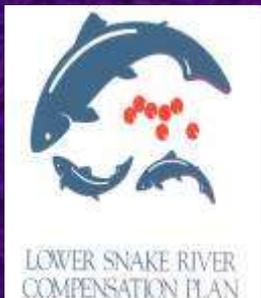


Comparison of Natural- and Hatchery-Origin Imnaha River Chinook Salmon After 20+Years of Supplementation: Twin Sons of Different Mothers?

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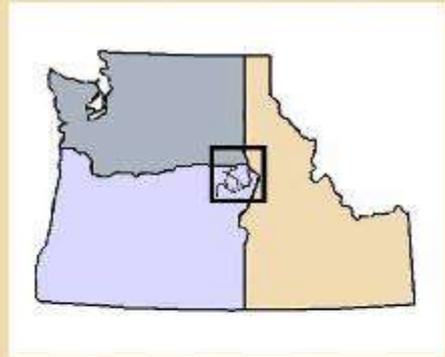
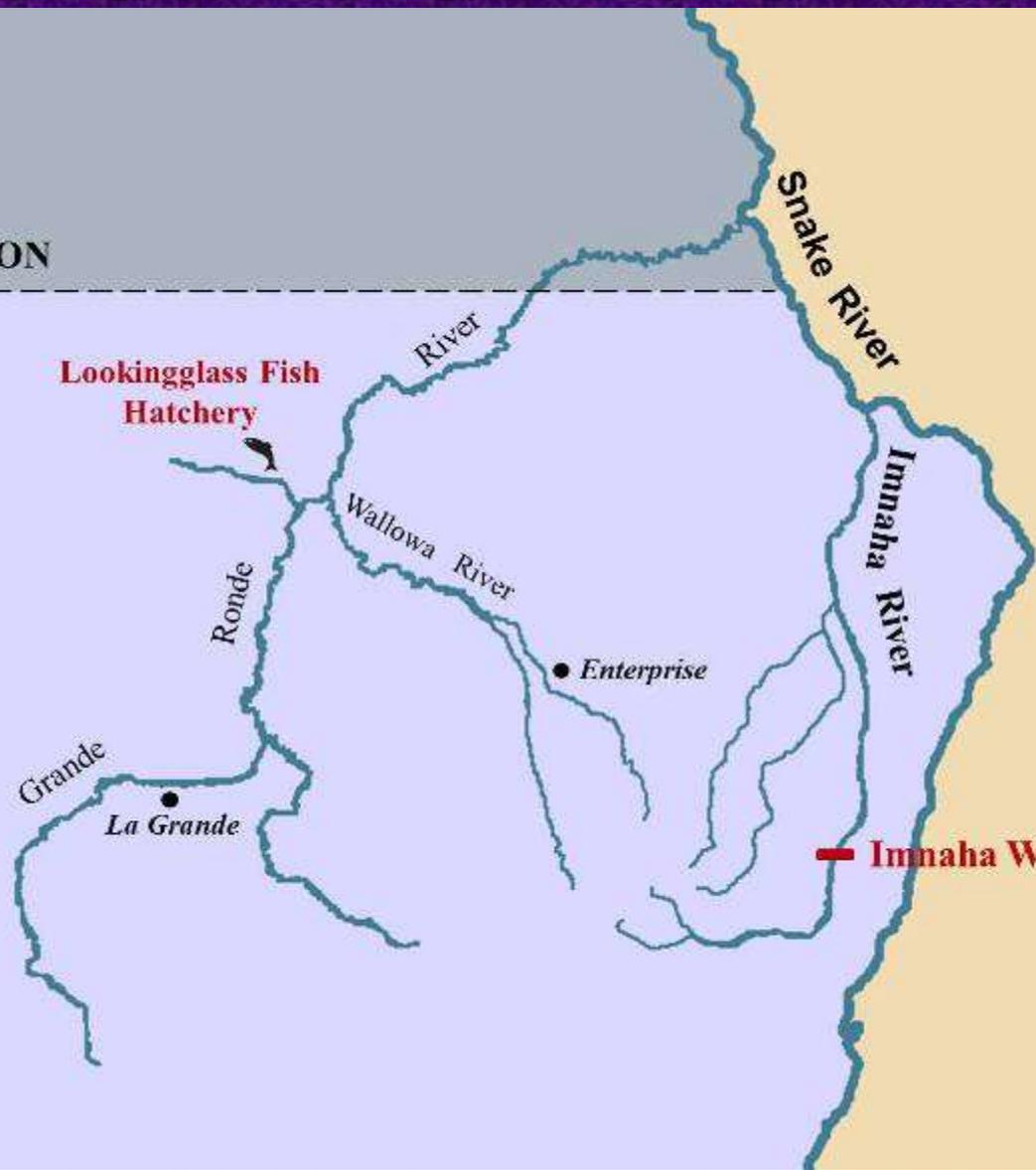
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Background

