# *Trends in Demographic and Phenotypic Traits of Hatchery- and Natural-Origin Upper Yakima River Spring Chinook Salmon*

**C. M. Knudsen[1], W. J. Bosch[2,] A. Fritts[3], M. V. Johnston[2], C. Stockton[3], and D. E. Fast[2]**

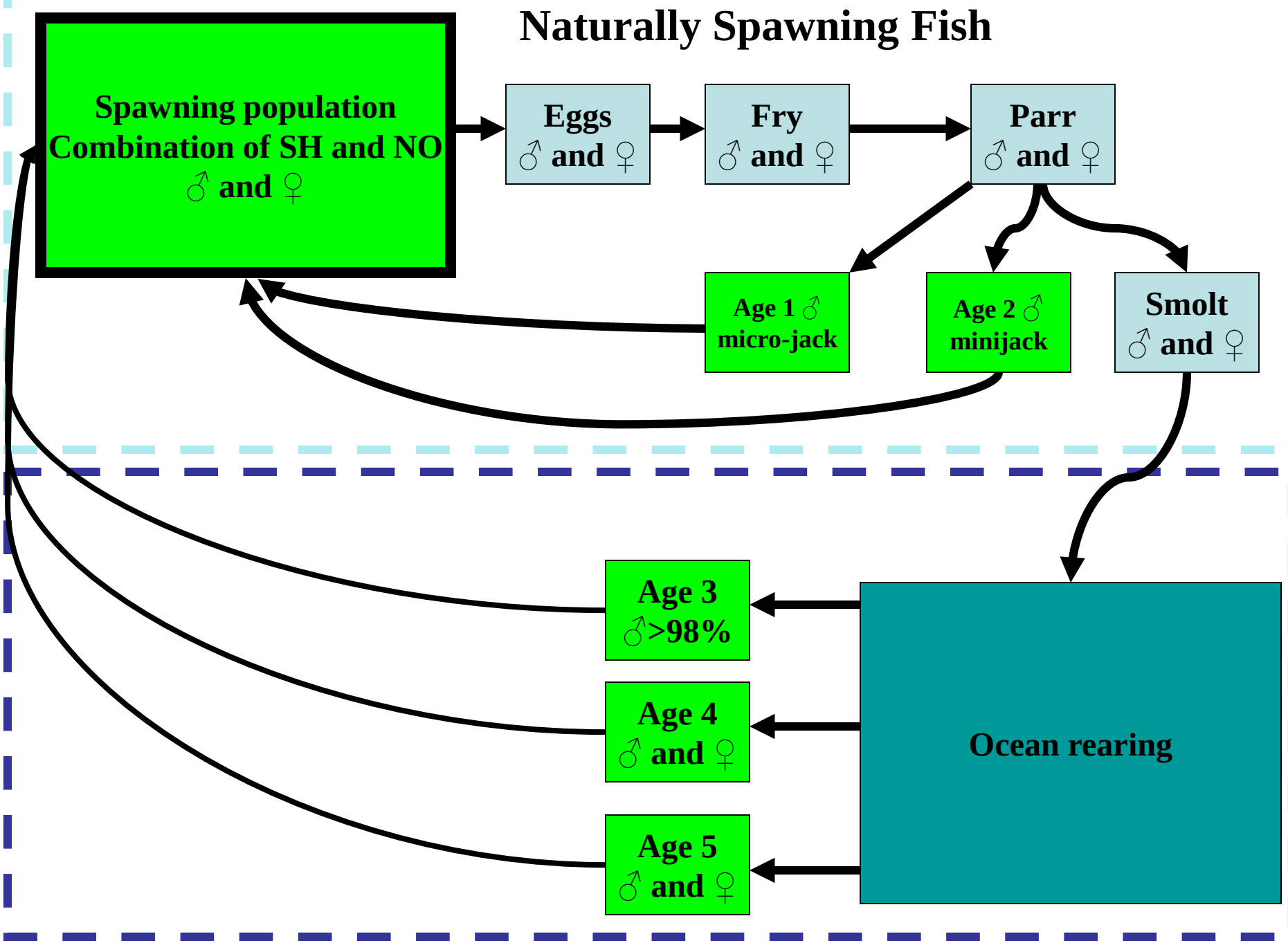
[1] Oncorh Consulting
[2] Yakama Nation
[3] Washington Department of Fish and Wildlife

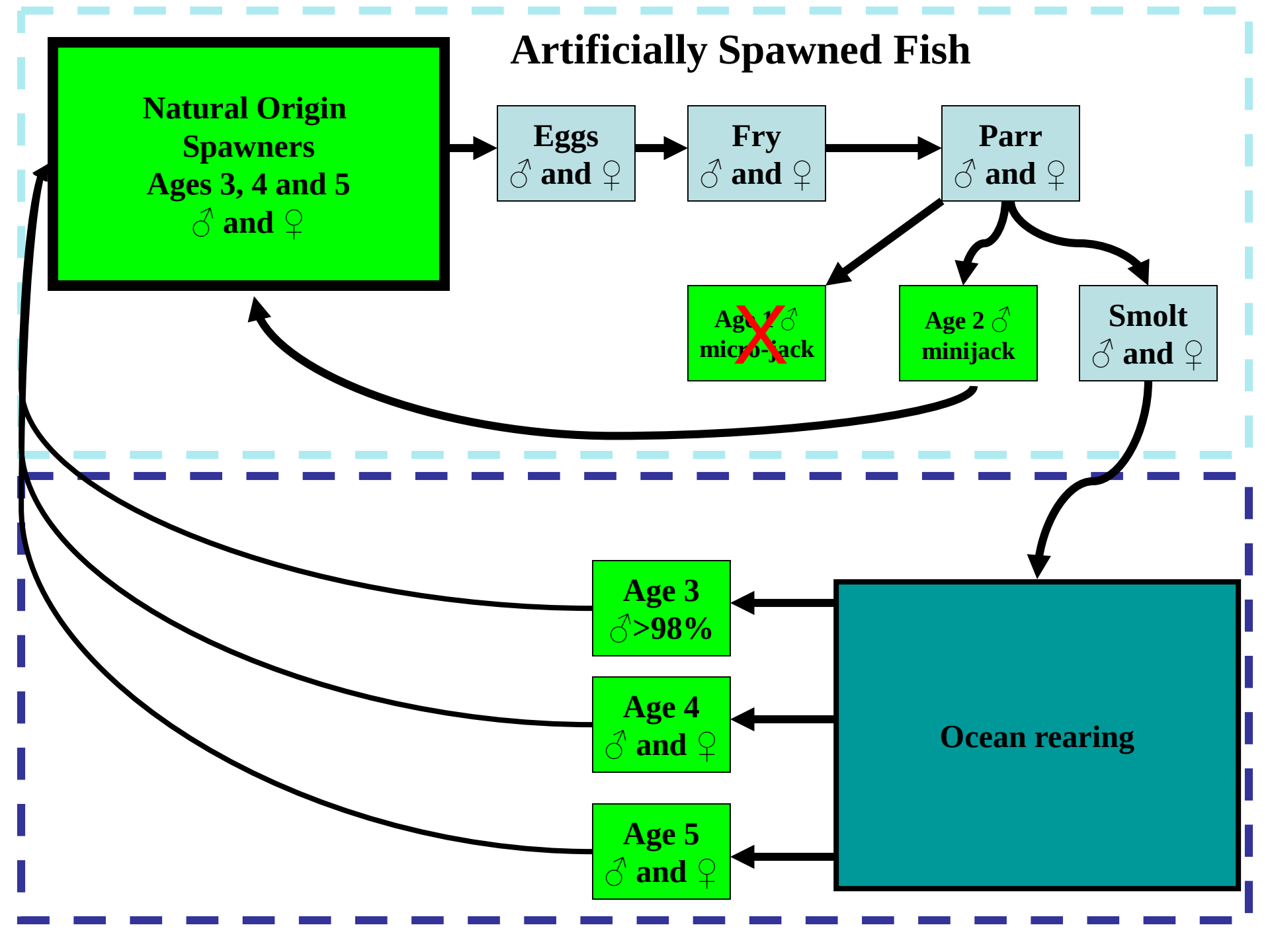
- Harstad et al. (2014). Variation in Minijack Rate among Hatchery Populations of Columbia River Basin Chinook Salmon. TAFS 143: 768-778.

