

Is rearing density a driver of domestication selection?

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Outline

- Background
 - Fitness of hatchery fish
- Causes of fitness loss
 - Domestication selection
- Density experiments
 - OHRC proposal

Fitness

- Araki et al. 2007
- Bernston et al. 2011
- Theriault et al. 2011
- Williamson et al. 2010
- Chilcote et al. 2011

Fitness

Hatchery fish $\neq$ Wild fish

Fitness

Hatchery fish $\neq$ Wild fish

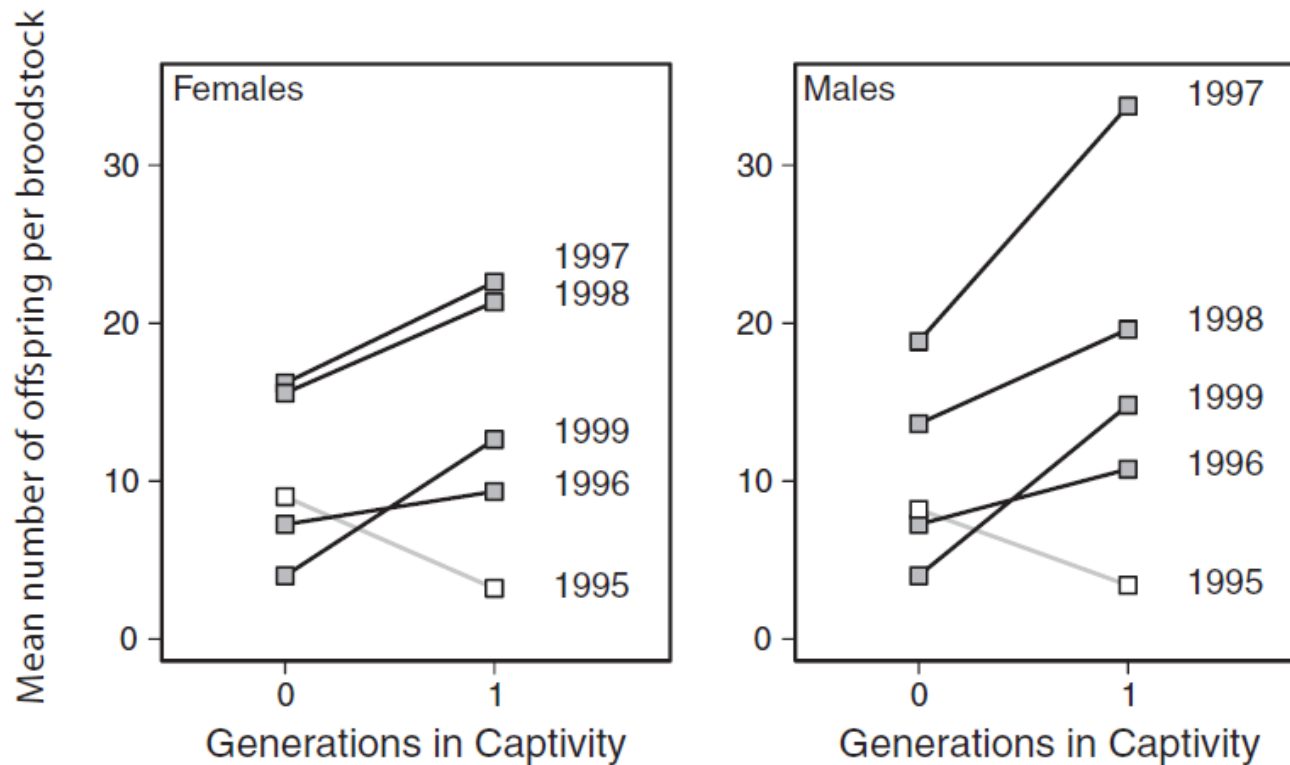
Why are hatchery fish different from wild fish?

