

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

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# Definitions

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

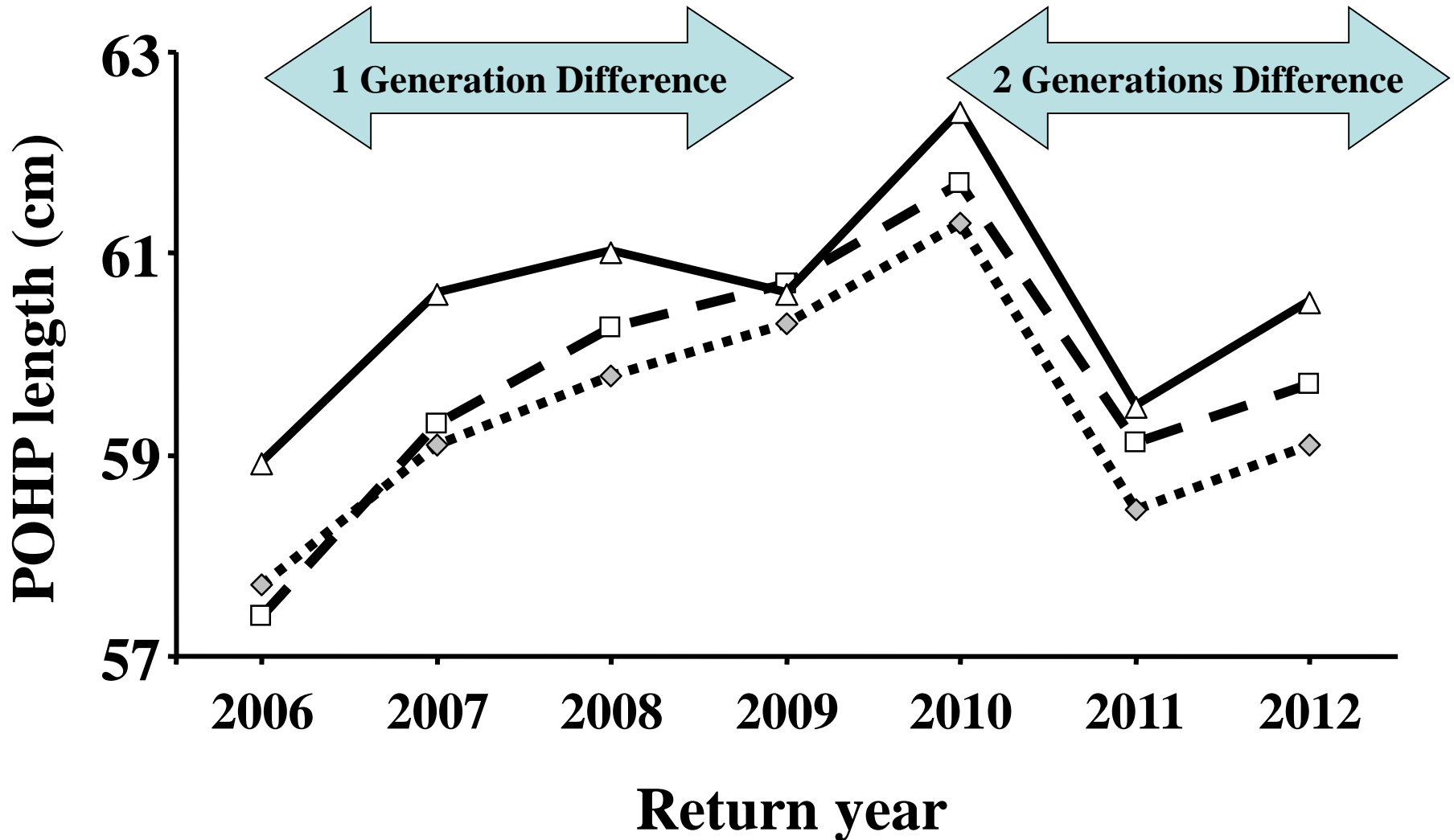
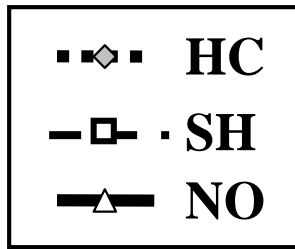
# Objectives

- **Compare mean size-at-maturity of age 4 SH and HC populations over the years 2006 and 2012.**
- **Compare HC and SH percent body mass lost while being held at CESRF.**
- **Compare HC and SH fat/lipid levels at spawning.**
- **Compare male Reproductive Effort by Origin (HC and SH) and Life History Type (Jacks and Adults).**