- Goal of supplementation program is to produce a self-sustaining natural population of Chinook.
- Integrated hatchery program: intent is that hatchery- and natural-origin salmon interbreed, both in the hatchery and in the river.
- Life-history and genetic traits of hatchery fish should mimic those of natural fish.

Imnaha weir facts

- **In most years, the Imnaha River weir is not installed until 1 July due to spring flows.**
- **Mean of only 43% of the run is intercepted at the weir annually.**
- **Once the weir is installed, all fish passing the weir site are intercepted.**
- **All fish trapped and passed above the weir receive a left opercle punch.**

Both natural- and hatchery-origin fish are passed above the weir to spawn naturally



07.18.2007

Imnaha Chinook broodstock

- **Brood are taken in proportion to origin, sex, age and timing of salmon that are trapped, to reflect composition of the run.**
- **Founded in 1982 with all native Imnaha Chinook.**
- **Steady infusion of natural salmon into broodstock - approximately 30% each year.**
- **Due to weir constraints, brood generally has been taken from last half of the run.**



On the Imnaha spawning grounds

- **We have been conducting redd and carcass surveys on the Imnaha River for 50+ years.**
- **Both natural and hatchery fish spawn in the river; hatchery fish have been passed upstream to spawn since 1990.**
- **Since 1990, the proportion of hatchery-origin salmon spawning in the Imnaha River has ranged from 30-80%.**

Do hatchery and natural salmon have different life-history traits?



Hatchery/natural salmon - differences in the river

| Trait | Natural | Hatchery |
|--------------------|-----------------------------|----------------------------|
| Return time | Earlier | Later |
| Spawn date | Earlier | Later |
| Spawn site | Higher in the system | Lower in the system |

Three women wearing light-colored short-sleeved shirts and dark green overalls are sitting on a concrete step outdoors. The woman on the left is covering her mouth with her hand. The woman in the middle has her hands behind her head. The woman on the right is covering her eyes with her hands. They appear to be reacting to something off-camera. The background consists of dry, tall grass and a dirt ground. A clear plastic container and a white lid are on the ground in the foreground.

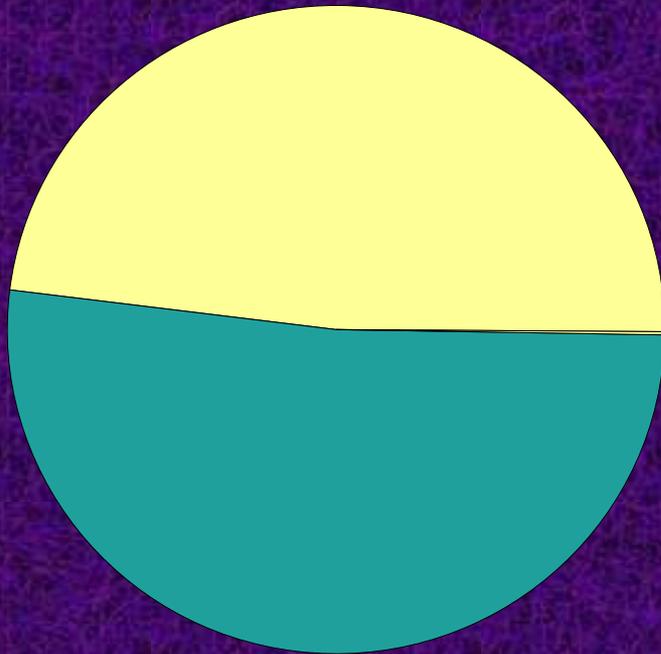
**Hatchery/natural females –
differences at the hatchery?**

