Oregon Hatchery Research Center

Research Plan
2 December 2015
NWFCC

OHRC

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OHRC GOAL 1: Understand Mechanisms Responsible for H vs W fitness differences

Focus Area 1: Causes by Mate Selection

Can we Replicate 'Wild-like' Mate Choice in Hatcheries as a Means to Reduce Impacts of Current Hatchery Practice on Wild Stocks?

Michael Banks, Prof. (coho)

Kathleen O'Malley, Assist. Prof. (Chinook)

Coastal Oregon Marine Experiment Station, Marine Fisheries Genetics, Department FW

Hatfield Marine Science Center

Oregon State University

GOALS FOR TODAY

Briefly overview coho H/W pedigree

- Umpqua valley, Southern OR
- Initial evidence - sexual selection

(Theriualt et al Molecular Ecology 2011)

Overview current activities for year one

- Determine which genomic combinations
  define most successful matings

Overall Theriault et al (2011) found:

- Wild fish had more returns than hatchery
- W>H even for H fry releases
  - Which life-stages are common and which are different between wild fish and fry releases from hatcheries?
    - Juvenile rearing and adult ocean and return stages same
    - mating & incubation different
- H jacks fitness was no different than wild fish
  - How do jacks get into the spawning action?

- sneakers

We posed that this points to potential mechanism for the H/W fitness decline owing to:

some effect during:

adult mating or

egg incubation or

newly hatched fry

OUR REASONING:

1) Even H fry releases experienced decline – early life stage
2) Age-3 H males were consistently less fit than W males – sexual selection
3) H Jacks (sneakers) did not show the same declines as H 3-year olds who compete differently for females – sexual selection

Test alternate mate choice hypotheses:

- Good Allele (additive)
- Compatible Allele (non-additive)

Kempenaers (Advan. in Study Behavior 2007)

Overall goal:

Identify genomic patterns among mate pairs that distinguish greater reproductive success families

Initial focus on components of genome:

MHC, other disease defense, olfactory receptors, length, fecundity, aggression,

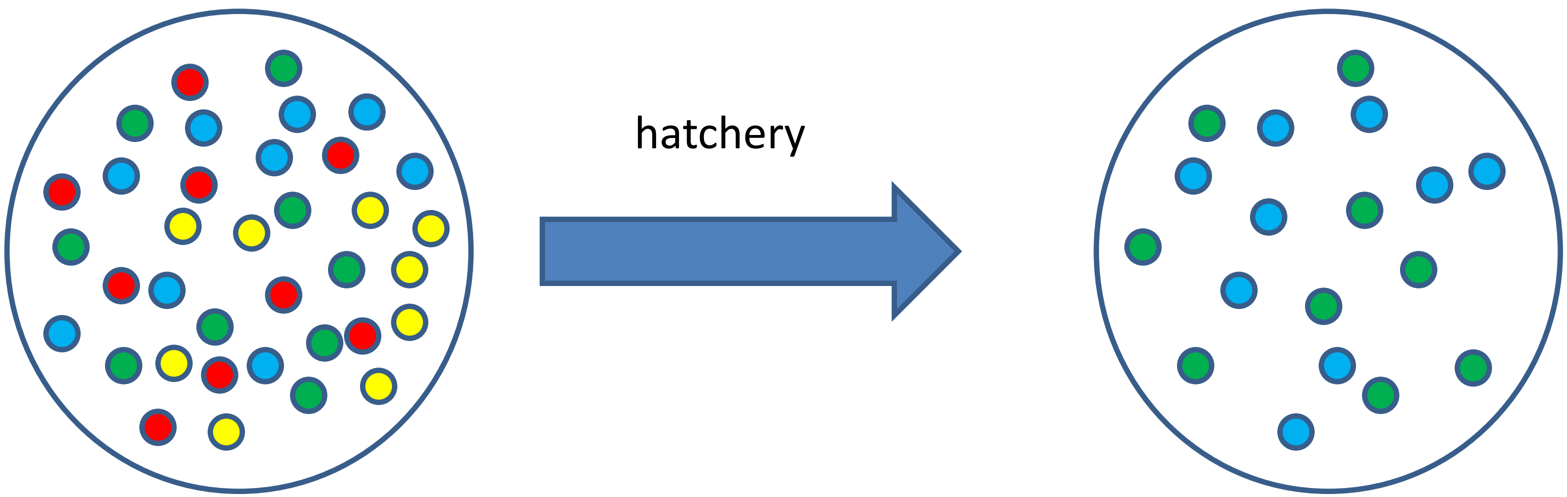
other behavioral aspects

Once we found genomic patterns that destinguish W-like mate choices, project has two other steps:

2. Develop cost effective, rapid turnaround assays to characterize these discriminatory genomic features among hatchery broodstock

3. Experiment with hatcheries (including OHRC) to modify hatchery spawning practice to better replicate WILD-LIKE match choices AND TEST IF RESULTING OFFSPRING HAVE MORE SIMILAR FITNESS TO THAT OF TRULY WILD FISH

Domestication selection:
some families do better than others



wild broodstock

F1 that return as adults

Michael Blouin
Professor
Integrative Biology, OSU

Goal: **Change hatchery to reduce the selection pressures**

Two big questions:

1. **What traits are under selection?**

2. **What aspects of hatchery culture increase selection?**

1. What traits are under selection?

Question: What traits distinguish high vs. low performing families in hatchery?

Approach: Raise multiple families together, assay their sibs

- Performance = body size at release
- Measure various traits on each family

Example traits to measure

- physiological
  e.g. metabolic rate

- behavioral
  e.g. position in water column
  aggressiveness

- patterns of gene expression

Neil Thompson

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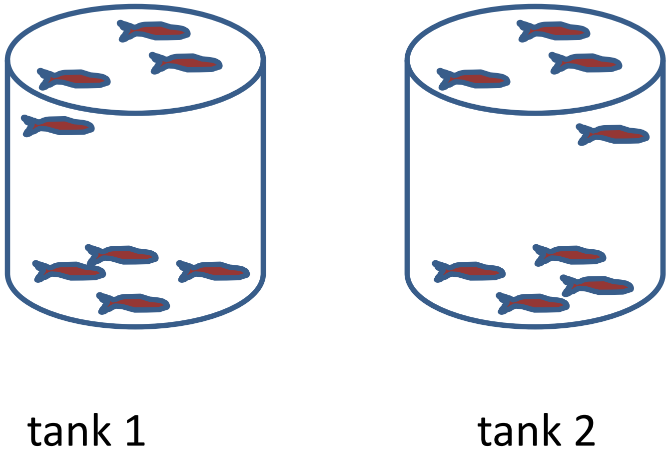
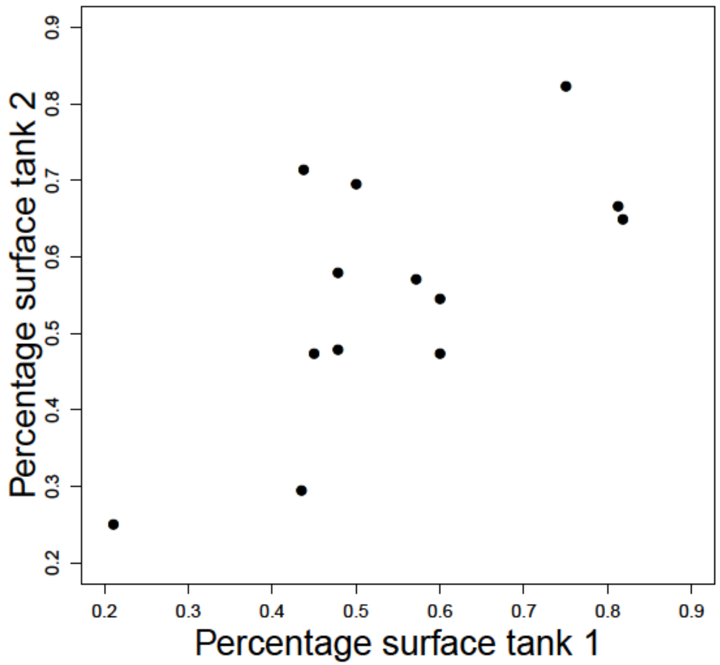
e.g. position in water column



