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

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Objectives

1. **Compare NO, SH and HC populations over brood years 2002 to 2010 for age 4's.**
   - **Compare differences in Length (POHP) and estimate trends over time.**

2. **HC vs SH Minijack rate comparisons.**
   - **Trends over time.**
   - **Revisit the Feed Ration Study (BY2002-2004)**

Population Definitions

- **Natural Origin (NO) – progeny of naturally spawning parents. Parents could be natural or hatchery origin.**
- **Hatchery Origin**
  - **Standard Hatchery (SH) Origin – Parental broodstock of NO only, one generation of domestication. Used to supplement the naturally spawning population, an integrated hatchery program.**
  - **Hatchery Control (HC) Origin – Parental broodstock of hatchery origin only. Multiple generations of domestication. Are not allowed to naturally spawn, a segregated hatchery line.**

HC vs SH Comparisons

- **Both have parents artificially spawned, share hatchery rearing and post-release environments (fresh and saltwater)**

- **SH returns have experienced a single generation of hatchery influence (NO parents)**

- **HC returns have experienced multiple generations of hatchery influence (HC parents)**

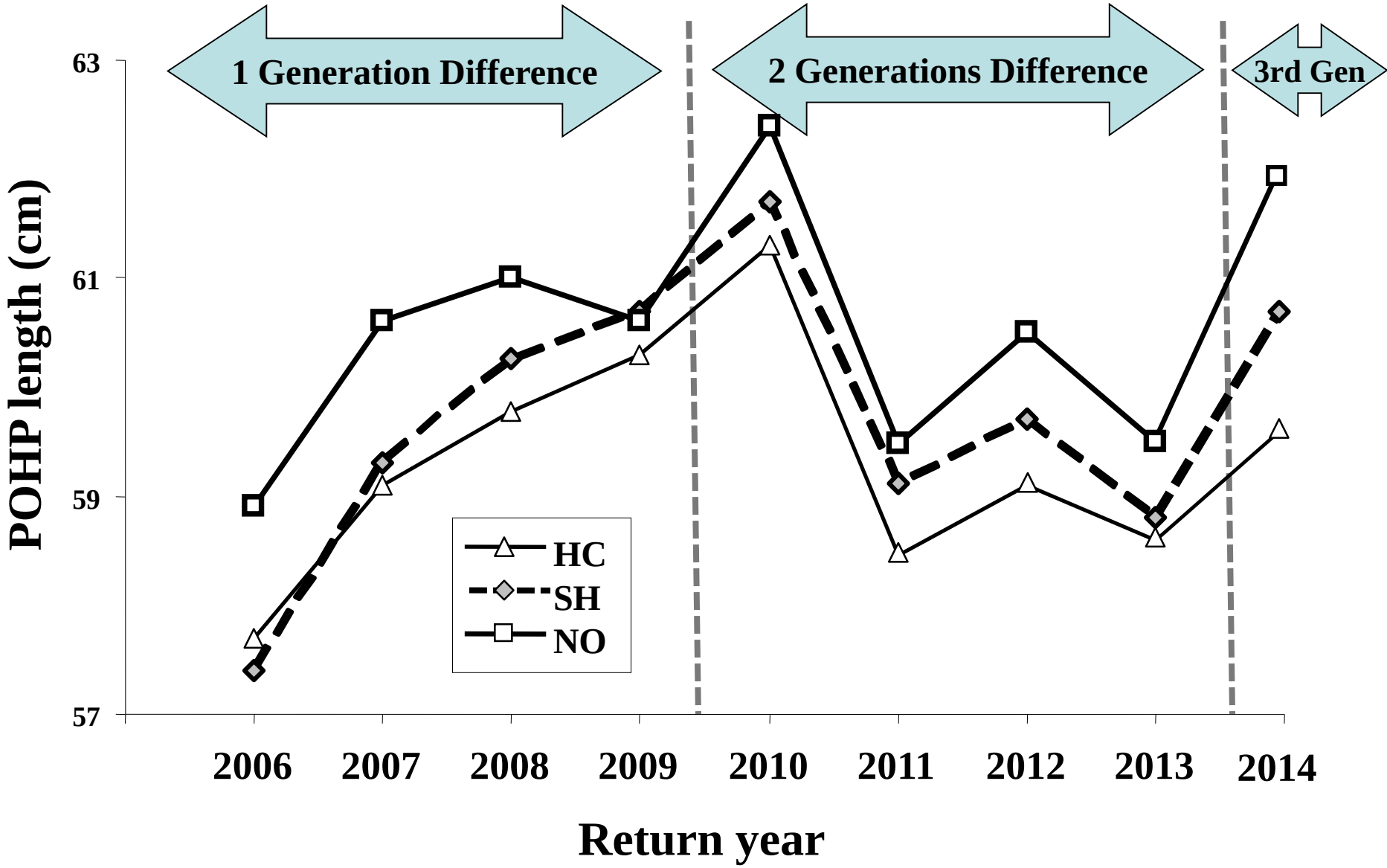
- **Differences in their phenotypic traits should be expressions of genetic differences due to the additional generations of hatchery influence experienced by the HC line**

		HC population begins in BY2002 founded from first generation hatchery returns (*SH*)			
	Broodyears→	**2002**	**2003**	**2004**	**2005**
←Time	**2005**	**3**			
	2006	**4**	**3**		
	2007	**5**	**4**	**3**	
	2008		**5**	**4**	**3**
	2009			**5**	**4**
	2010				**5**
	2011				
	2012				
	2013				
	2014				
	2015				

