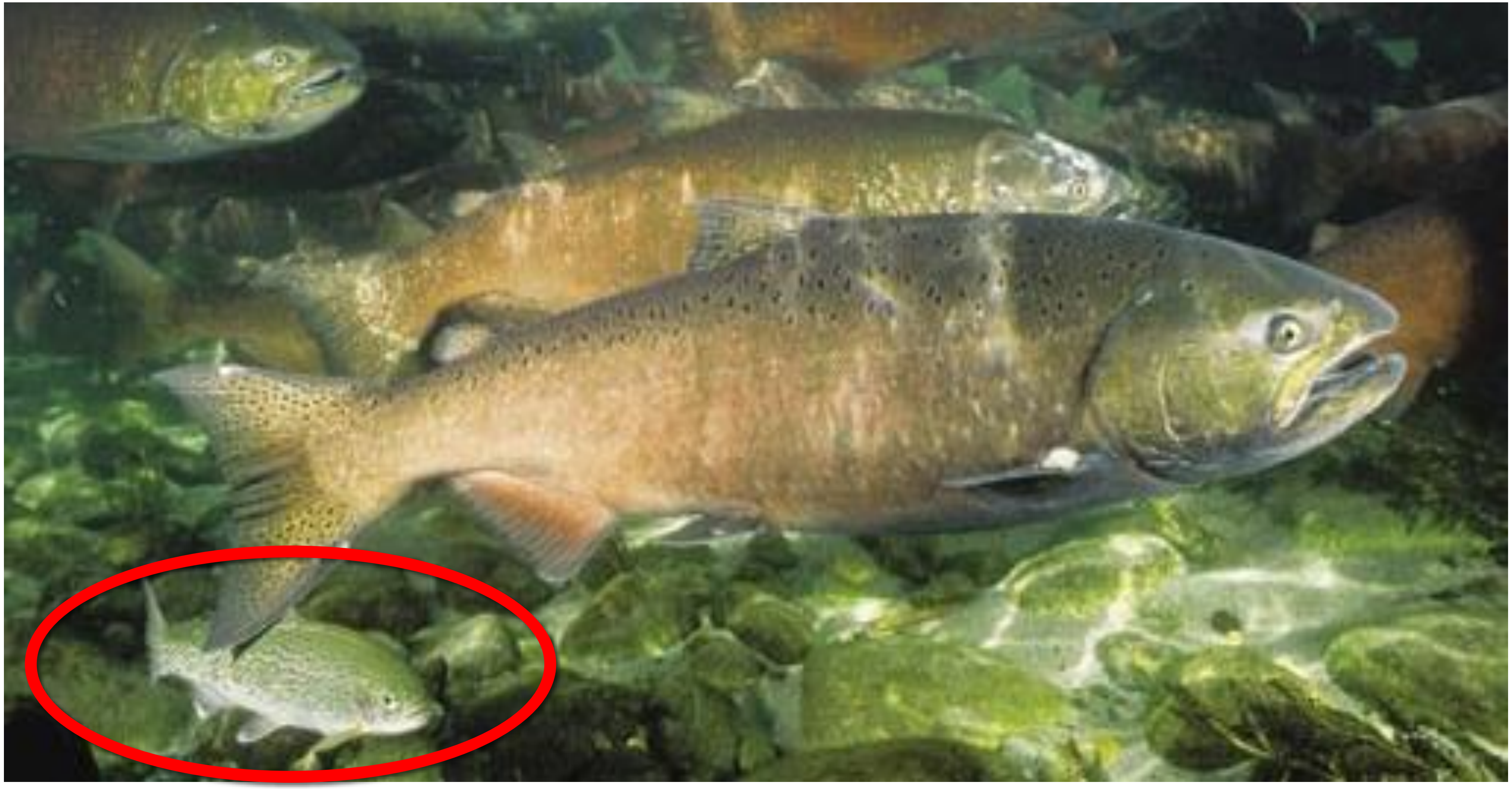


Figure from Larsen *et al*, 2004



Current Study

Study design, analysis, results and discussion

Photo credit: NOAA

Methods: Study Design

Part of a larger, ongoing study that is investigating the effect of parent age on minijack production at CESRF