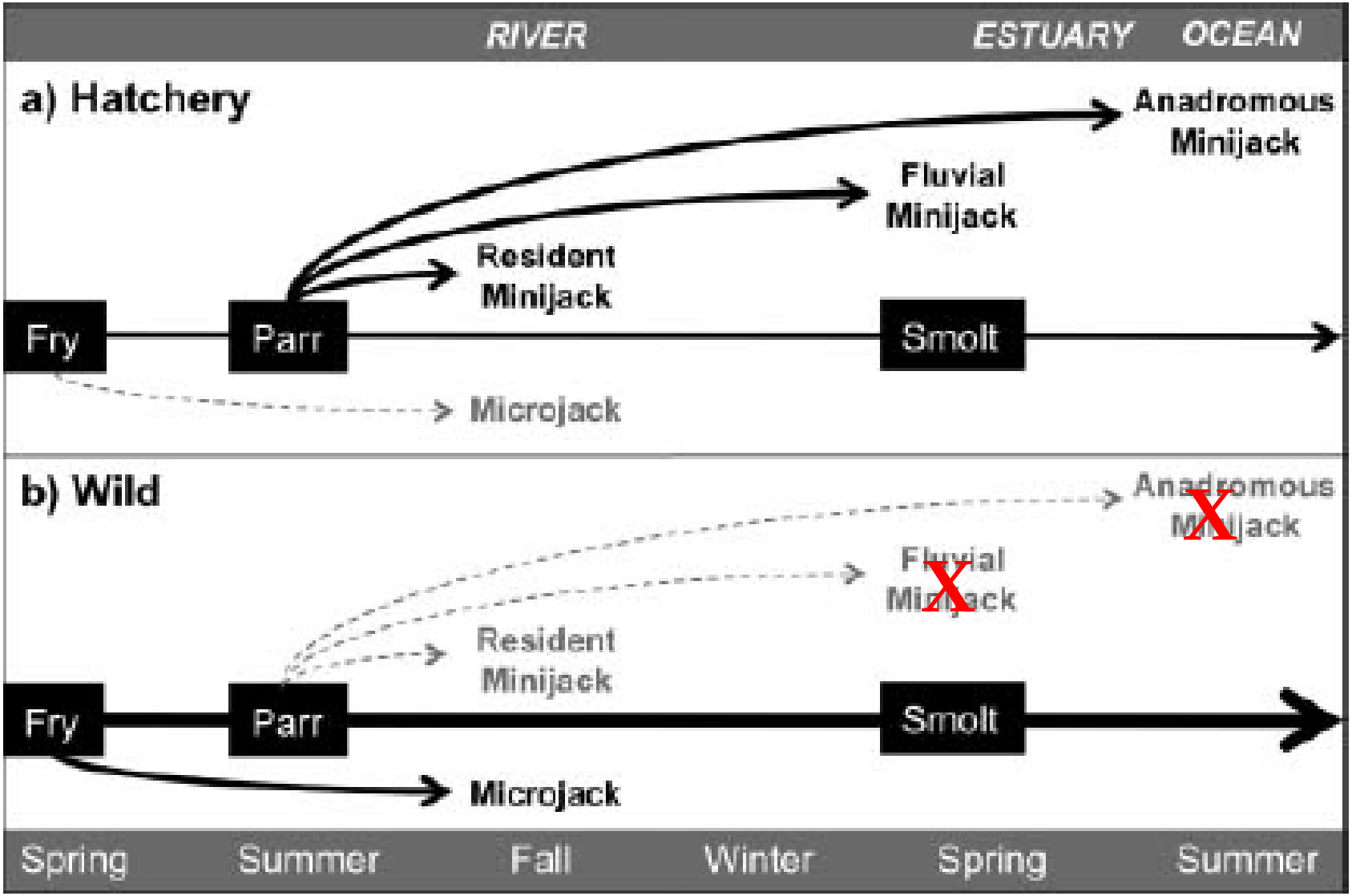
- Larsen et al. (2013). Early life history variation in hatchery- and natural-origin spring Chinook salmon in the Yakima River, Washington. TAFS 142: 540-555.

# Issues posed by minijacks:

- Are minijack rates for yearling spring Chinook Salmon hatchery programs higher than for wild populations?
- Do hatchery minijack rates in Chinook Salmon reduce the number of male smolts released?
- Do high minijack rates in Chinook Salmon hatchery programs result in a reduction in the number of males returning as full-sized anadromous adults for harvest or spawning?