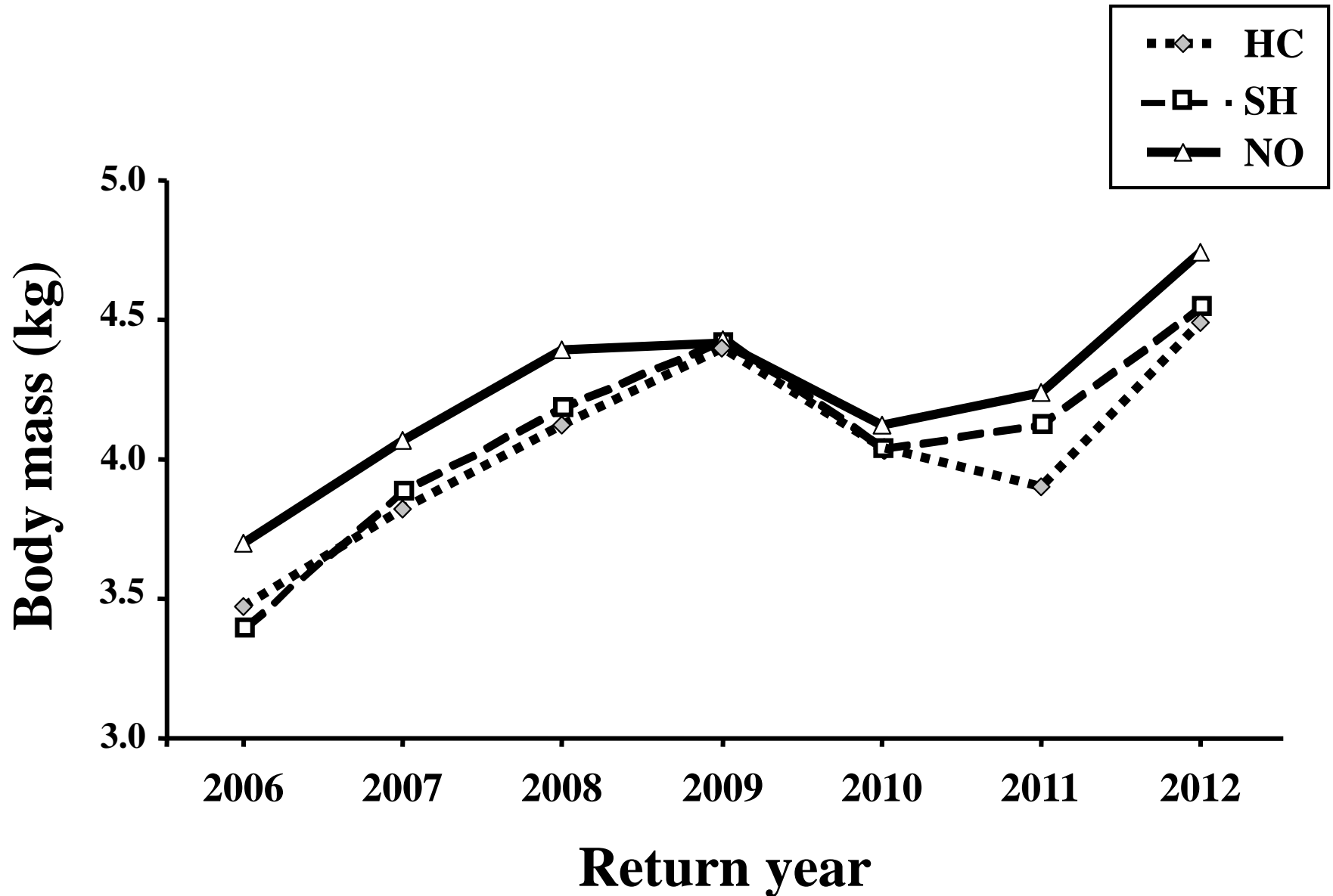
# Hatchery Control vs SH Comparisons

- **Both share common hatchery and post-release environments**
- **SH returns experienced one generation of hatchery influence**
- **HC returns experienced multiple generations of hatchery influence**
- **Differences in their phenotypic traits should be expressions of genetic differences due to the additional generations of hatchery influence experienced by the HC line**

# Age 4 POHP Length



# Age 4 Roza Body Mass

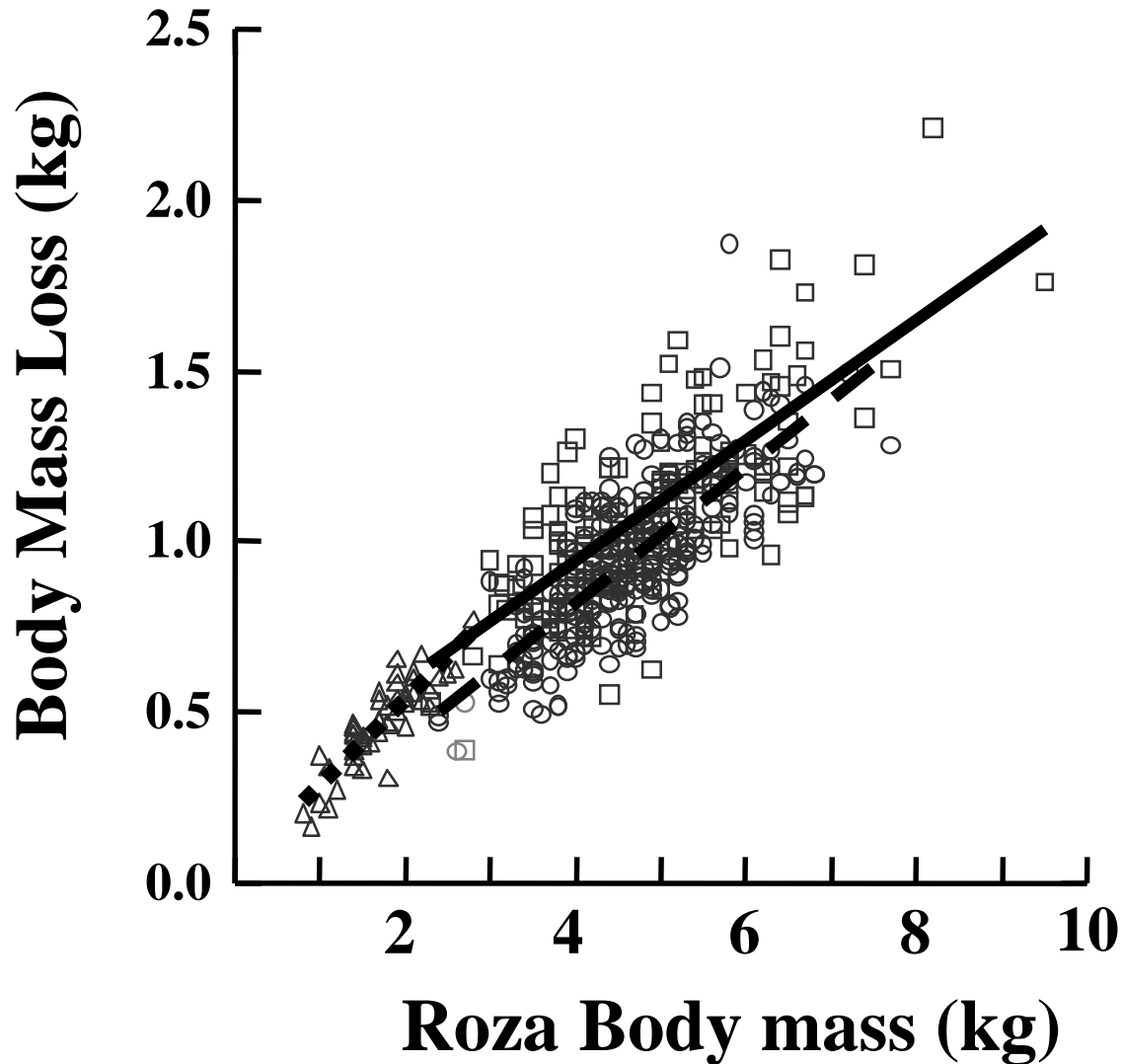


# Body Mass Caveats

- **All fish lose body mass from capture at Roza to spawning (captivity).**
- **Thus, body mass is lower at spawning than on the date of capture.**
- **Body mass loss and percent body mass loss are correlated with:**
  - **number of days of captivity**
  - **initial body mass at capture (Roza)**
- **BM loss differs by Gender (Female, Male, Jack)**