Strong family component to positional preference in water column



<u>Next</u>: test whether "top" families also grew fastest in main growth experiment

2. What aspects of hatchery culture increase selection?

Question: Can we even out the performance differences among families?

Approach: Vary environmental conditions

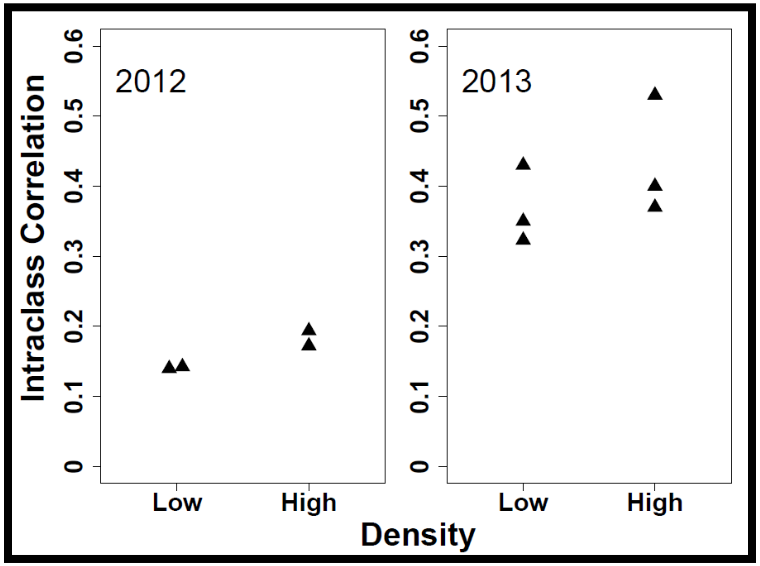
Test whether:

(1) *among-family* variance in body size changes

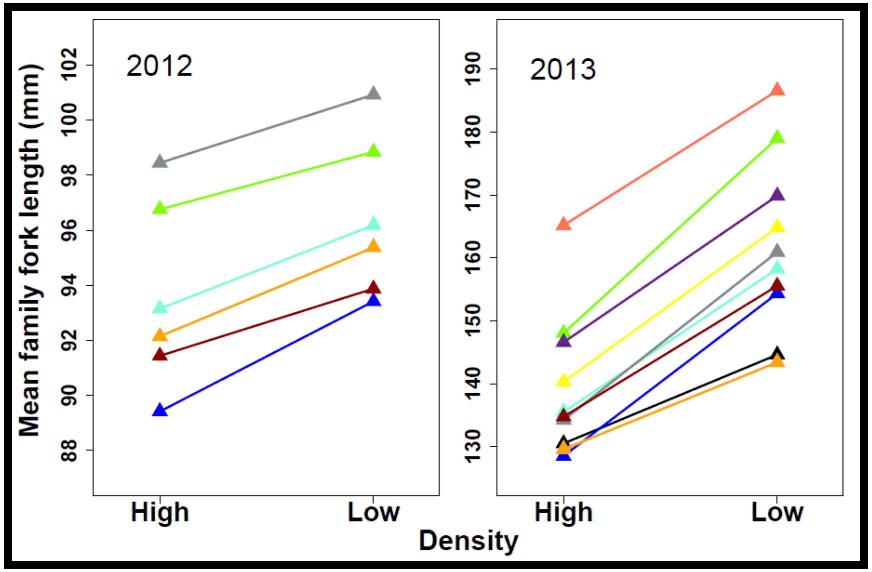
(2) there is a strong family-by-environment interaction

Results: both hypotheses rejected

No increase in variance among families



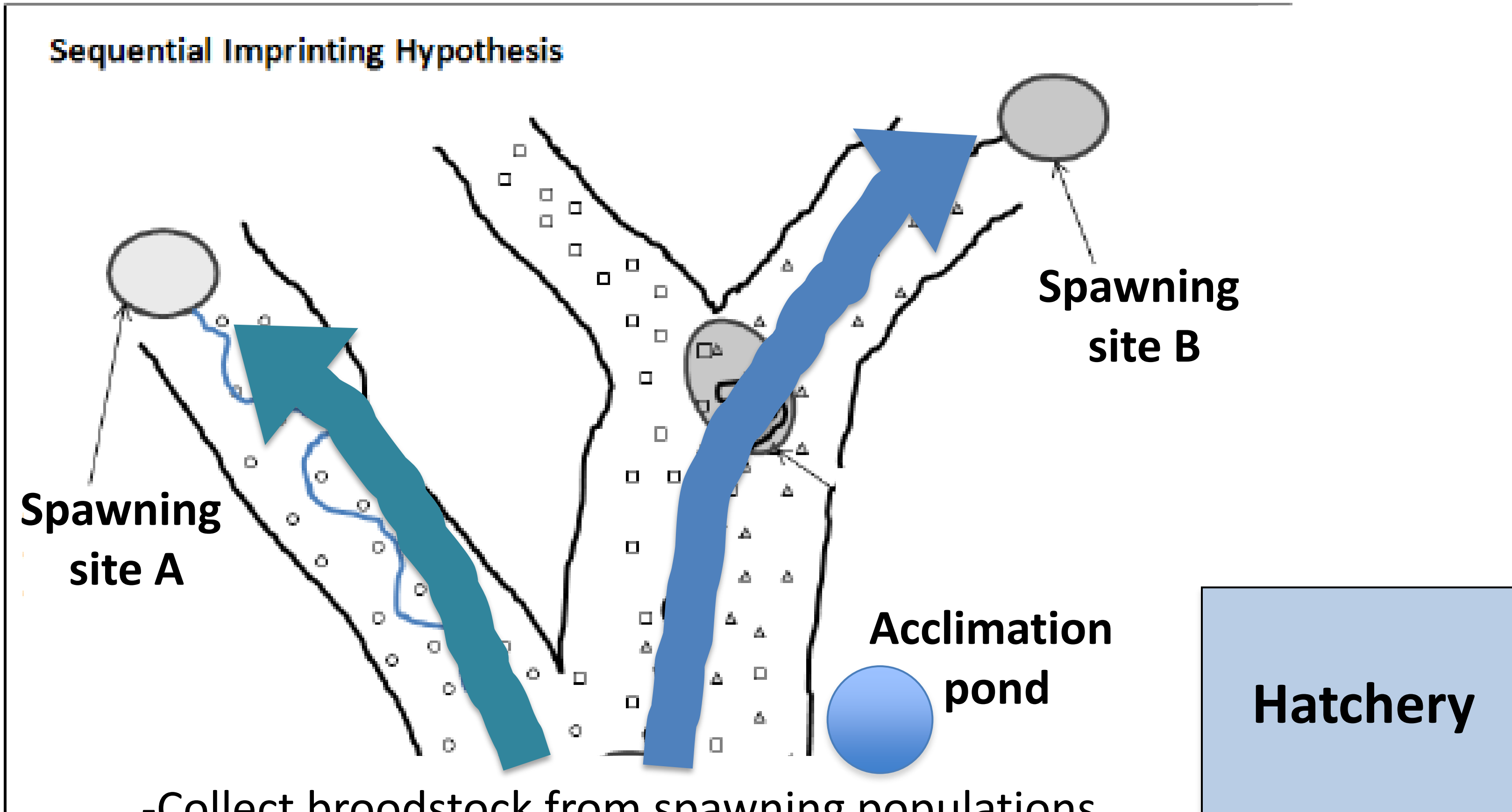
Minimal family x environment interaction