Differences between hatchery and natural females used for brood

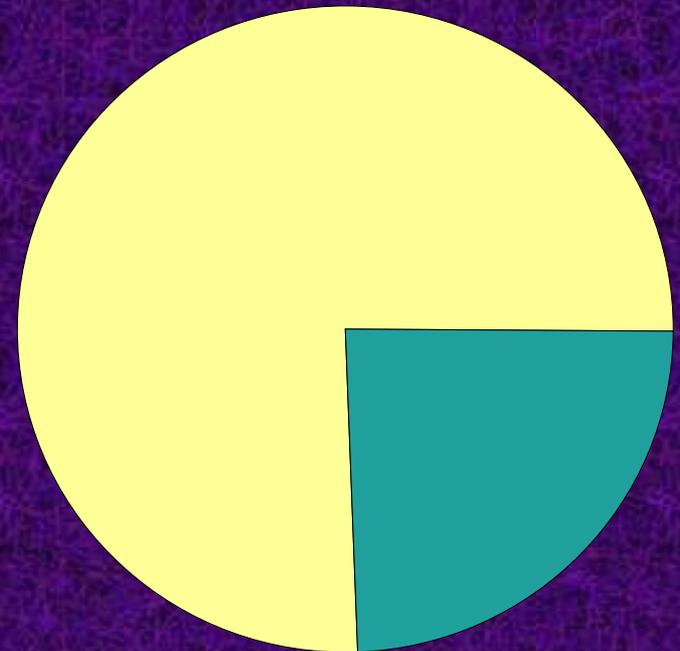
| Trait | Natural | Hatchery |
|--------------------|------------------|-------------------|
| Female size | Larger | Smaller |
| Fecundity | More eggs | Fewer Eggs |
| Egg Weight | Heavier | Lighter |
| Spawn date | Earlier | Later |

Age at return of Imnaha River Chinook salmon females, 1982 -2003 cohorts

Age 4
Age 5



Natural Females
52% Age 5



Hatchery Females
24% Age 5

P = 0.0078

Differences between hatchery and natural females used for brood

| Trait | Natural (mostly age 5) | Hatchery (mostly age 4) |
|--------------------|-----------------------------------|------------------------------------|
| Female size | Larger | Smaller |
| Fecundity | More eggs | Fewer Eggs |
| Egg Weight | Heavier | Lighter |
| Spawn date | Earlier | Later |

Supplementation program challenges

- Different age compositions causes different traits in hatchery and natural fish.
- Age of all females is getting younger.
↓
- Smaller eggs and lower fecundity.
↓
- Less production, in hatchery and nature.

Are hatchery and natural salmon genetically similar, or genetically different?



Concerns and questions

- Hatchery and natural fish exhibit differences.
- Is there a genetic difference between hatchery and natural Imnaha River Chinook?
- We founded our hatchery program with, and continue to take brood from, fish collected from the last half of the run.
- Is there a genetic difference between early- and late-returning salmon?

Methods

- We collected tissue samples from 2006 and 2008 return years, both from hatchery broodstock and on spawning surveys.
- We genotyped samples at 23 microsatellites.
- We used a variety of genetic analysis softwares to compare different groups.
- Early-returning fish on the spawning grounds (passed upstream pre-weir) were identified by the lack of an opercle punch.



