Comparison of upper Yakima Hatchery, Hatchery-control and Natural-origin spring Chinook: Teasing Out the Genetic Component

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First Phase Objective:

Compare first generation hatchery and wild origin fish returning from broodyears 1997 to 2000.

First generation results in:

Knudsen, C. M., S. L. Schroder, C. A. Busack, M. V. Johnston, T. N. Pearsons, W. J. Bosch, and D. E. Fast. 2006.

Comparison of life-history traits between first-generation hatchery and wild Upper Yakima River spring Chinook salmon.

Transactions of the American Fisheries Society 135:1130–1144.

Knudsen, C. M., S. L. Schroder, C. Busack, M. V. Johnston, T. N. Pearsons, and C. R. Strom. In press.

Comparison of female reproductive traits and progeny of first generation hatchery and wild Upper Yakima River spring Chinook salmon.

Transactions of the American Fisheries Society.

Phase 1 (BY97-BY00) Conclusions

- Wild fish were larger at age (faster growth) in all years, differing by as much a 1 SD from hatchery fish
- The differences in body size were significant in all comparisons accept BY2000 age 4's
- Differences observed in age-3 fish had to occur sometime over the ~18 months after release

Phase 1 Conclusions - cont'd

- Age Composition – increasing proportion of hatchery age 3 returns.
- Sex Ratios – increasing proportion of hatchery male returns due to increase in age 3 males.
- Passage timing at RAMF – Some differences, but the differences were relatively small with no consistent trend.
- Spawn timing at CESRF - Hatchery fish consistently spawned earlier by 5.1 days on average.

First Phase Objective: Compare first generation hatchery and wild origin fish returning from broodyears 1997 to 2000.

Second Phase Objective:
Compare Hatchery Control, Hatchery Supplementation, and Natural-origin fish returning from broodyears 2002 and on.

HC vs SH Comparisons

- SH returns experienced one generation of hatchery selection

- HC returns experienced two generations of hatchery selection

- Share common hatchery, freshwater and ocean rearing environments

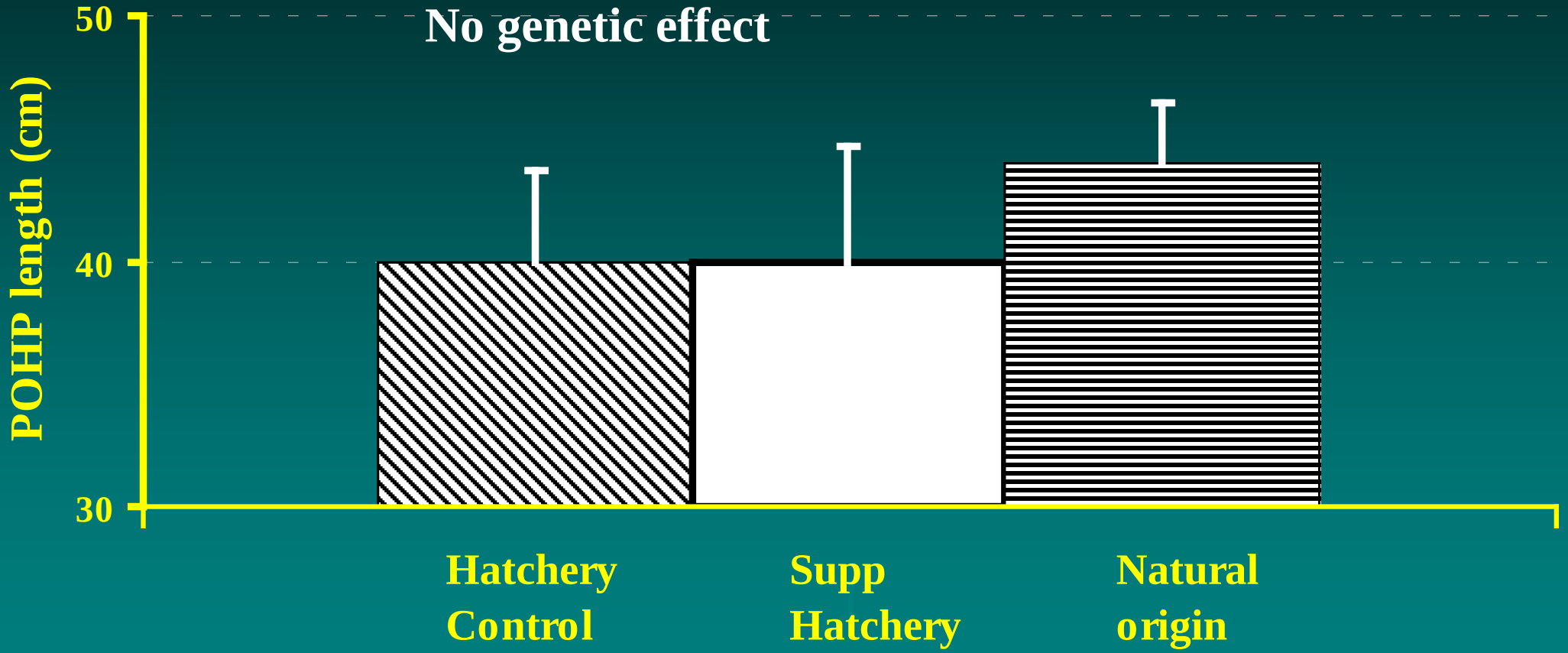
- Differences in their phenotypic traits should be expressions of genetic differences due to the one additional generation of hatchery selection experienced by the HC line

General Analytical Design

- **Compare mean trait values of NO vs SH vs HC**
- **NO vs SH trait difference is due to a combination of EV and AV**
- **SH vs HC trait difference is genetic due primarily to AV**

Mean POHP Length

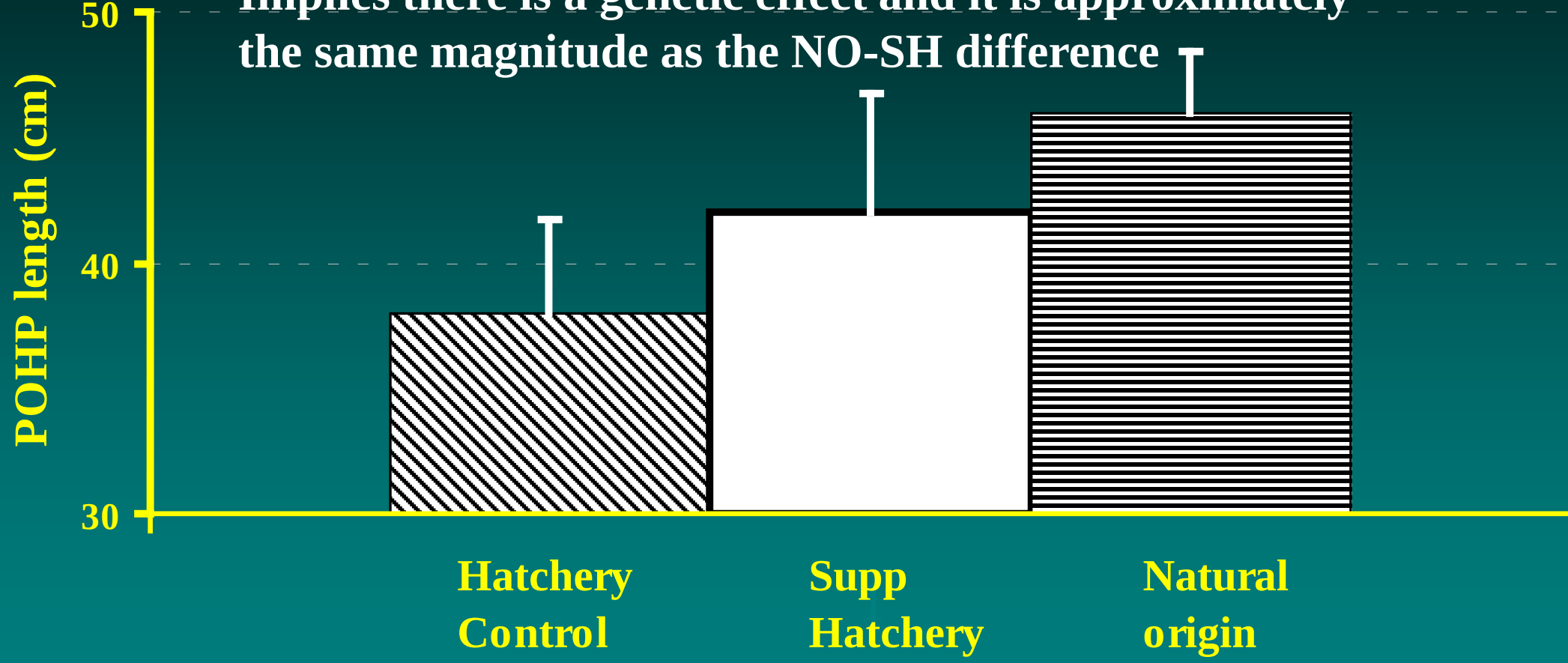
HC = SH < NO
Implies an environmental effect, but
No genetic effect