Domestication selection

- Could explain heritable fitness decline
- Natural selection on traits which affect survival and reproduction in a human-controlled (domestic) environment. Doyle, 1983

Domestication selection

Performance in the hatchery



Tradeoff among wild families

Broodstock

Returning
offspring



X



X



Tradeoff among wild families

Broodstock



X



Returning
offspring

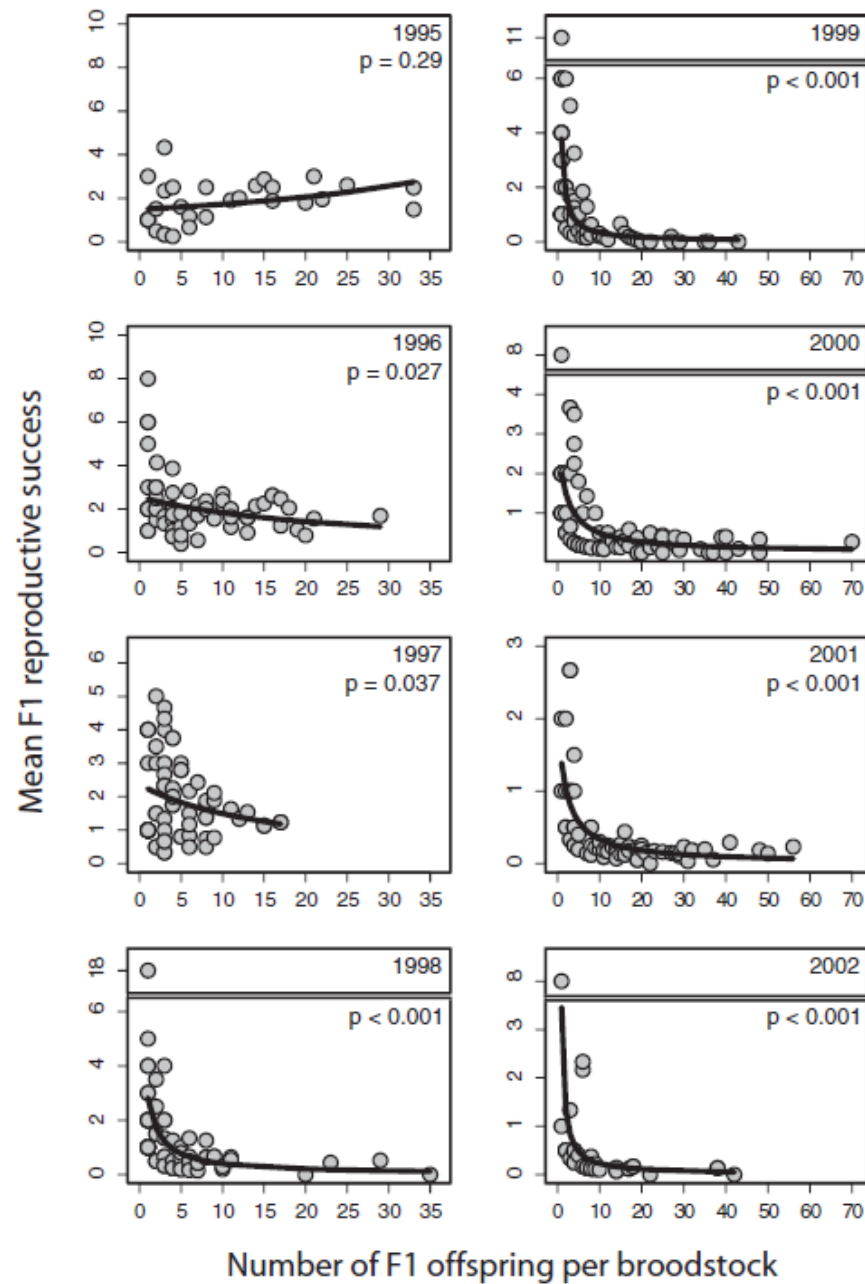


Wild-born offspring

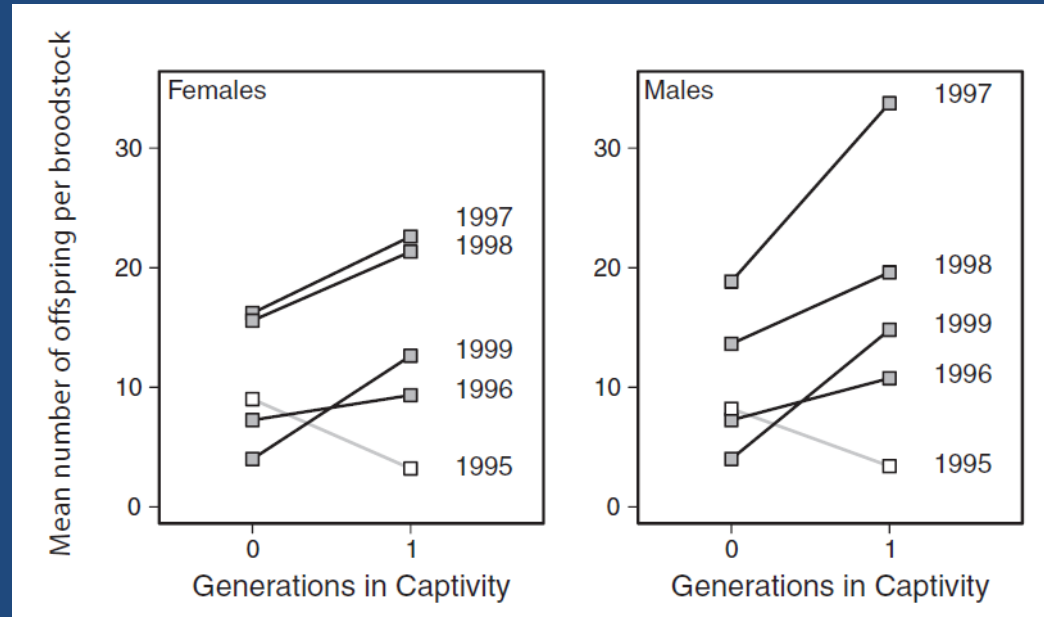
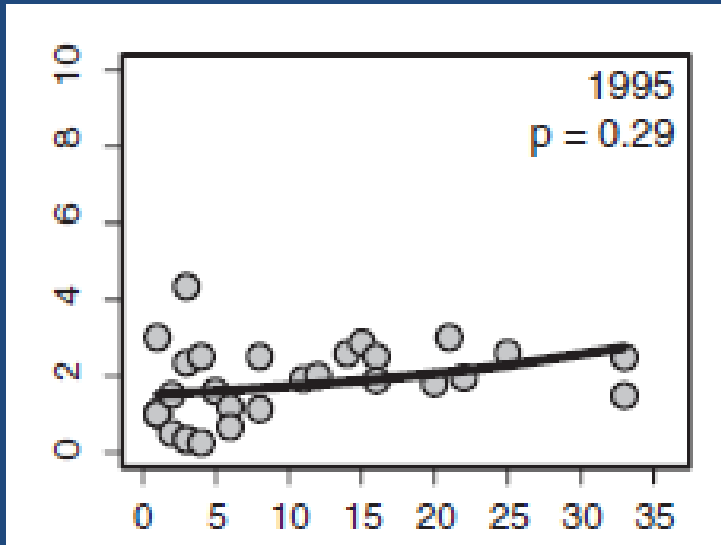


X





1995 Run Year



4,600 vs 40,000 - 60,000 juveniles released
Larger body size at release in 1995 RY