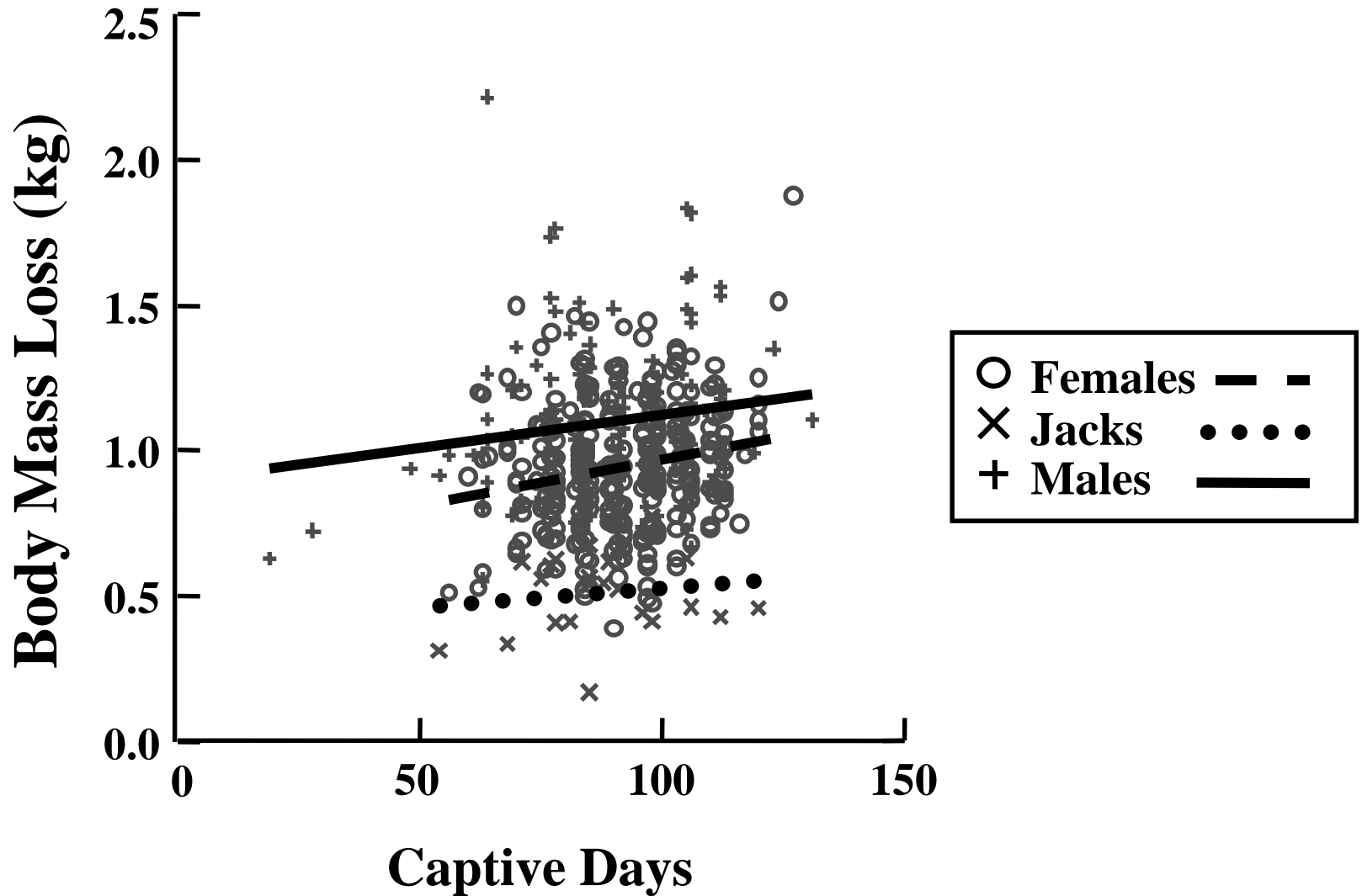
# Body Mass Loss vs Body Mass

(Origins Pooled)