In April 2016, 459 BY2014 juvenile Chinook were non-lethally sampled, PIT tagged, and returned to the raceway for continued rearing

- Blood collected via caudal puncture

The following September, surviving fish were lethally sampled and a testes weight collected from males in order to calculate a GSI

Photo credit: Curt Knudsen

Methods: Sample Processing

Blood samples were spun down on site, plasma decanted, and samples stored at -80C until processing (which occured at U of I)

The plasma was ether extracted, and then run in a commercially available enzyme-linked immunosorbent assay that detects how much 11-KT is in the sample

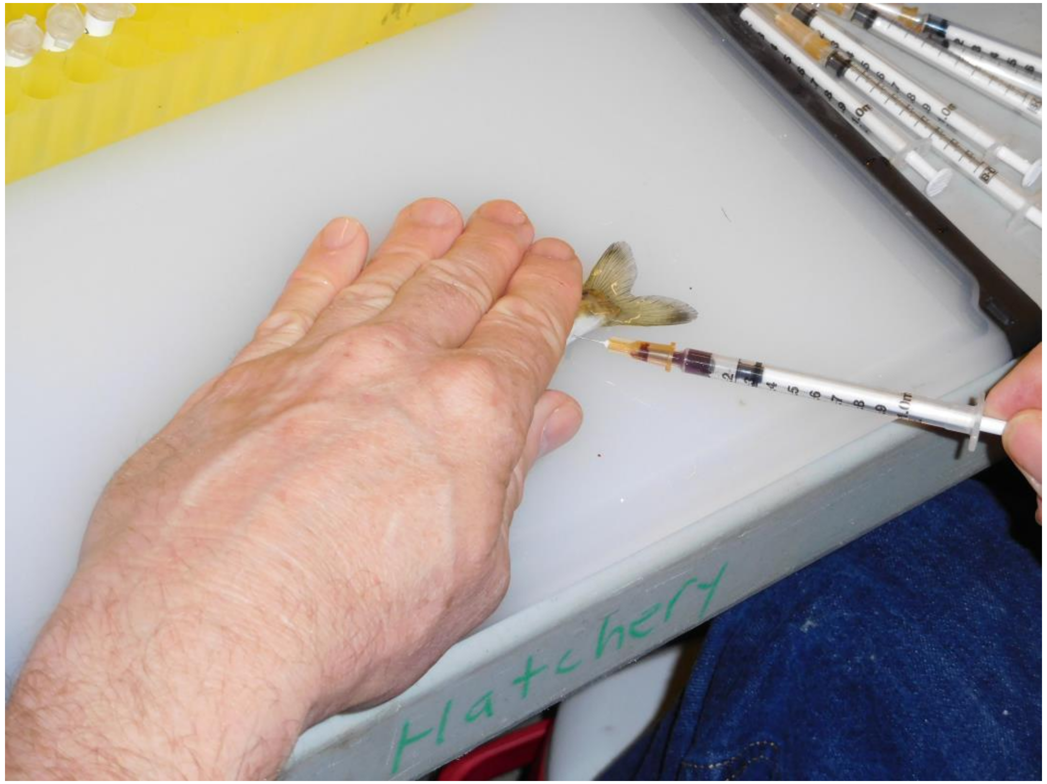


Photo credit: Curt Knudsen

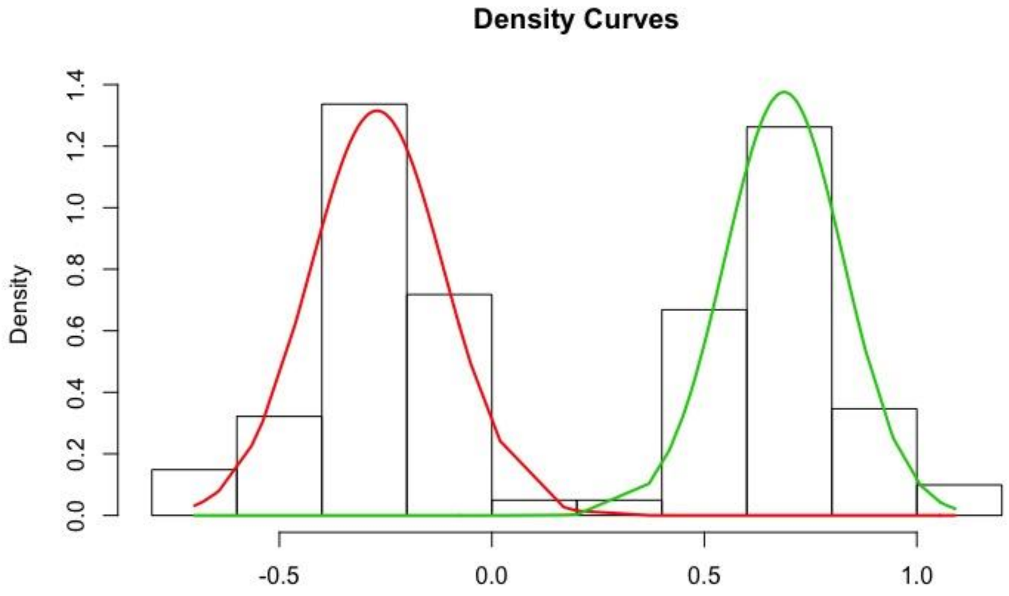
Methods: Statistics

Cutoff determination was performed in R Studio

First, Hartigan’s dip test was used to evaluate modality

Used two-component mixture model to fit curves to the distributions

Value with a 50:50 probability of being chosen from either curve (aka the cutoff value) was calculated



Two-Component Mixture Model

April 11-KT in BY2014 Juvenile spring Chinook

Determined from non-lethally sampled males (N = 201), collected in April 2016

Hartigan's dip test statistic P < 0.01

Established a cutoff of 1.75 ng/mL

Proportion of minijacks (48%) similar to the proportion found in other studies (typically around 40-50%)

Cutoff value higher (Larsen *et al.*, 2004 = 0.8 ng/mL), but sampled later and processed differently