Domestication summary

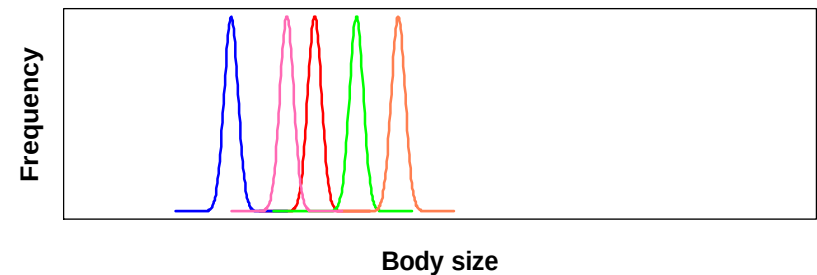
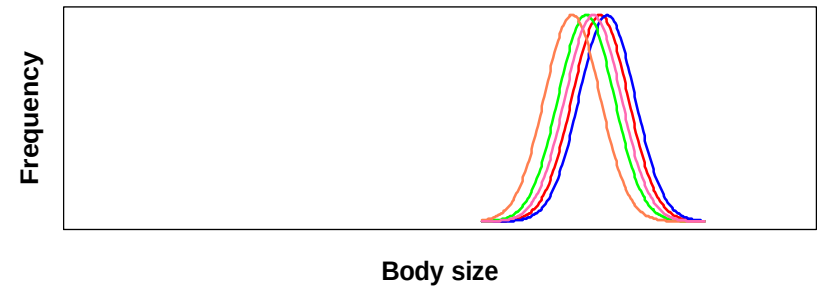
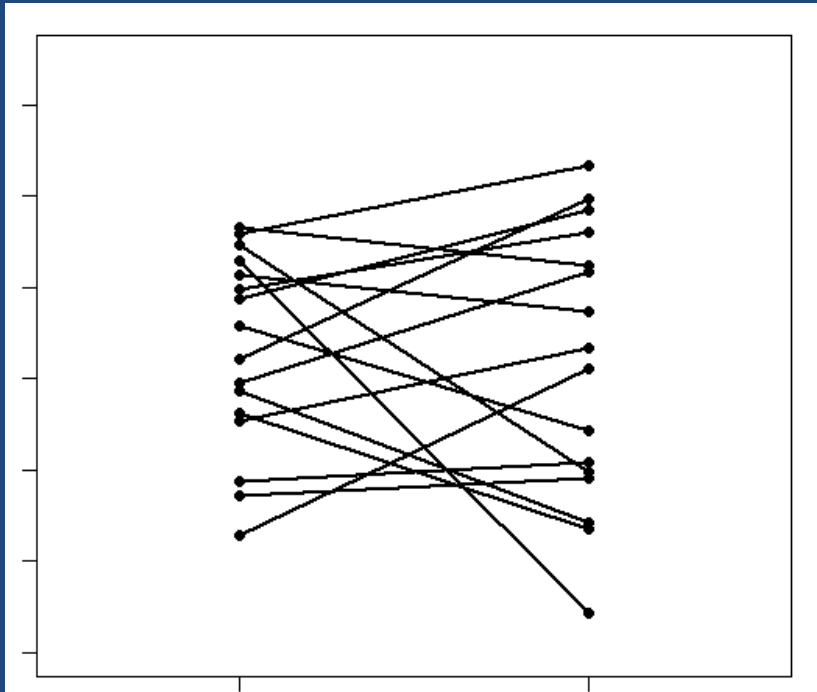
- Hatchery ancestry makes better hatchery fish
- Tradeoff in performance
- Density could be a major driver of domestication

Density Experiments

- Test for:
 - Tradeoff in family performance
 - Increasing variance in family performance
- Responses: fork length and weight
- 10 families – F1 Siletz River

Density Experiments

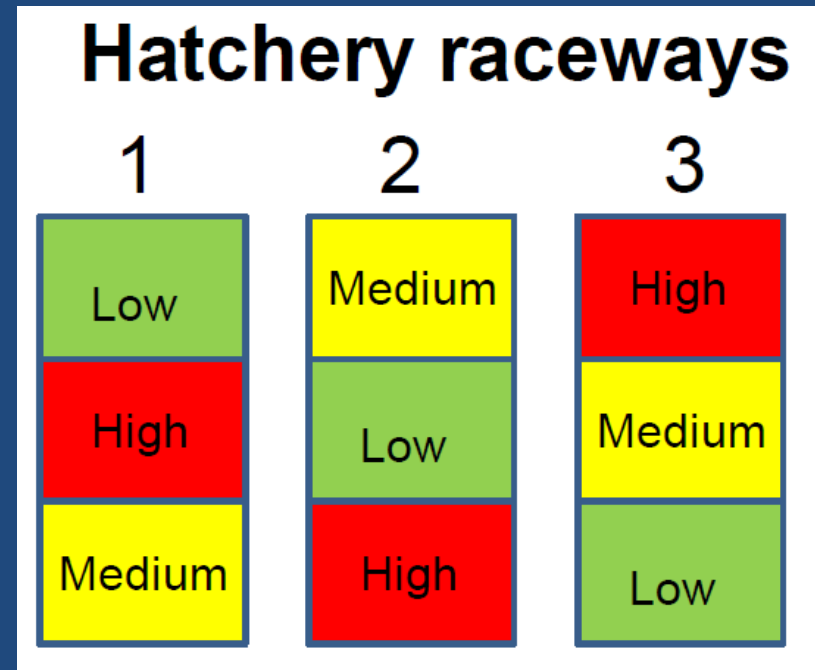
- Test for:
 - Tradeoff in family performance
 - Increasing variance in family performance



Density Experiments

Raceways

- High density = 140 fish/m³
- Medium density = 70fish/m³
- Low density = 20 fish/m³
- Measure FL and weight
 - Early Dec