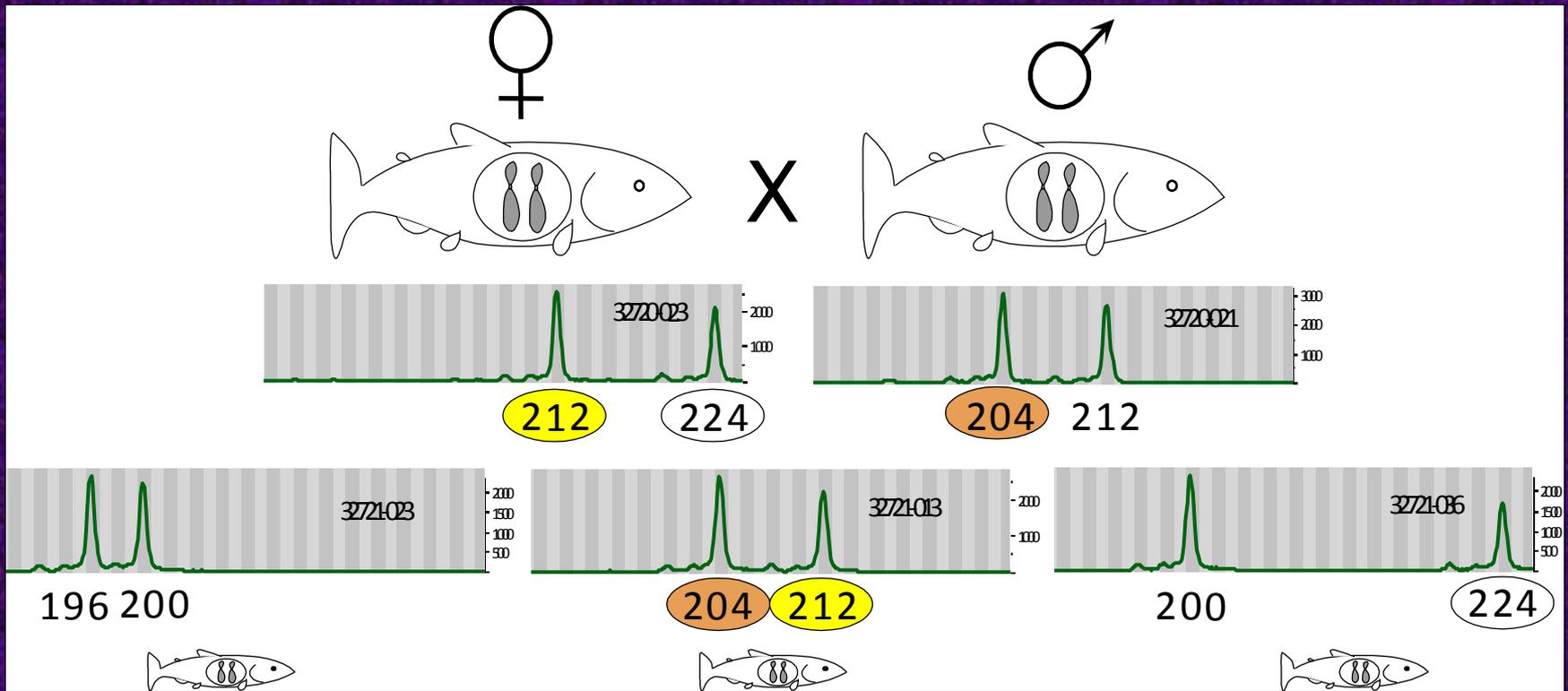


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