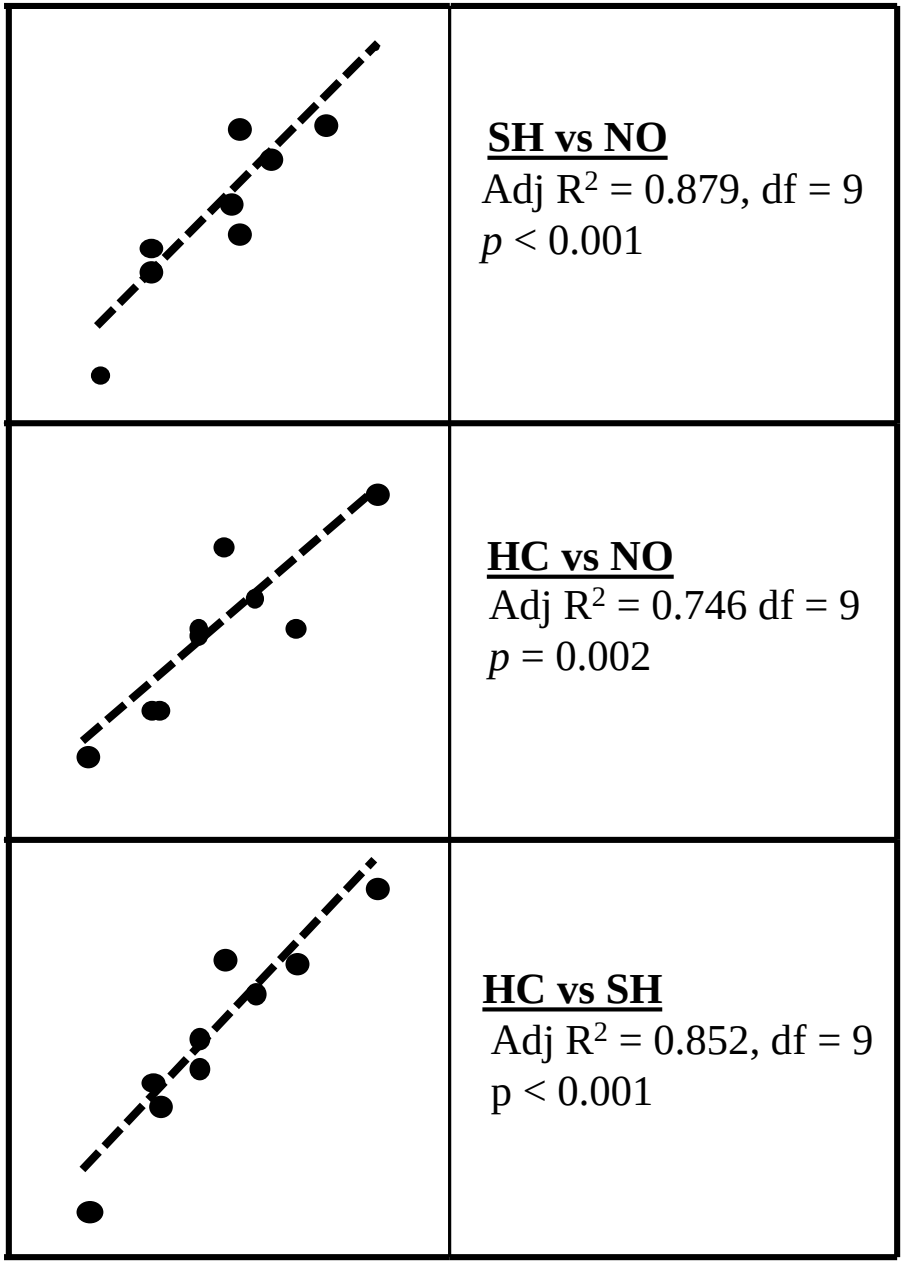
Objective 1

- **Compare differences in Length (POHP) and trends over time.**

Age 4 POHP Length



Pairwise Regressions of POHP

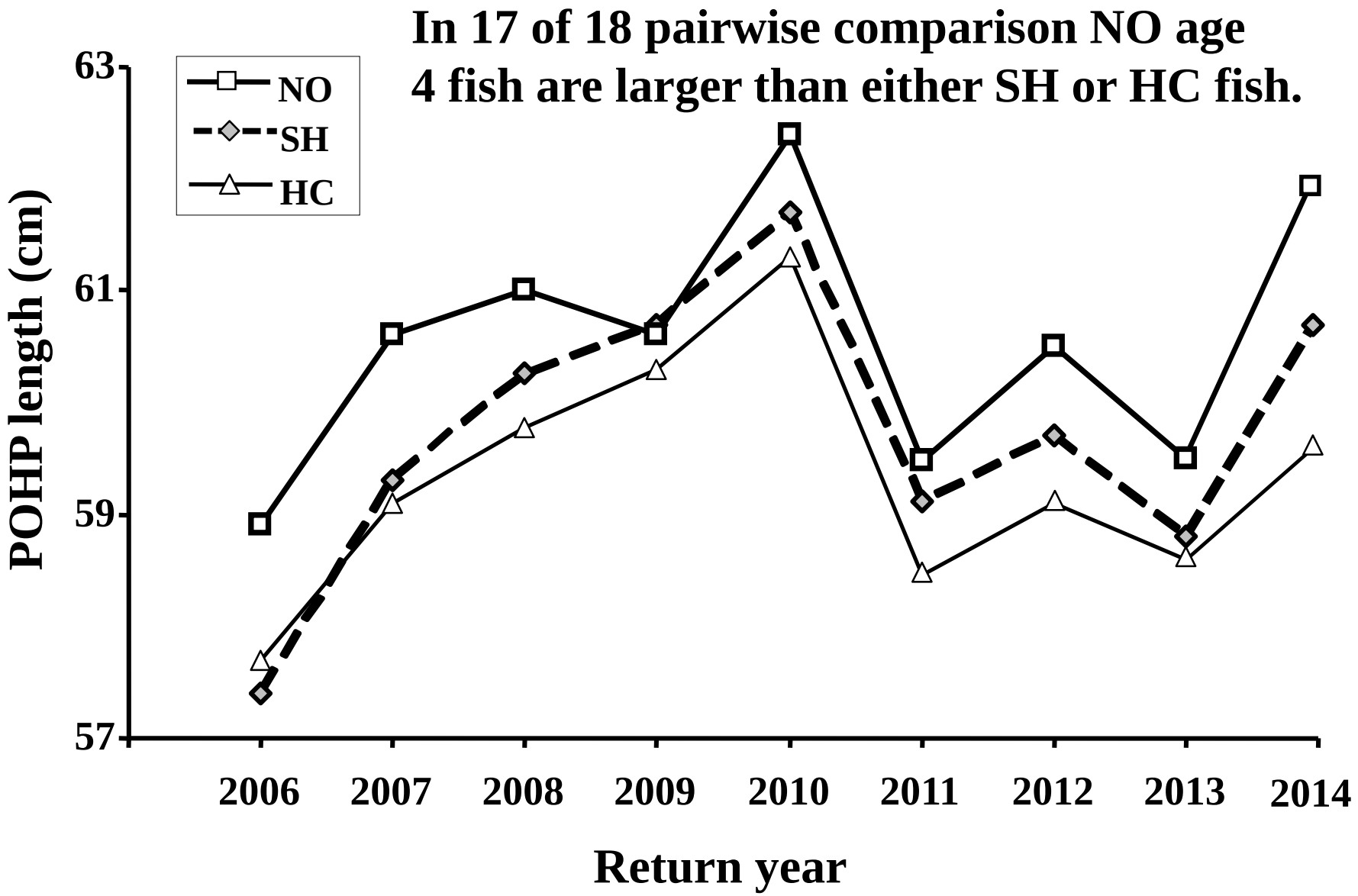


SH vs NO
Adj R^2 = 0.879, df = 9
$p < 0.001$

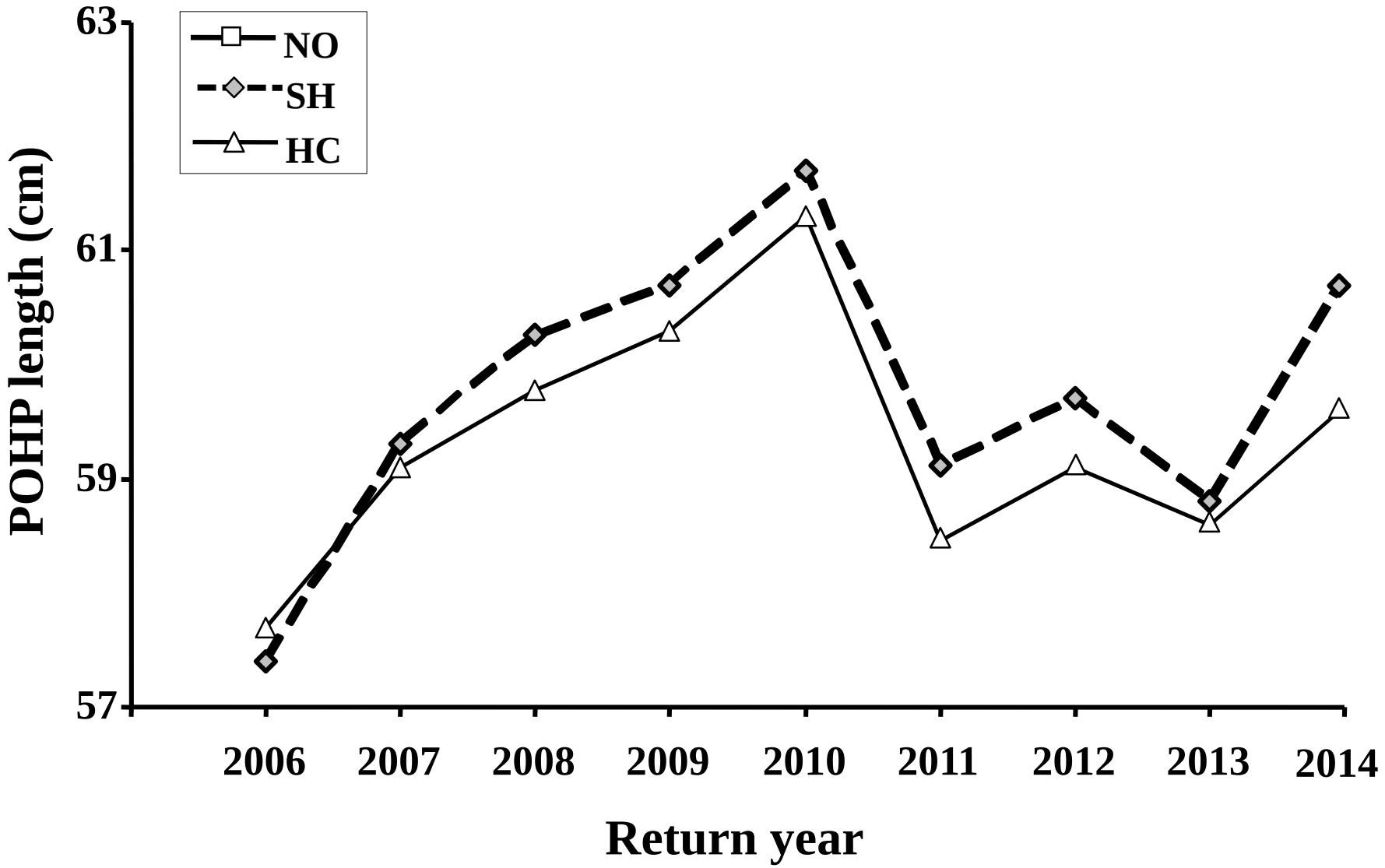
HC vs NO
Adj R^2 = 0.746 df = 9
$p = 0.002$