Imprinting of Hatchery-reared Salmon to Targeted Spawning Locations: A New Early Imprinting Paradigm for Supplementation Programs?

M. Gorman

Sequential Imprinting Scenario



- Collect broodstock from spawning populations
- Spawn and fertilize at Central hatchery
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- Incubate in natal water during hatching and emergence
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Can Chinook salmon embryos learn incubation water?

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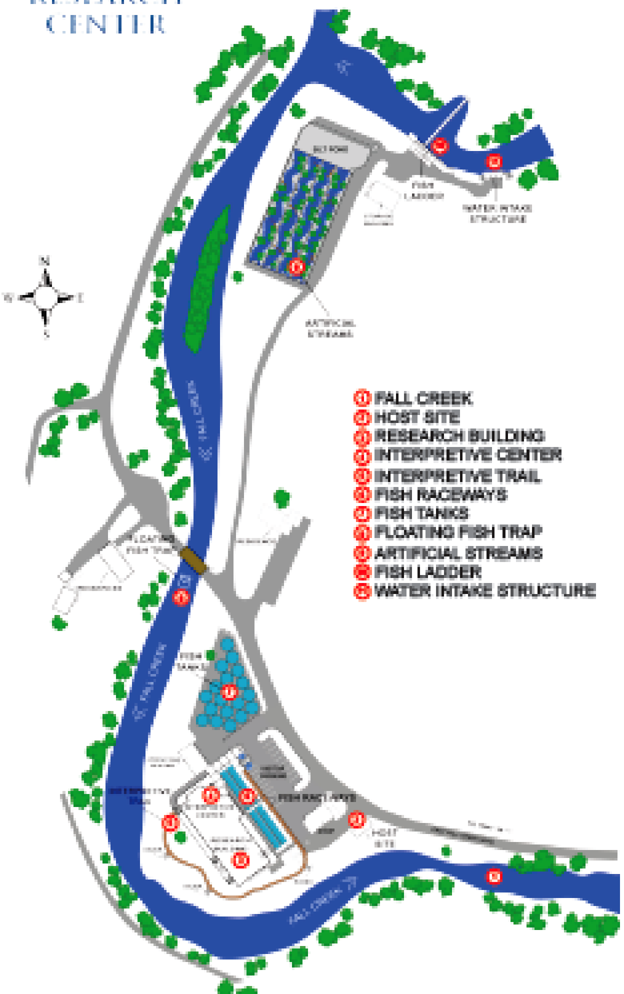
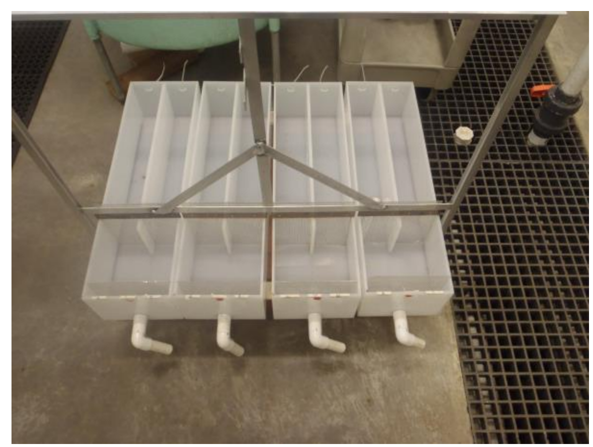