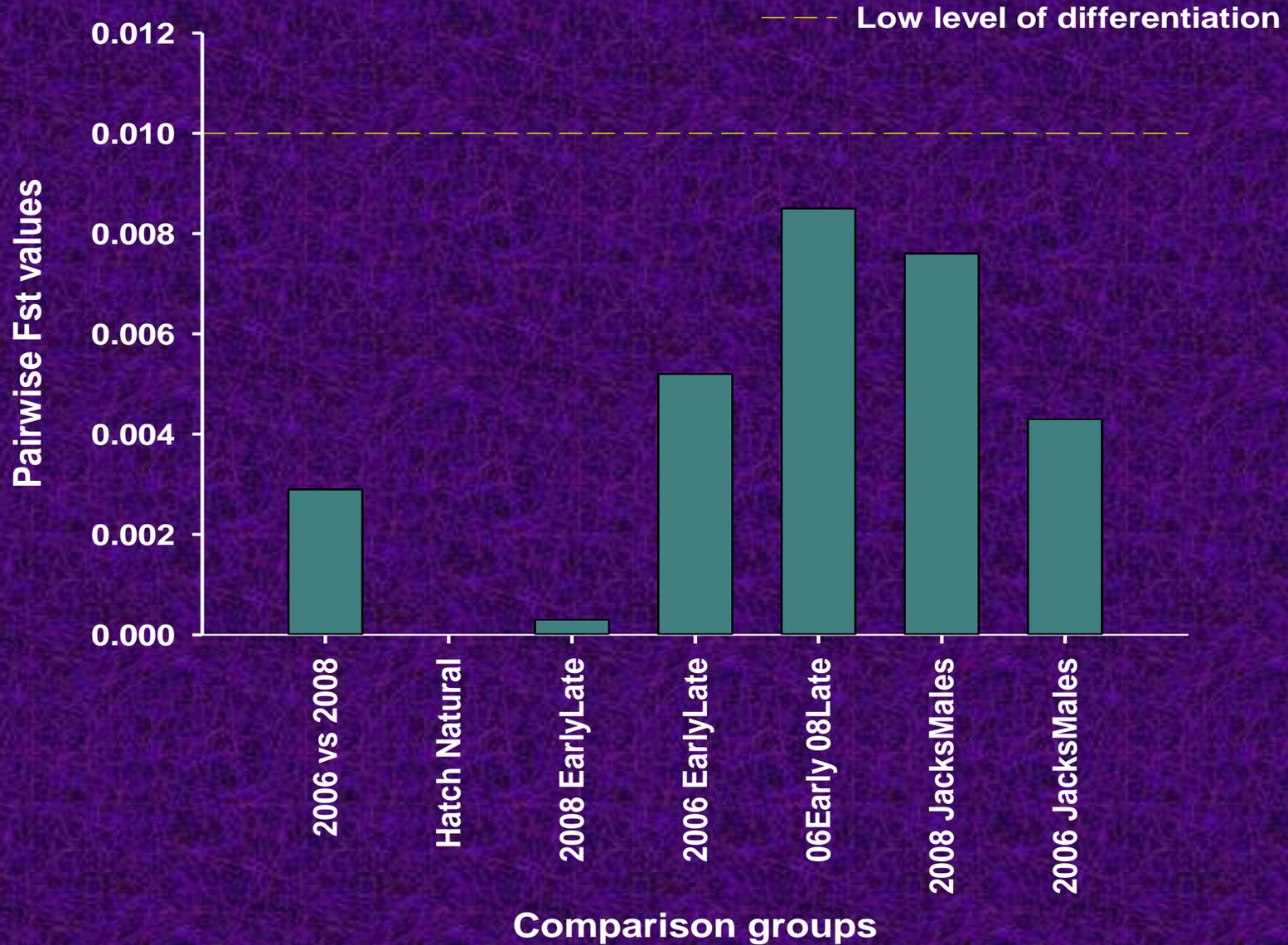
Genetic material from each parent = unique fingerprint for each fish



