Genetic and Phenotypic Risks of Inbreeding in Chinook Salmon Across Two Hatchery Management Regimes

Charles Waters[1], Jeffrey Hard[2], David Fast[3], Kenneth Warheit[4],
Curtis Knudsen[5], William Bosch[3], and Kerry Naish[1]

[1]School of Aquatic and Fishery Sciences, University of Washington
[2]Northwest Fisheries Science Center, NOAA
[3]Yakama Nation
[4]Washington Department of Fish and Wildlife
[5]Oncorh Consulting

Effectiveness of managed gene flow to reduce genetic and phenotypic risks associated with captive breeding of Chinook salmon

1: Effectiveness of managed gene flow in reducing genetic divergence associated with captive breeding

2: Evaluate effects of managed gene flow on trait-linked loci

3: Genetic and phenotypic risks of inbreeding in hatchery and wild populations of Chinook salmon

4: Characterize genetic and phenotypic differences in disease resistance between integrated and segregated populations of Chinook salmon

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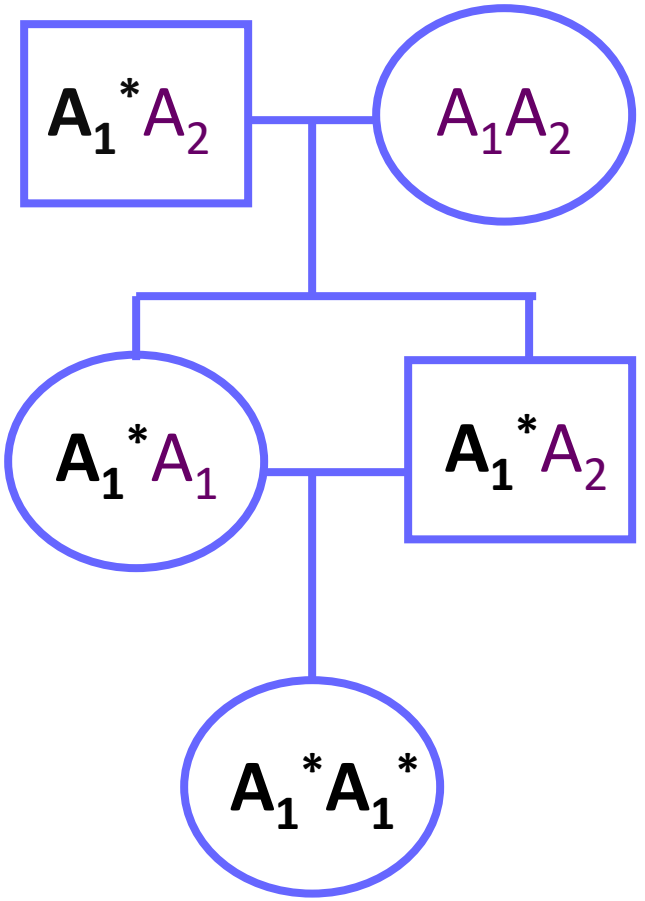
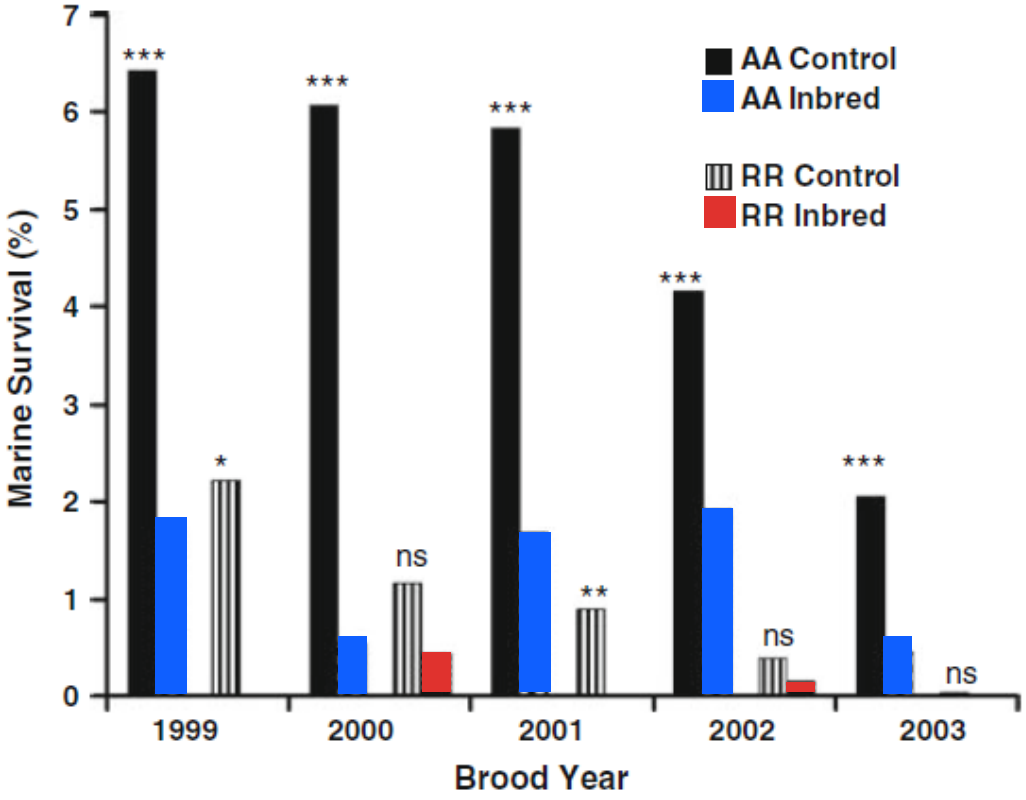
Inbreeding

- The mating of related individuals
- *F - "the probability that both alleles at a locus are identical by descent"*
- More likely to occur in small populations



Inbreeding depression (IBD)