Mean POHP Length

HC < SH < NO

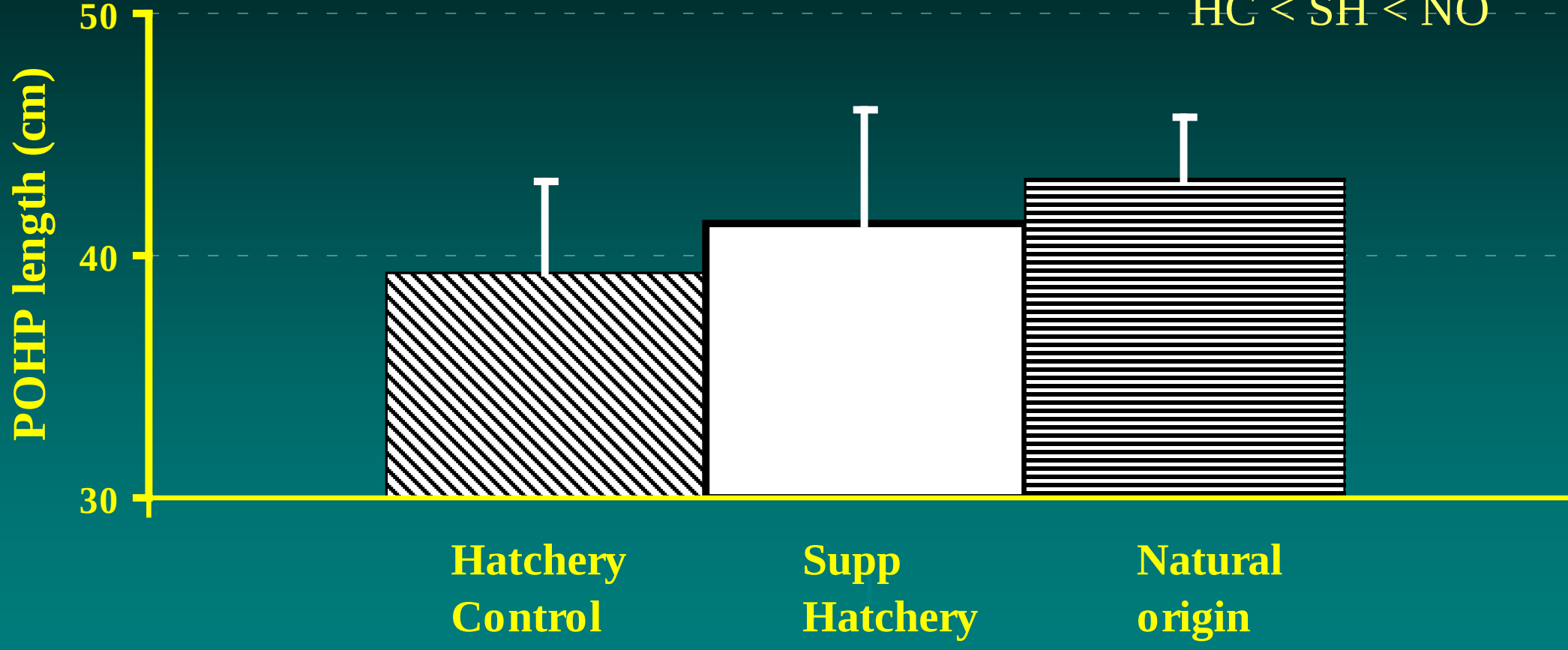
Implies there is a genetic effect and it is approximately the same magnitude as the NO-SH difference



Size-at-Age
(reflecting growth rates)