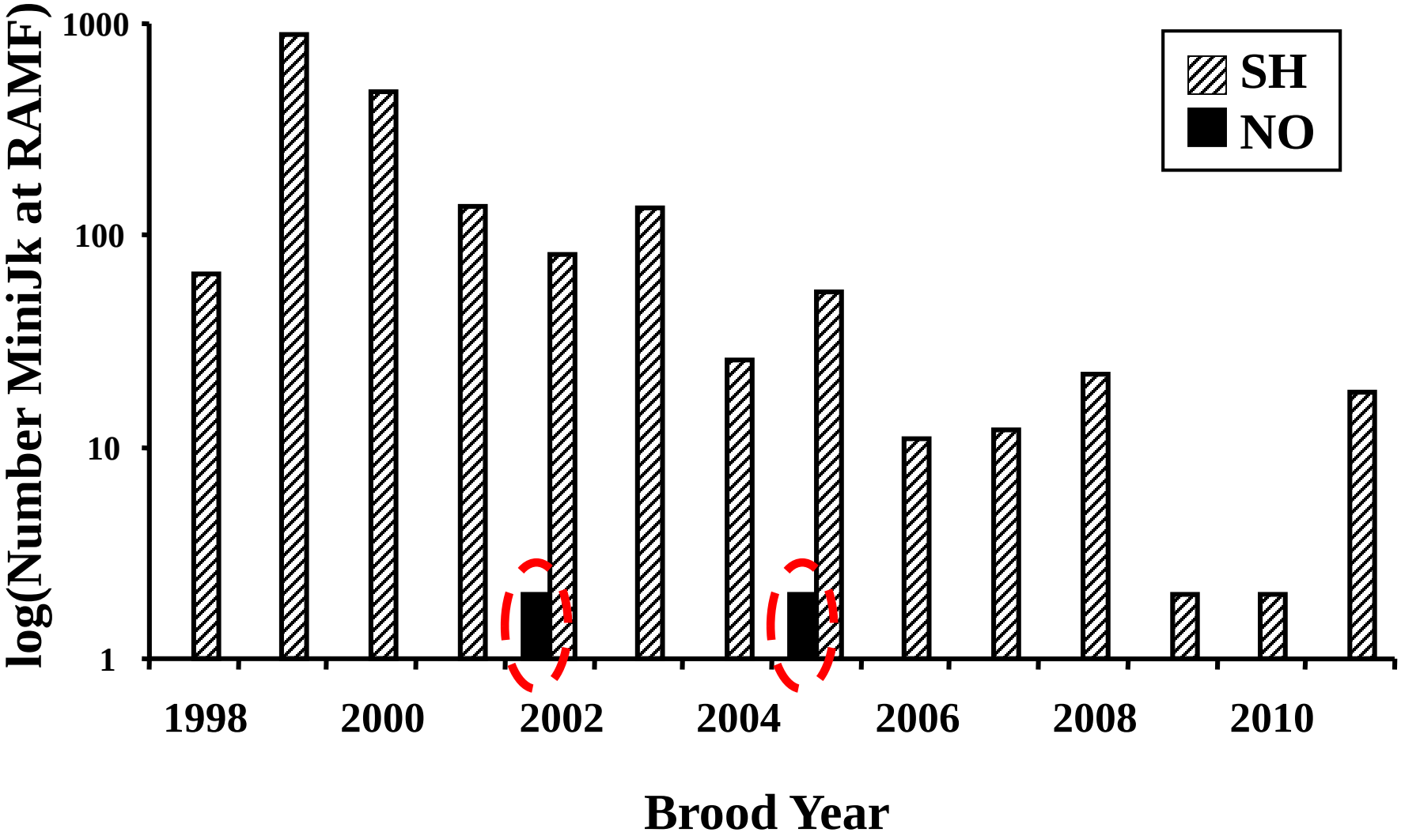

Naturally Spawning Fish
Spawning population
Combination of SH and NO
♂ and ♀
Eggs
♂ and ♀
Fry
♂ and ♀
Parr
♂ and ♀
Age 1 ♂
micro-jack
Age 2 ♂
minijack
Smolt
♂ and ♀
Age 3
♂>98%
Age 4
♂ and ♀
Age 5
♂ and ♀
Ocean rearing


Artificially Spawned Fish
Natural Origin Spawners Ages 3, 4 and 5 ♂ and ♀
Eggs ♂ and ♀
Fry ♂ and ♀
Parr ♂ and ♀
Age 1 ♂ micro-jack
Age 2 ♂ minijack
Smolt ♂ and ♀
Age 3 ♂>98%
Age 4 ♂ and ♀
Age 5 ♂ and ♀
Ocean rearing