- A reduction in fitness due to inbreeding



Inbred steelhead and rainbow trout had 71% and 89% reduced marine survival compared to controls (Thrower and Hard 2009)

Risks of Inbreeding in Chinook

Aim: To quantify genetic, phenotypic, and demographic effects of inbreeding in hatchery and supplemented wild populations of Chinook salmon

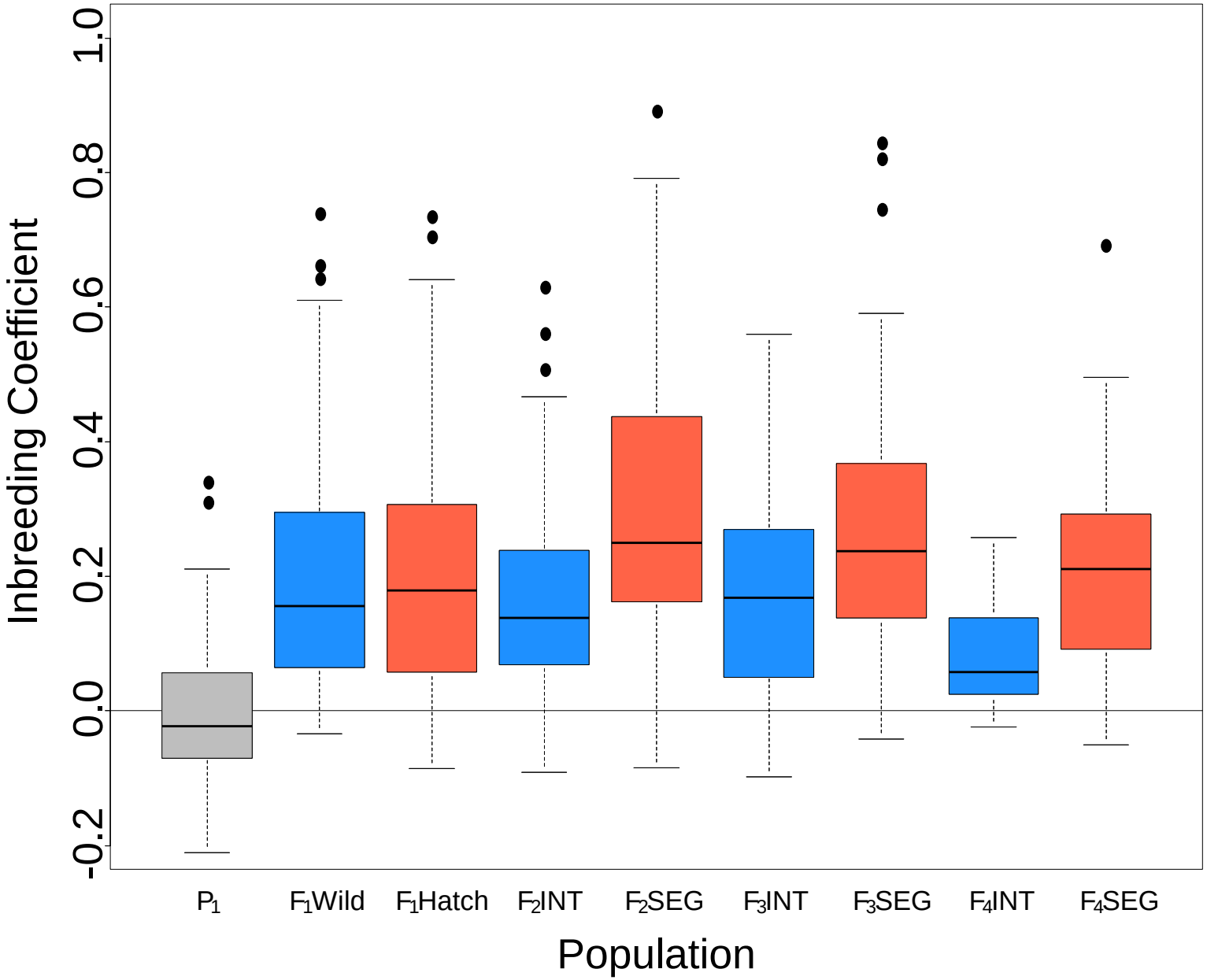
Objectives:

1. Estimate inbreeding coefficients in the wild founders and four generations of the segregated and integrated hatchery lines