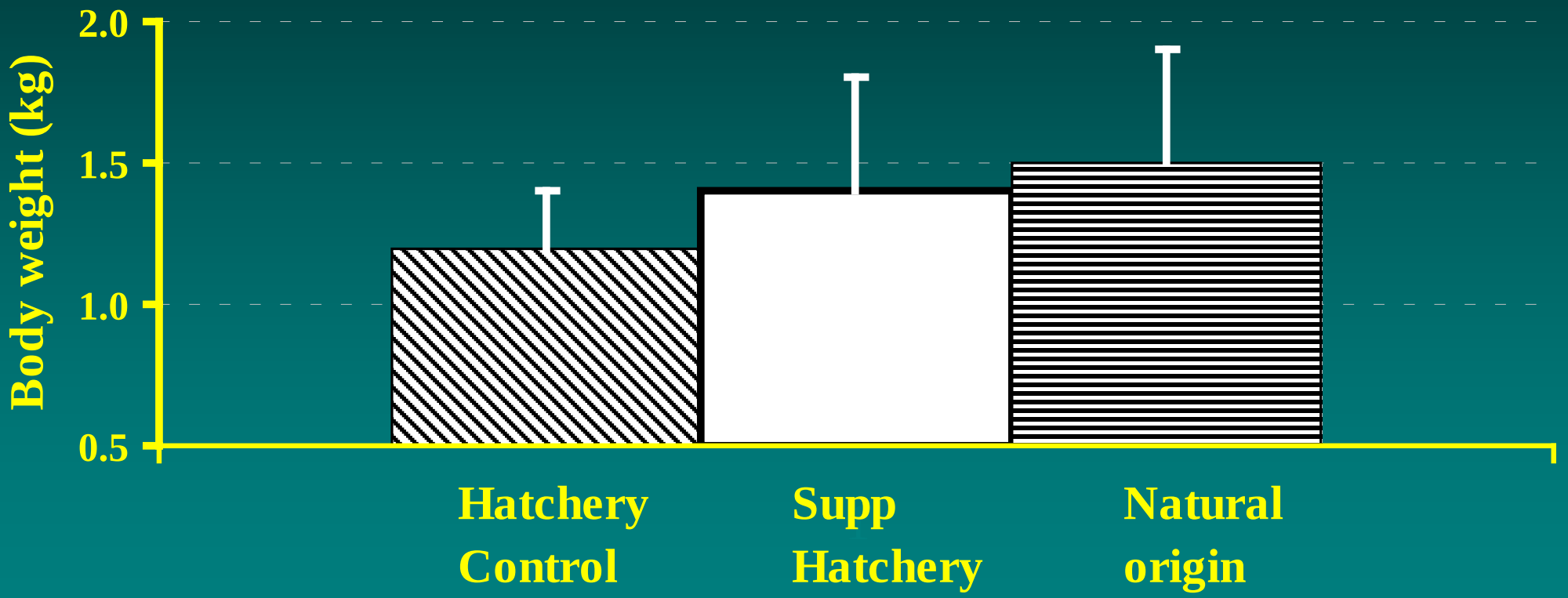
POHP (± 1 sd) Age 3 - 2007

Origin p=0.001
Tukey MCT
HC < SH < NO

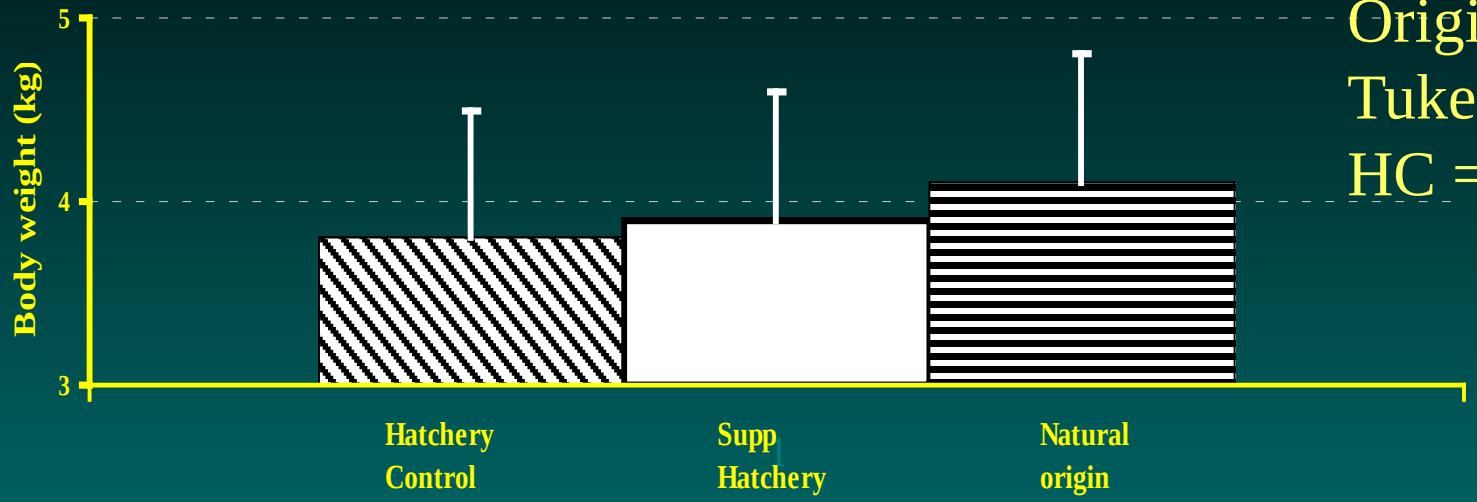


Body weight (± 1 sd) Age 3 - 2007

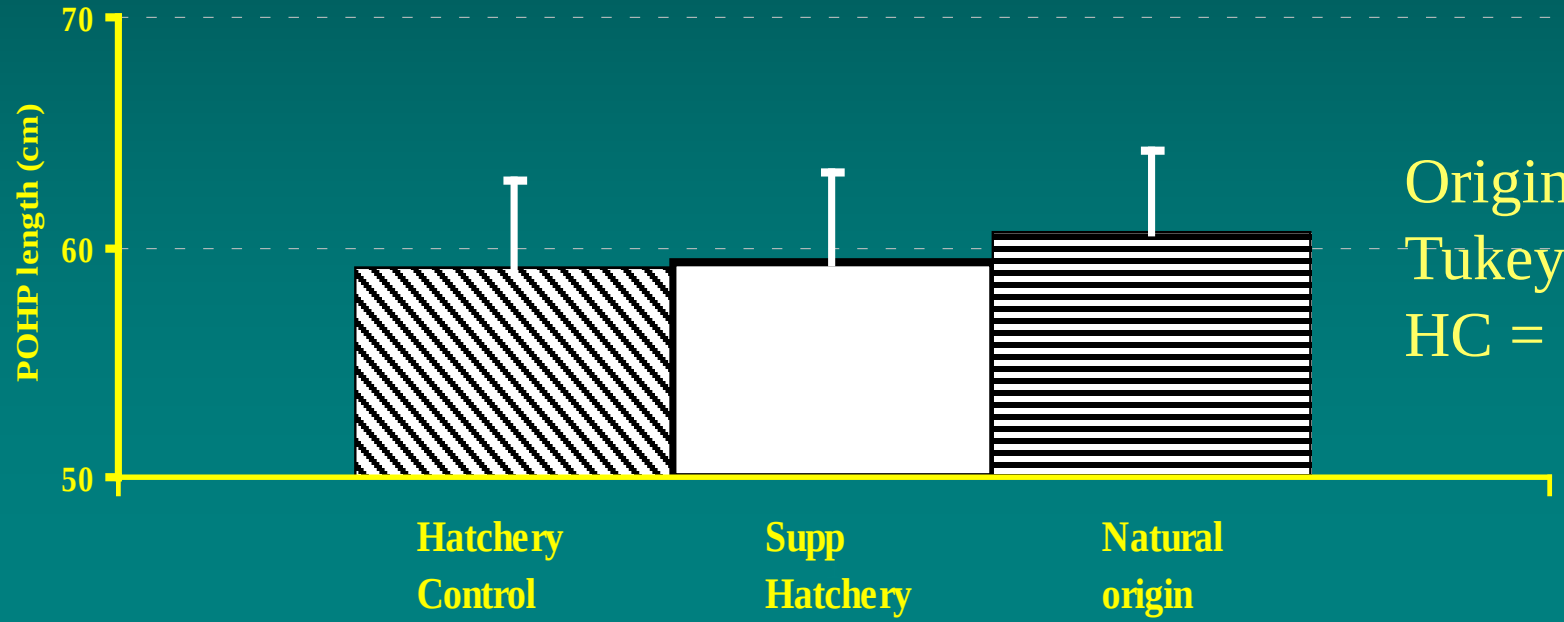
Origin p=0.001
Tukey MCT
HC < SH < NO



Age 4 - 2007



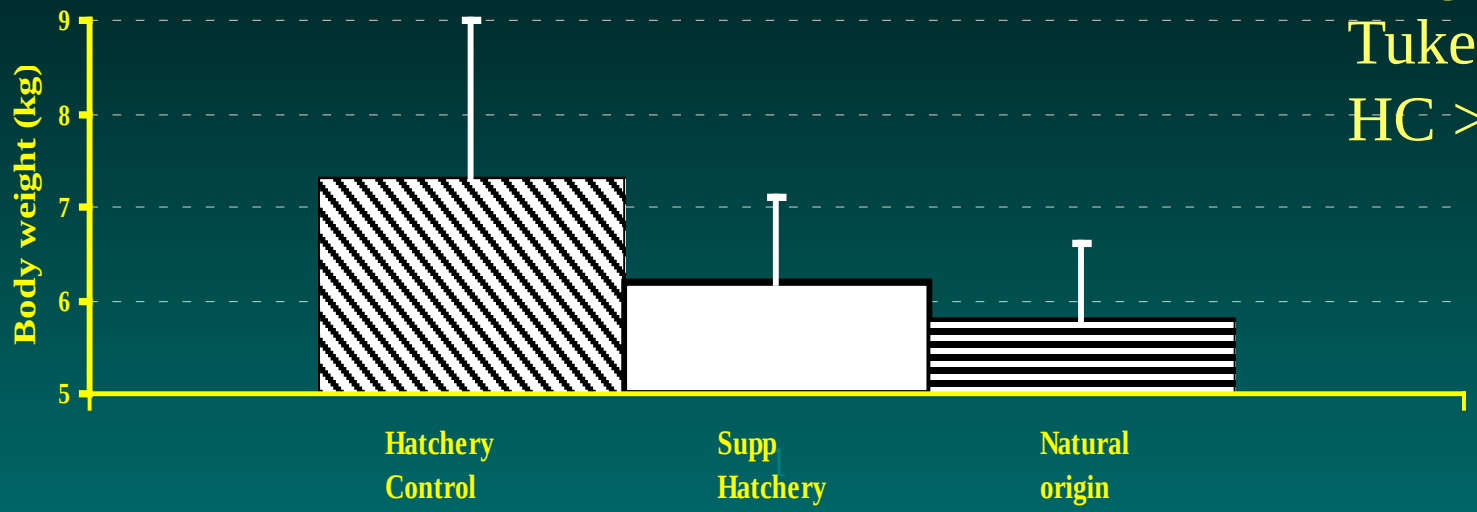