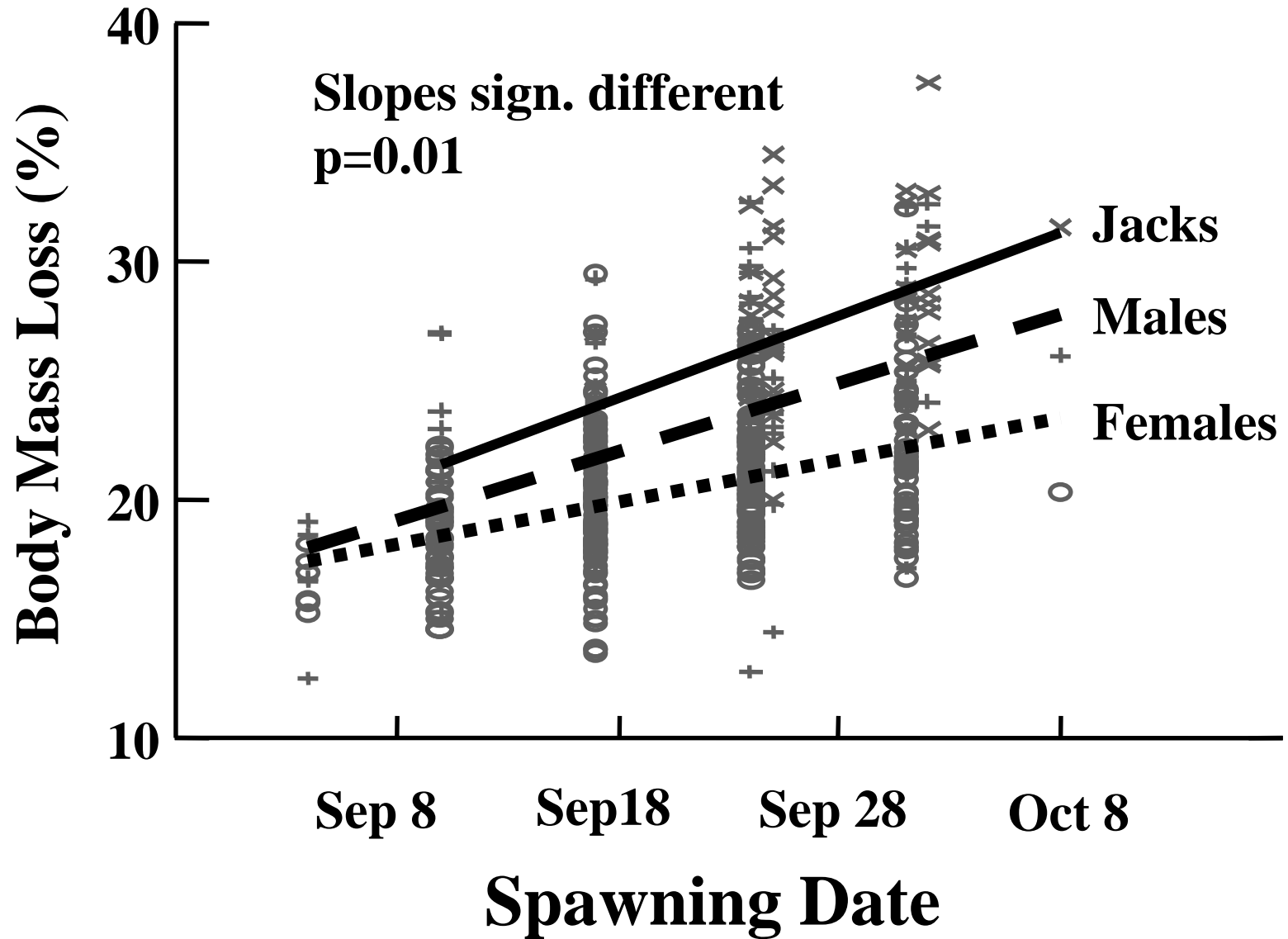




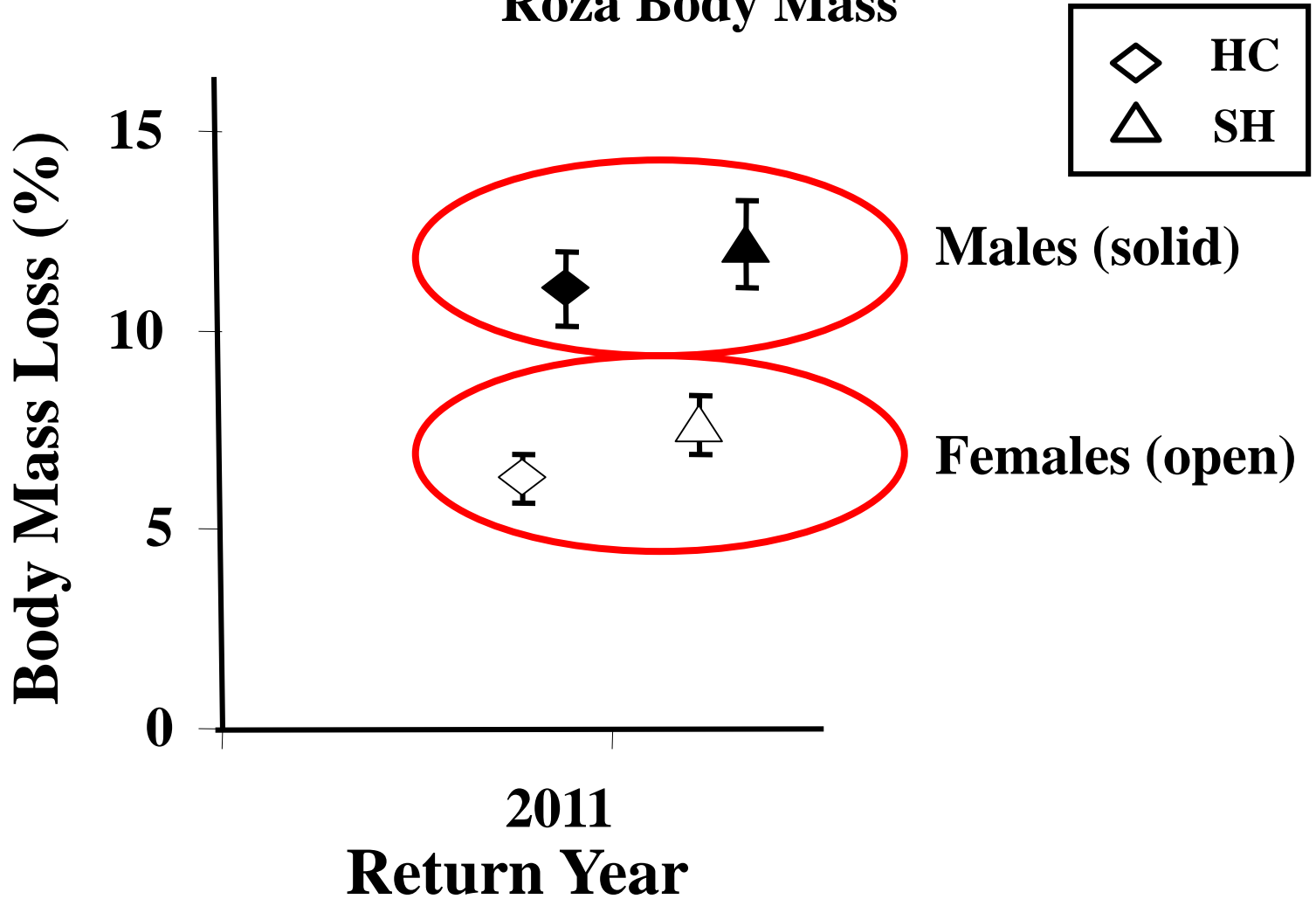
# Body Mass Loss vs Captive Days



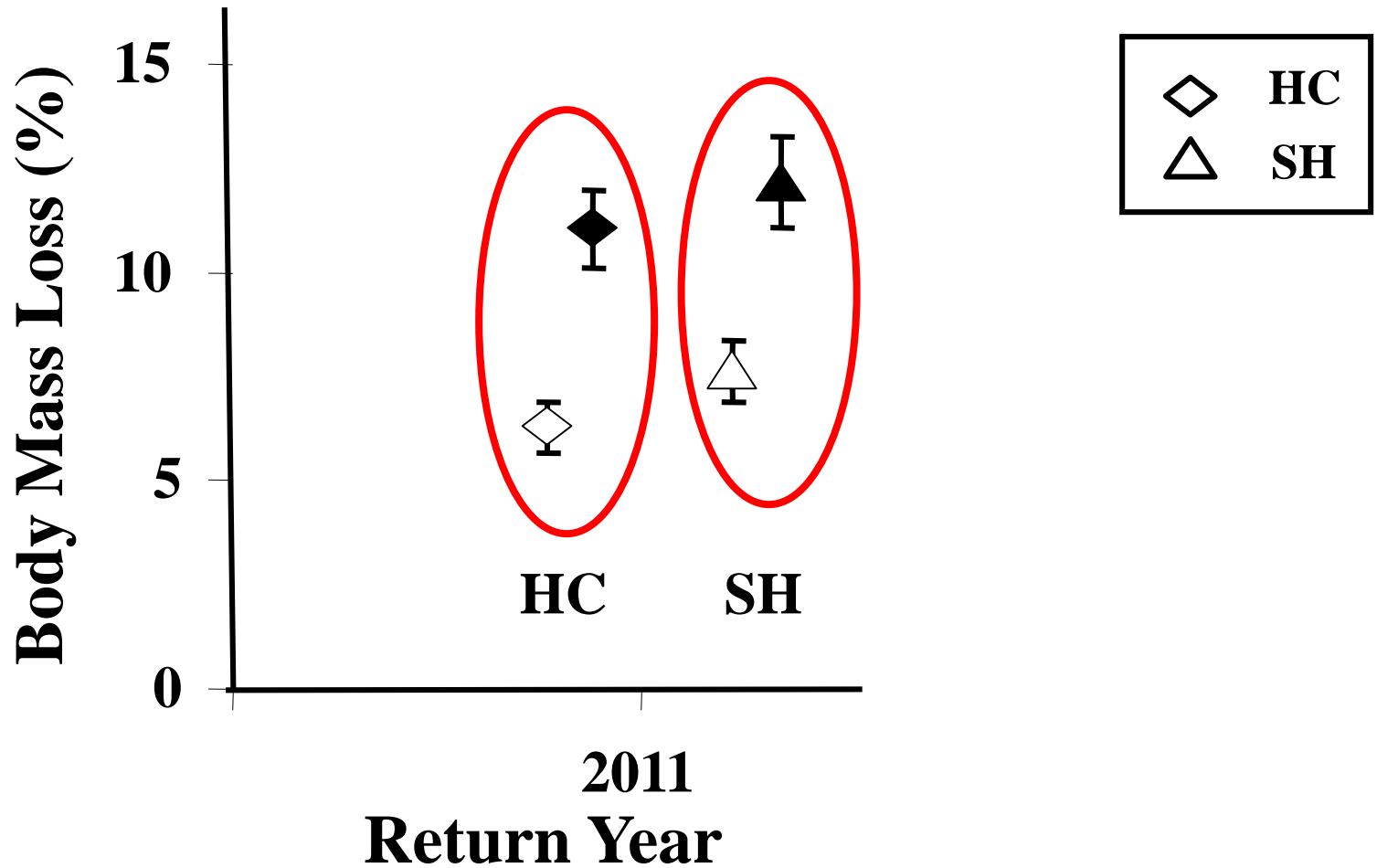