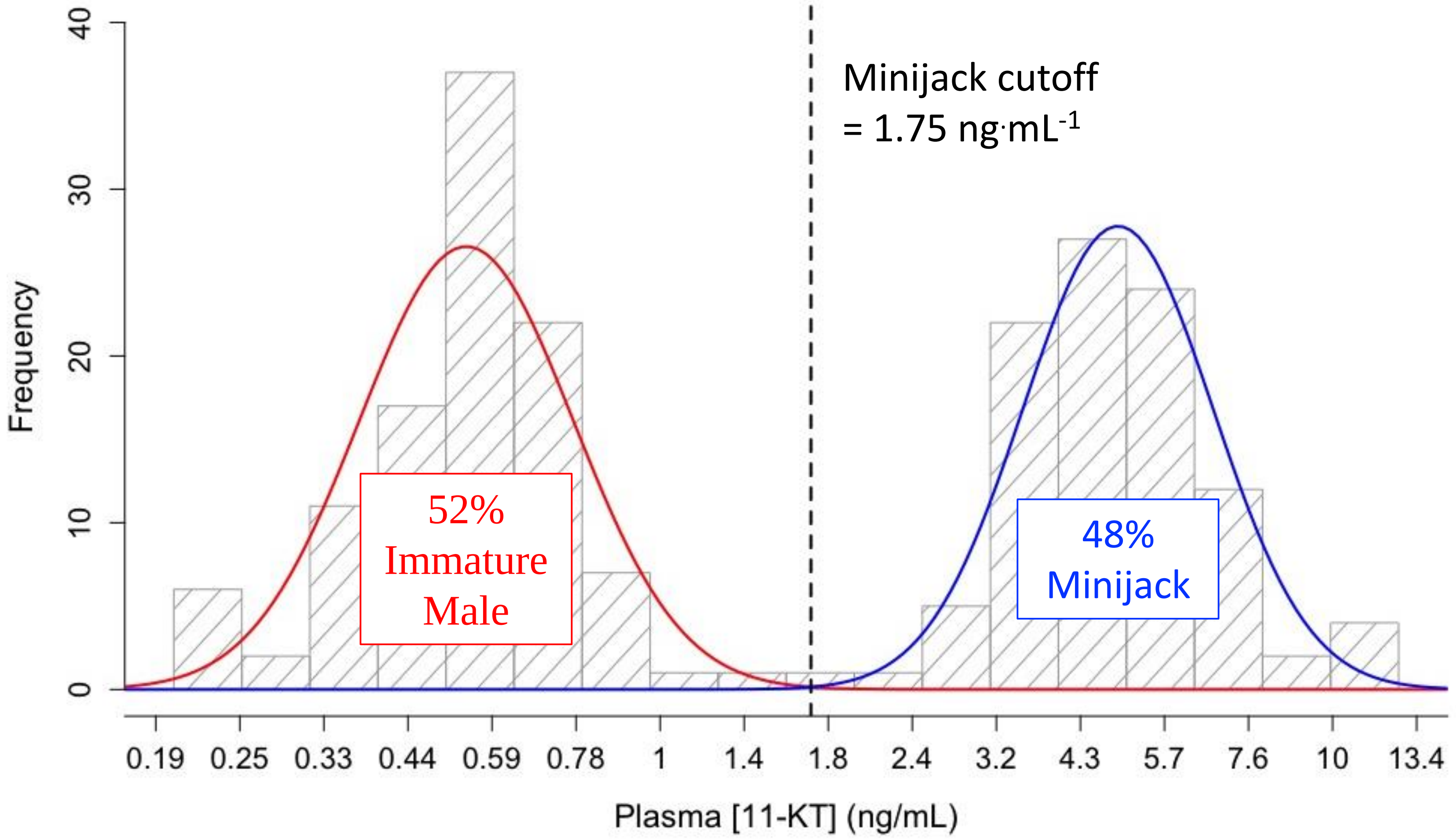


Figure adapted from Medeiros *et al.* (in press)

April 11-KT vs September GSI

Determined from surviving non-lethally sampled males (N = 102)

Plasma collected in April 2016 , GSI calculated from lethal sampling in September 2016

Superimposing the cutoff indicates that using plasma 11-KT as a predictor for maturation is correct 99% of the time