Origin p=0.001
Tukey MCT
HC = SH < NO



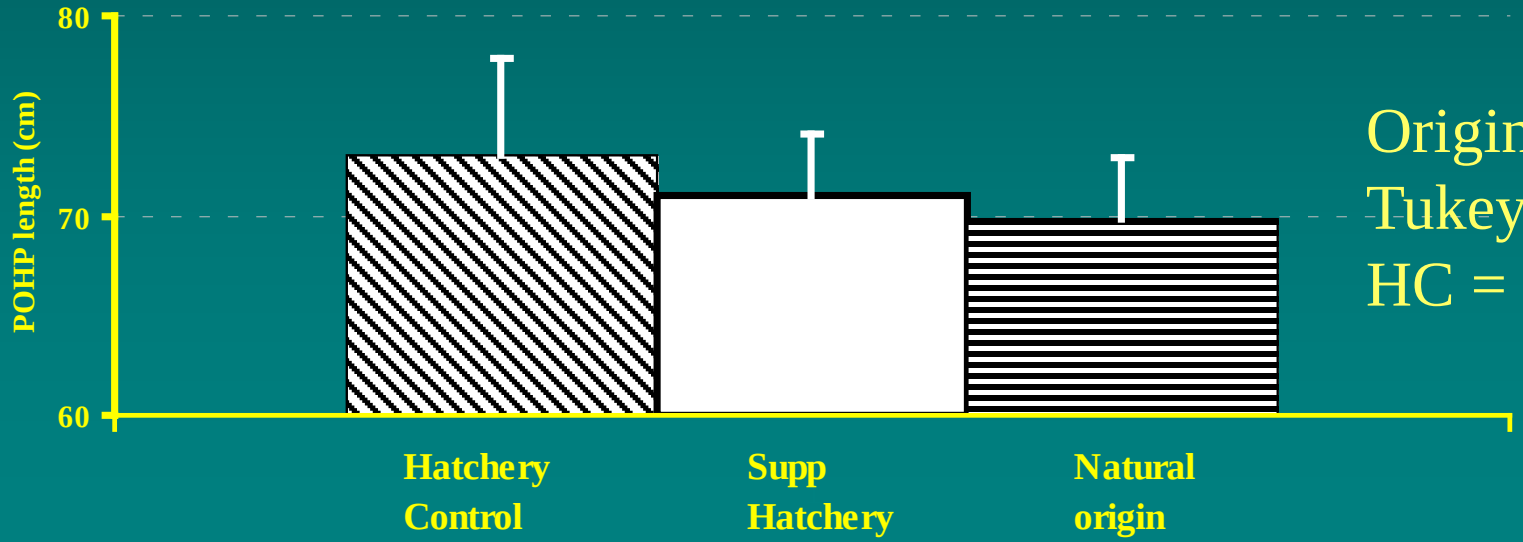
Origin p=0.002
Tukey MCT
HC = SH < NO

Age 5 - 2007

Origin p=0.058
Tukey MCT
HC > SH = NO

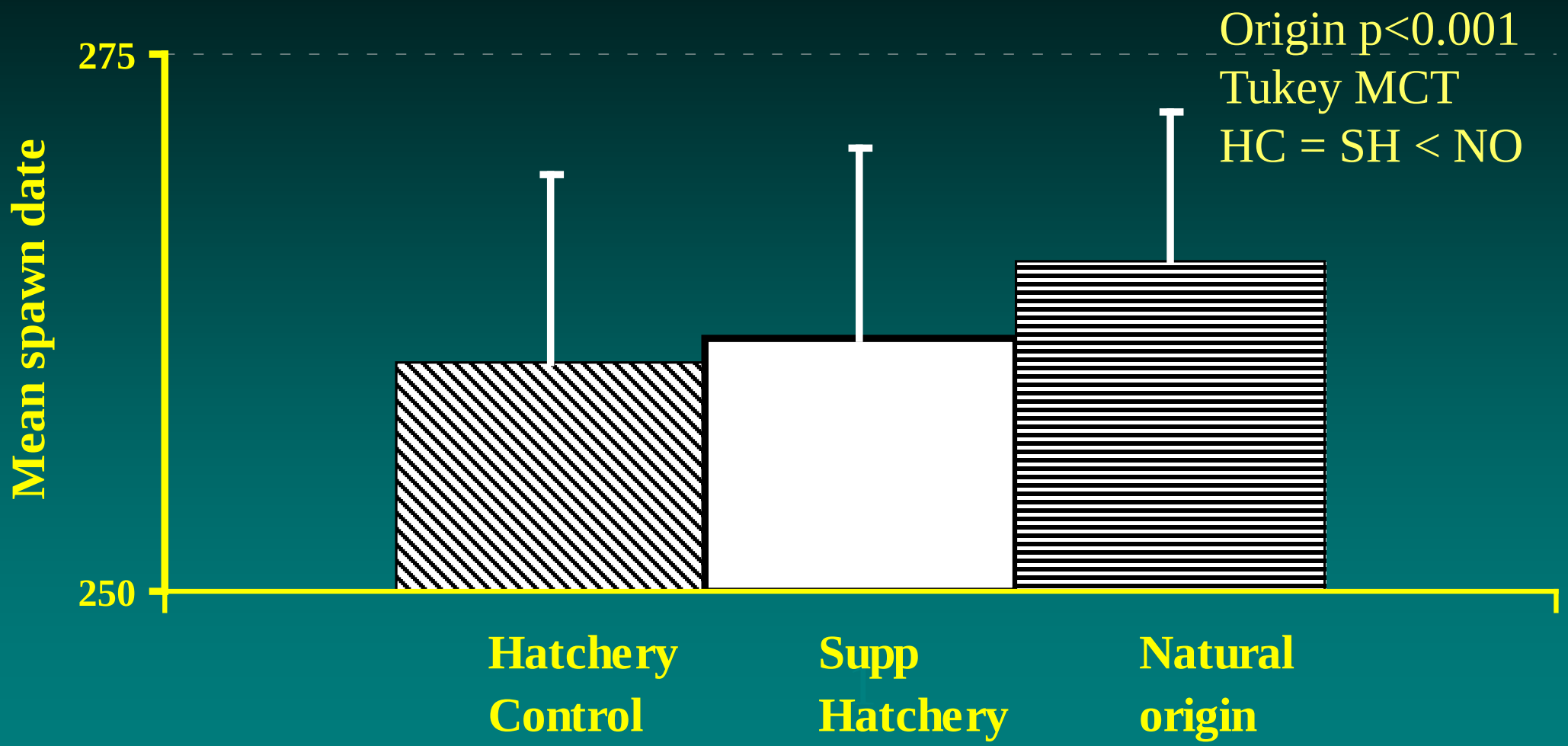


Origin p=0.002
Tukey MCT
HC = SH = NO

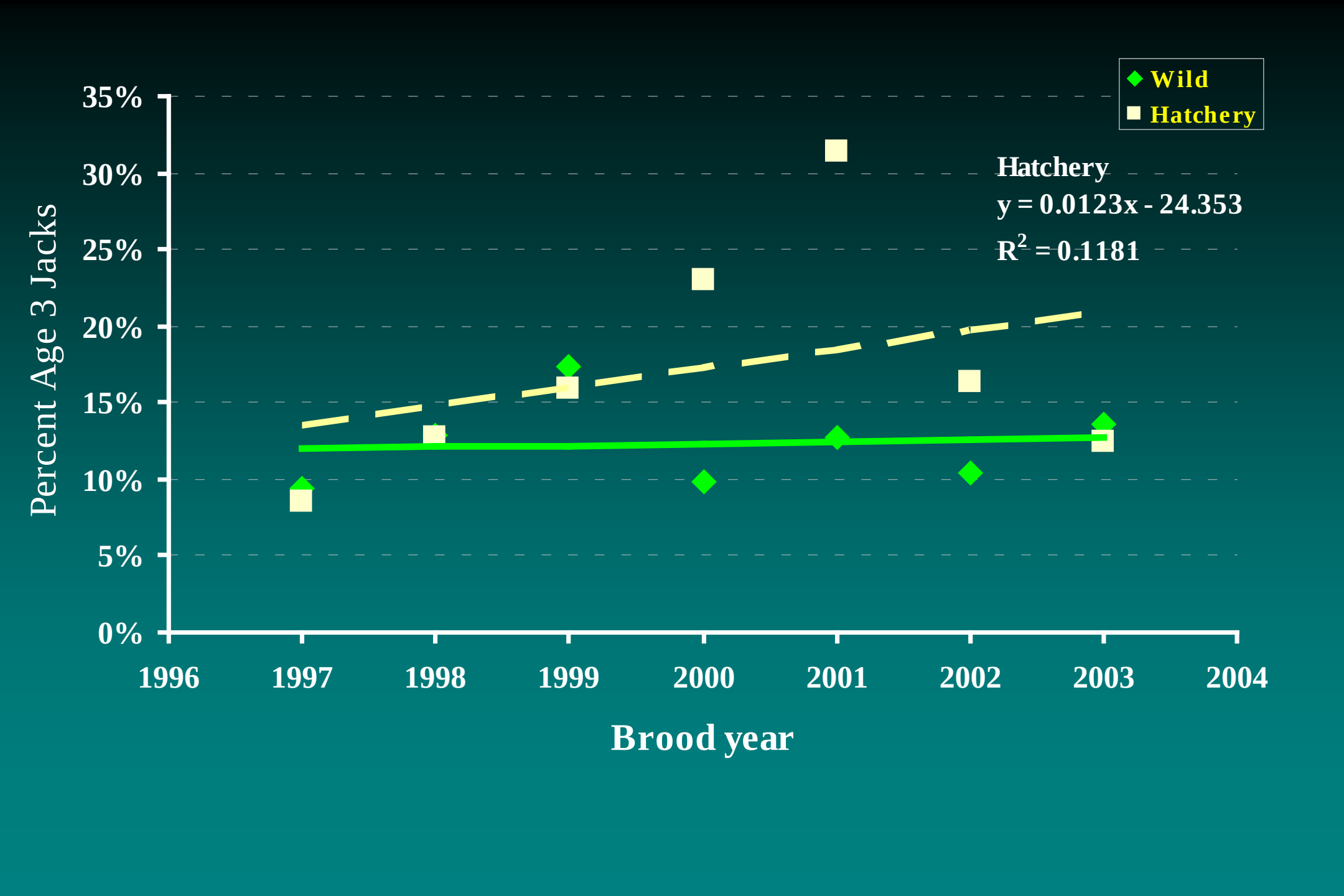