# “Broodstock Sorting” Effect



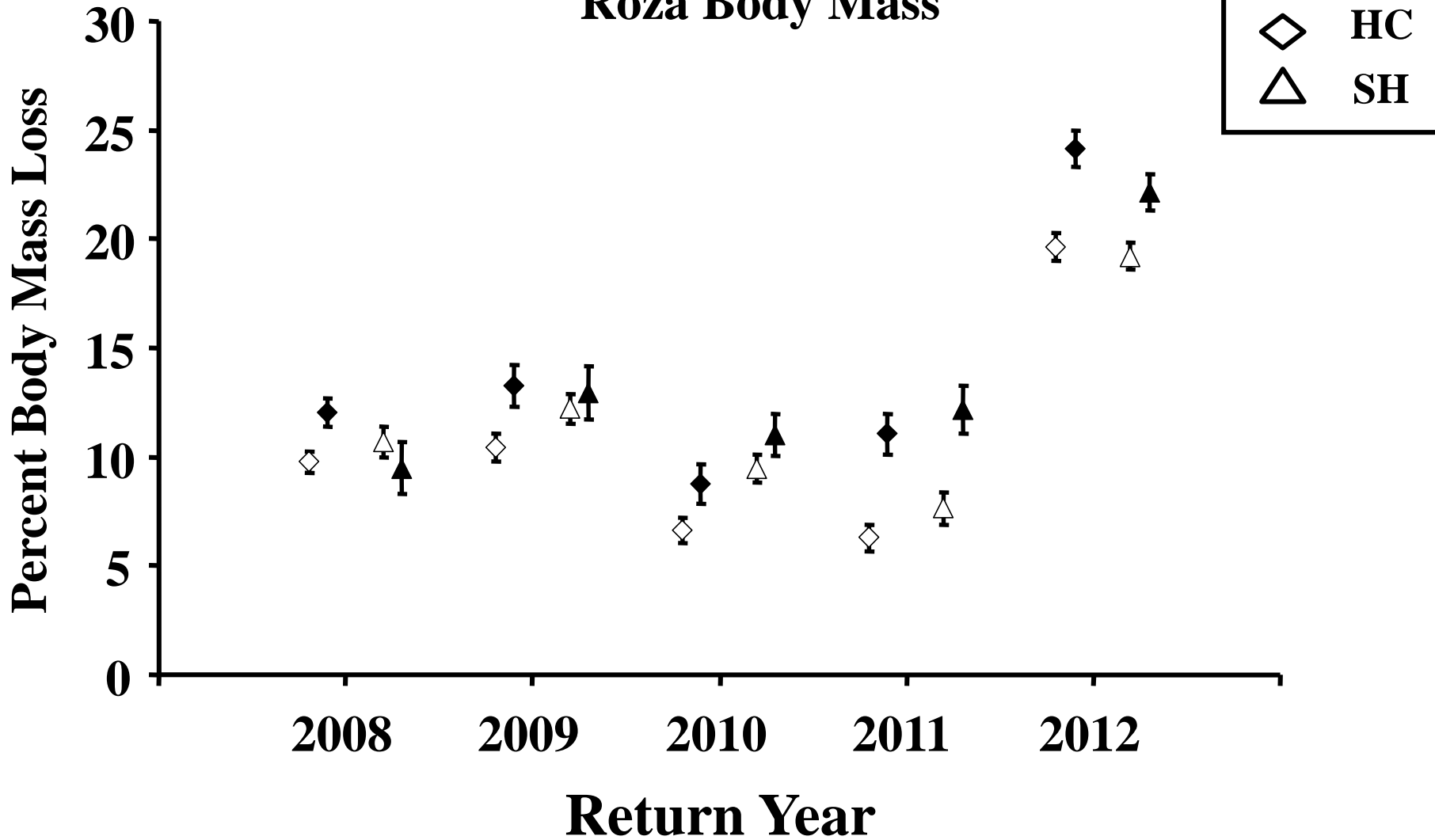
**Means ( $\pm$  1 se) adjusted for:  
Captive Days  
Roza Body Mass**