No evidence of testes resorption

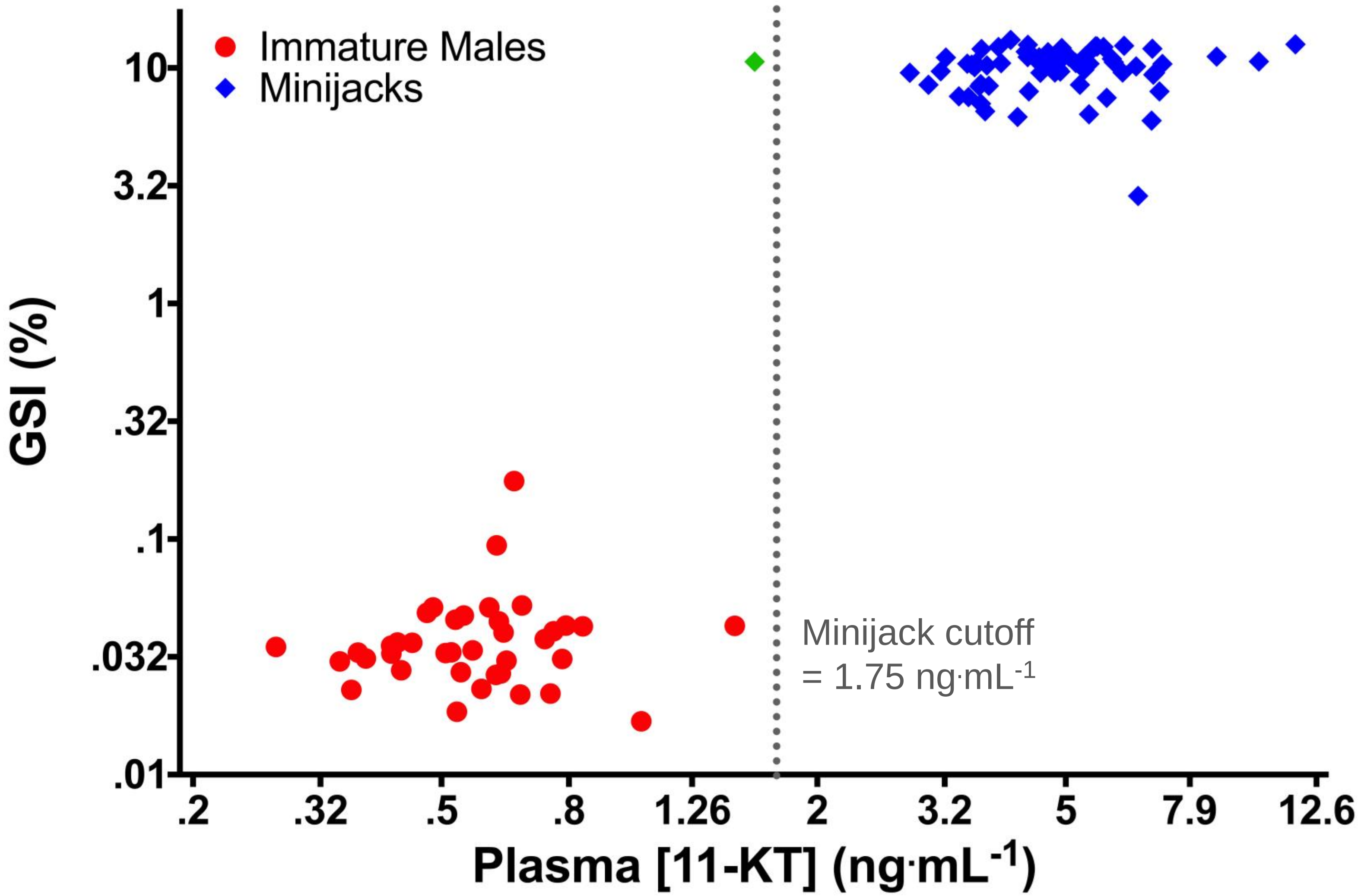


Figure adapted from Medeiros *et al.* (in press)

September 11-KT vs September GSI

Determined from surviving non-lethally sampled males (N = 102)

Plasma and GSI determined from lethal sampling in September 2016

Cutoff calculated using September 11-KT values

Stray fish is now in the minijack grouping (11-KT level continued to increase over time)

Two fish are outliers, though did not mature – possible jacks?