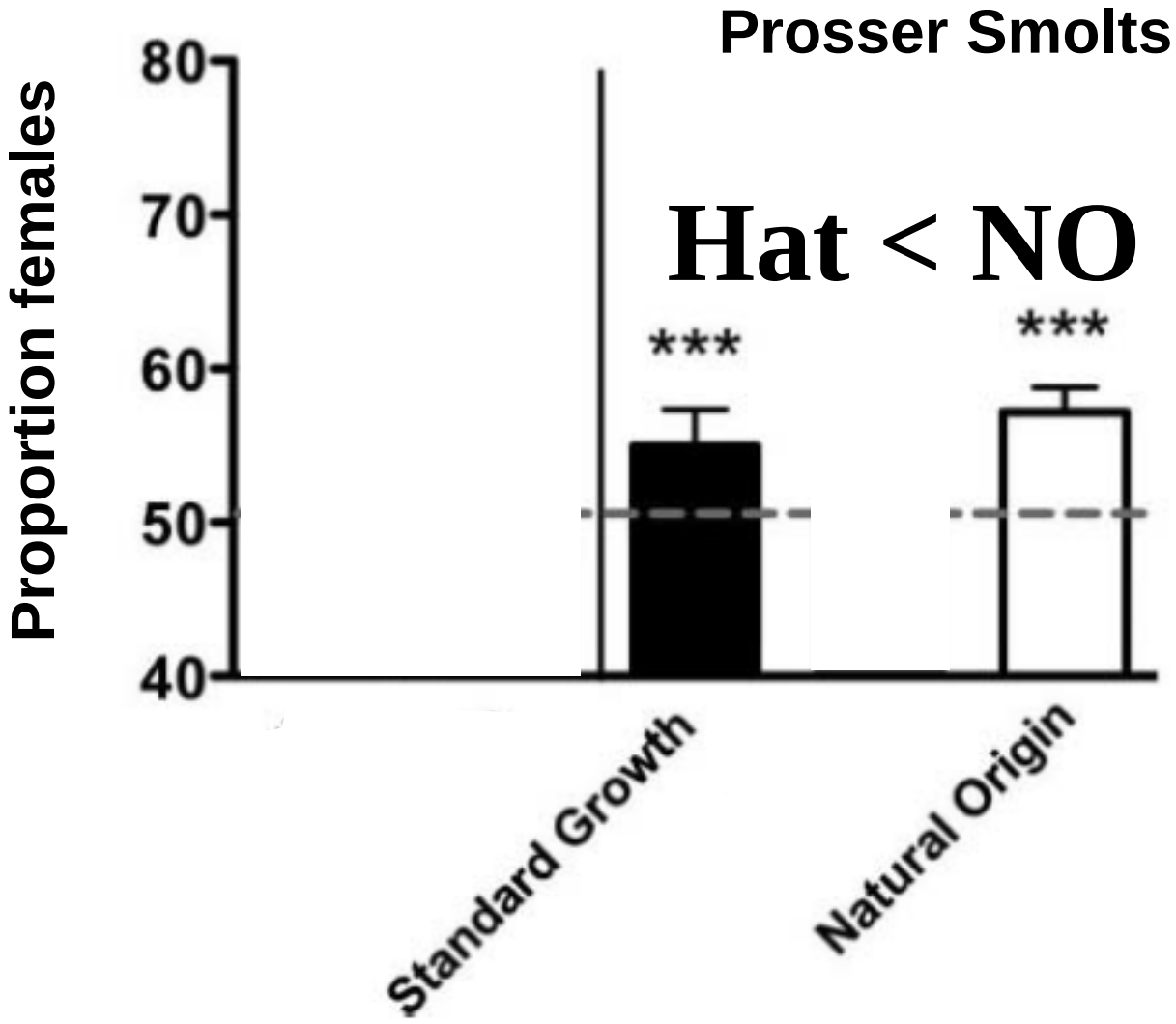



**A simple diagram depicting different early maturation phenotypes among (a) hatchery and (b) wild spring Chinook salmon. (Figure 9 in Larsen et al. 2013. TAFS 142(2): 540-555.)**

# Age 2 Mini-Jacks Captured at RAMF



Issue 1: Are minijack rates for yearling spring Chinook Salmon hatchery programs higher than for wild populations?

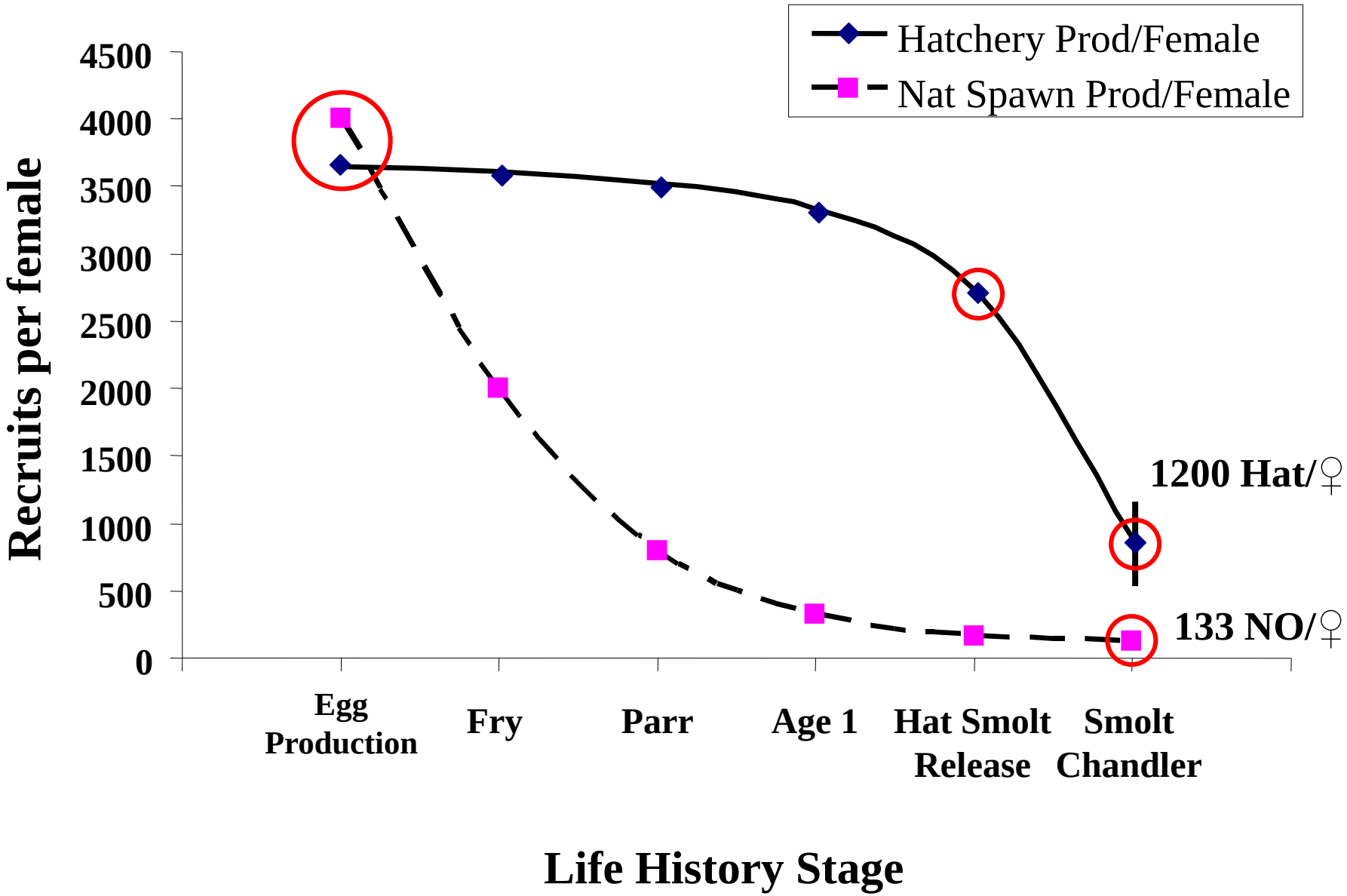



**The percentage of female smolts averaged (+SE) across brood years (2001–2007) among fish sampled at Prosser Dam. (Taken from Figure 8 in Larsen et al. 2013. TAFS 142(2): 540-555.)**

# Hatchery MiniJack Rates Higher?

- CESRF Hatchery spring Chinook males mature early as age 2 minijacks.
- Natural origin males mature early as age 1 micro-jacks and to a lesser degree age 2 mini-jacks.
- Total proportion of  males “lost” prior to outmigration as early maturing hatchery and natural origin males is equal.
- This results in equally female-skewed sex ratios in both hatchery and natural origin smolts at Chandler.