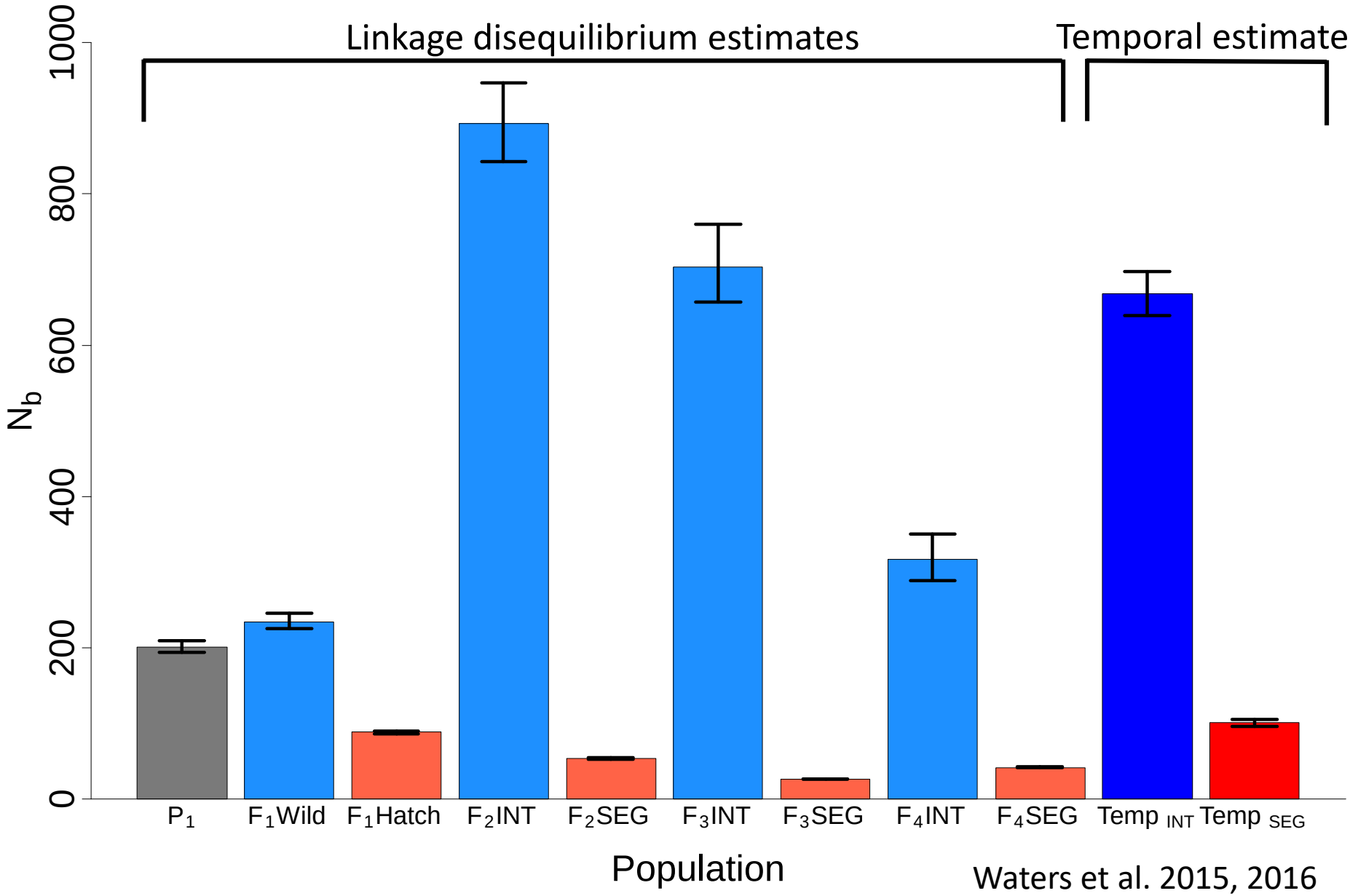
2. Quantify the effect of inbreeding on fitness traits

3. Build an Integral Projection Model (IPM) to determine how inbreeding depression affects productivity in supplemented wild populations