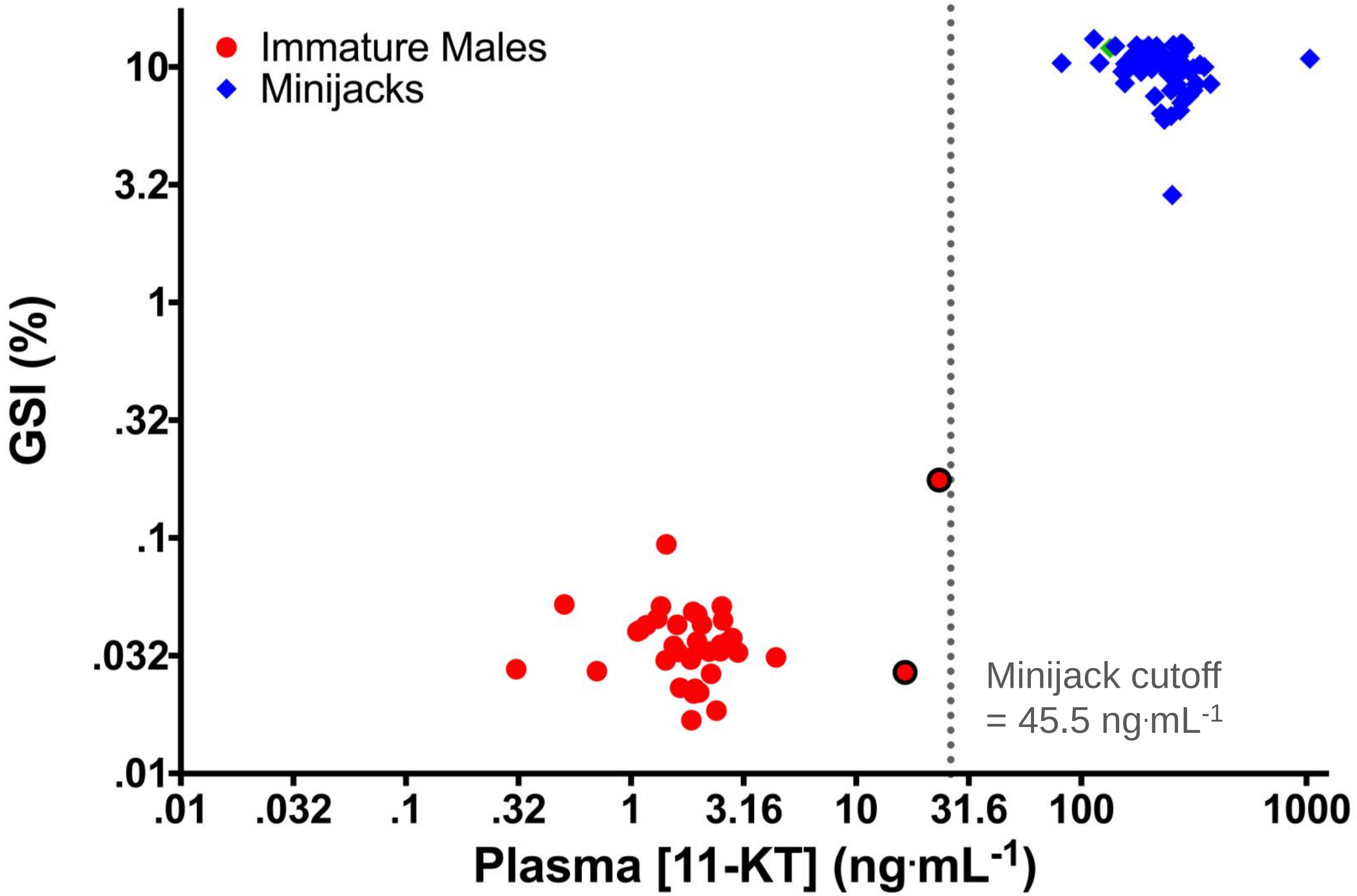


Figure adapted from Medeiros *et al.* (in press)