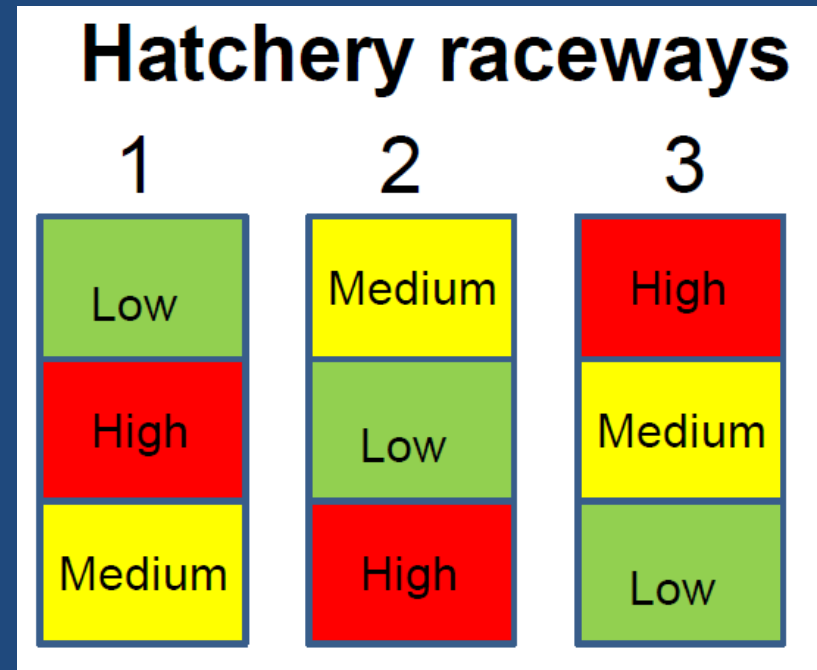


Density Experiments

Raceways

- **High density** = 140 fish/m^3 = Hood River average density
- Medium density = 70 fish/m^3
- **Low density** = 20 fish/m^3 = Hood River 1995 density