**Means ( $\pm$  1 se) adjusted for:  
Captive Days  
Roza Body Mass**



**Means ( $\pm$  1 se) adjusted for:  
Captive Days  
Roza Body Mass**



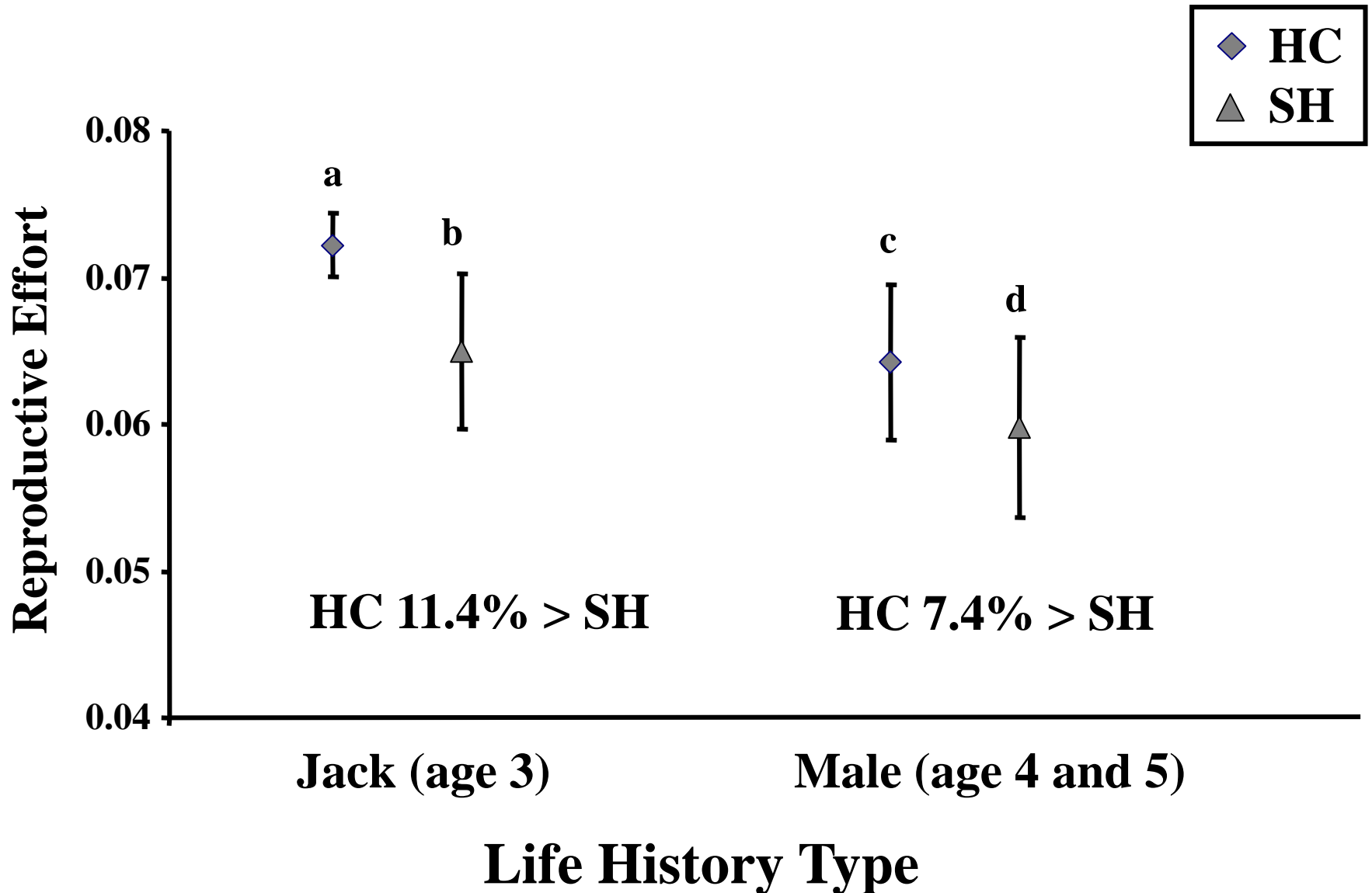
## 3-way ANOVA: Age 4 HC and SH Percent Body Mass Loss 2008-2012

Source	Sum-of-Sq	df	Mean-Sq	F-ratio	P
Return Year	0.054	3	0.018	11.96	<0.001
Origin	0.013	1	0.012	8.29	0.004
Sex	0.040	1	0.040	26.73	<0.001
RY*Origin	0.006	3	0.002	1.38	0.248
RY*Sex	0.016	3	0.005	3.52	0.015
Origin*Sex	<0.001	1	<0.001	0.24	0.622
RY*Origin*Sex	<0.001	3	<0.001	0.07	0.975
Days in Captivity	0.030	1	0.030	20.05	0.001
Roza Body wt	0.002	1	0.002	1.24	0.266
Error	0.663	439	0.002		

# Male Reproductive Effort:

- **Reproductive effort = (weight milt)/(Body mass)**
- **We combined data across years 2003-2012**
- **Comparing SH and HC males**
- **Comparing two categories of male:**
  - **Adult (ages 4 and 5)**
  - **Jack (age 3)**