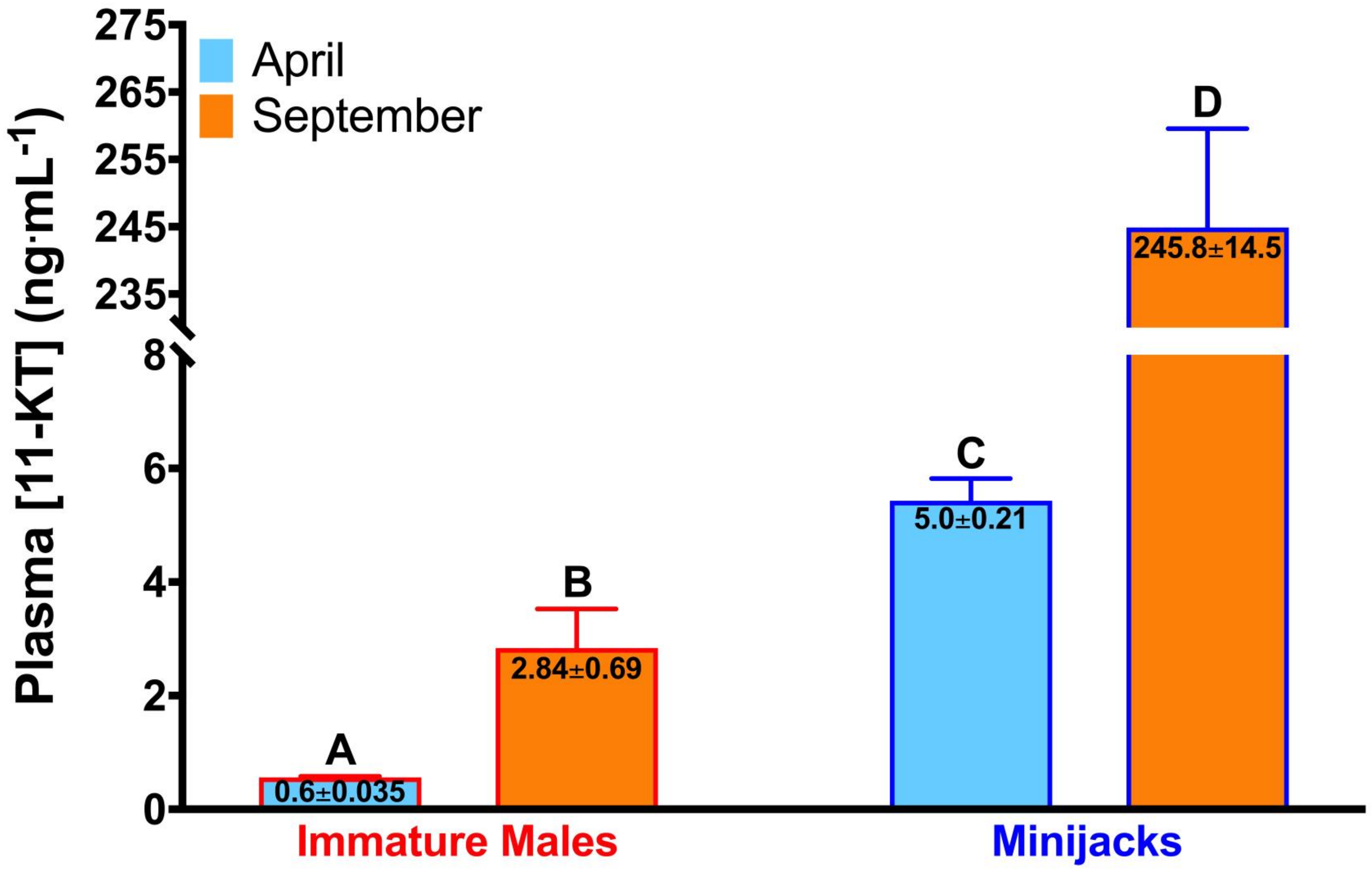
Changes in plasma 11-KT over time

Plasma continued to increase over time in both groups

Nearly 50-fold increase in minijacks, whereas immature males only experienced a 5-fold increase

Females saw no increase (data not shown)

Previous study has observed a similar increase in immature males and could indicate the ability to mature, but "deciding" to put maturation off for (at least) another year