No water quality
degradation



Density Experiments

Circular Tanks

- High density = 140 fish/m^3
- Low density = 20 fish/m^3

Reduced water quality



Density Experiments

Circular Tanks

- High density = 140 fish/m³
- Low density = 20 fish/m³

Reduced water quality

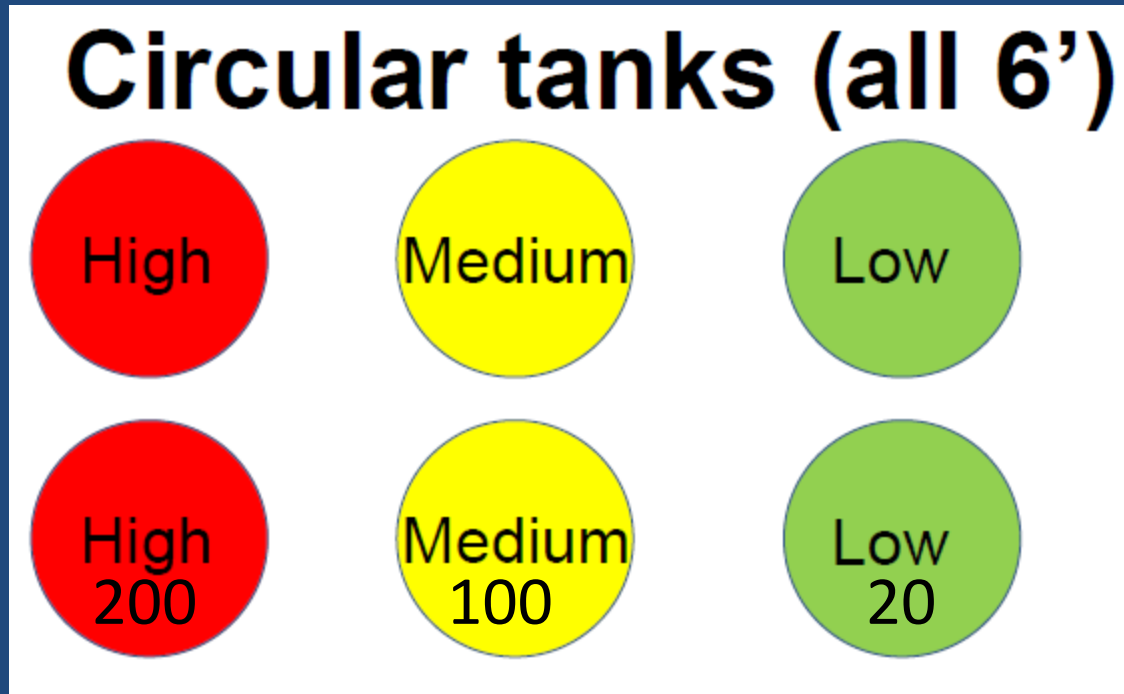
Density confounded
with enclosure size



Density Experiments

Non- confounded circular tanks

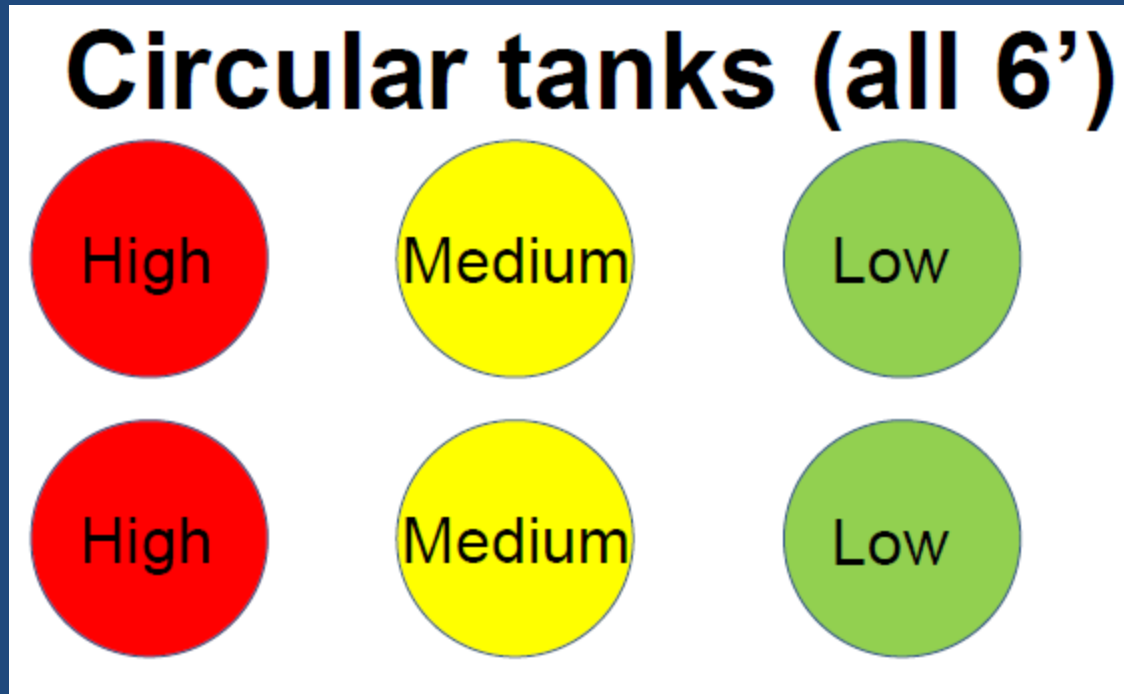
Different # fish per tank



Density Experiments

Non- confounded circular tanks

Different # fish per tank



Account for confounding density with enclosure size

Density Experiments - Recap

Raceways: density confounded, no water quality degradation

Circular tanks: density confounded, lower water quality

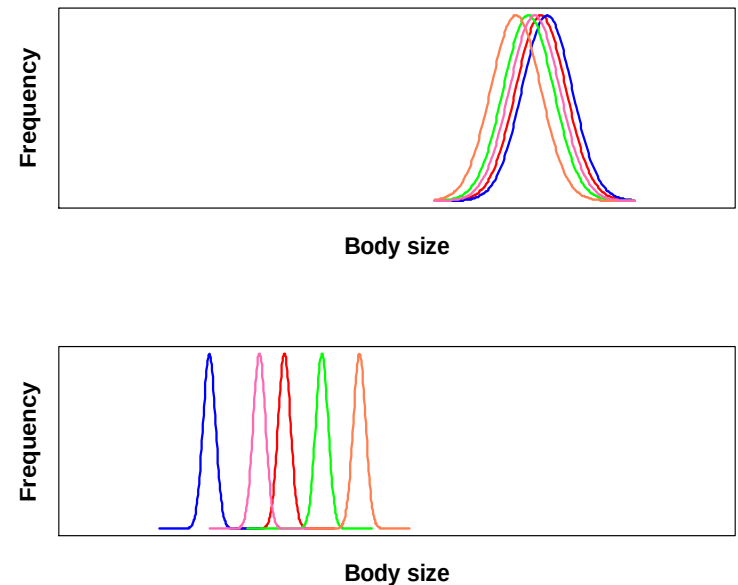
Circular tanks: density not confounded, serves as backup in case no effect found