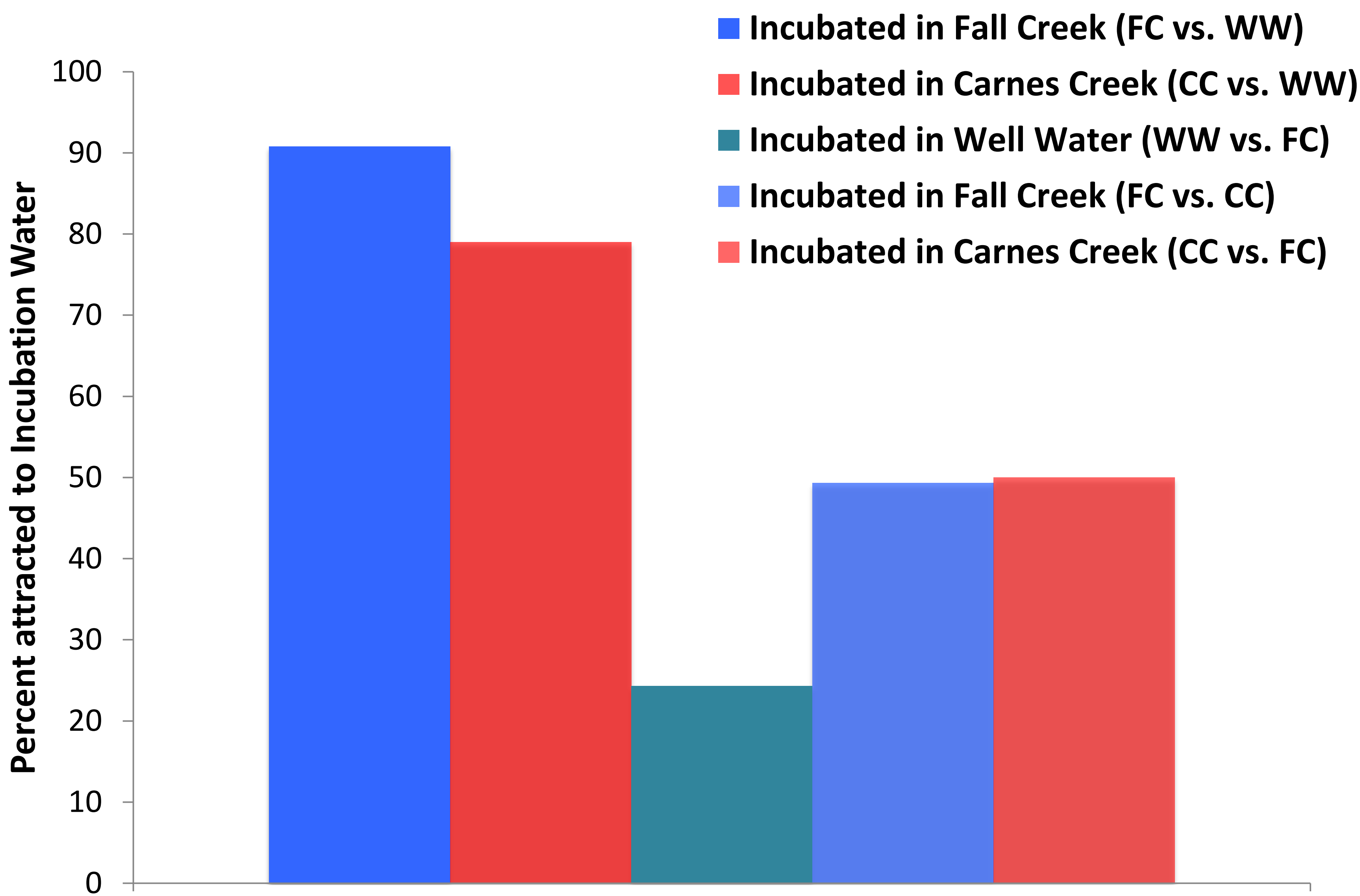
Clackamas Spring Chinook

Fall Creek | Well water | Carnes Creek

Y-maze testing of emergent fry

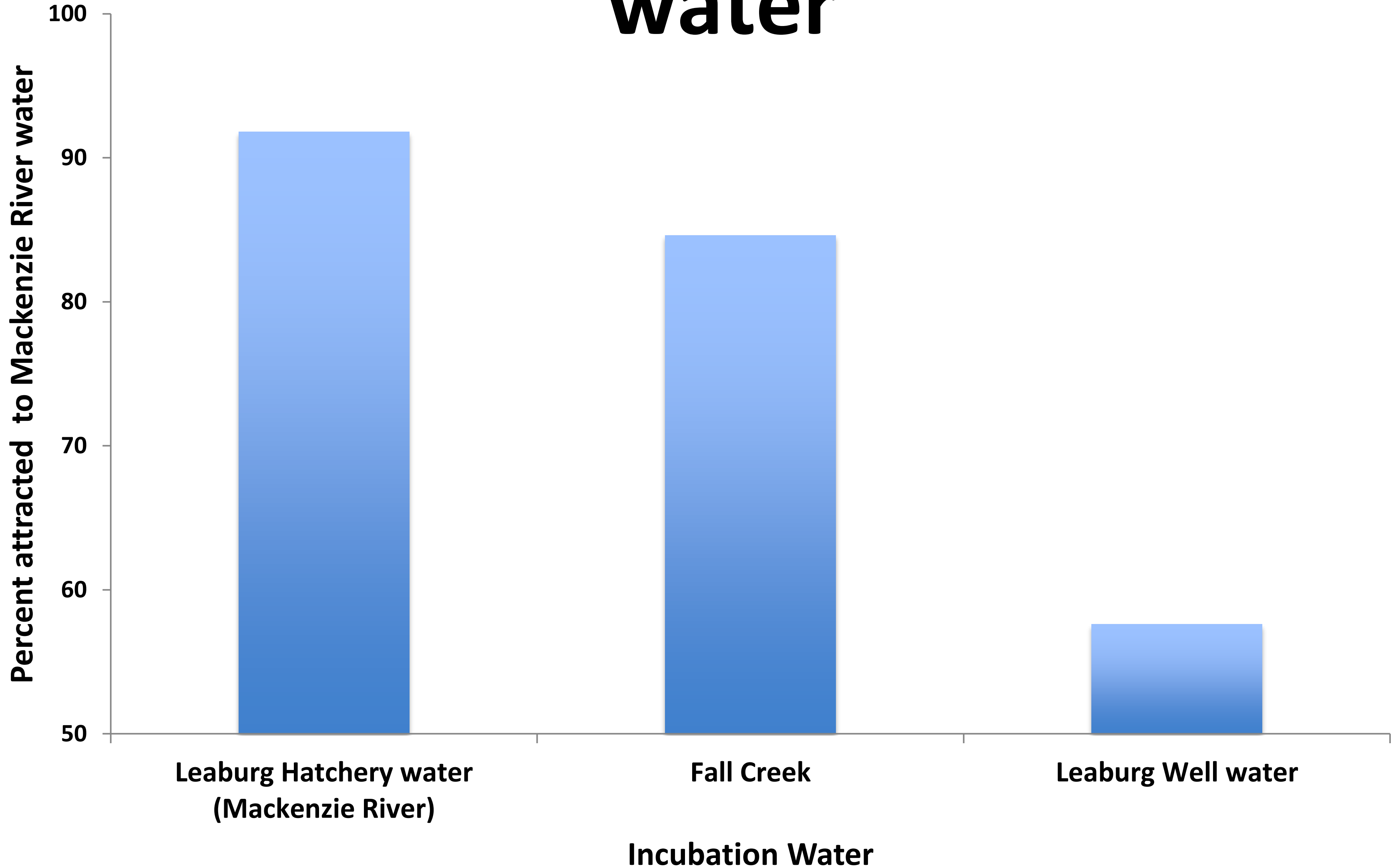


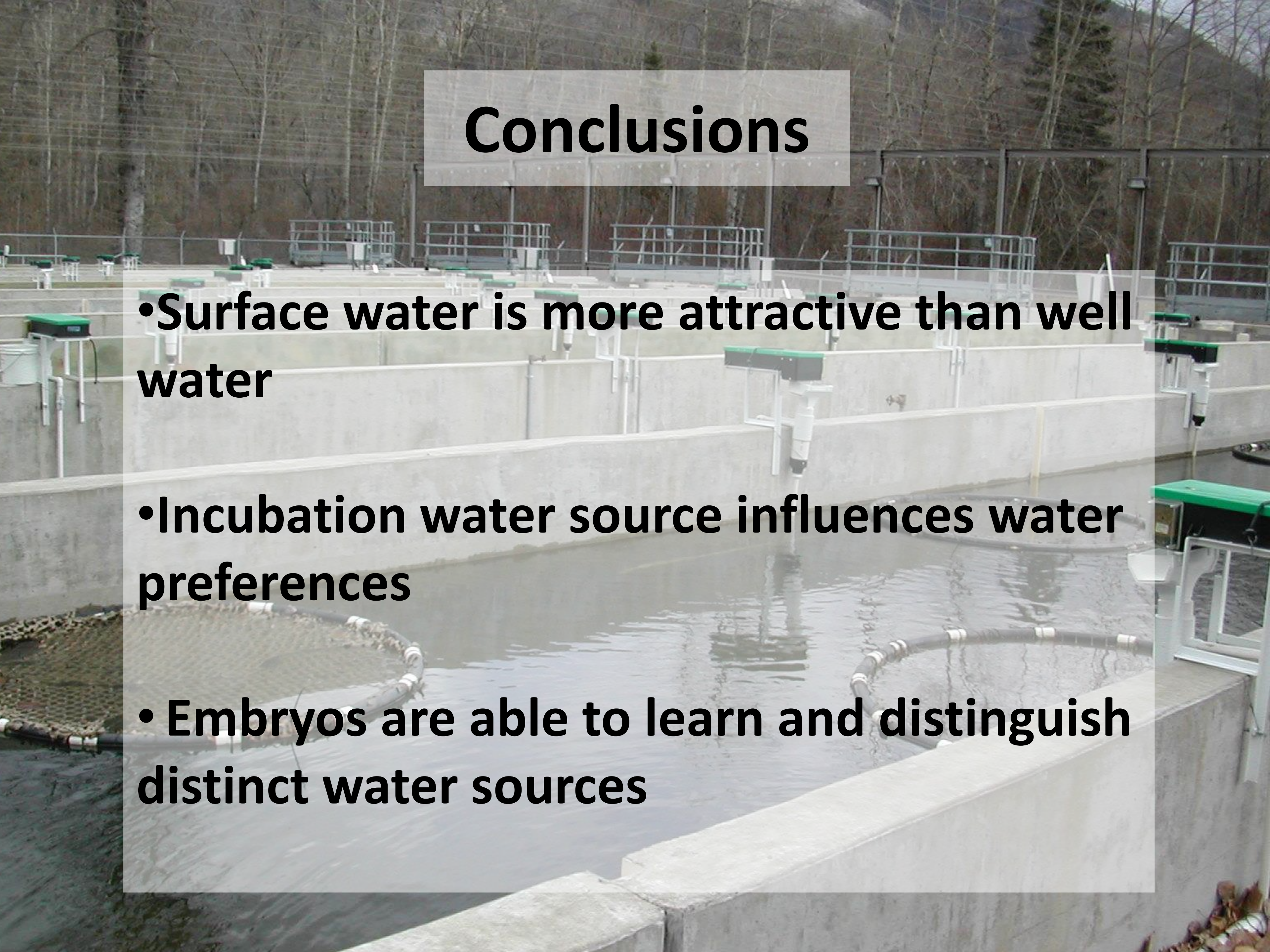
Spring Chinook embryonic learning?



Dittman, Couture, O'Neil, and Noakes