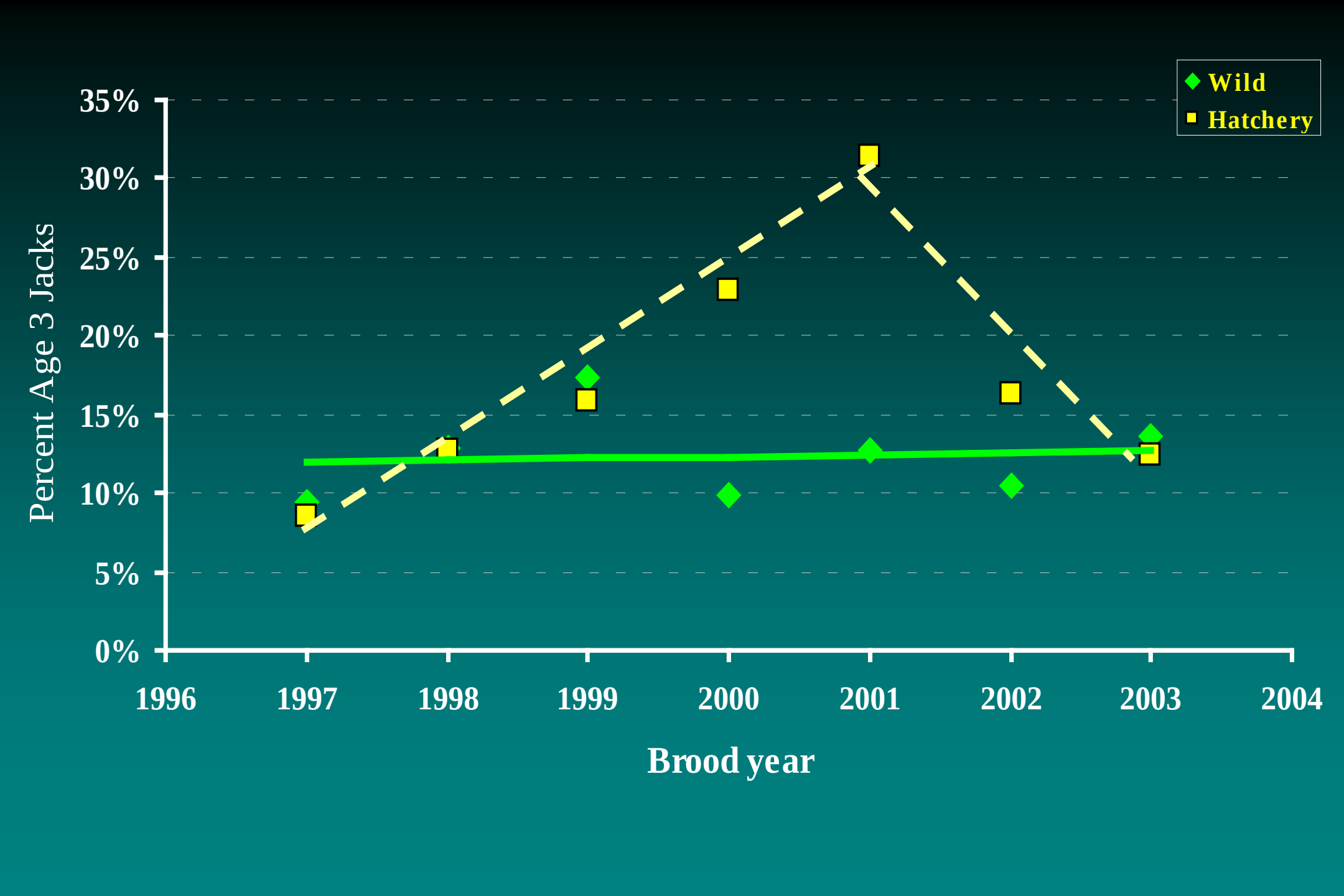
Spawn Timing At CESRF

Spawn Timing CESRF (± 1 sd) - 2007

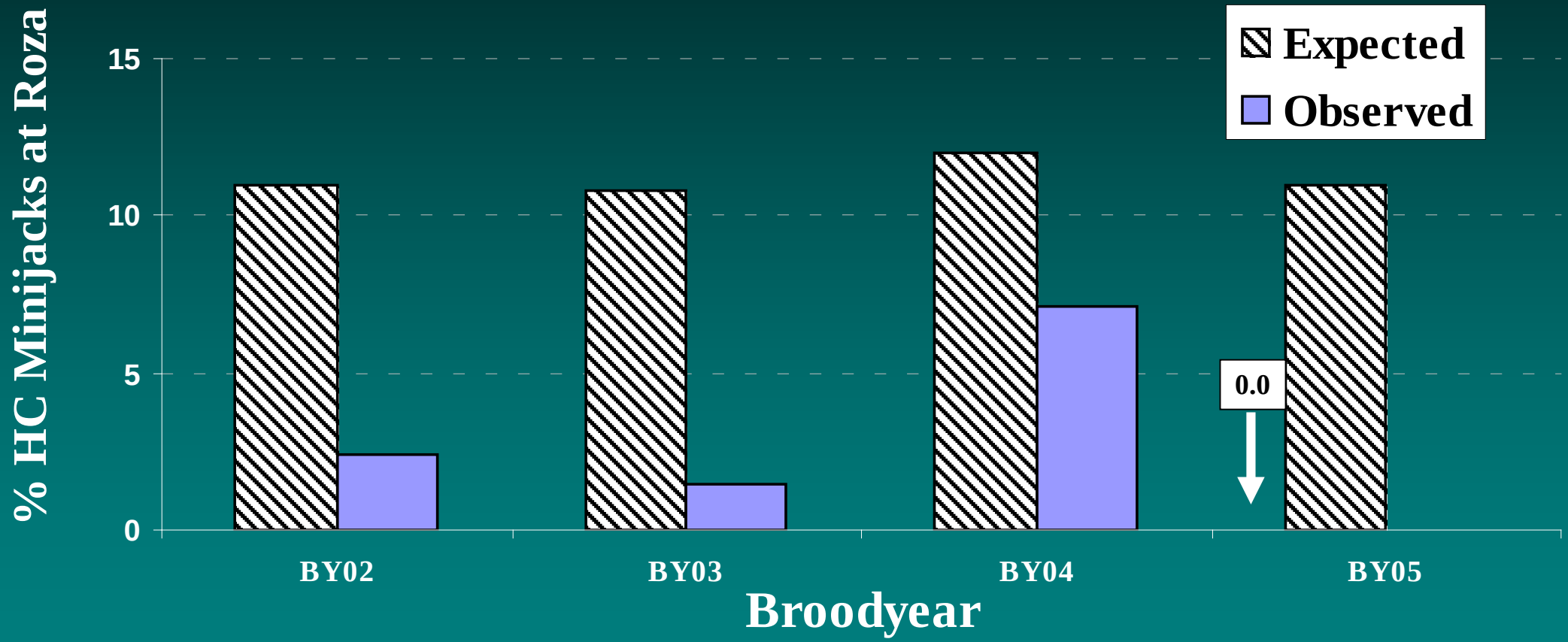


Age Composition


Wild
Hatchery
Hatchery
y = 0.0123x - 24.353
R2 = 0.1181
35%
30%
25%
20%
15%
10%
5%
0%
Percent Age 3 Jacks
1996
1997
1998
1999
2000
2001
2002
2003
2004
Brood year