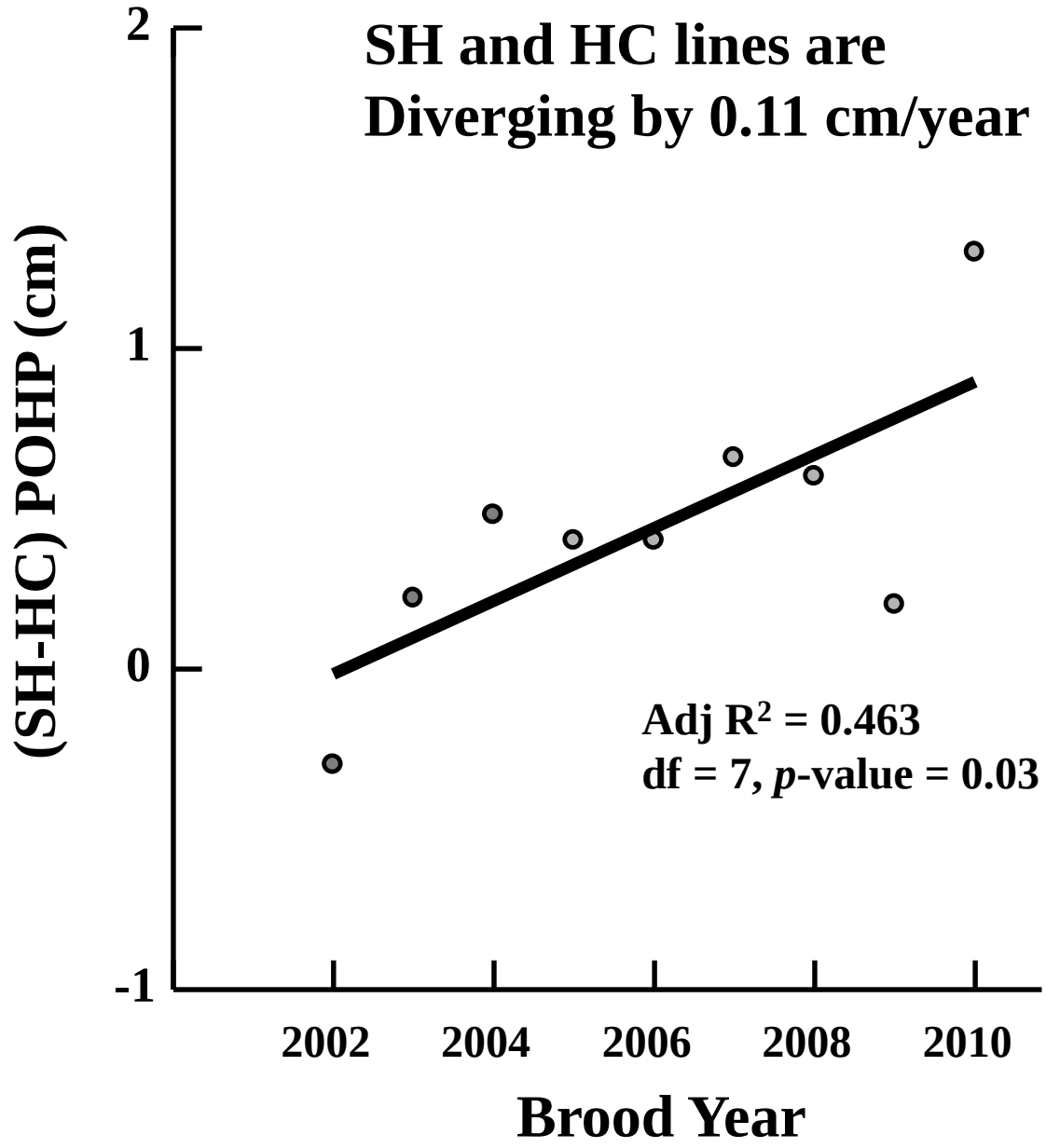
HC vs SH
Adj R^2 = 0.852, df = 9
p < 0.001

Age 4 POHP Length

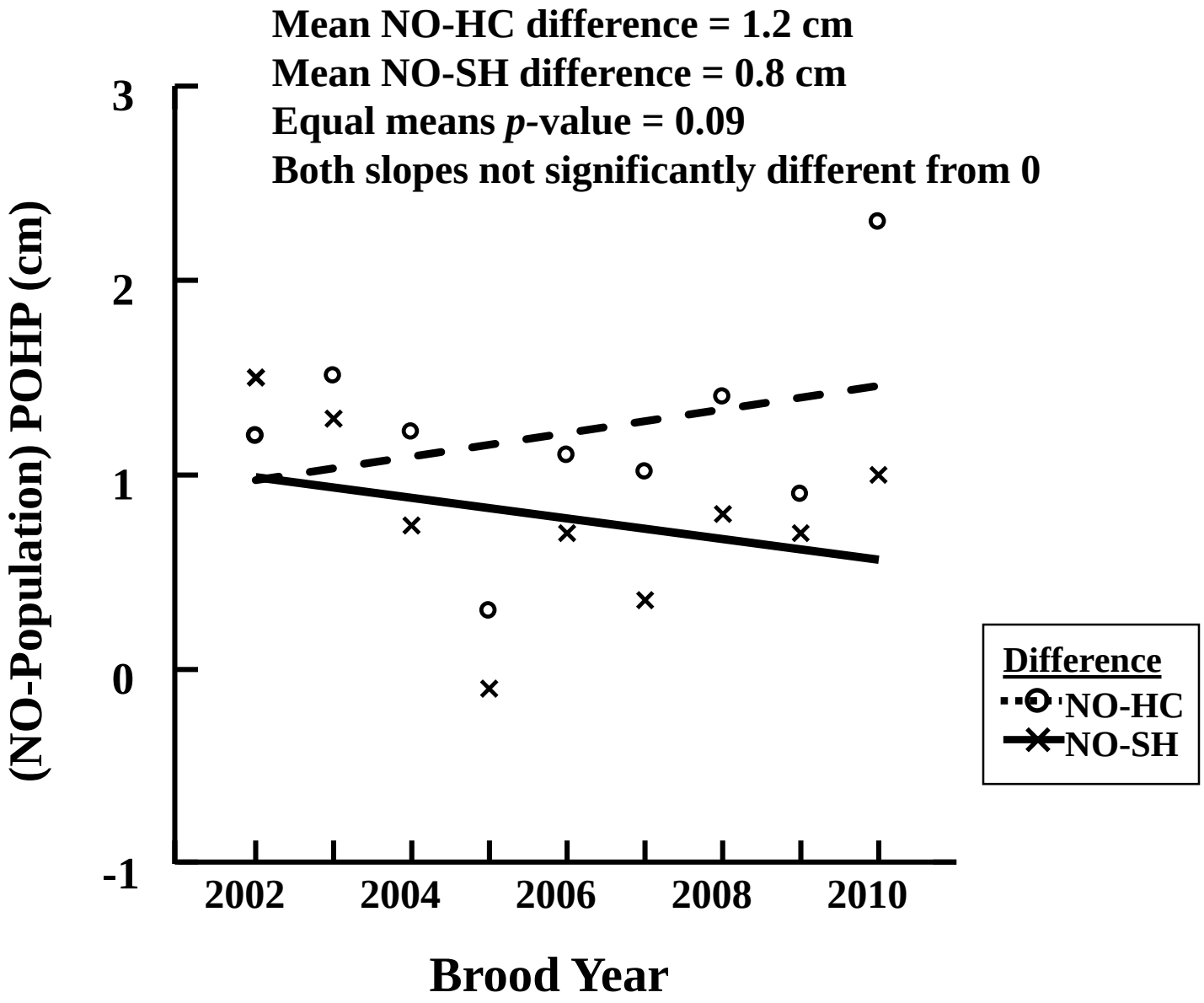


Age 4 POHP Length




SH and HC lines are
Diverging by 0.11 cm/year
(SH-HC) POHP (cm)
2
1
0
-1
2002
2004
2006
2008
2010
Brood Year
Adj R2 = 0.463
df = 7, p-value = 0.03