Leaburg Y maze trials: Mackenzie River water vs. well water

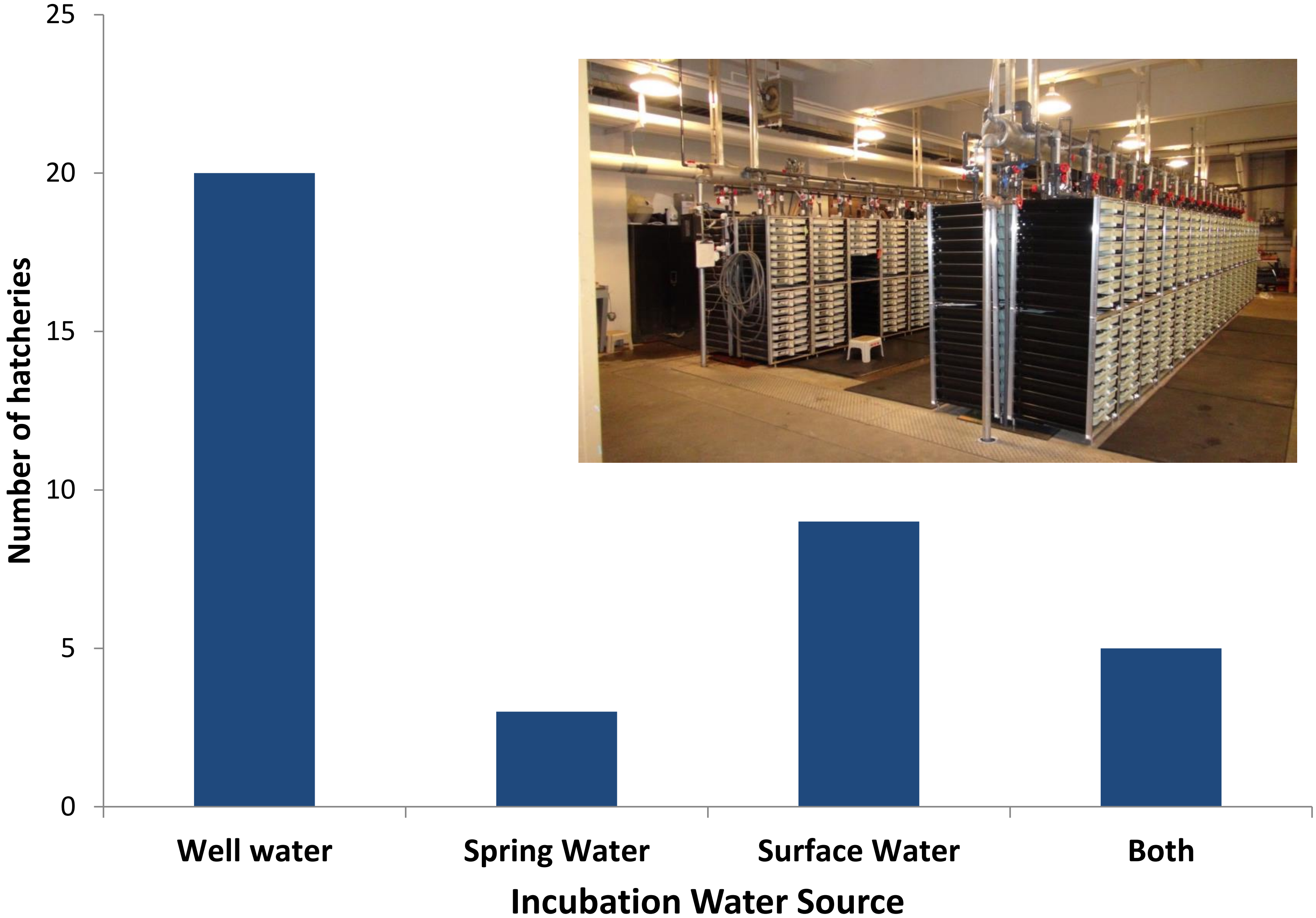




Conclusions

- **Surface water is more attractive than well water**
- **Incubation water source influences water preferences**
- **Embryos are able to learn and distinguish distinct water sources**