# Issue 2: Does hatchery minijack production in Chinook Salmon reduce the number of male smolts released?


Hatchery Prod/Female
Nat Spawn Prod/Female
Recruits per female
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1200 Hat/♀
133 NO/♀
Egg Production
Fry
Parr
Age 1
Hat Smolt Release
Smolt Chandler
Life History Stage

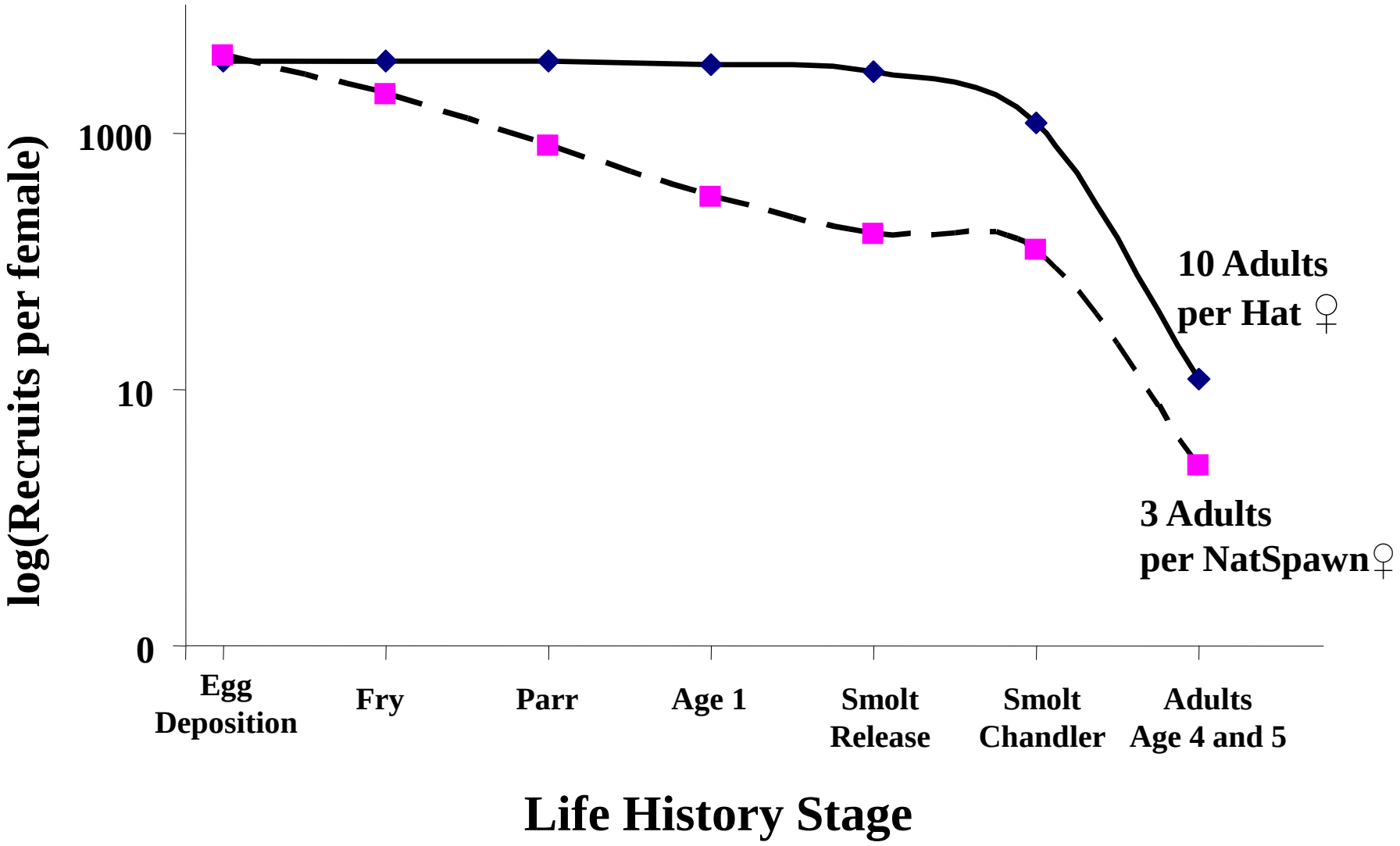
# Issue 2: Does hatchery minijack production in Chinook Salmon reduce the number of male smolts released?

Yes, hatchery minijack production does reduce the number of male smolts, but no more than the reduction in NO male smolts.

And the mean productivity of hatchery females (R/S) is much greater than NO female production.

**Issue 3**: Do high minijack rates in Chinook Salmon hatchery programs reduce the number of males returning as full-sized anadromous adults for harvest or spawning?

# Adult Age 4 and 5 Recruits per Female



# Sex Composition RY's 2010-2013

- 100% of fish passing RAMF were sexed using ultra-sound unit.
- 400+ fish were taken to CESRF and used to verify sexing accuracy.