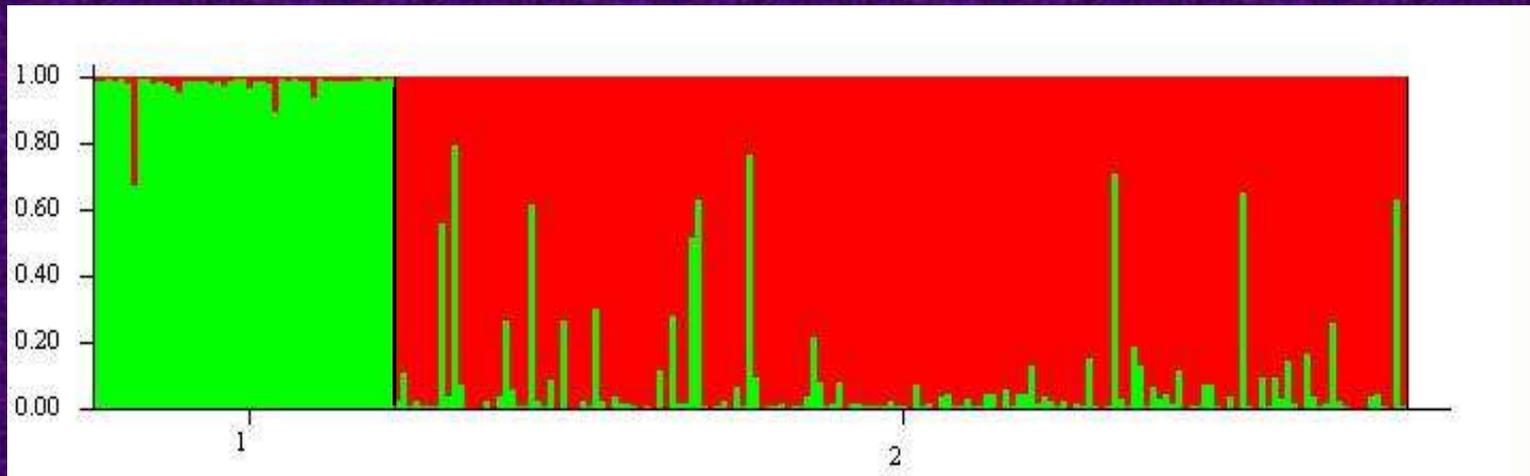
Genetic comparisons – are they different?

| Groups Compared | Sample Size |
|--|--------------------|
| 2006 vs. 2008 Return Year | n = 678 |
| Hatchery vs. Natural | n = 678 |
| 2008 Return Year Early vs. Late | n = 373 |
| 2006 Return Year Early vs. Late | n = 305 |
| 2006 Early vs. 2008 Late | n = 297 |
| 2006 Jacks vs. Males (age 4, 5) | n = 166 |
| 2008 Jacks vs. Males (age 4, 5) | n = 204 |

Divergence between groups?