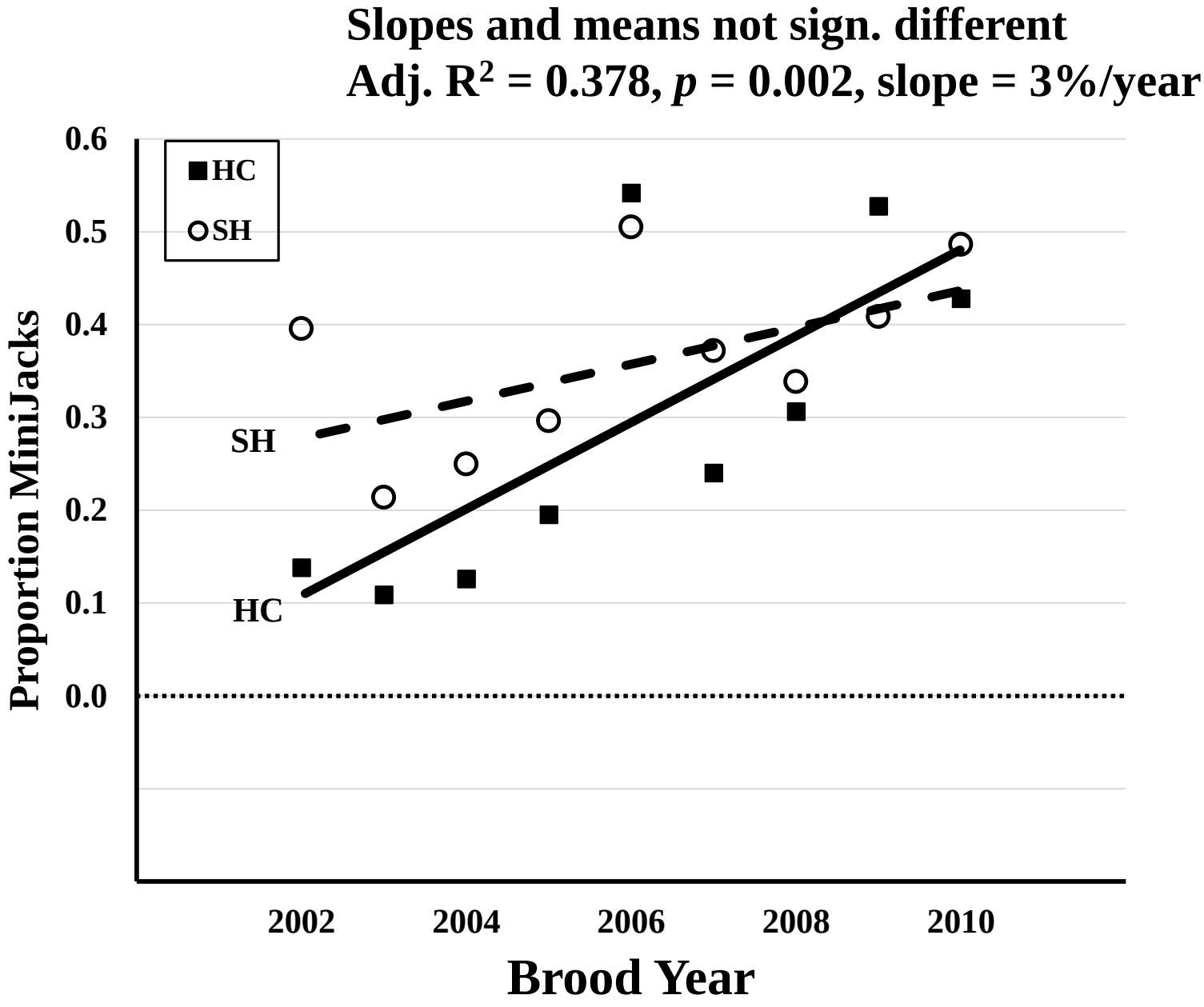
Differences From NO Population



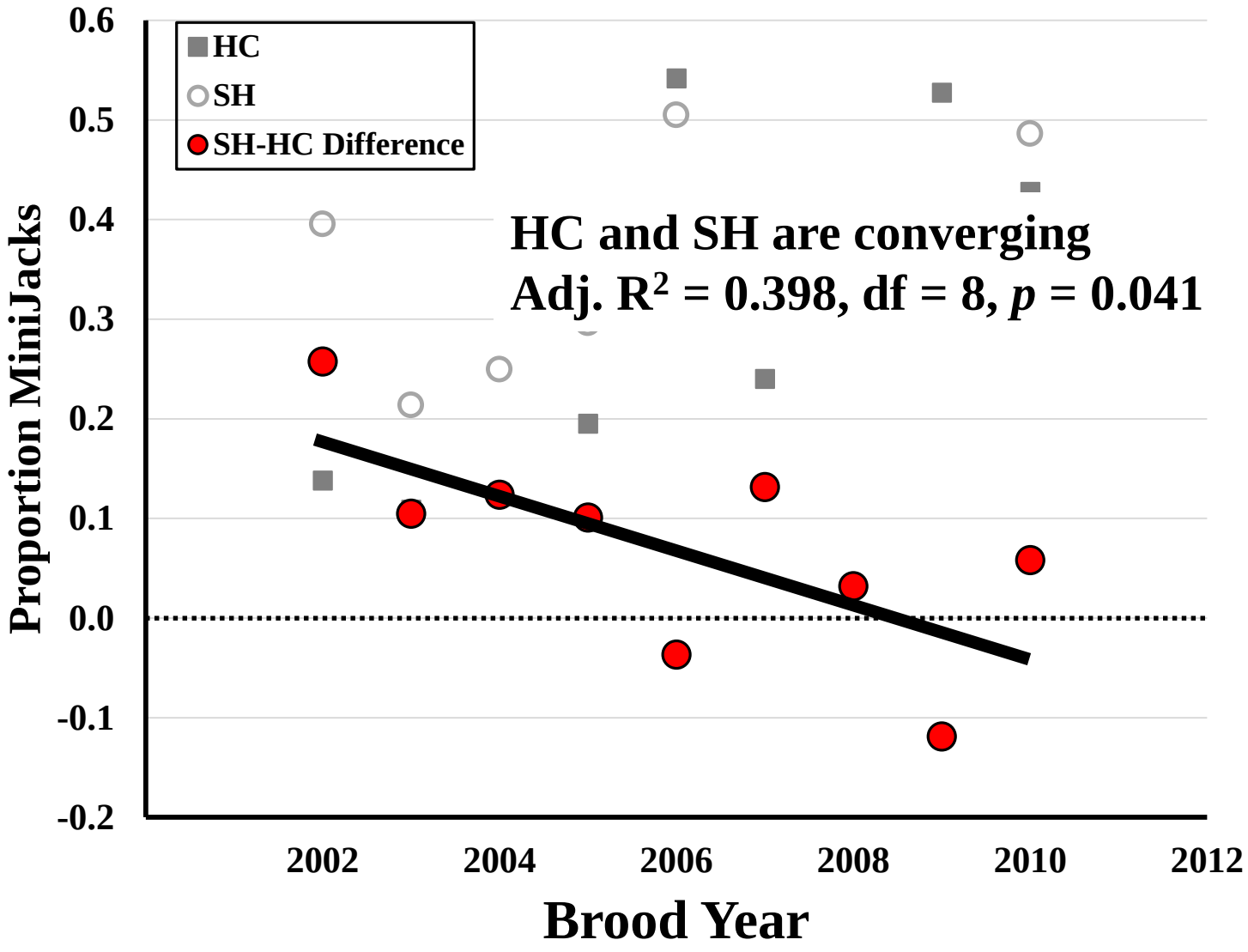
Objective 2:
HC vs SH Minijack rates

1. Trends over BY2002 to BY2010

2. Revisit the Feed Ration Study (BY2002-2004)


Slopes and means not sign. different
Adj. R2 = 0.378, p = 0.002, slope = 3%/year
HC
SH
SH
HC
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Proportion MiniJacks
2002
2004
2006
2008
2010
Brood Year

Paired Differences: SH and HC MiniJack Proportions



HC vs SH Minijack rates

1. Revisit the Feed Ration Study (BY2002-2004)

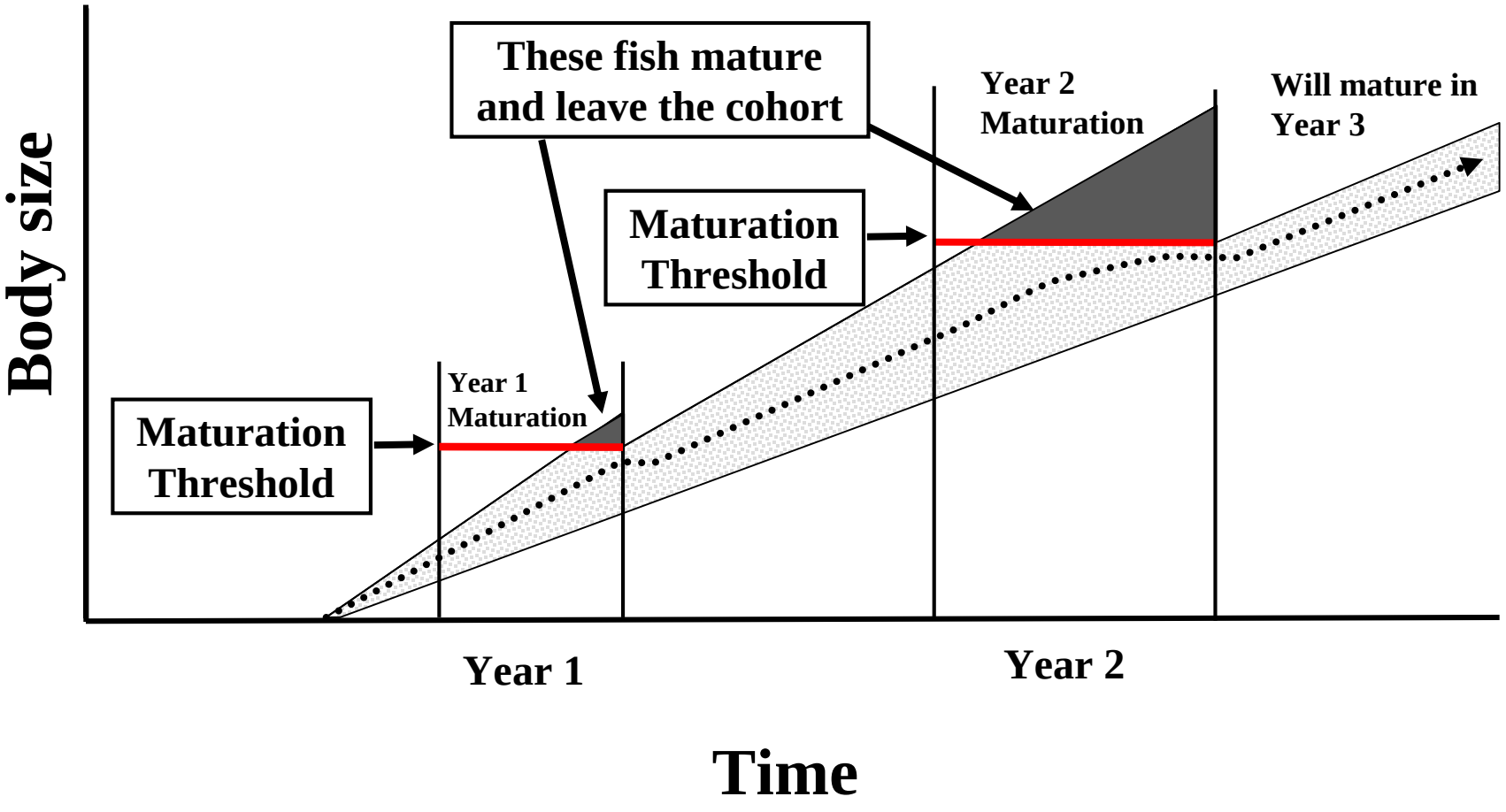
Feed Ration Study Design

- 50% of hatchery production was reared on a High Ration diet and 50% on a Low Ration diet.
- Replicated over 3 brood years (2002-2004).
- There were two populations treated: HC and SH.
- Genetic effects on Treatments were controlled.