# Male Reproductive Effort





# **Fat/Lipid Levels 2012**

## **PRELIMINARY RESULTS**

**Measured the fat content (percent fat/lipids) in:**

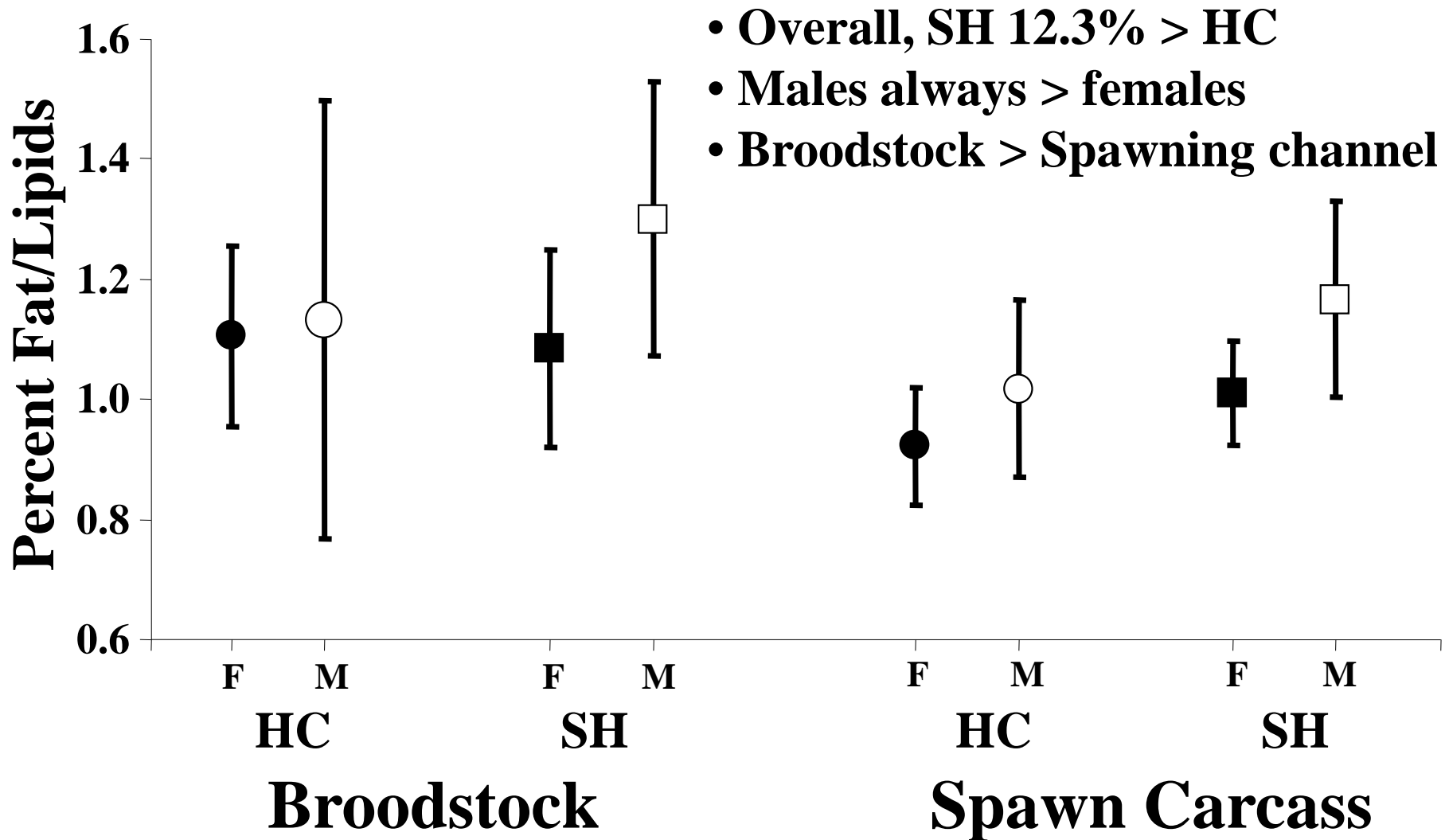
- broodstock on the day of spawning and**
- carcasses of natural spawners from the spawning channel.**

**Device measures the water content in fish tissue based on the impedance of a very low power, high frequency microwave signal.**

**There is a species-specific negative relationship between water content and total lipid content in fish muscle.**

# Fat/Lipid Level Means (+ 1 sd)

## 2012



# 3-way ANOVA Comparing HC and SH Fat/Lipid Levels 2012

**Type (Channel/Broodstock), Origin (HC/SH), and Sex main effects**

Source	SSq	df	Mean Sq	F-ratio	p
<b>Type</b>	<b>0.332</b>	<b>1</b>	<b>0.332</b>	<b>8.533</b>	<b>0.004</b>
<b>Sex</b>	<b>0.317</b>	<b>1</b>	<b>0.317</b>	<b>8.138</b>	<b>0.005</b>
<b>Origin</b>	<b>0.192</b>	<b>1</b>	<b>0.192</b>	<b>4.940</b>	<b>0.028</b>
<b>Type*Sex</b>	<b>&lt;0.001</b>	<b>1</b>	<b>&lt;0.001</b>	<b>0.002</b>	<b>0.962</b>
<b>Type*Origin</b>	<b>0.011</b>	<b>1</b>	<b>0.011</b>	<b>0.274</b>	<b>0.602</b>
<b>Sex*Origin</b>	<b>0.082</b>	<b>1</b>	<b>0.082</b>	<b>2.098</b>	<b>0.151</b>
<b>Type*Sex*Origin</b>	<b>0.021</b>	<b>1</b>	<b>0.021</b>	<b>0.533</b>	<b>0.467</b>
<b>Error</b>	<b>3.973</b>	<b>102</b>	<b>0.039</b>		

# Summary

- **SH fish were longer than HC in 6 out of last 7 years, heavier in 5 of 7 years.**
- **SH lose a significantly larger percentage of body mass than HC age 4 fish.**
- **HC males allocate significantly more energy toward milt production than SH males.**
- **HC fish had significantly lower mean fat/lipid levels at spawning than SH fish in 2012.**

# Acknowledgements

**Charlie Strom, Vernon Bogar, DJ Brownlee, Greg Strom, Simon Goudy, and Quinn Jones (CESRF) helped sampled fish and collect eggs.**