Inbreeding coefficients using 5,328 loci

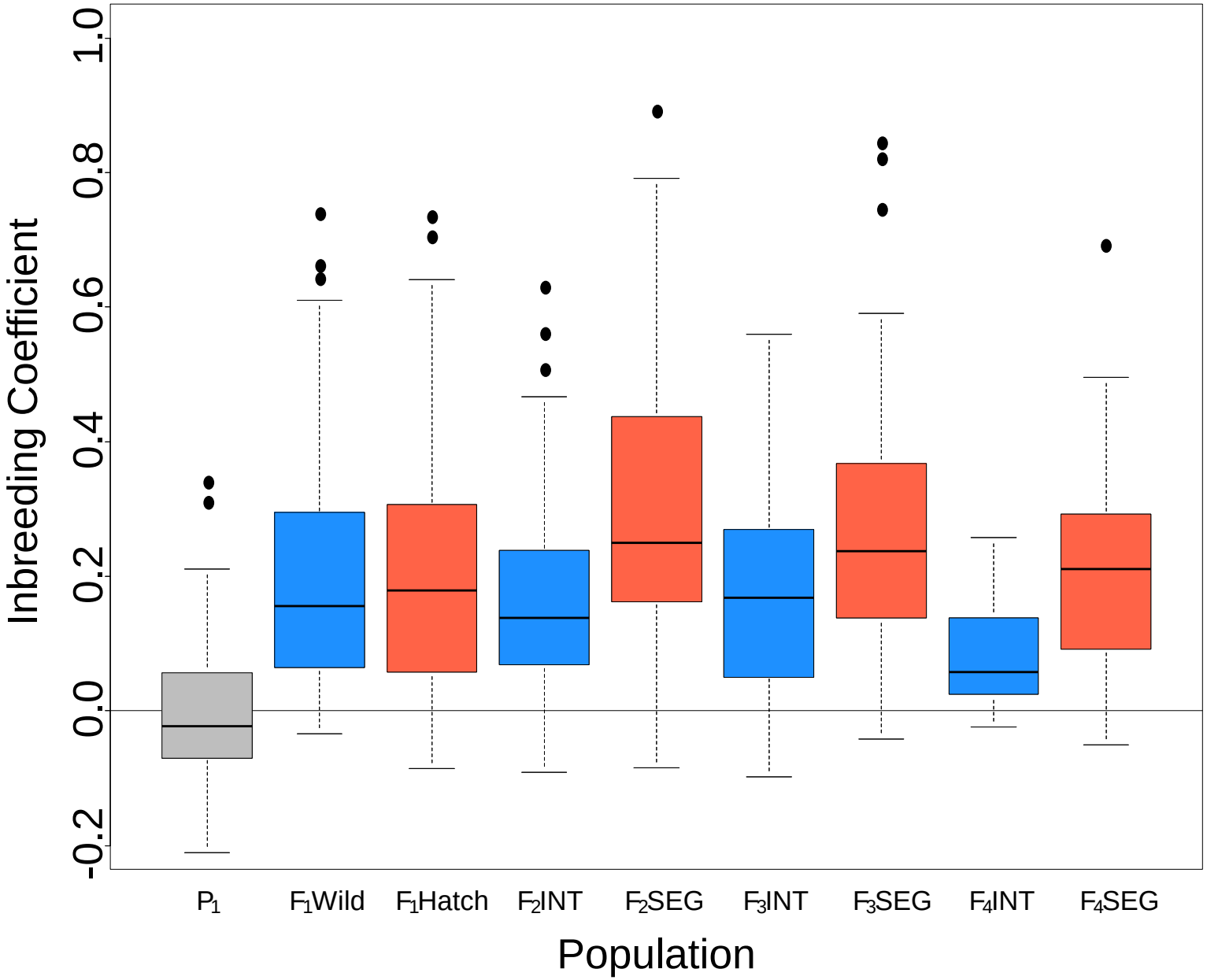


Effective number of breeders, N_b

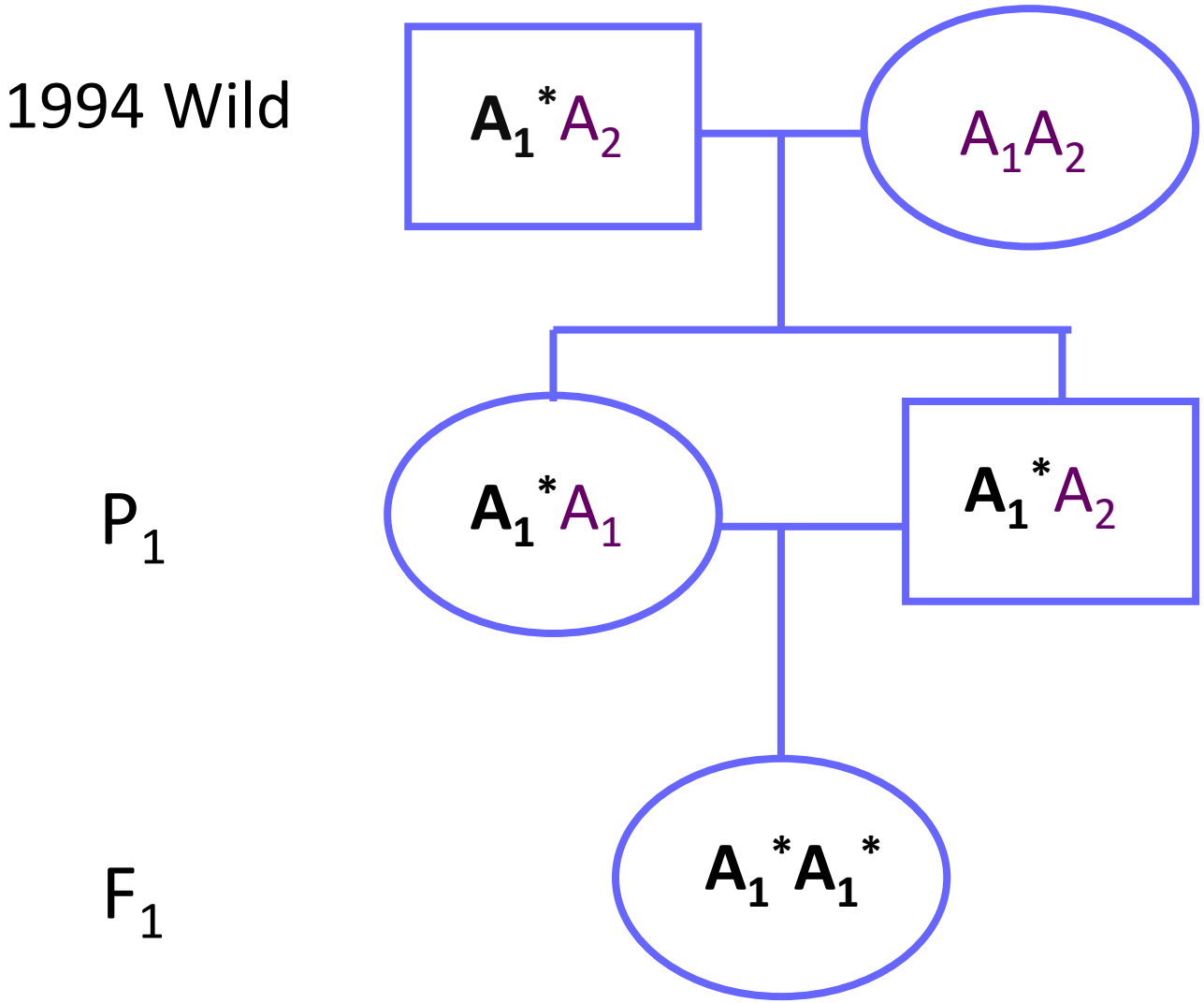


Waters et al. 2015, 2016