# Sex Classification Error Rates In 2013 Based On Known Genders

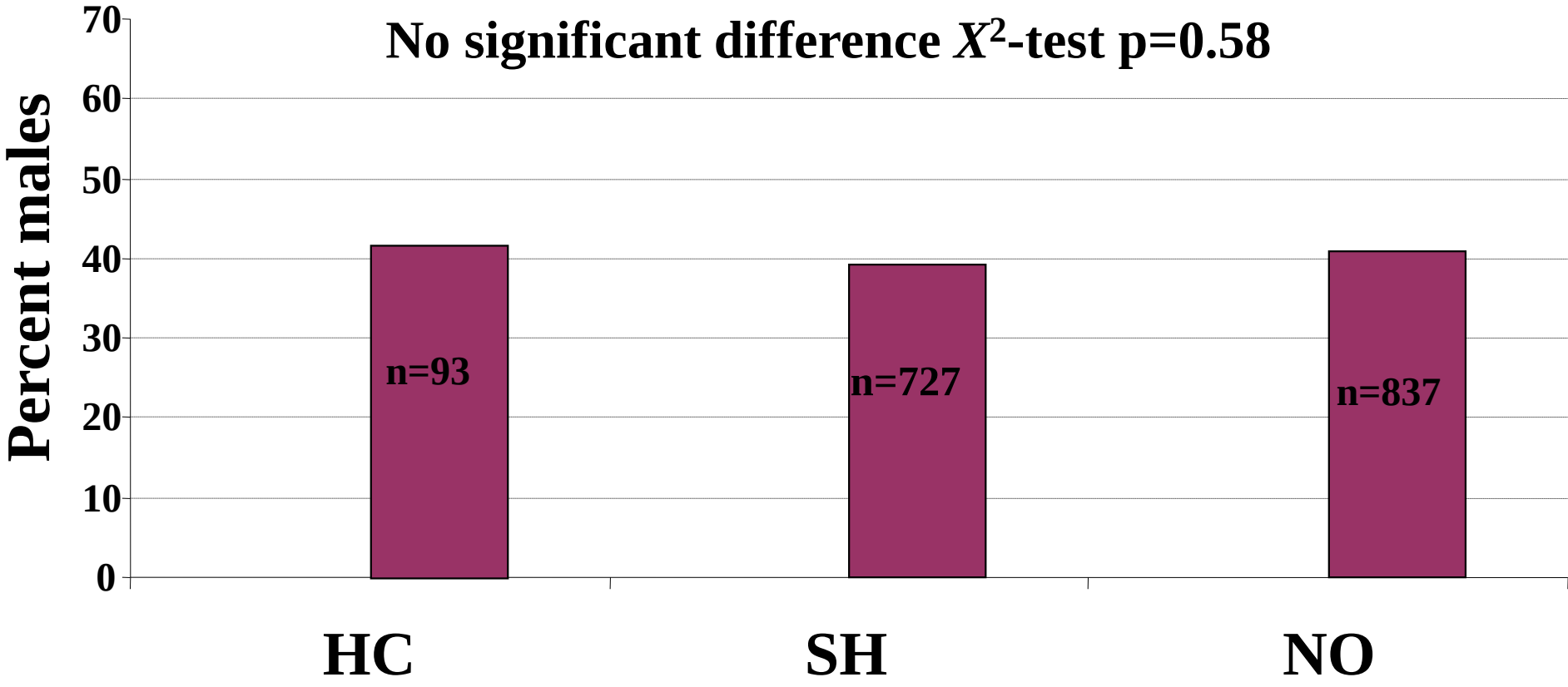
**Overall accuracy = (429/432) = 99.3%**

| | ***True sex (at CESRF)*** | |
|---|---|---|
| ***Classification (at Roza)*** | **Male** | **Female** |
| **Male** | 196 (**99.0%**) | 1 ( 0.4%) |
| **Female** | 2 ( 1.0%) | 233 (**99.6%**) |
| Total | 198 | 234 |

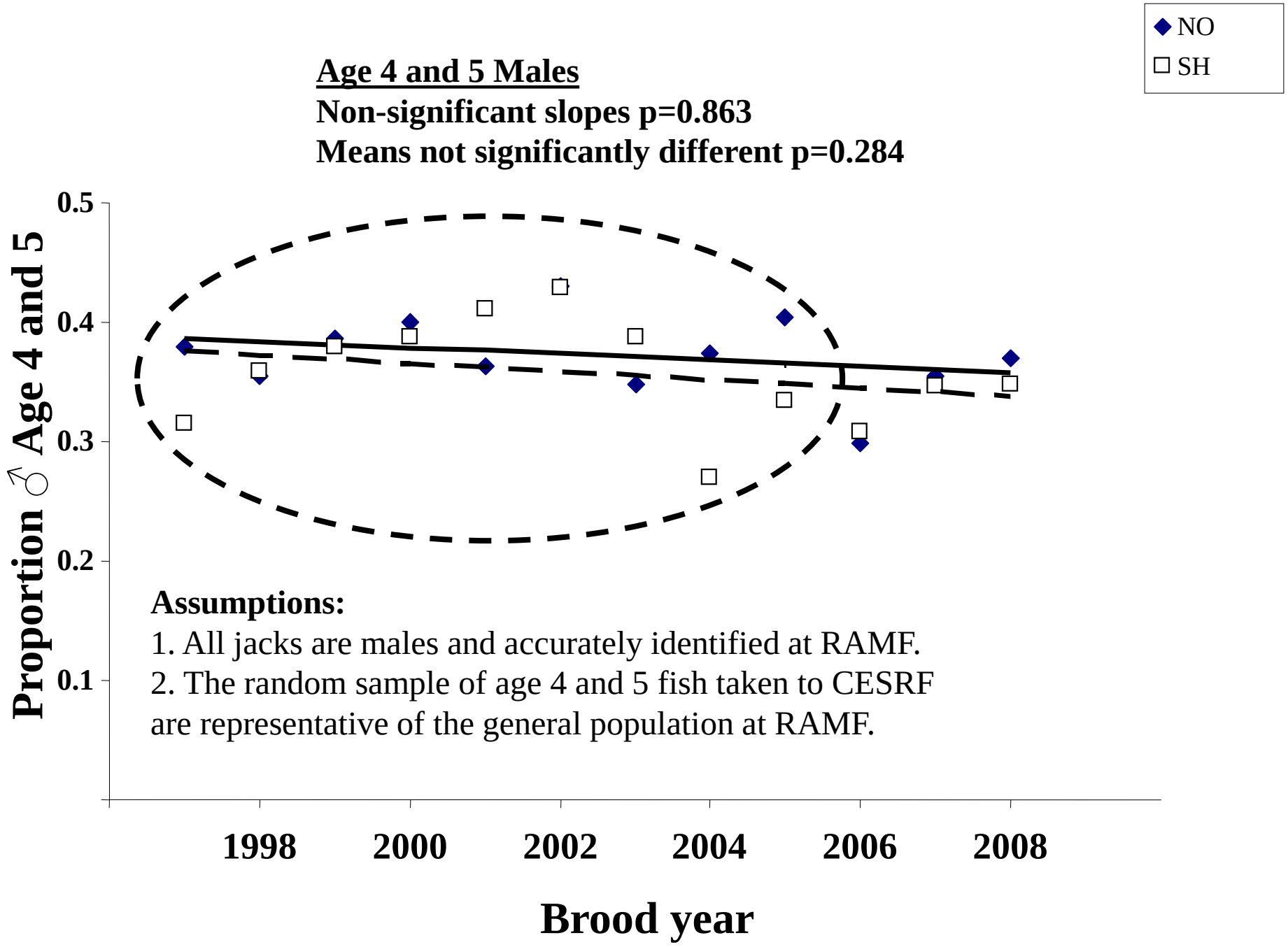
# Sex Composition RY's 2010-2013

- 100% of fish passing RAMF were sexed using ultra-sound unit.
- Fish taken to CESRF were used to verify sexing accuracy.
- Over 2010-2013 accuracy averaged 98%.