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

**WDFW personnel Jamie Schlump, Brian Johnson, Danielle Rockey, Rebecca Powell, and Matt Sizer.**

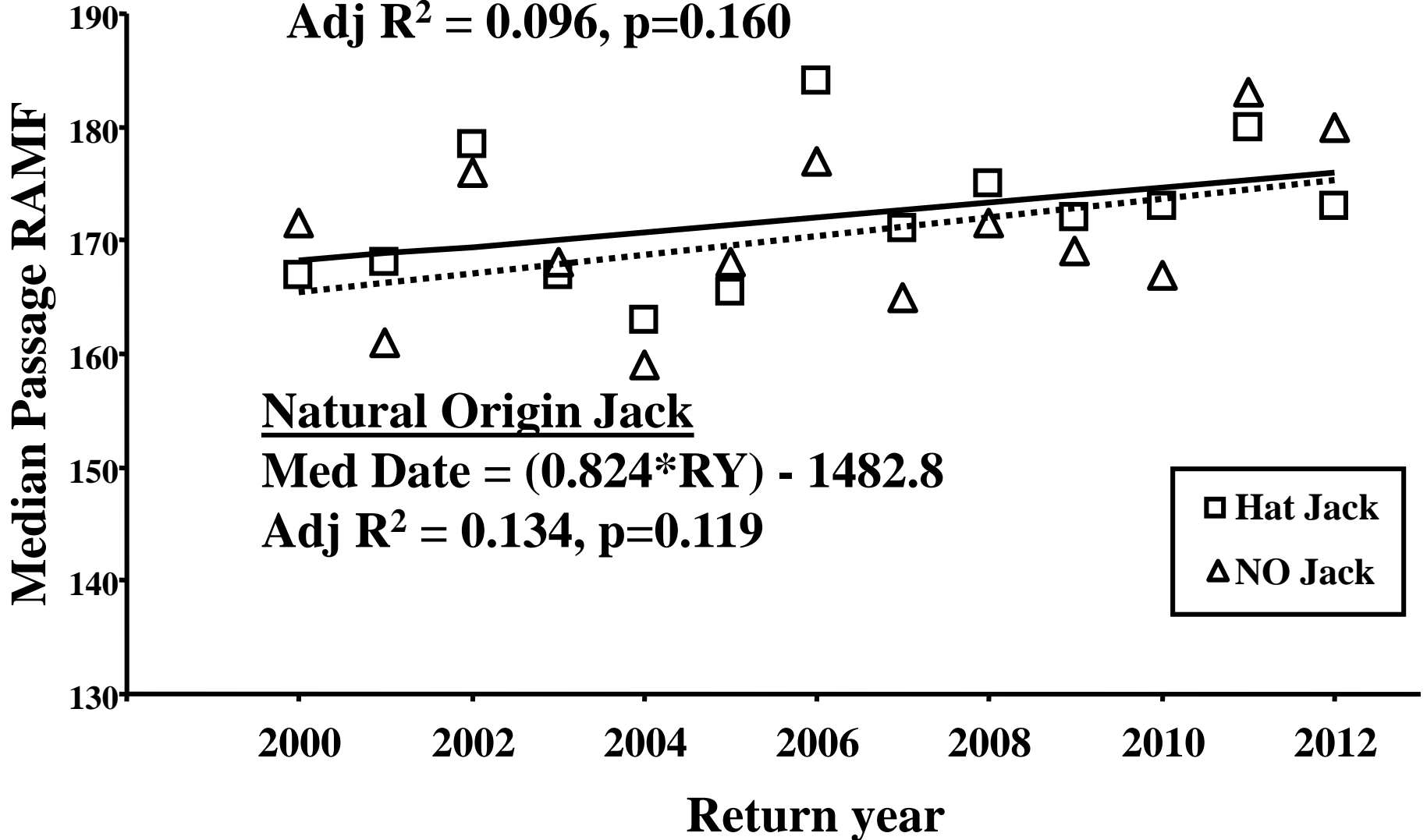
**BPA for funding**



**Hatchery Jack**

**Med Date = (0.651\*RY) - 1134.0**

**Adj R<sup>2</sup> = 0.096, p=0.160**



**Natural Origin Jack**

**Med Date = (0.824\*RY) - 1482.8**

**Adj R<sup>2</sup> = 0.134, p=0.119**



**Hatchery Adult**

**Med Date = (1.755\*RY) - 3363.6**

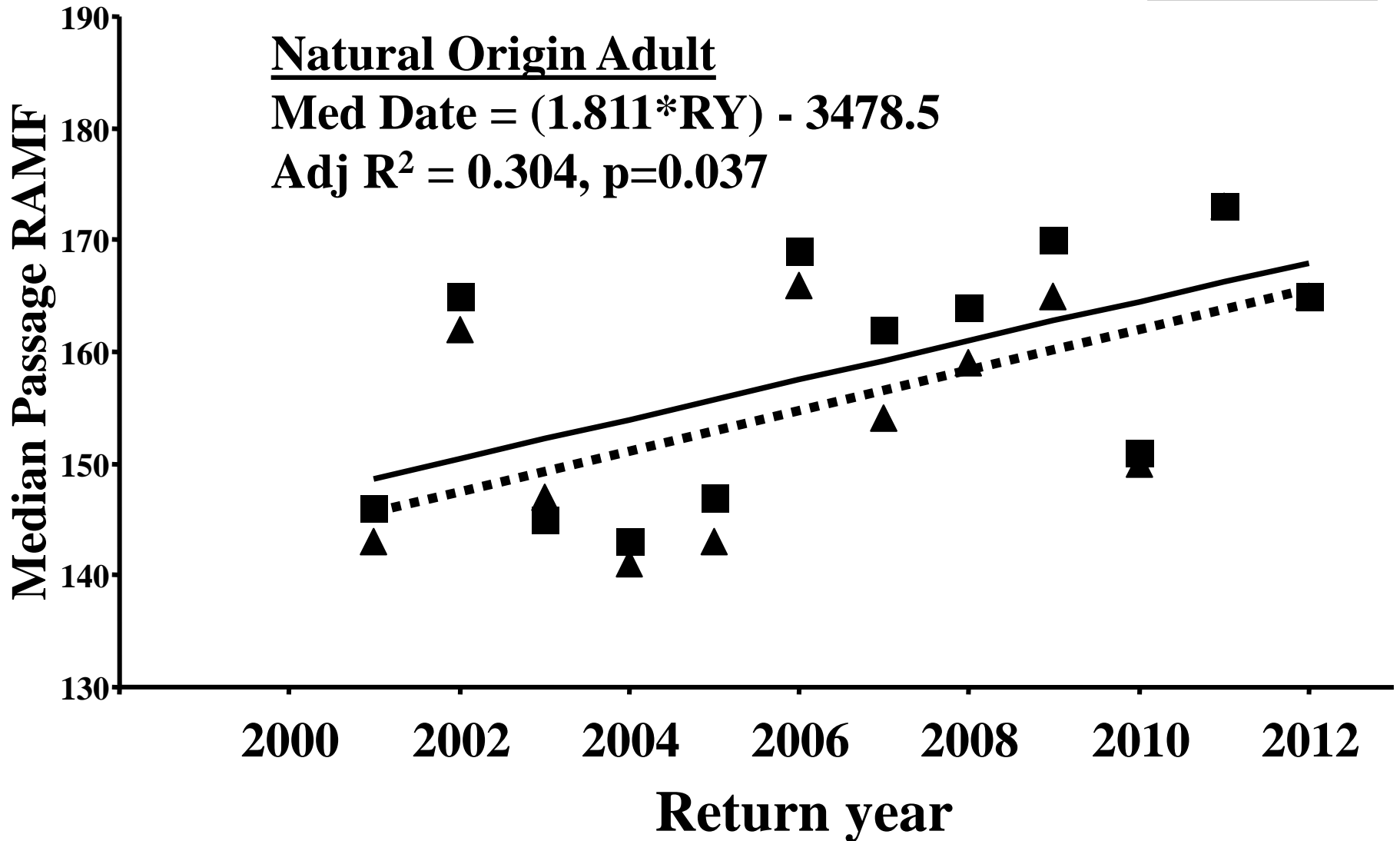
**Adj R<sup>2</sup> = 0.260, p=0.052**



**Natural Origin Adult**

**Med Date = (1.811\*RY) - 3478.5**

**Adj R<sup>2</sup> = 0.304, p=0.037**





# Instantaneous Growth Rate (*IGR*)