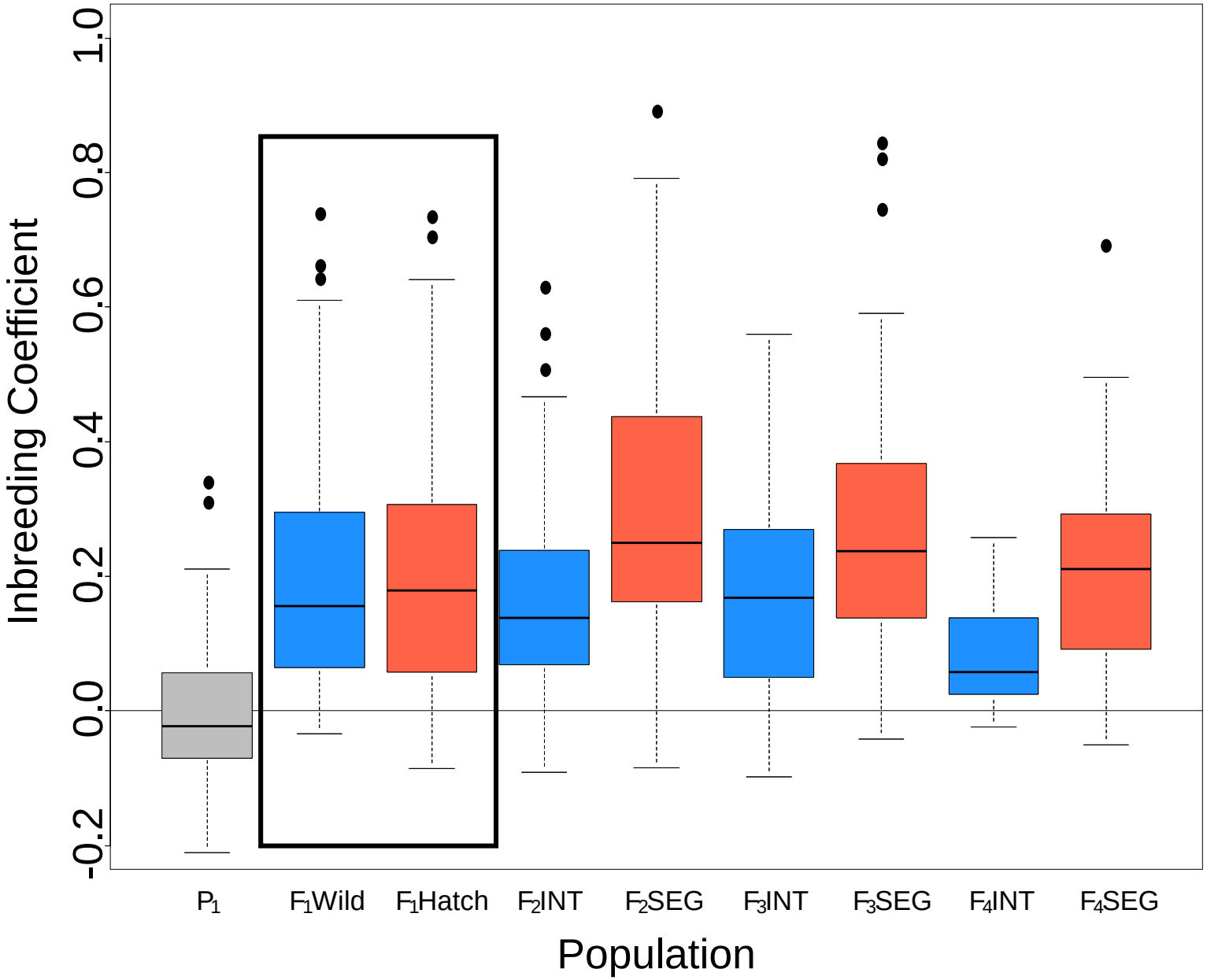
Estimates of Inbreeding Coefficients

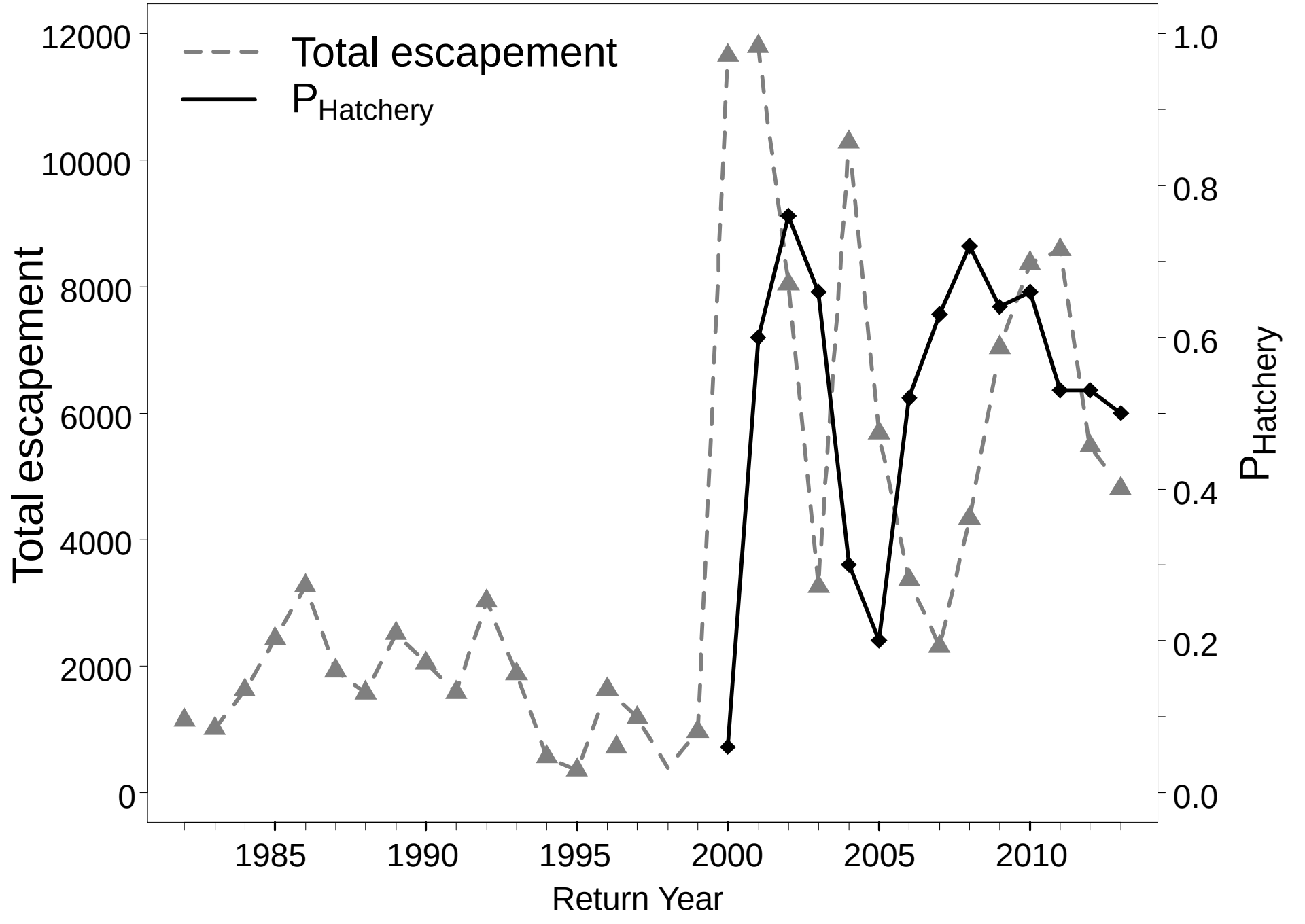


Generational Lag of Inbreeding Coefficients

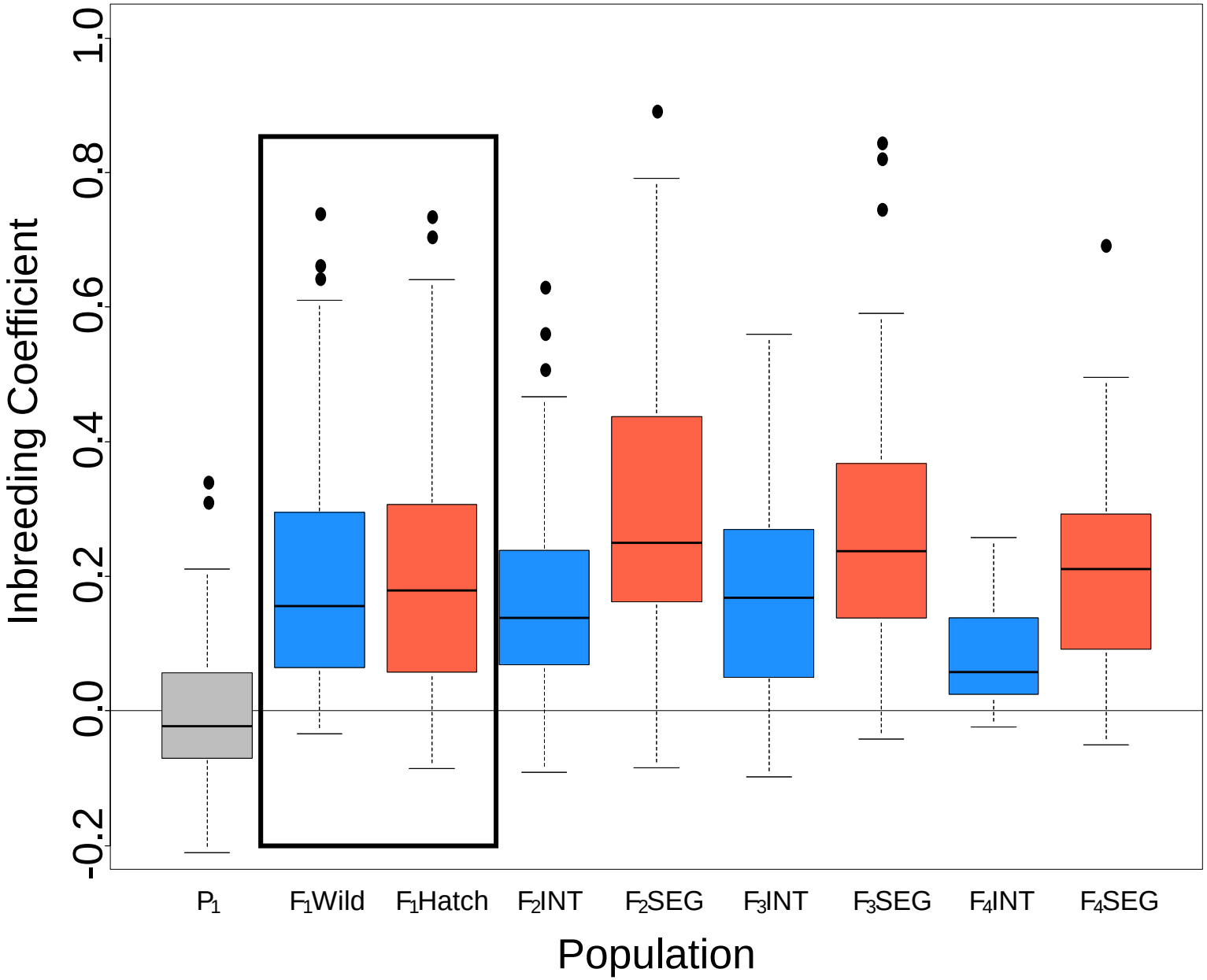


Estimates of Inbreeding Coefficients




Total escapement
P Hatchery
12000
10000
8000
6000
4000
2000
0
Total escapement
1.0
0.8
0.6
0.4
0.2
0.0
P Hatchery
1985
1990
1995
2000
2005
2010
Return Year