Incubation water in Columbia River hatcheries



Source: Hatchery and genetic management plans

Implications

- Water source may be important for more reasons than just temperature and disease (Olfactory enrichment?)
- Do hatcheries using well water have elevated stray rates?
- Supplementing with small % of surface water may help
- Further study needed (timing of water exposure, degree of enrichment, water chemistry)

Collaboration, Cooperation

http://www.dfw.state.or.us/OHRC/

- Problems
- Questions
- Research
- Education
- Operation
- Outreach

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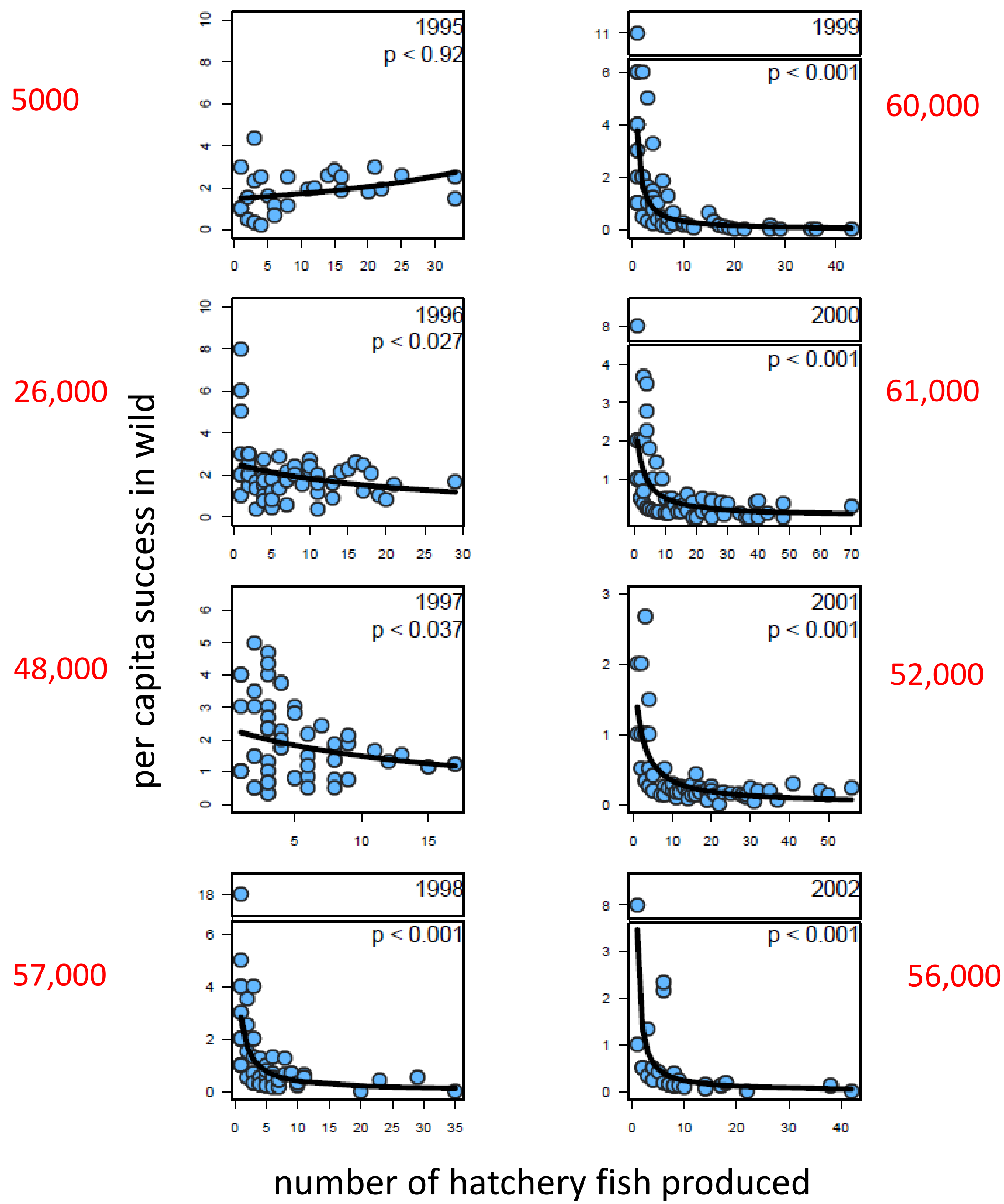
e.g. effects of changing rearing density (Thompson & Blouin 2015, *CJFAS*)

Hypothesis: high *crowding* increases variance in performance among families

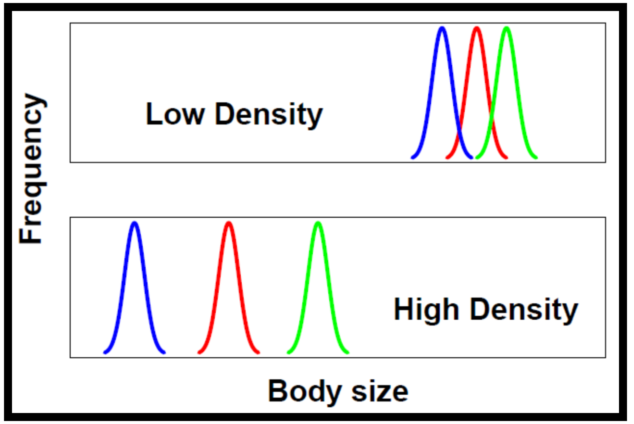


5000
26,000
48,000
57,000
60,000
61,000
52,000
56,000
per capita success in wild
number of hatchery fish produced
1995
p < 0.92
1996
p < 0.027
1997
p < 0.037
1998
p < 0.001
1999
p < 0.001
2000
p < 0.001
2001
p < 0.001
2002
p < 0.001

- Raised multiple families at 2 densities
- Two years
- 2-3 replicate tanks per density