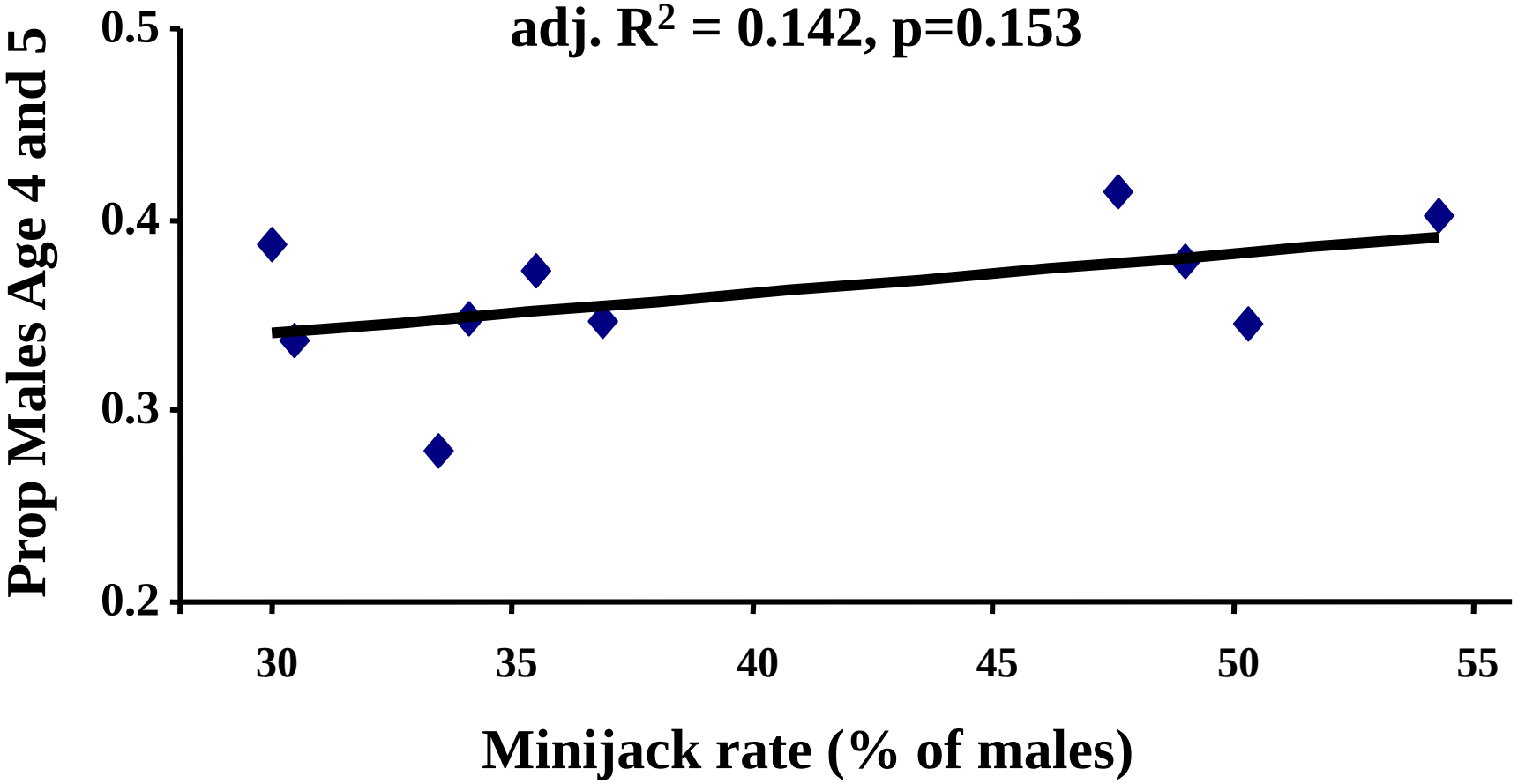
# Age 4 and 5 Sex Composition 2013



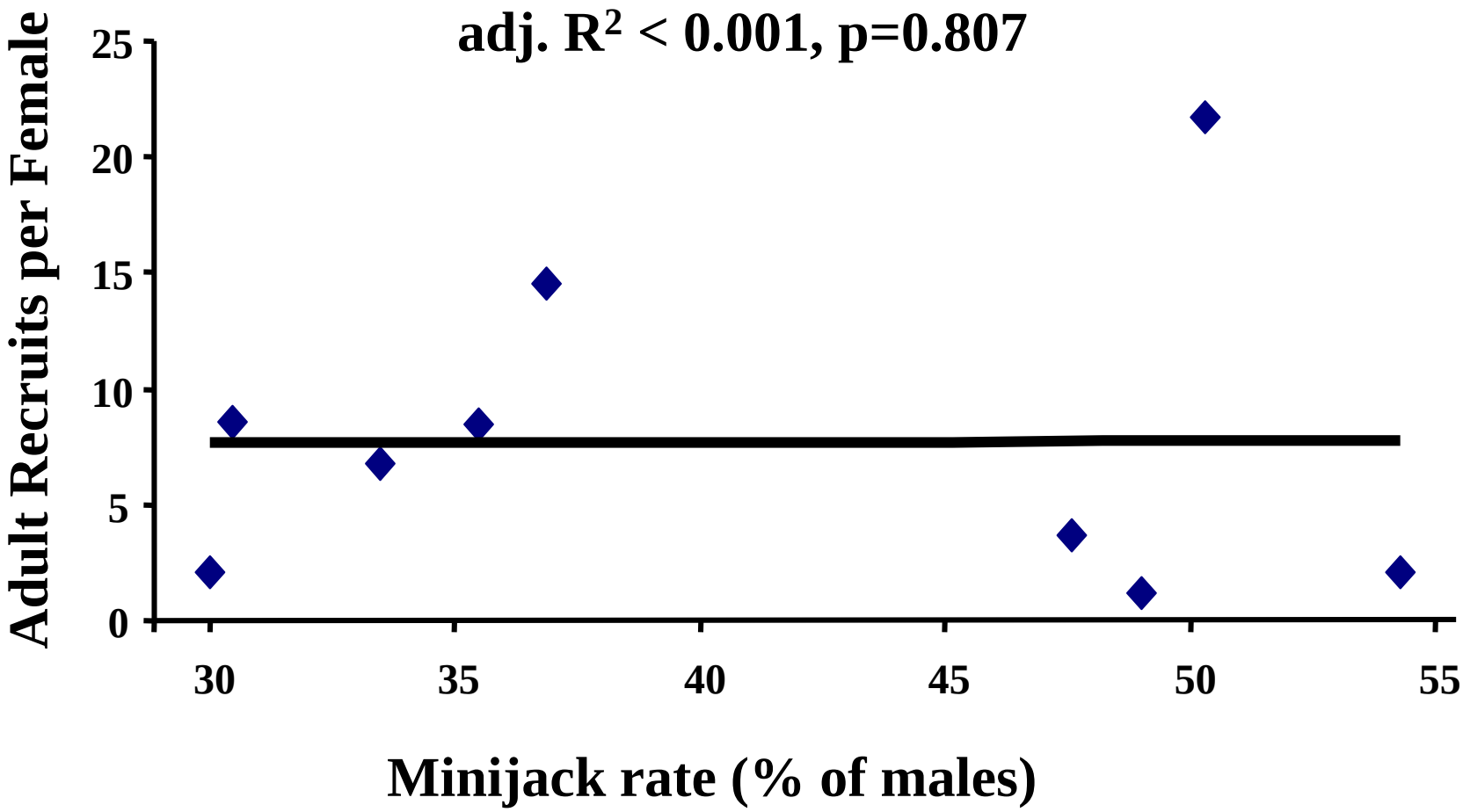

**Same result for RY 2010 through 2012**


NO
SH
Age 4 and 5 Males
Non-significant slopes p=0.863
Means not significantly different p=0.284
Proportion ♂ Age 4 and 5
0.5
0.4
0.3
0.2
0.1
Assumptions:
1. All jacks are males and accurately identified at RAMF.
2. The random sample of age 4 and 5 fish taken to CESRF are representative of the general population at RAMF.
1998
2000
2002
2004
2006
2008
Brood year

# Prop. Males Age 4 and 5 vs Minijack Rate



# Recruits (Age 4 and 5) per Female vs Minijack Rate



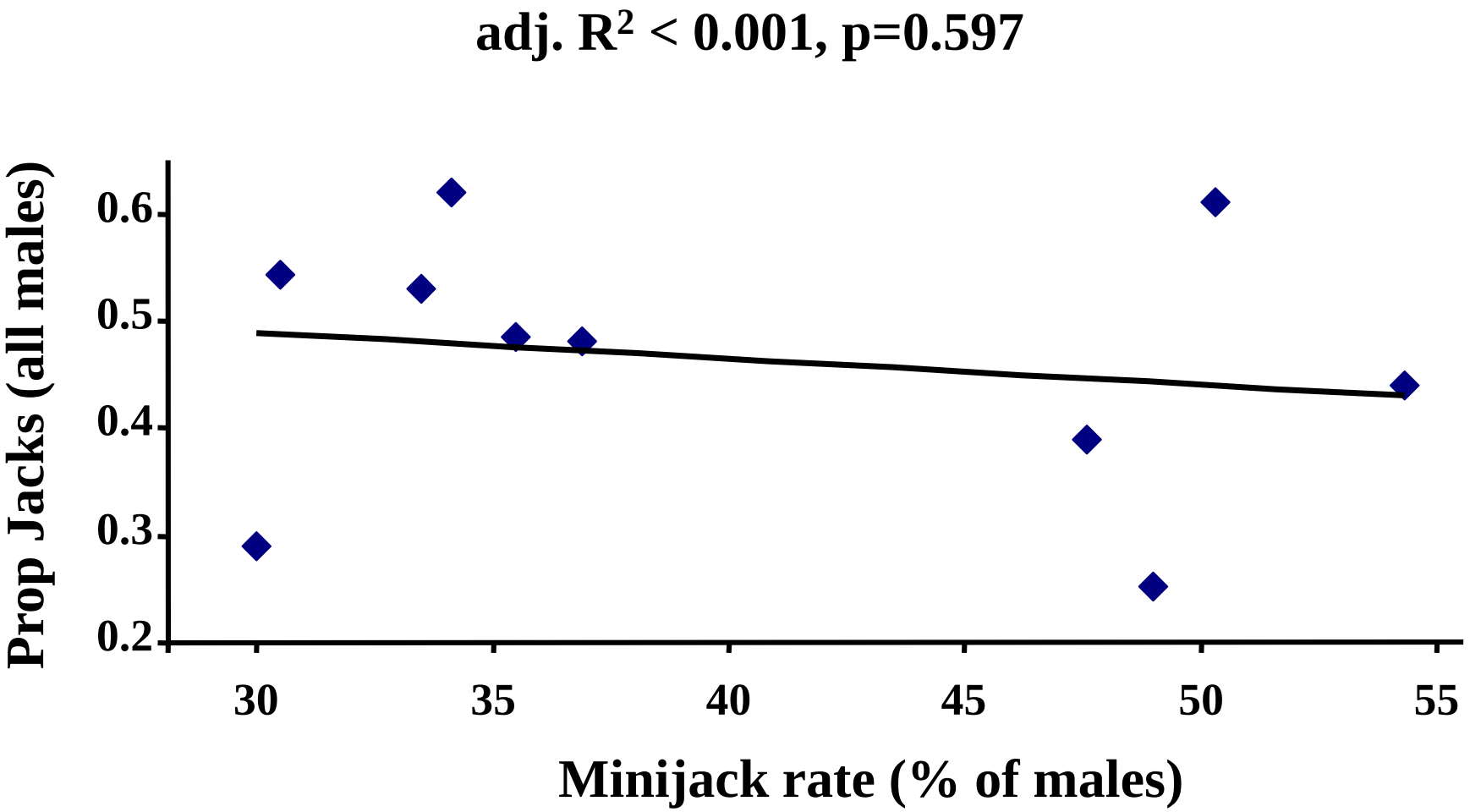
**Issue 3**: Do high minijack rates in hatchery programs reduce the number of males returning as full-sized anadromous adults for harvest or spawning?

- No, age 4 and 5 adult returns were not affected by hatchery minijack production either in terms of shifting sex ratio from that of the NO population or reducing productivity.

# Summary

- Both hatchery and natural origin spring Chinook lose equal proportions of males to early maturation prior to outmigration – equal F:M sex ratios as smolts.
- Both hatchery and NO age 4 and 5 fish have equal female:male proportions.
- Hatchery minijack production is not significantly related to the sex ratios of age 4 and 5 fish.
- Nor to the production of age 4 and 5 males.

# Proportion Jacks (all males) vs MiniJack Rate



# Minijack Rate vs Mean Age-At-Maturity

adj. $R^2 < 0.0001$, p=0.821