Estimates of Inbreeding Coefficients



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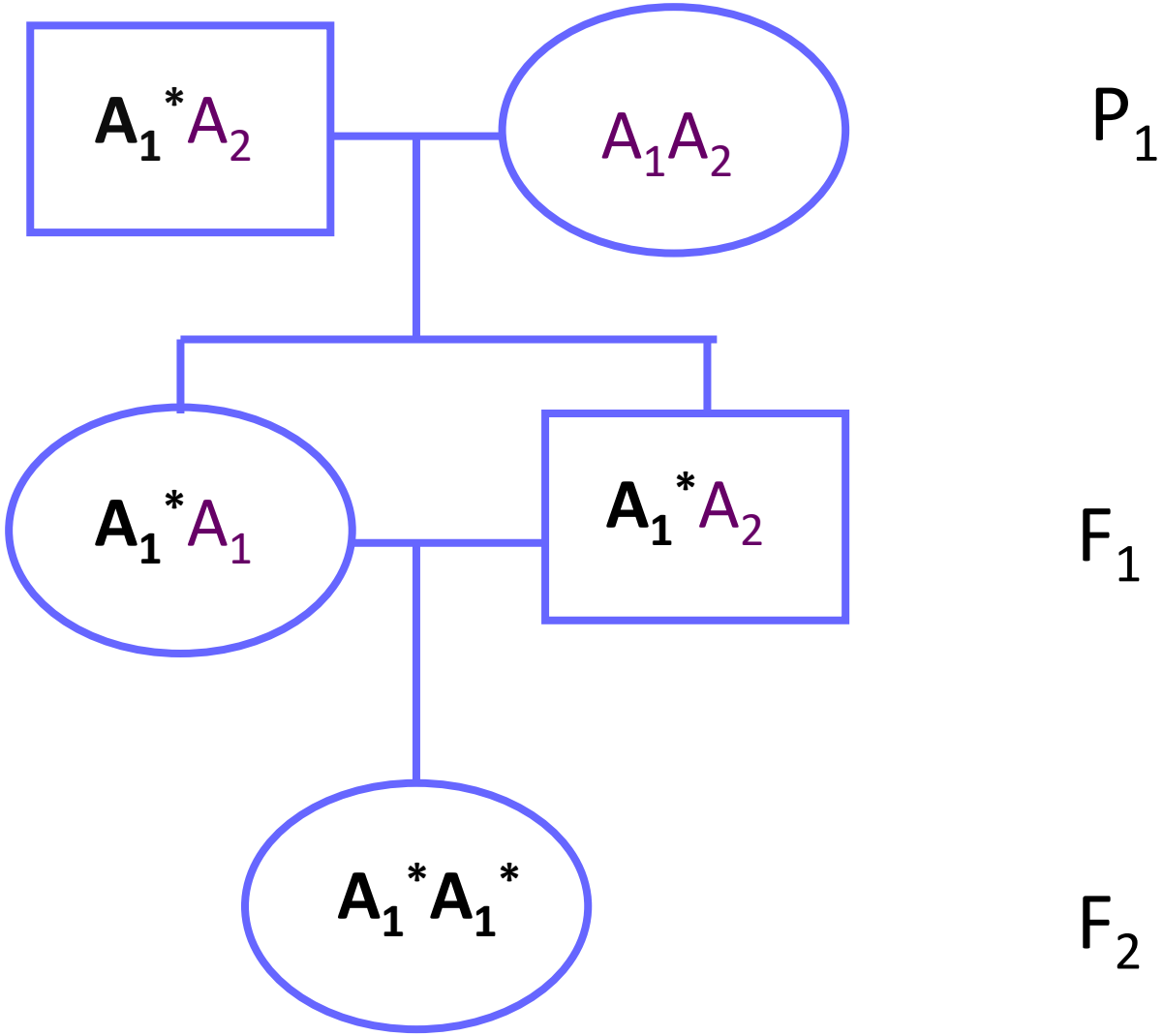