Data analysis - Tradeoff

- Mixed linear model
 - $Y_{ijk} = \beta_0 + \beta_1 \text{Family} + \beta_2 \text{Density} + \beta_3 \text{Enclosure} + \beta_4 \text{Environment} + \beta_5 \text{Density} * \text{Family} + \beta_6 \text{Density} * \text{Family} * \text{Environment} + \varepsilon_{ij}$
- B_5 tests for tradeoff
- B_6 tests for effect of water quality

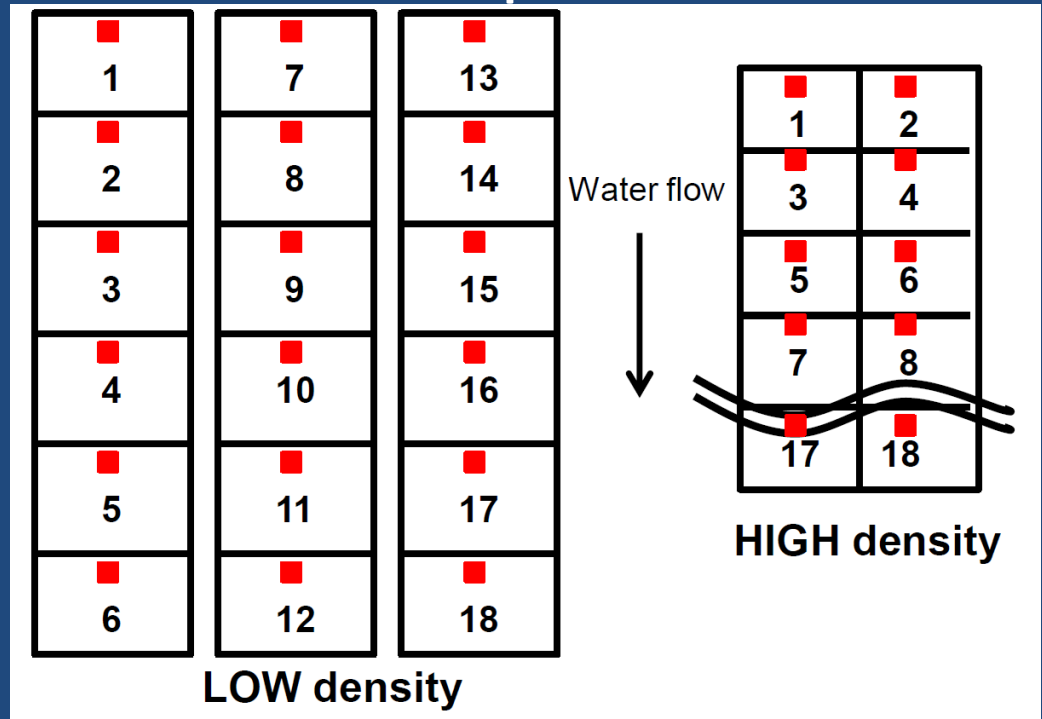
Data analysis – Increasing Variance

- Intraclass Correlation
 - Measure of between family variance to total variance
- Differences between families in different densities?
- Use Likelihood Ratio test