<u>Expectation with higher density:</u>

1. increase variance among families



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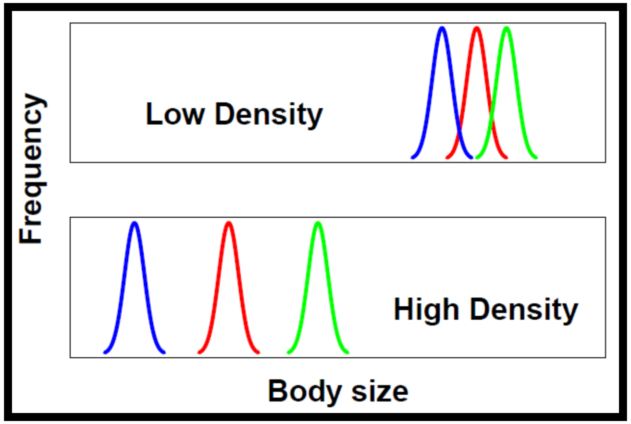
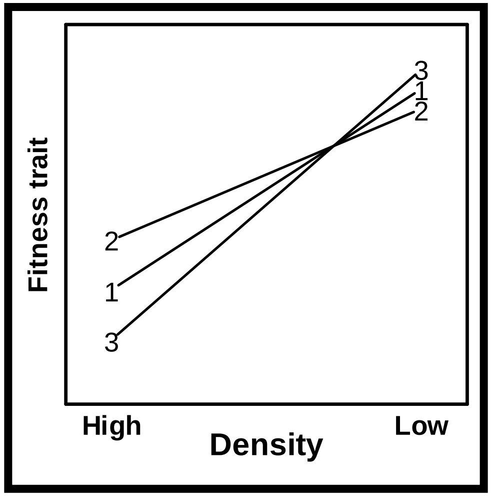
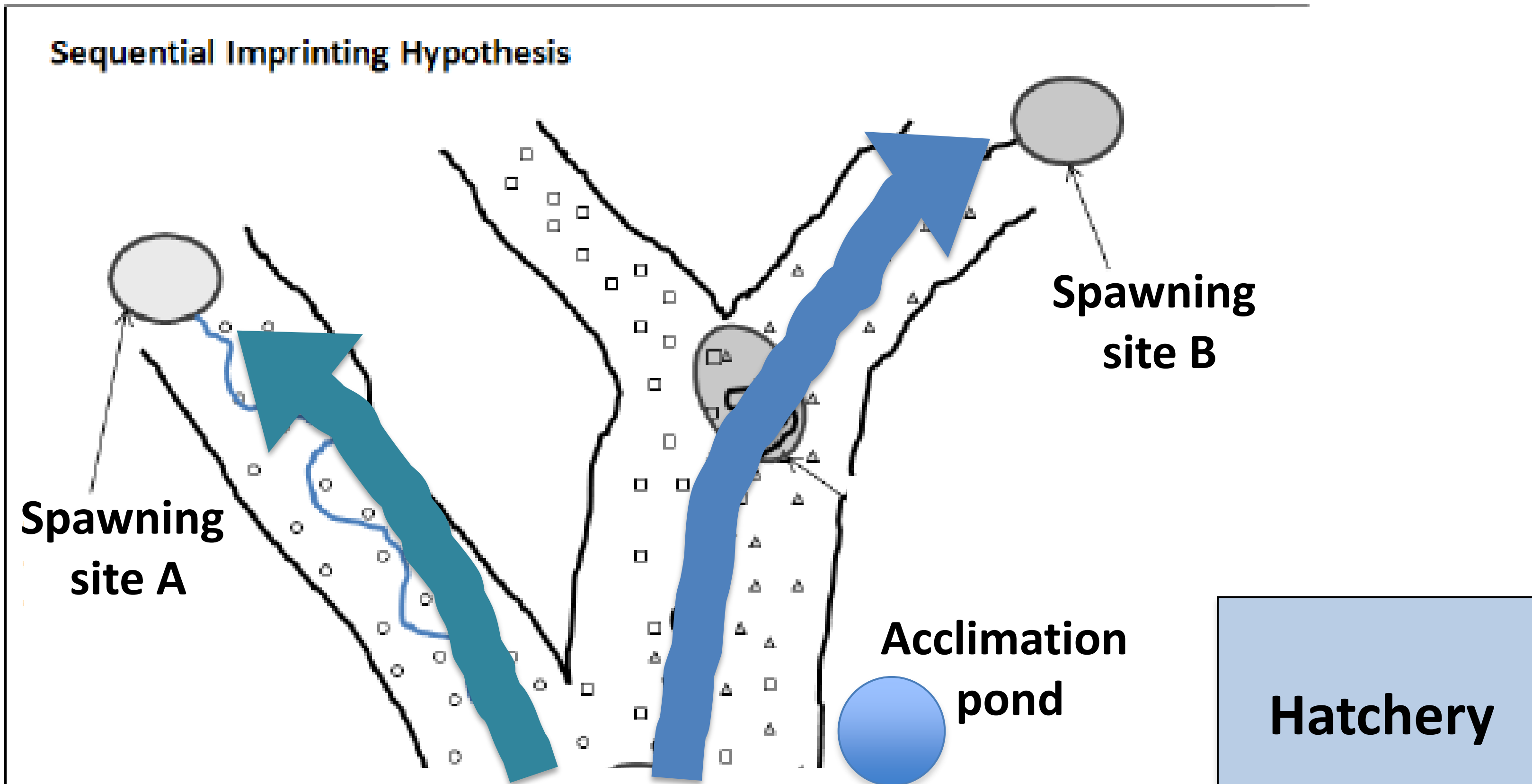


2. substantial family x environment interaction



Smolt acclimation is the primary tool for imprinting salmon to release locations.

Sequential Imprinting Scenario



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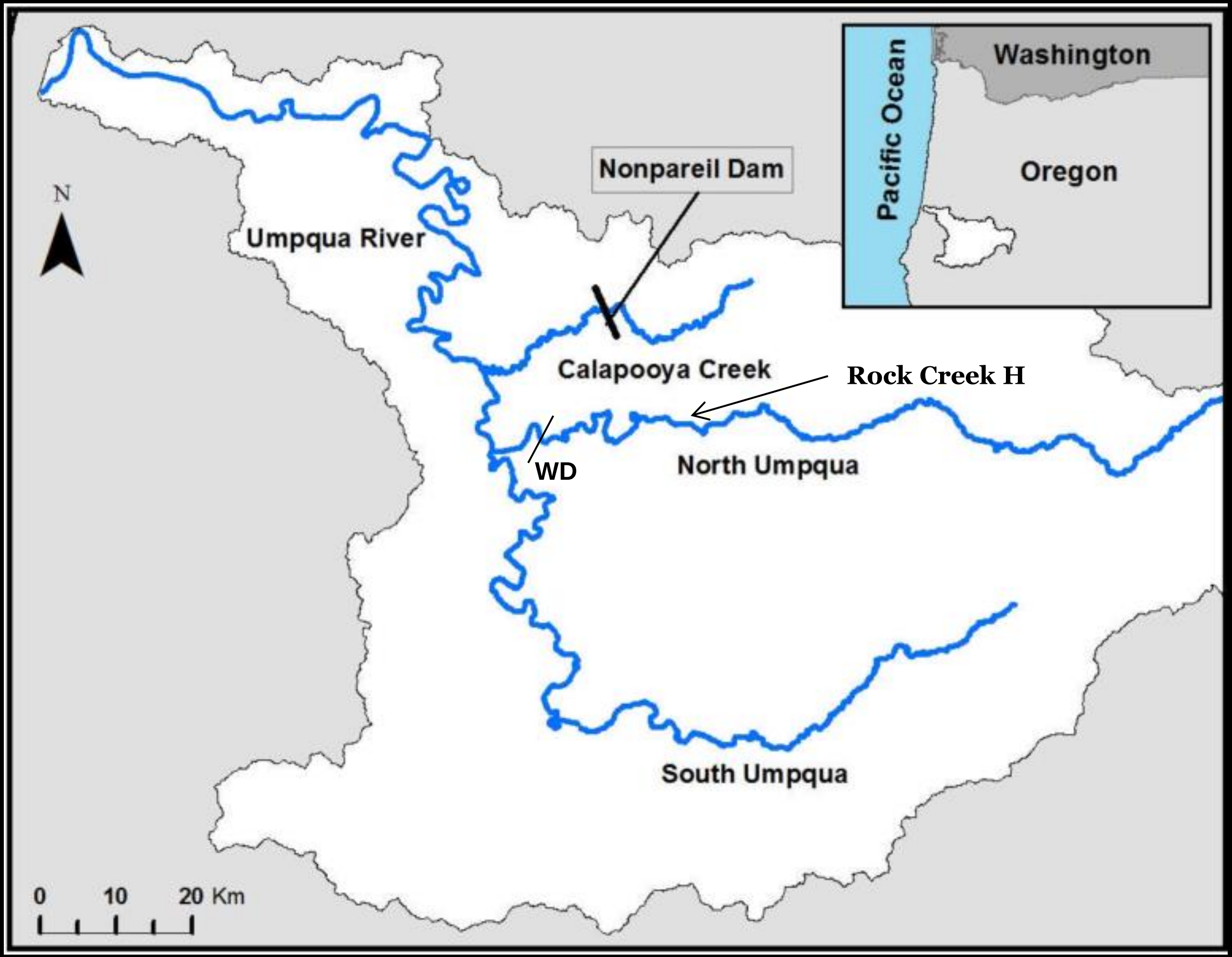
CHIP program – Nonpareil Dam