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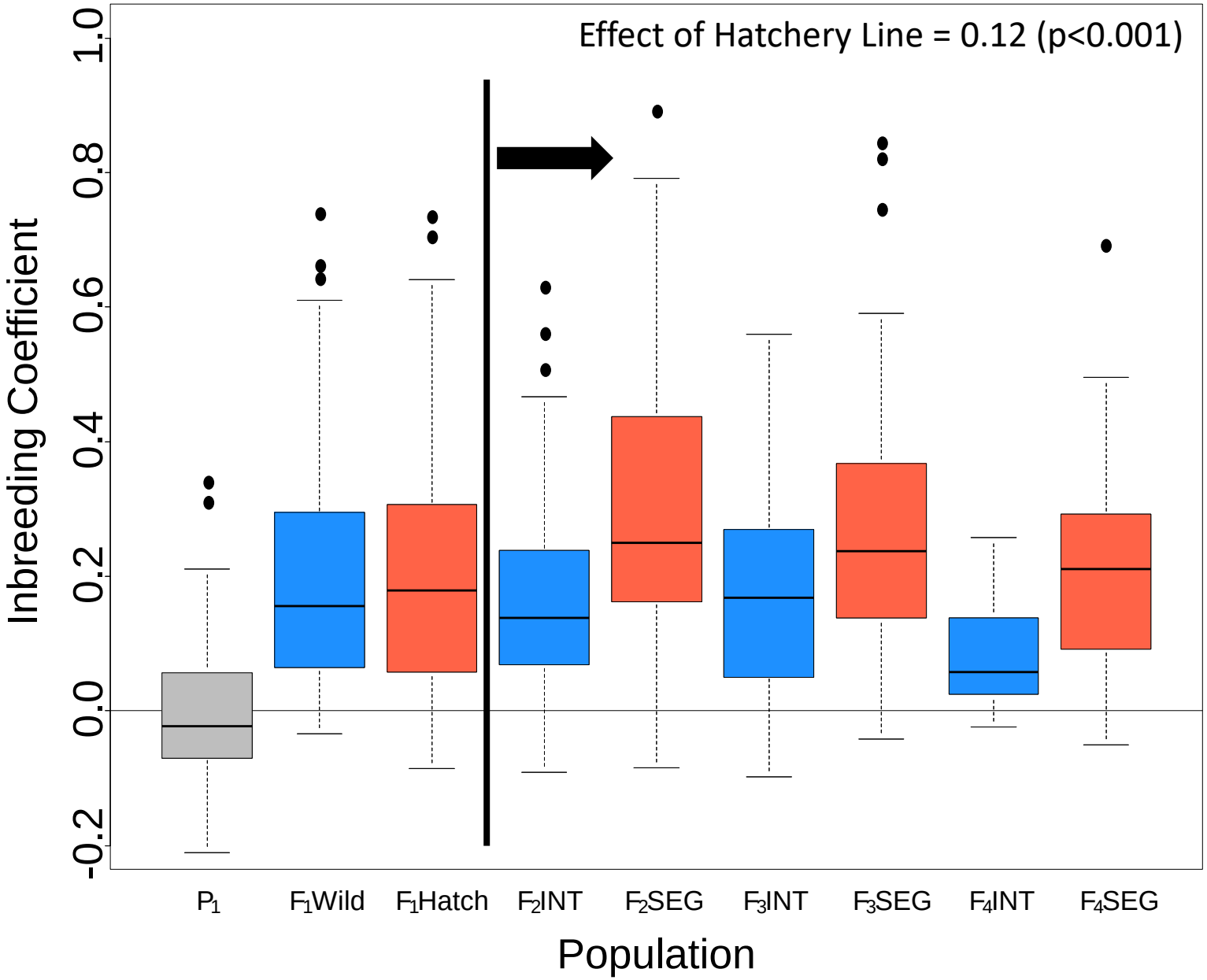
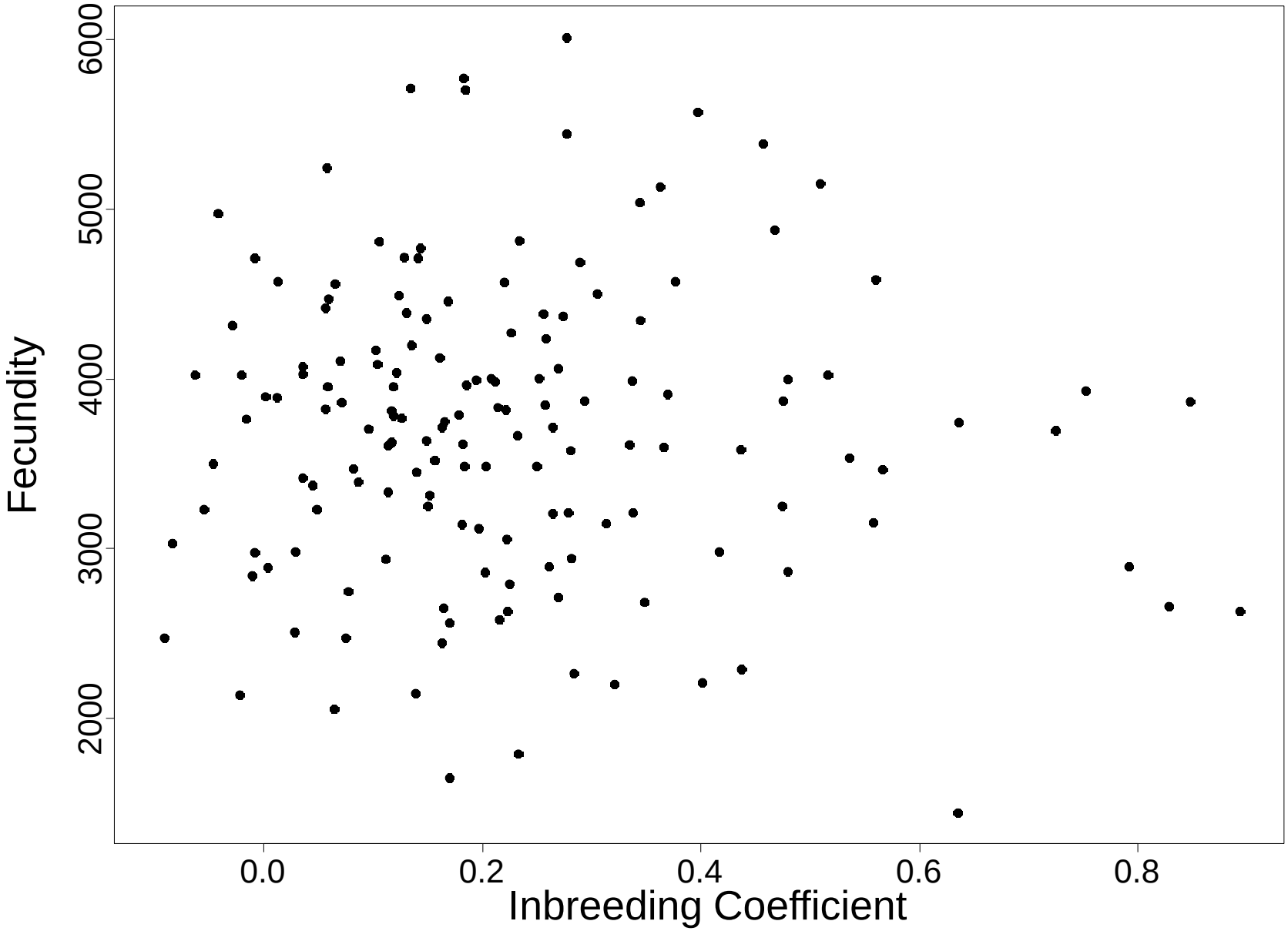


Effects of Inbreeding on Fitness



Effects of Inbreeding on Fitness

No correlation of inbreeding with:

- Return time to Roza
- Spawn time
- Forklength
- Weight
- Condition factor
- Fecundity
- Reproductive effort

Quantifying Risks to Productivity

Aim: To understand how inbreeding affects the fitness and productivity of supplemented wild populations

Objectives:

1. Build an Integral Projection Model (IPM) using four functions to link genetics and phenotypic variability to demographic processes:
   - Survival $S(t,z,f)$ = probability that an individual with trait value z and inbreeding coefficient f at time t survives to $t+1$
   - Growth $G(t,z'|z,f)$ = probability that individual with z and f at time t will shift to any z' at time $t+1$
   - Recruitment $R(t,z,f)$ = number of offspring that an individual with z and f produces from time t to time $t+1$
   - Inheritance $I(t,z',f'|z,f)$ = probability that an individual with z and f at time t produces an offspring of trait value z' and inbreeding coefficient f' at time $t+1$
2. Conduct sensitivity analyses to quantify the importance of each parameter and function to population growth rate.

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Questions: cwaters8@uw.edu

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