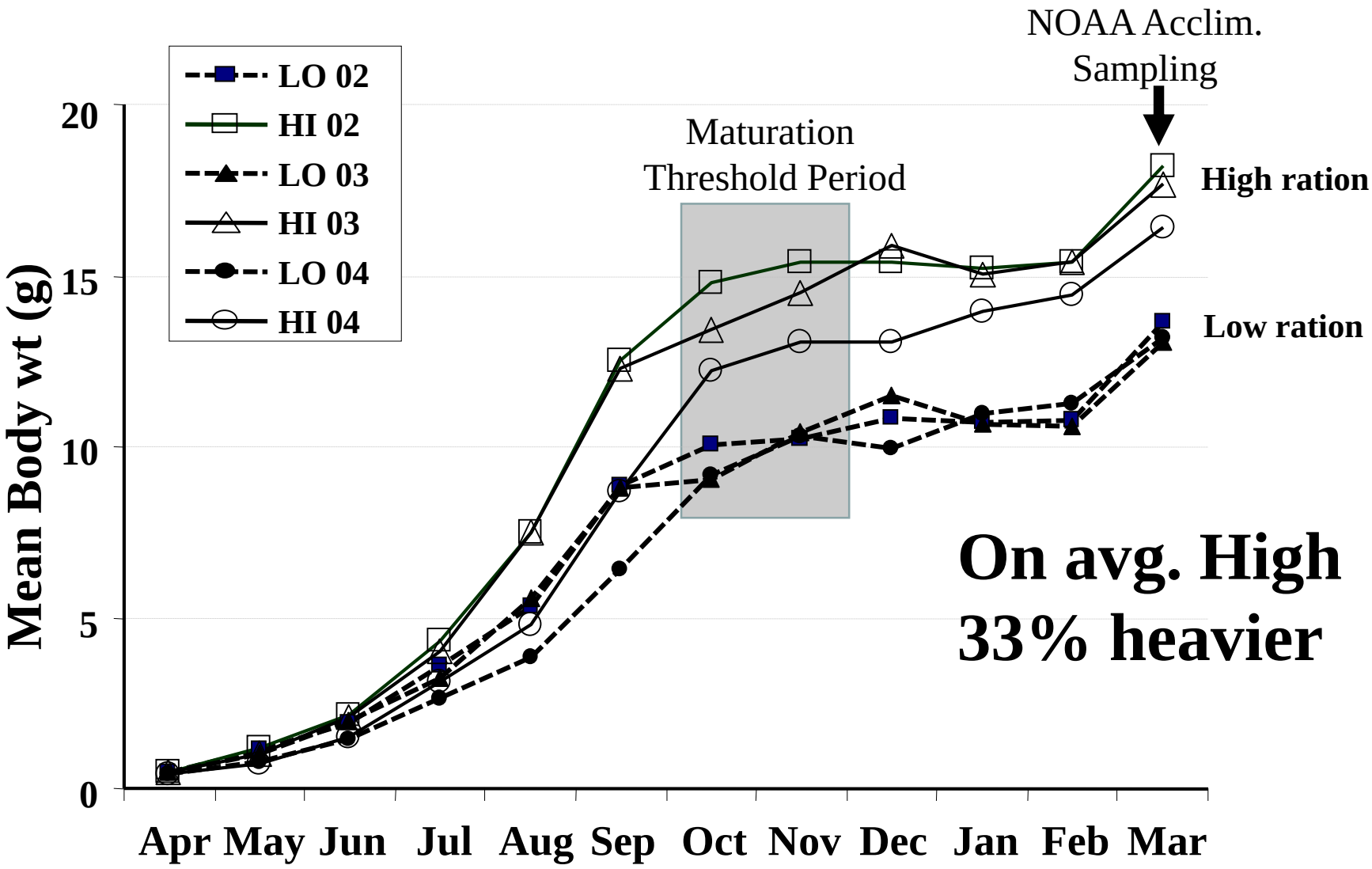
Controlling for Genetic (Family) Effects

- There are 9 pairs of raceways at CESRF: 8 SH pairs and 1 HC pair.
- Each RW in a pair was randomly assigned a Treatment: High or Low Ration.
- Eggs from approximately 24 females were divided in half and allocated to each raceway.
- Treatments within pairs (High and Low Ration) were represented by the same families.
- Differences in traits are strictly environmental, not genetic.

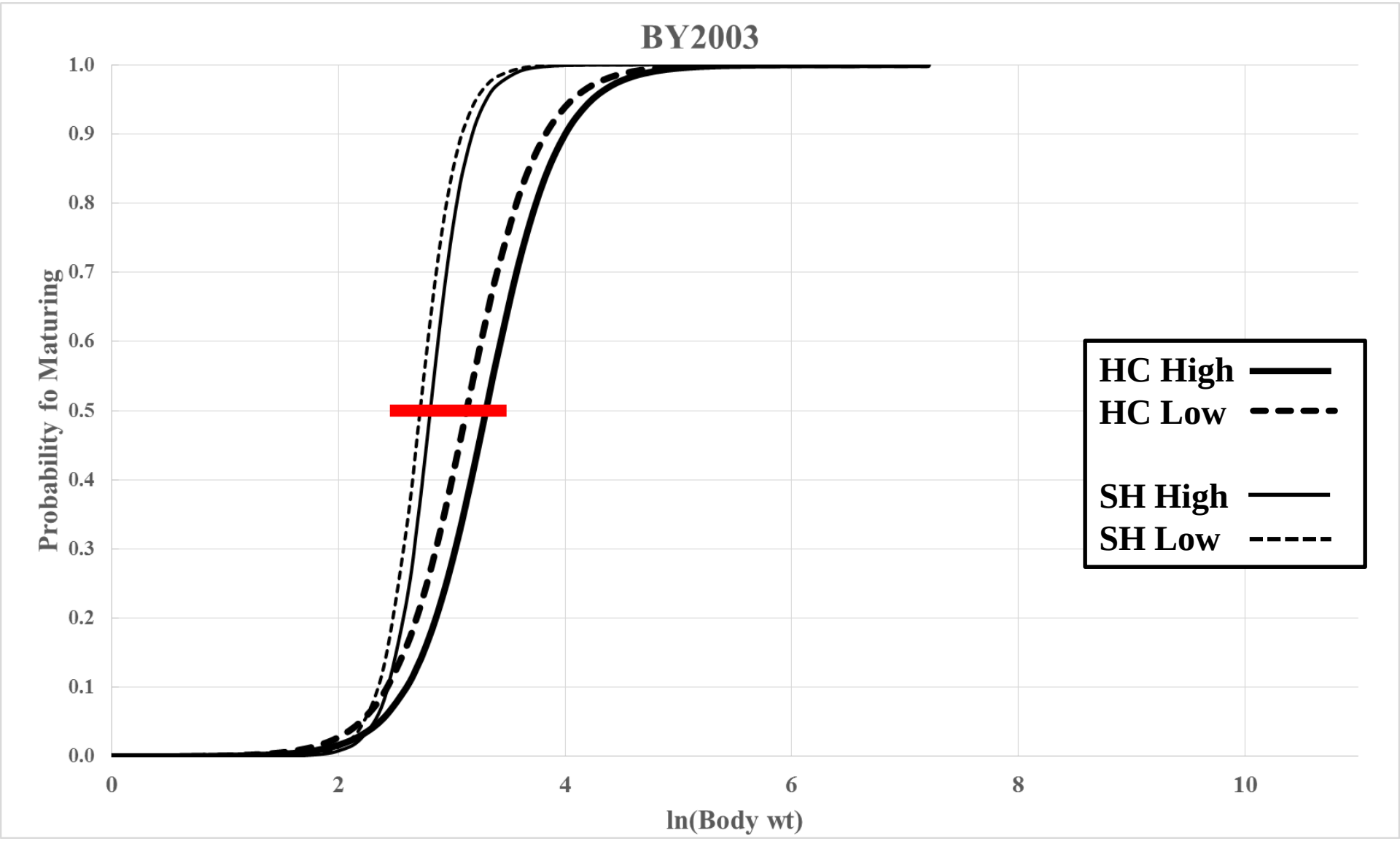
Body Size-Time Growth Trajectory With Reaction Norms for Maturation