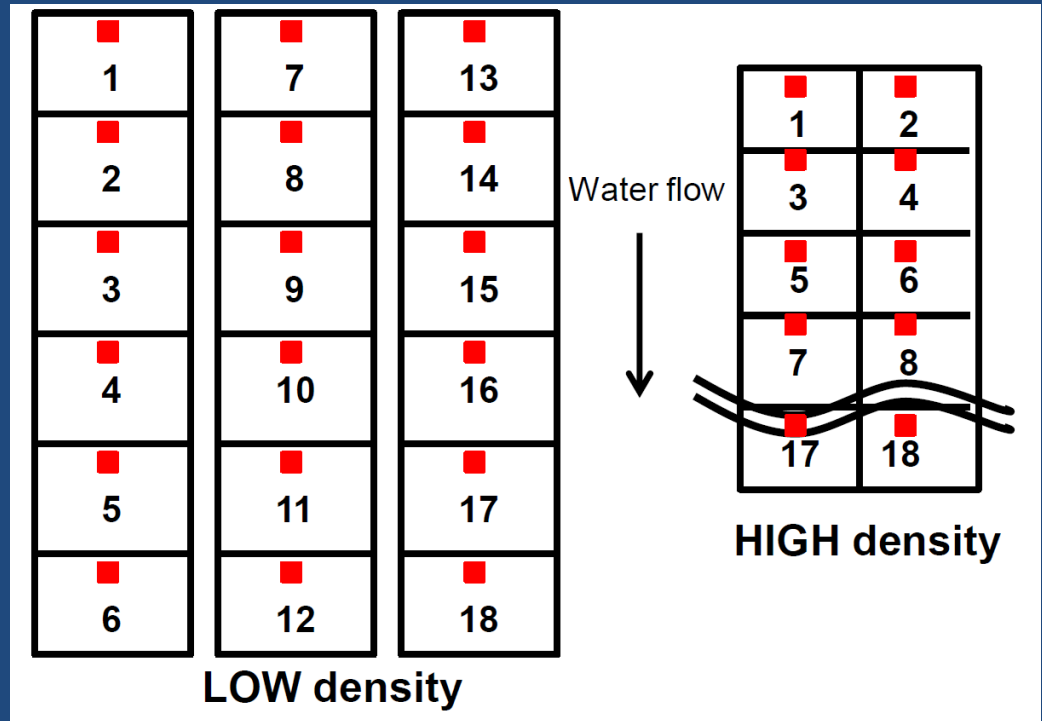
Behavioral trials

- Use same 10 families
- First feeding juveniles
- Does dominance correlate with performance?



Behavioral trials - analysis

- Tradeoff? Wilcoxon paired ranks test
- Correlation with performance?
 - Spearmens correlation



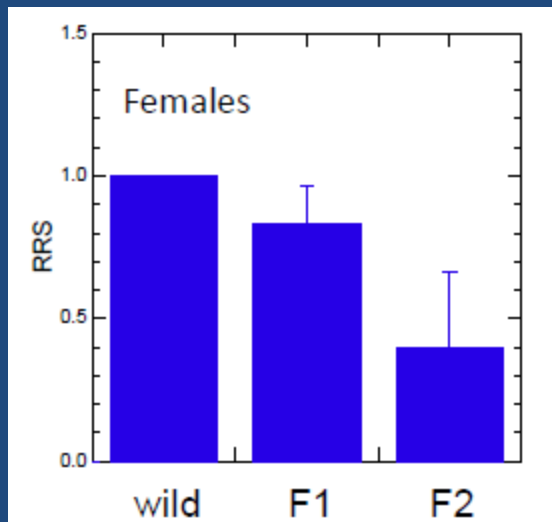
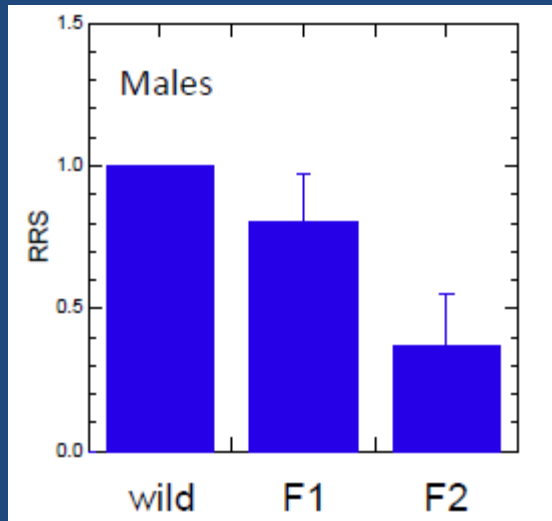
Expected Product

1. Tradeoff present
 - Families who do well in high density do poorly at low density and vice versa
2. Larger differences between families at high density
 - Evidence for domestication selection
3. Dominant families at high density perform well at high density

Future Work

- Add environments
 - Raceways and artificial streams
- Add more fitness measurements
 - Salt-water challenge, blood nutrition levels
- Replicate with chinook USACE project
 - Eric Billman, David Noakes, Carl Schreck

Hood River Studies



Mean over both sexes

F1 RRS ~ 0.85

F2 RRS ~ 0.3-0.4

Wild born fish