Greg Moyer, Post Doc 2007
Regional Geneticist, USFWS - Georgia

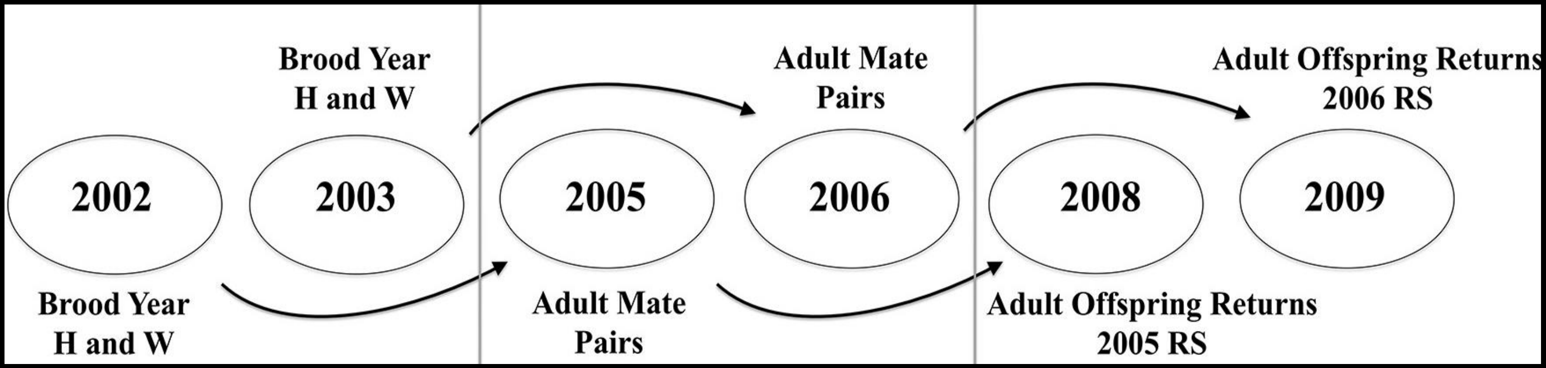
Veronique Theriault, Post Doc 2009
AECOM, Montreal, Quebec



MATE SELECTION STUDY

Step 1. : Determine which genomic combinations were most successful in producing greater # of returns

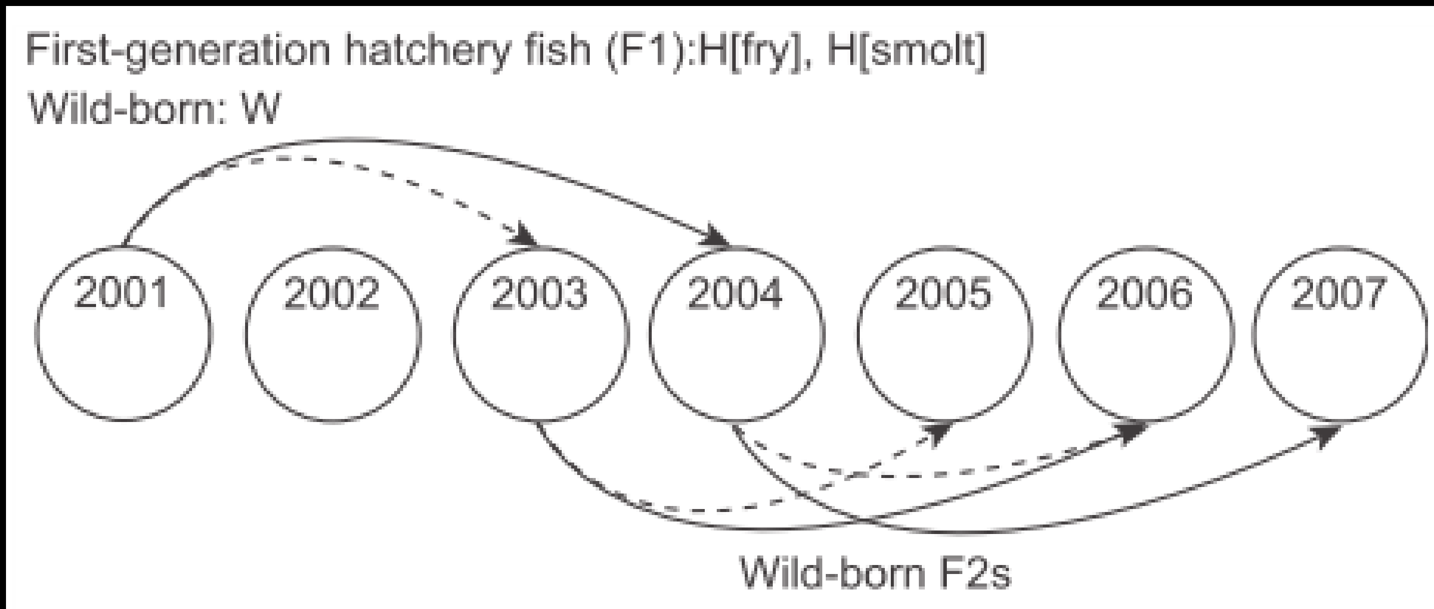
Umpqua COHO – focus 2005 & 2006



Whitcomb et al 2014

Amelia Whitcomb
WAD


Rock Creek



Beauty of this study design:

Observe first generation H spawning in the wild along with W-born

Through pedigree & counting # adult returns we can evaluate total lifetime success, and assess relative reproductive success (H/W)