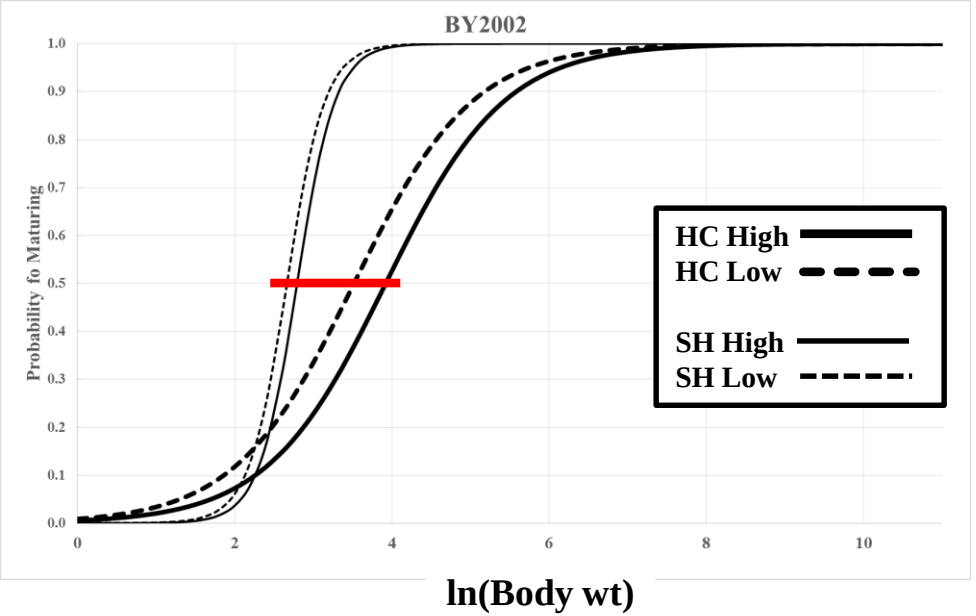
Body Wt Over Time Feed Study

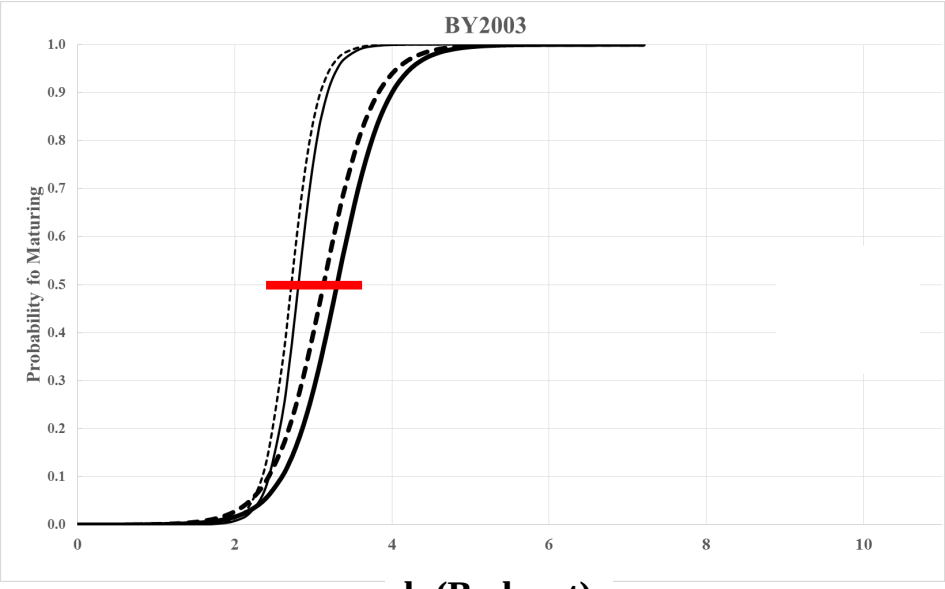


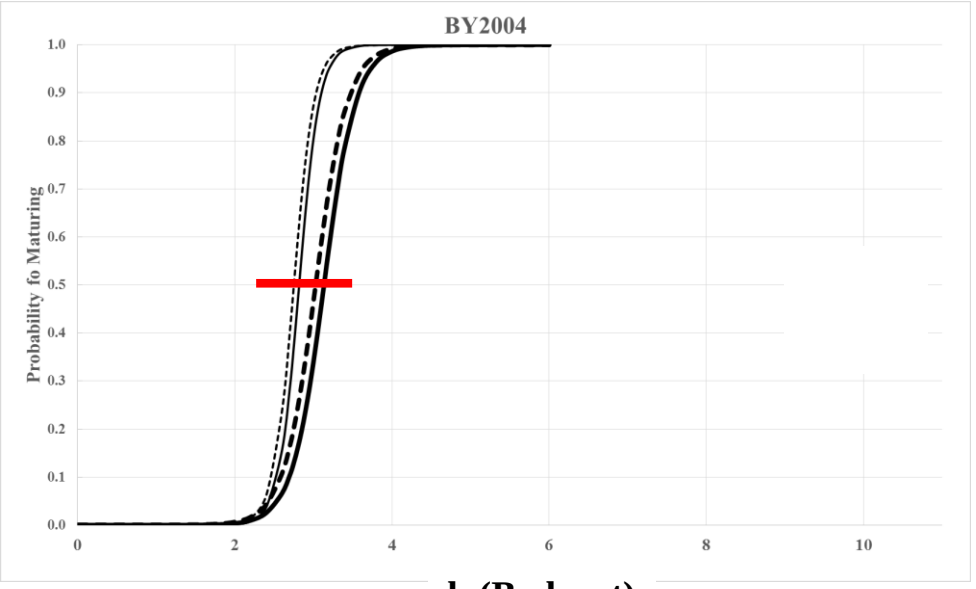
Logistic Regression: ln(Body wt) vs Prob. Maturation



Parameter	Estimates	Z	p-value
Constant	10,333.027	3.086	**0.002**
BY	-5.167	-3.091	**0.002**
Treatment	-0.538	-1.956	**0.050**
Origin	6.313	2.344	**0.019**
ln(Body wt)	-3,626.768	-2.910	**0.004**
BY * ln(Body wt)	1.814	2.914	**0.004**
Origin * ln(Body wt)	-2.795	-2.782	**0.005**







Summary Objective 1

- All 3 populations are highly correlated in size over time ($R^2>0.75$, $p<0.01$), due to very similar freshwater and ocean rearing environments.
- Age 4 NO fish are larger in 94% (17 of 18) of the pairwise comparisons.
- SH fish are larger that HC (8 of 9 years).
- SH and HC populations are diverging in length at the rate of 0.1 cm/year.

Summary Objective 2

- Minijack temporal trends of SH and HC were equal (no significant difference in slopes or means).
- Both SH and HC minijack rates were significantly increasing over time (3% per yr).
- HC and SH minijack rates show are converging, becoming more similar.

Summary Objective 2 cont'd

- The HC population's norm of reaction for maturation from the logistic regression showed significant variation over the 3 years of the feed study
- In comparison, the SH population was very stable.
- More work needed here.