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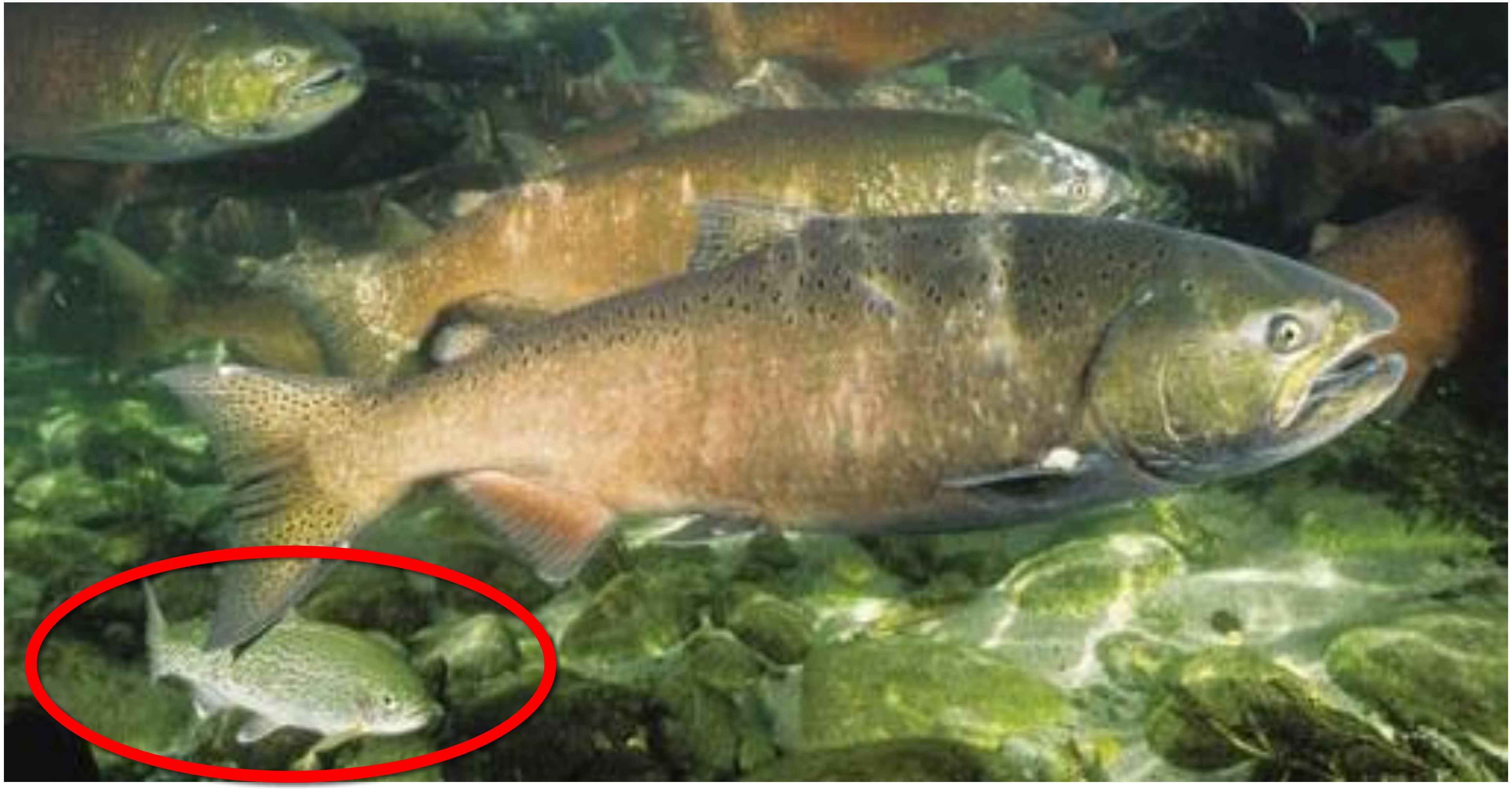

Current and future work

Parentage study & other projects

Photo credit: NOAA

Aims of current and future work

1. **Reduce minijack rate**
   - Determine solution that is feasible in a hatchery setting (on a large scale)
2. **Keep size at release similar to what is now being observed**
   - Bigger smolts are associated with higher adult returns
3. **Preserve wild genetics**
   - Goal of CESRF
   - Solution needs to stay in line with this

Photo credit: https://www.washington.edu/news/files/2018/02/Bond_McKenzie_Chin-1-web.jpg

Parent Age study

Factorial mating study designed to determine if there is any effect of parent age on minijack production

Required needing to know the individual fate of each fish in the study, not just a general estimate

Analyses are ongoing

- April 2018 was the last sampling point, so stay tuned for the results

		Male Age		
		2	3	4
Female Age	3	?	?	?
	4	?	?	?
	5	?	?	?

Reproductive Decision Window

Continue to further refine estimates for when reproductive decisions are made

If you know *when* the fish is making the decision to mature or not, methods to decrease precocious maturation can be better targeted

Based on previous work that points to lipid reserves and/or growth rate

- Feeding studies that monitor growth and lipid levels
- Common garden growth study

Photo credit: Curt Knudsen

Acknowledgements

HUGE thank you to the Yakama Nation and WDFW staff at CESRF that cared for the fish through this experiment!

Also, we couldn't have done this without the excellent help from the CRITFC technicians and University of Idaho undergraduates that were willing to come stare at fish gonads and blood for a week at a time

And I would be lost in the ether (literally) if it weren't for the UI undergraduates that help me extract and run thousands of samples

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