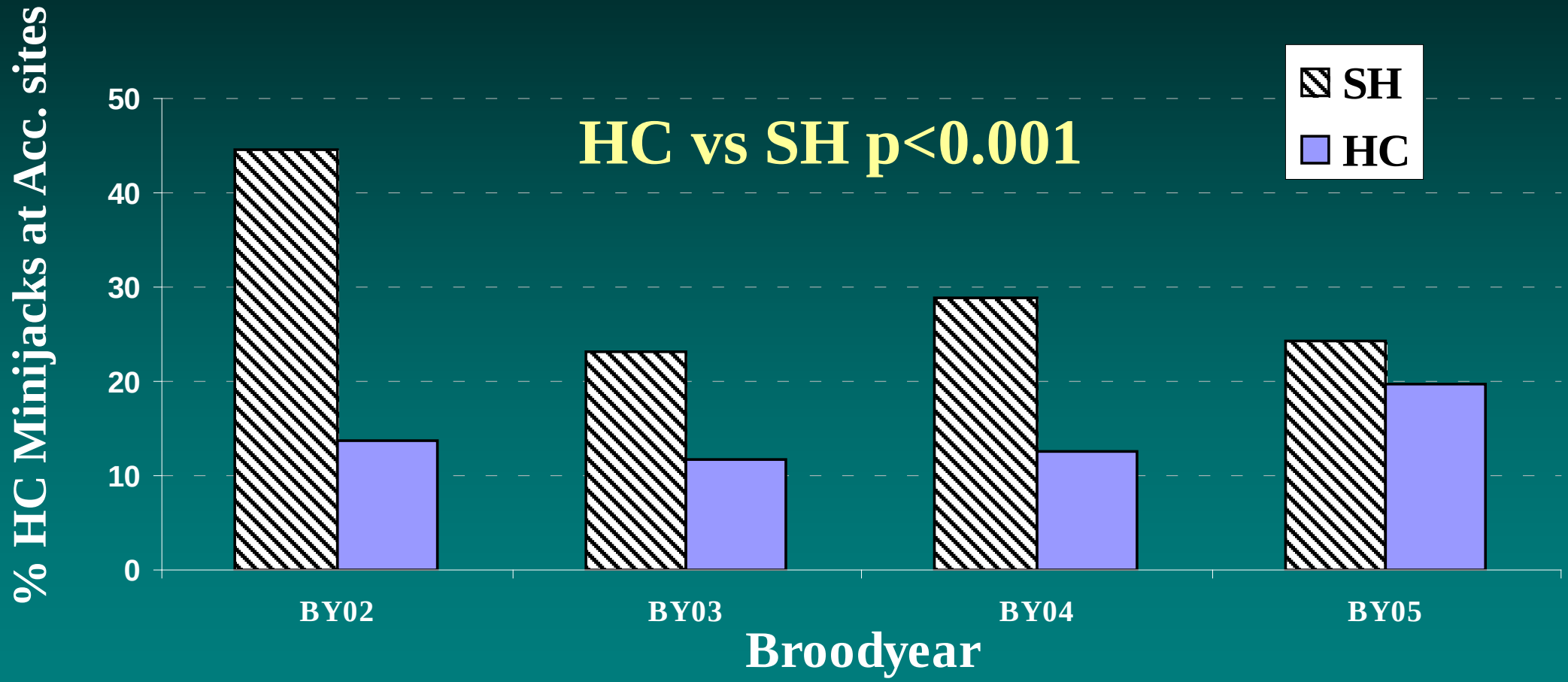

Wild
Hatchery
35%
30%
25%
20%
15%
10%
5%
0%
Percent Age 3 Jacks
1996
1997
1998
1999
2000
2001
2002
2003
2004
Brood year

Proportion of HC minijacks at Roza



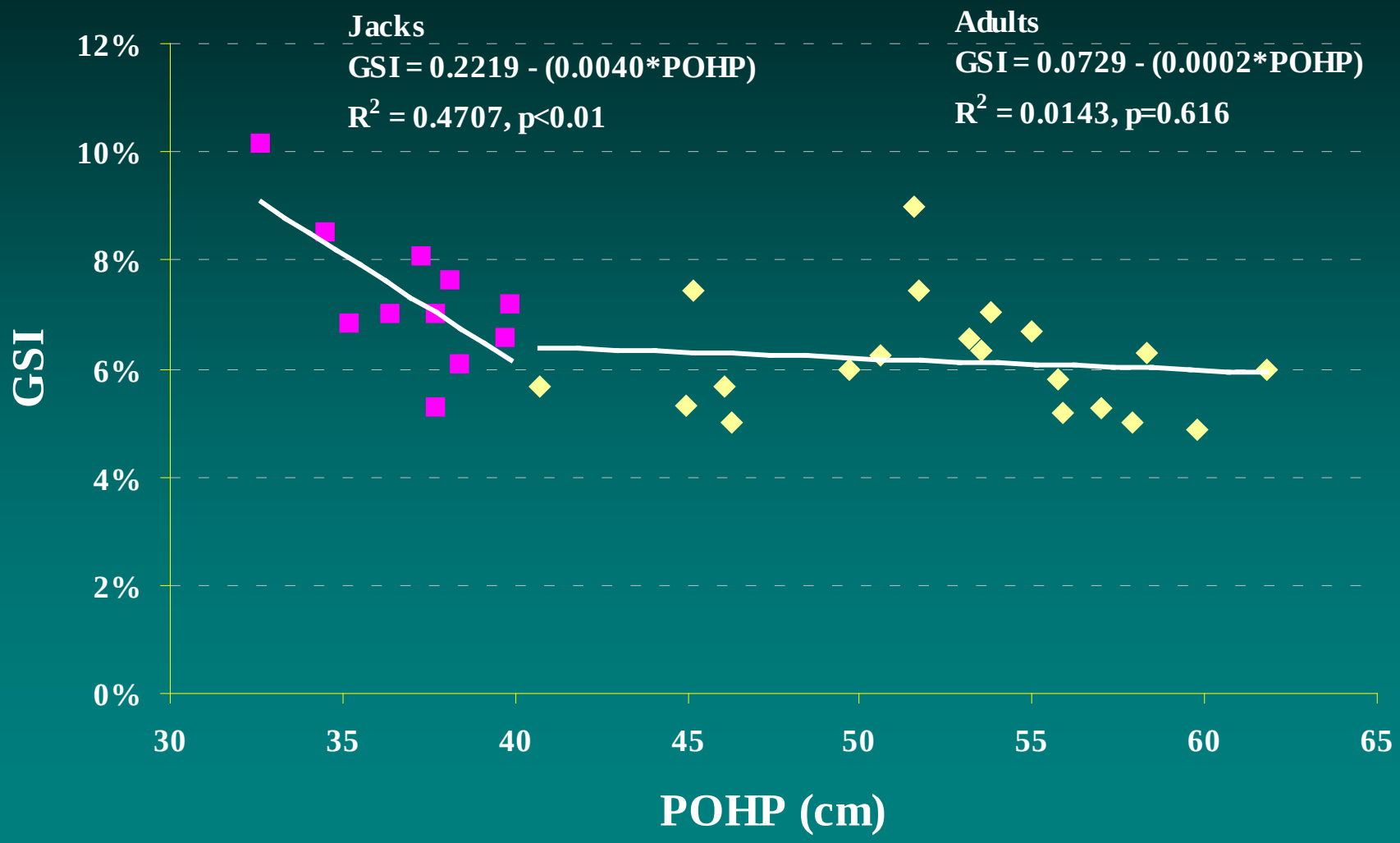
Proportion of Minijacks at Release

From Neeley, D. 2008. Annual Report 2007.