Acknowledgements

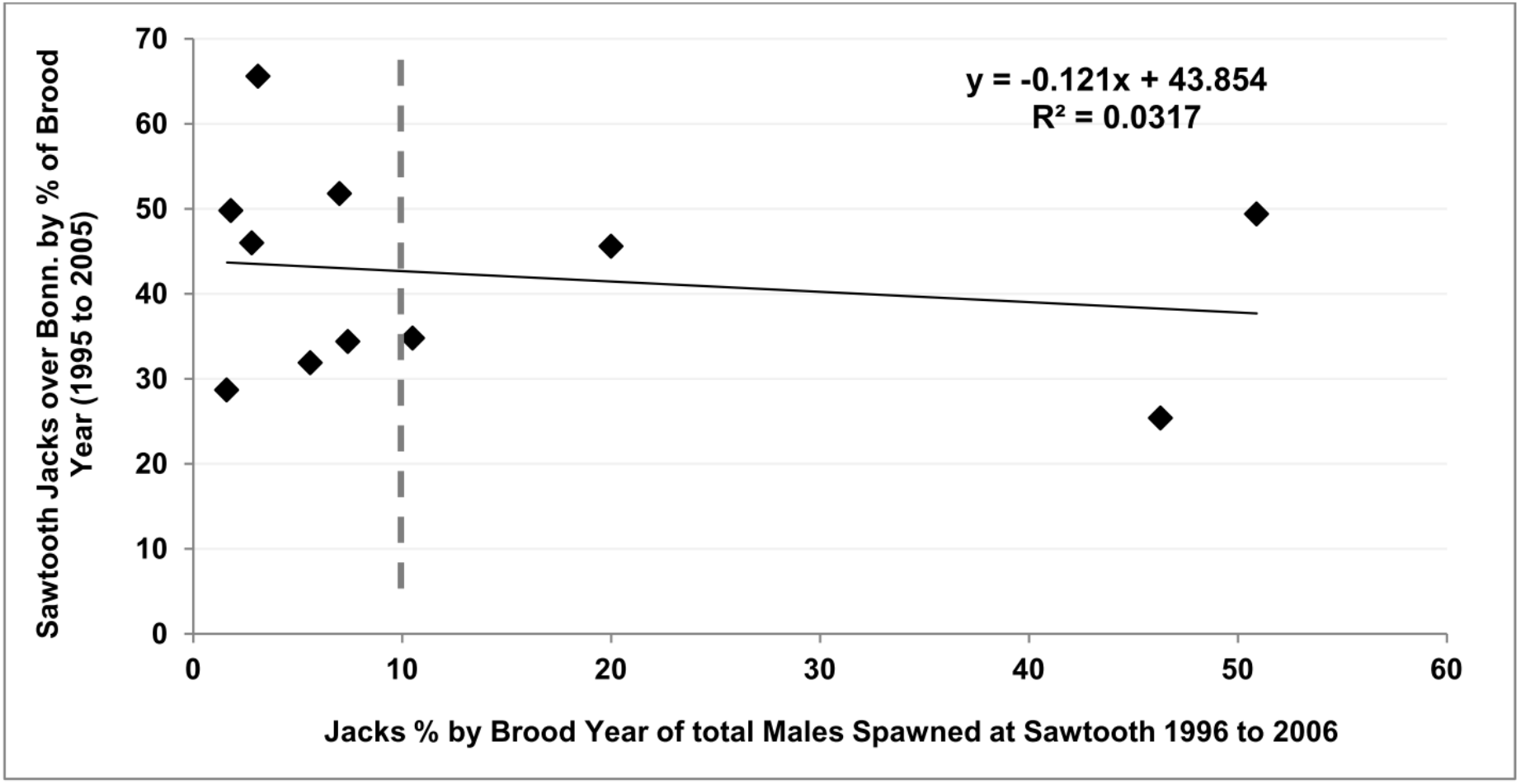
Charlie Strom, DJ Brownlee, Greg Strom, Simon Goudy, and Quinn Jones (CESRF) helped process and sample fish.

Mark Johnston and his crew collected and sampled fish at Roza.

WDFW personnel Jamie Schlump, Brian Johnson, Danielle Rockey, Rebecca Powell, and Matt Sizer helped sample during the spawning season.

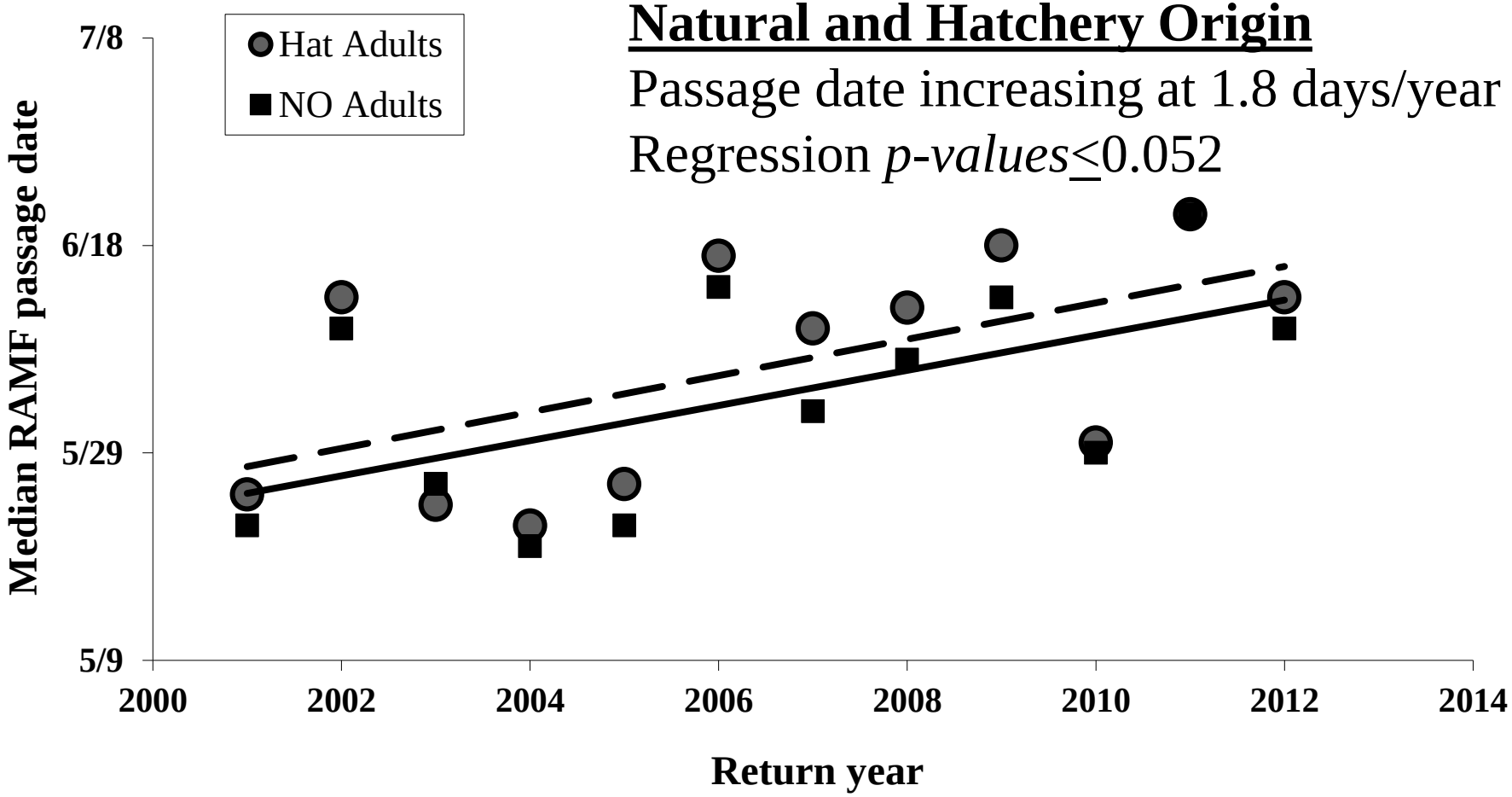
BPA provided funding.

Does the proportion of jacks used as broodstock affect subsequent jack production?