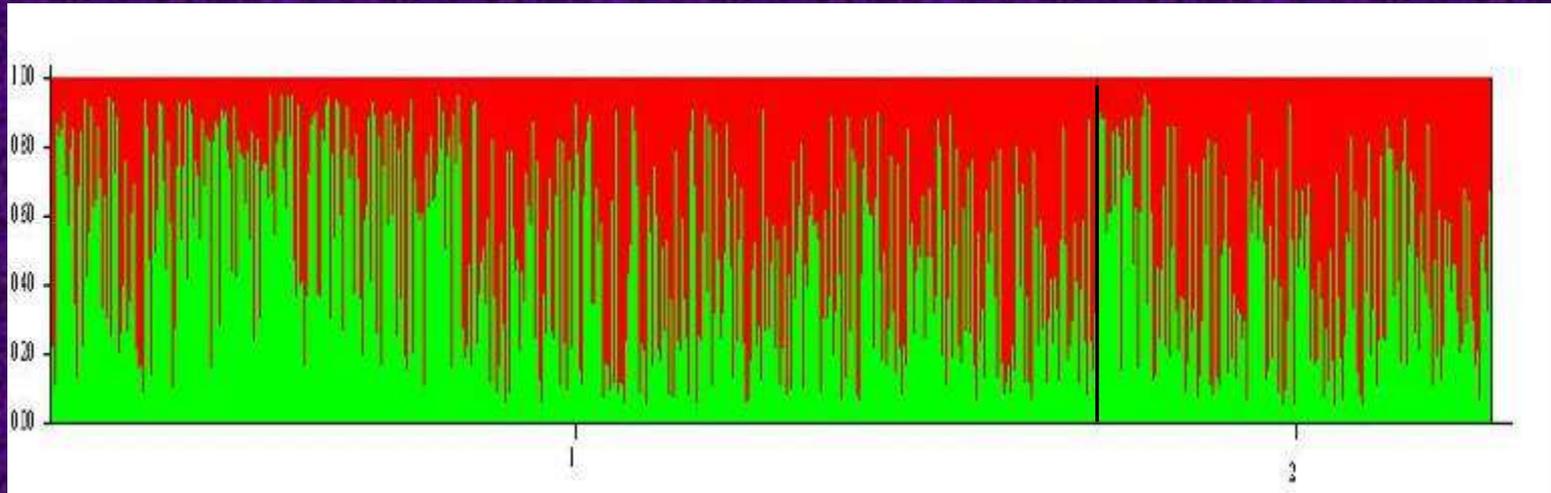


Genetic differentiation



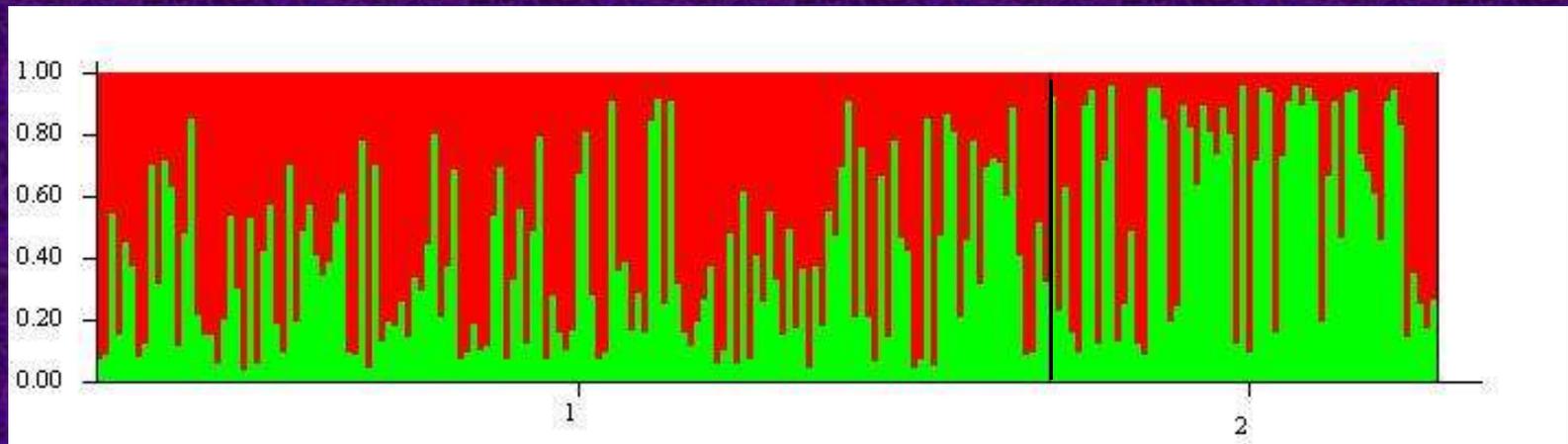
Two distinct genetic groups; individuals cluster into “green” and “red” segments fairly well, with some overlap

Hatchery vs. natural - lack of differentiation



No distinct clusters, because there is little differentiation. Both origins fall into one genetic group.

2008 Return Year Jacks vs. age 4 and 5 males



Individuals are clustering 62% of the time (vs. 50% of the time for hatchery/natural). Still not two populations, a little more structure.

Genetic analysis results

- **No difference between hatchery and natural salmon.**
- **No difference between early- and late-returns, although this group appeared closest to a low level of differentiation.**
- **No difference between age 3 males (jacks) and age 4 and 5 males (sorry, Barry)!**
- **No difference between return years 2006 and 2008.**

Conclusions

- **Most differences between hatchery and natural salmon seem to be due to differences in age composition.**
- **Later return time of hatchery salmon likely results from taking brood from last half of the run for 20+ years.**
- **Early- and late-returning fish have not yet segregated into two genetically distinct groups.**
- **Hatchery and natural salmon are genetically similar.**
- **Suggests some successful interbreeding between hatchery and natural salmon in nature.**

Acknowledgements

Lower Snake Compensation Plan

ODFW Restoration and Enhancement Board

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ODFW, CTUIR, NPT spawning surveyors

“Looks like twin sons of different mothers to me, Catwoman.”



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