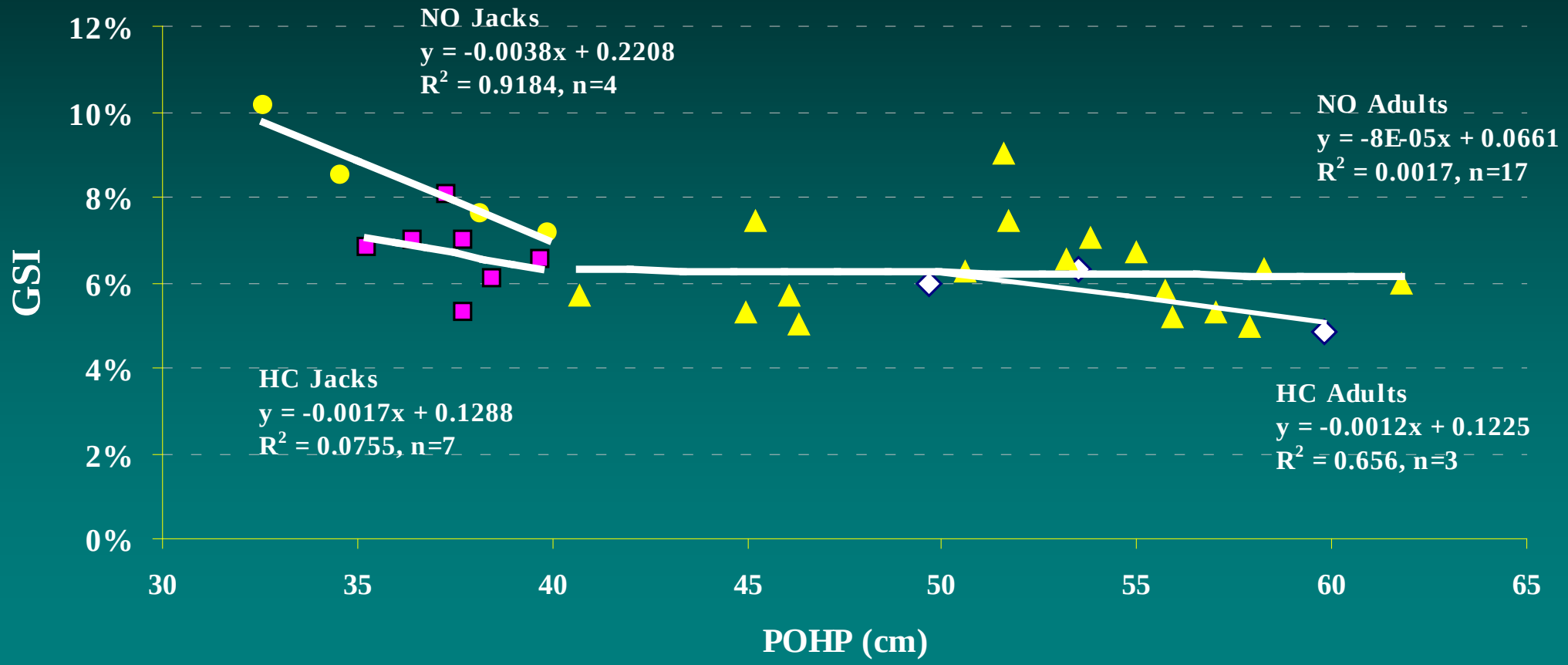


Gametes

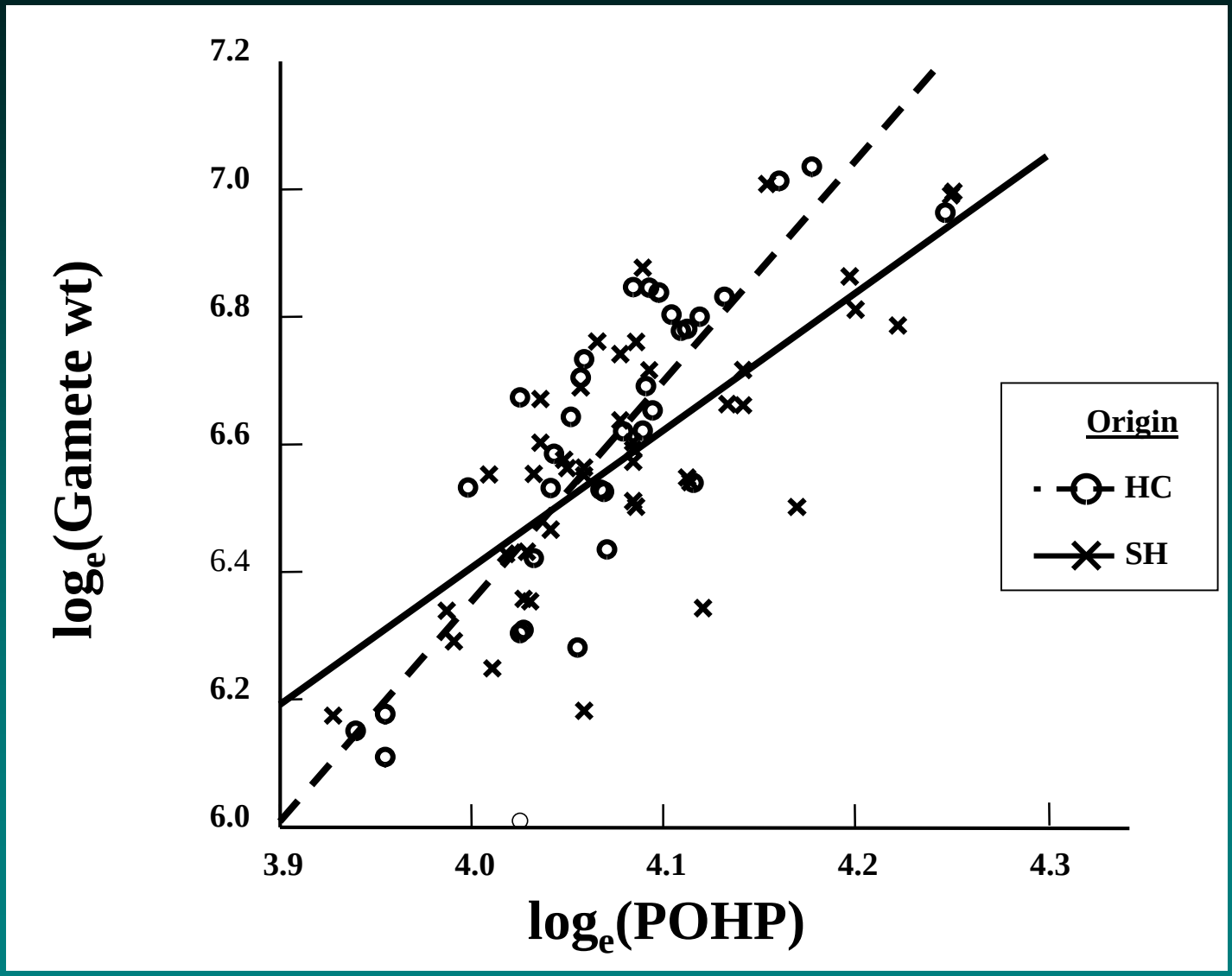
Male Gonadosomatic Index 2007



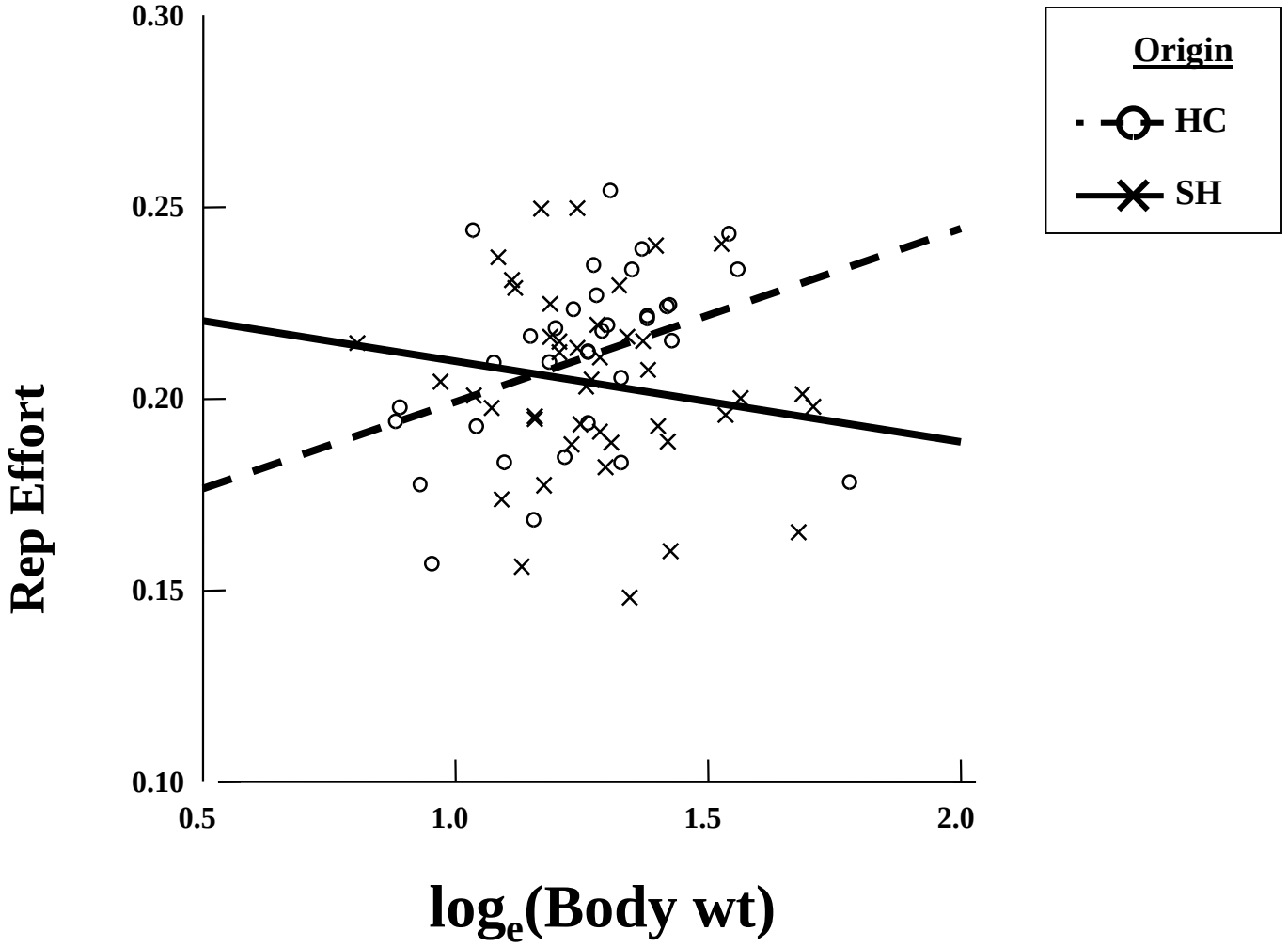
Male Gonadosomatic Index 2007



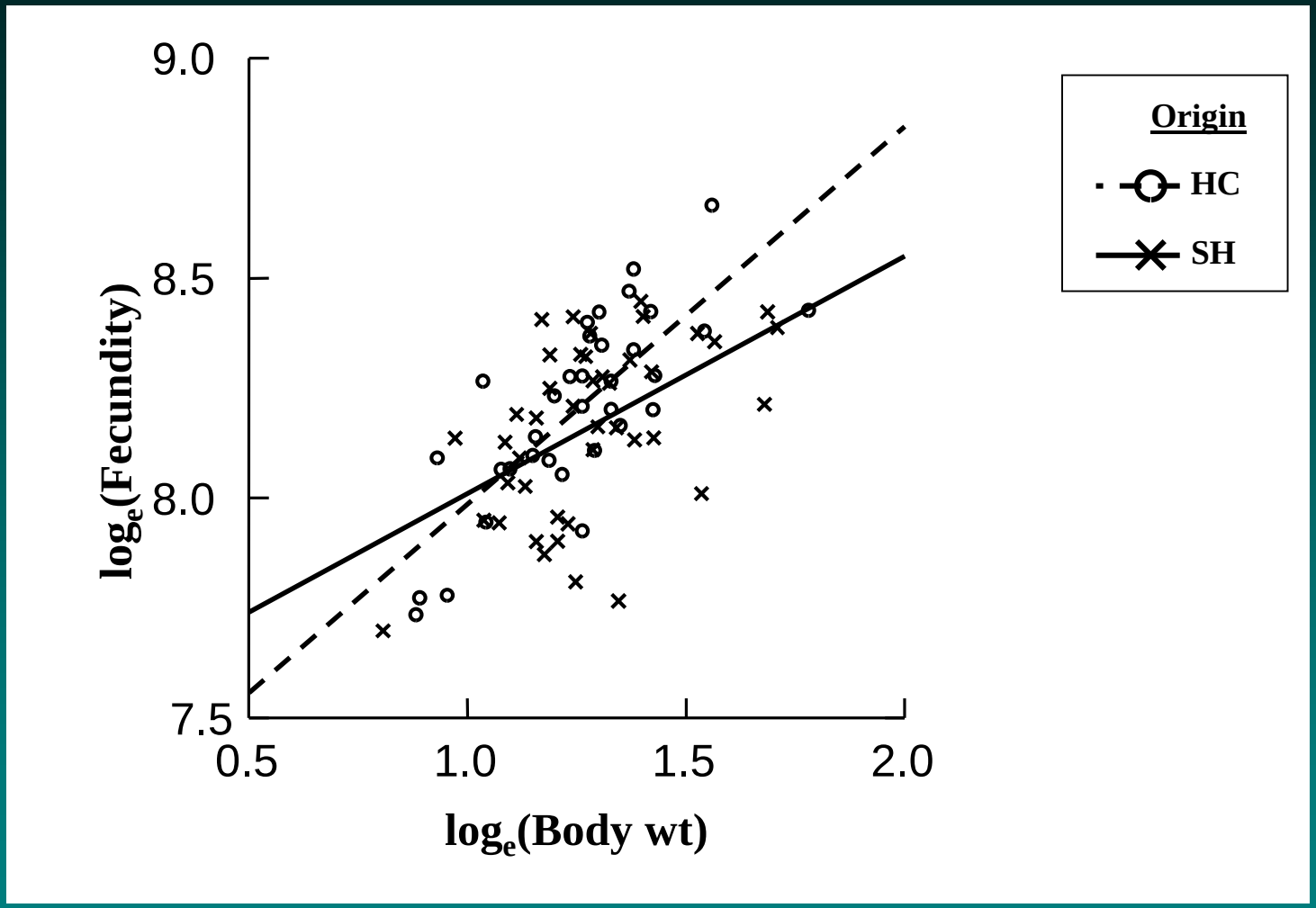
ANCOVA: Equal slopes p=0.014



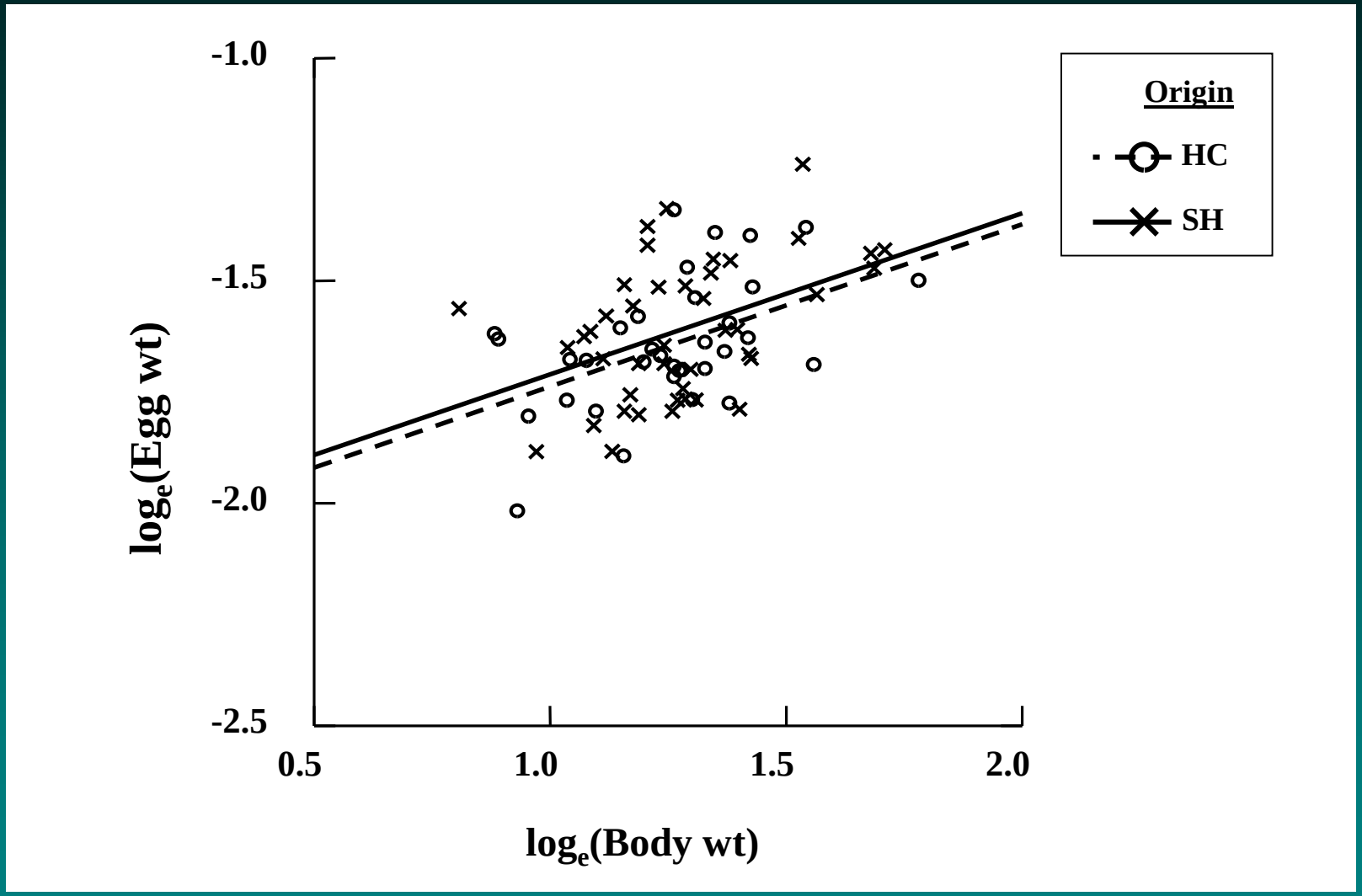
ANCOVA: Equal slopes p=0.020



ANCOVA: Equal slopes p=0.102



ANCOVA: Equal slopes p=0.989



Conclusions

- **Spawn timing of HC and SH fish at CESRF was sign earlier than NO fish with ~1/3 of the effect due to genetics**
- **Age 3 and 4 SH and HC fish continue to grow at sign. slower rate (smaller size-at-age) than NO fish**
- **This appears to be entirely a genetic effect in age 3's and declines in age 4's (<50%) and increases in age 5's (>67%), but reverses the trend (HC>SH>NO)**
- **Increased proportions of Hatchery age 3 jacks has reversed itself**

Conclusions – cont'd

- **Basic gametic traits have been significantly affected by an additional generation of domestication**
  - **The rate of gamete biomass production (kg gametes per unit body growth) HC> SH**
  - **Reproductive effort HC>SH**
  - **The rate of fecundity production (# eggs per unit body growth) HC>SH (p=0.10)**
- **Egg weight was not affected HC=SH**
- **Jack GSI vs Body size relationship appears to have been relaxed in HC, but no SH jacks to compare yet**

Conclusions – cont'd

- **The production of minijacks by HC line was significantly lower than in the SH line indicating a significant genetic component to this life history strategy**

Acknowledgements

- **Yakama Nation Roza Adult Monitoring Facility Crew**
- **Cle Elum Supplementation and Research Facility Crew**
- **Bonneville Power Administration for providing funding**

Questions?