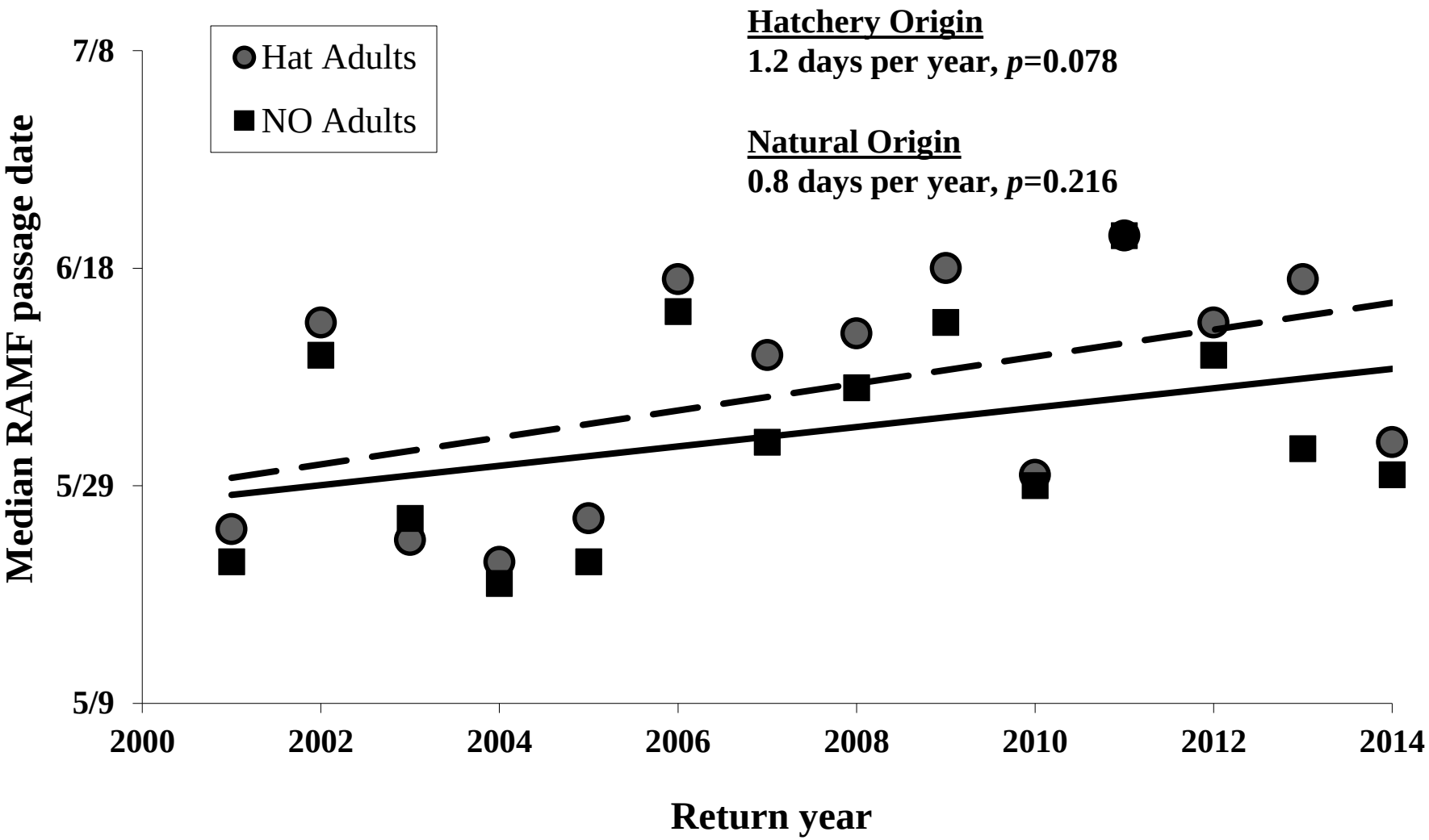


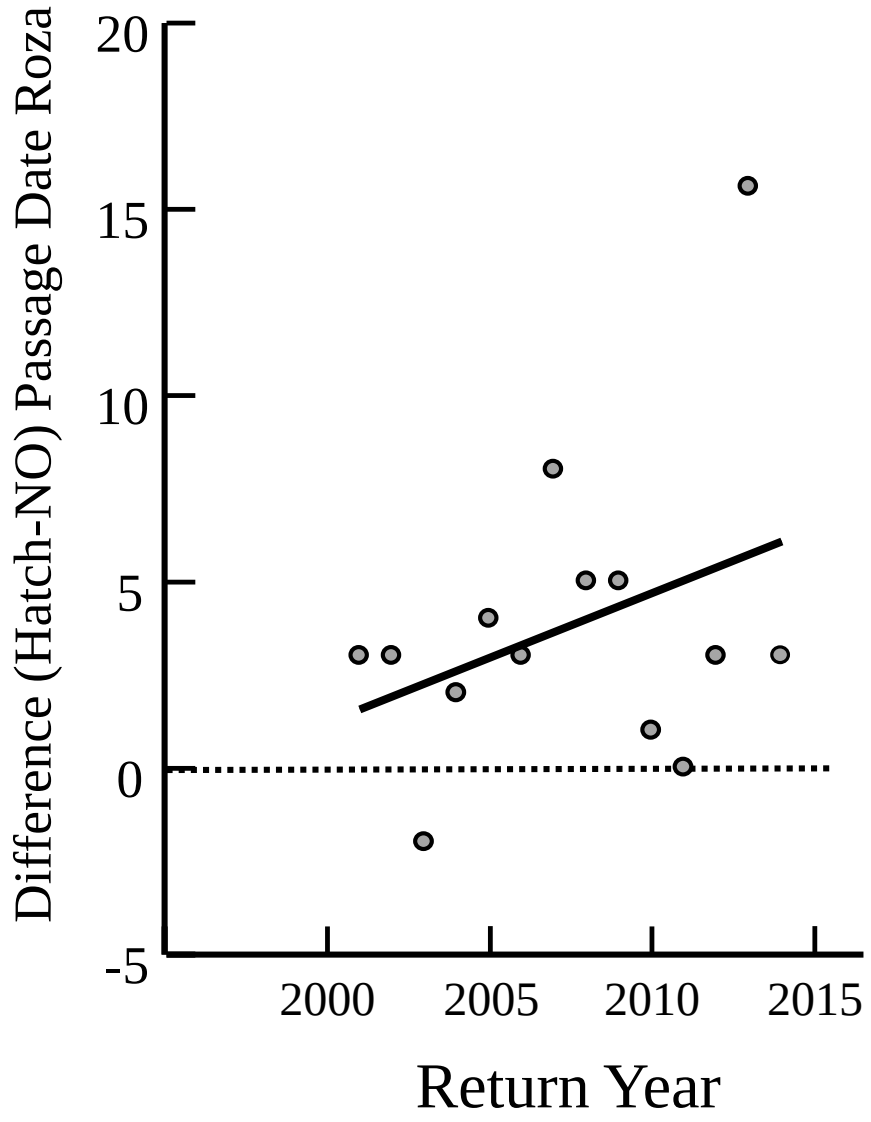
Taken from: Cassinelli, et al. 2012. 2011 CALENDAR YEAR HATCHERY CHINOOK SALMON REPORT: IPC AND LSRCP MONITORING AND EVALUATION PROGRAMS IN THE STATE OF IDAHO. IDFG Report Number 12-02.

Return Years 2001 to 2012



2001 to 2014 Return Years





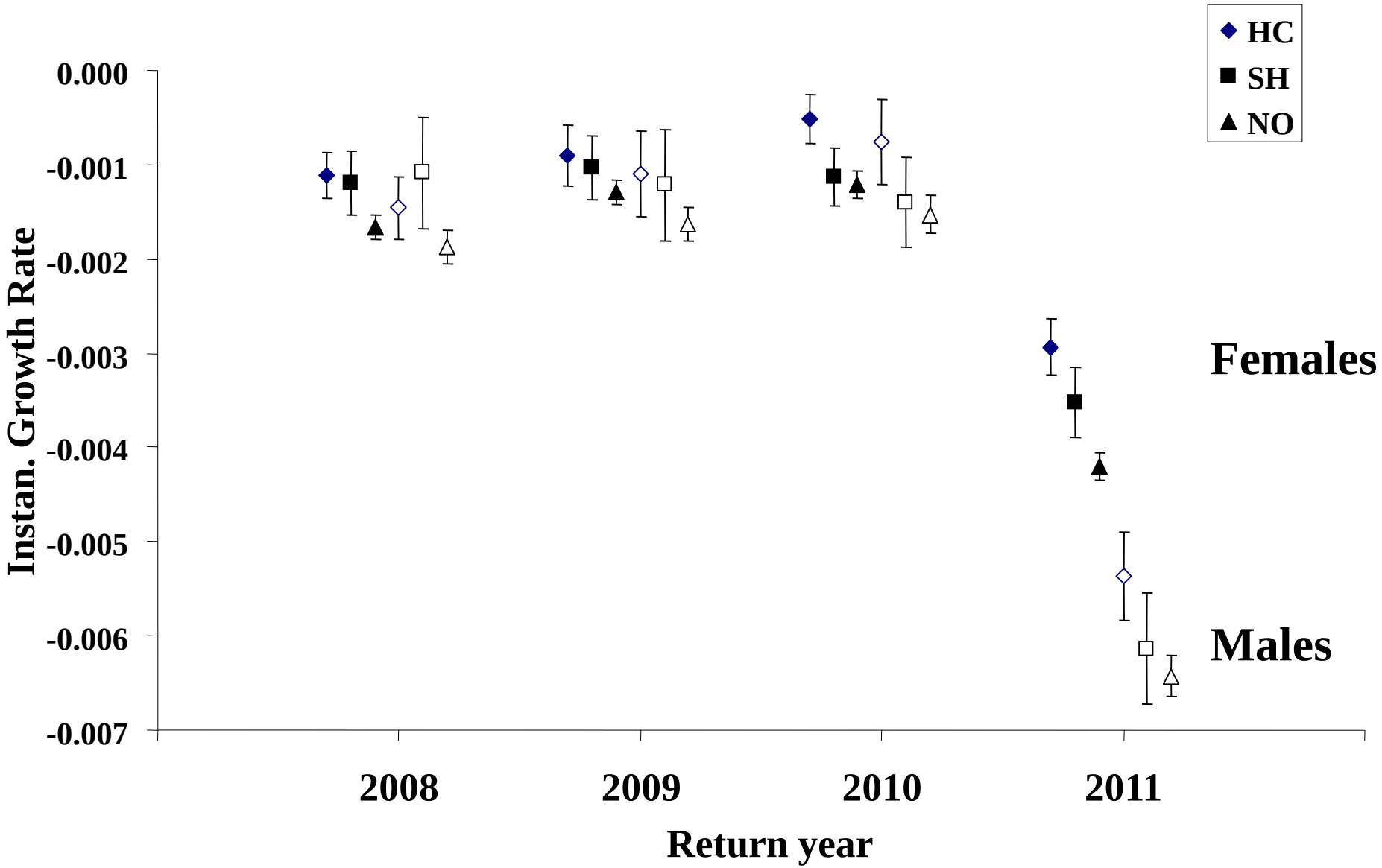
T-test Mean difference=0

Mean difference = 3.8 days
t = 3.47, df = 13,
p-value = 0.004

Temporal Trend Regression

Adj. R^2 = 0.050, *p*-value = 0.22

Instantaneous Growth Rate (*IGR*)



Age 4 Roza Body Mass