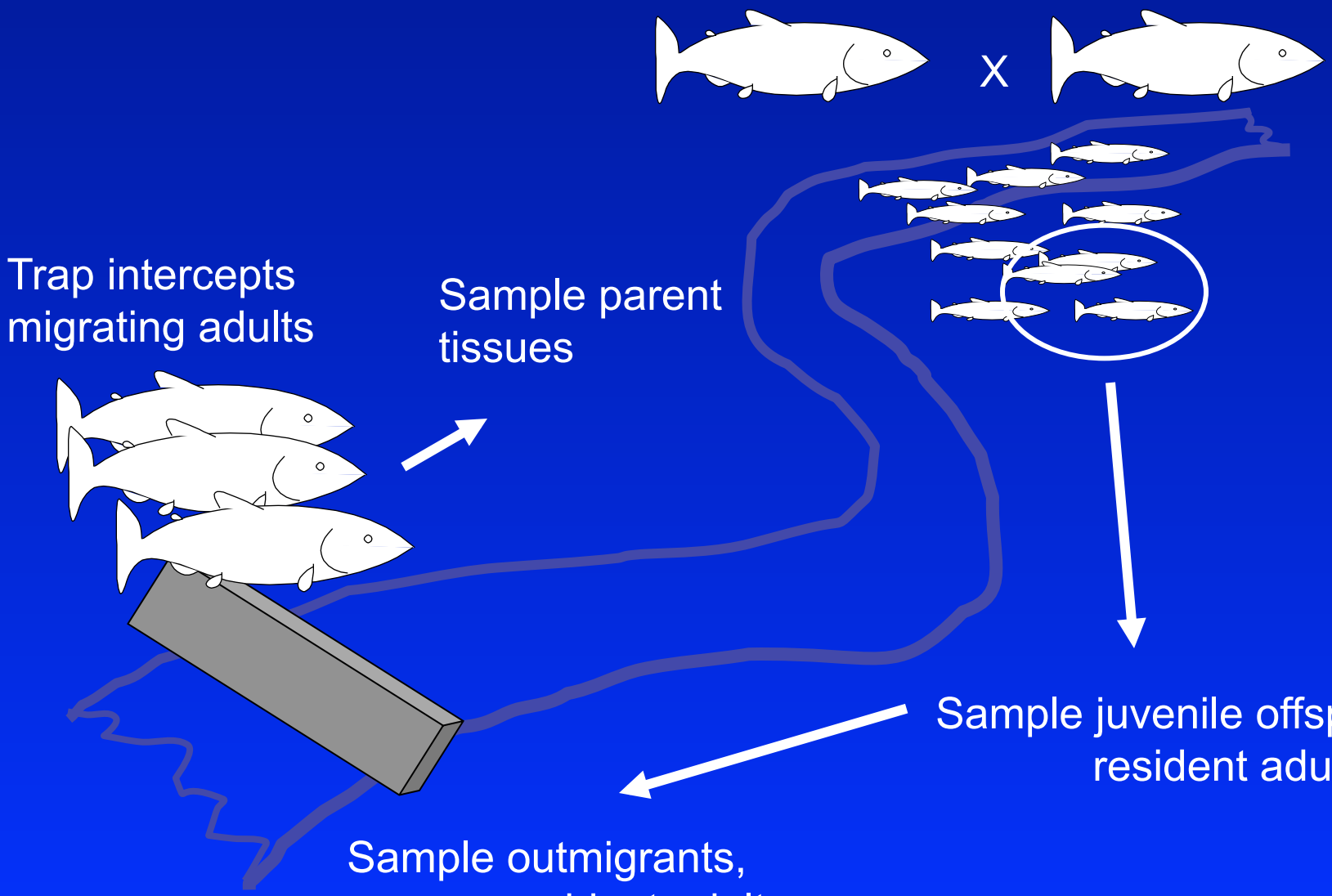
Relative Reproductive Success of Hatchery and Natural Origin Steelhead in Little Sheep Creek

Ewann Berntson[1], Richard Carmichael[2], Robin Waples[1], Eric Ward[1], Paul Moran[1]

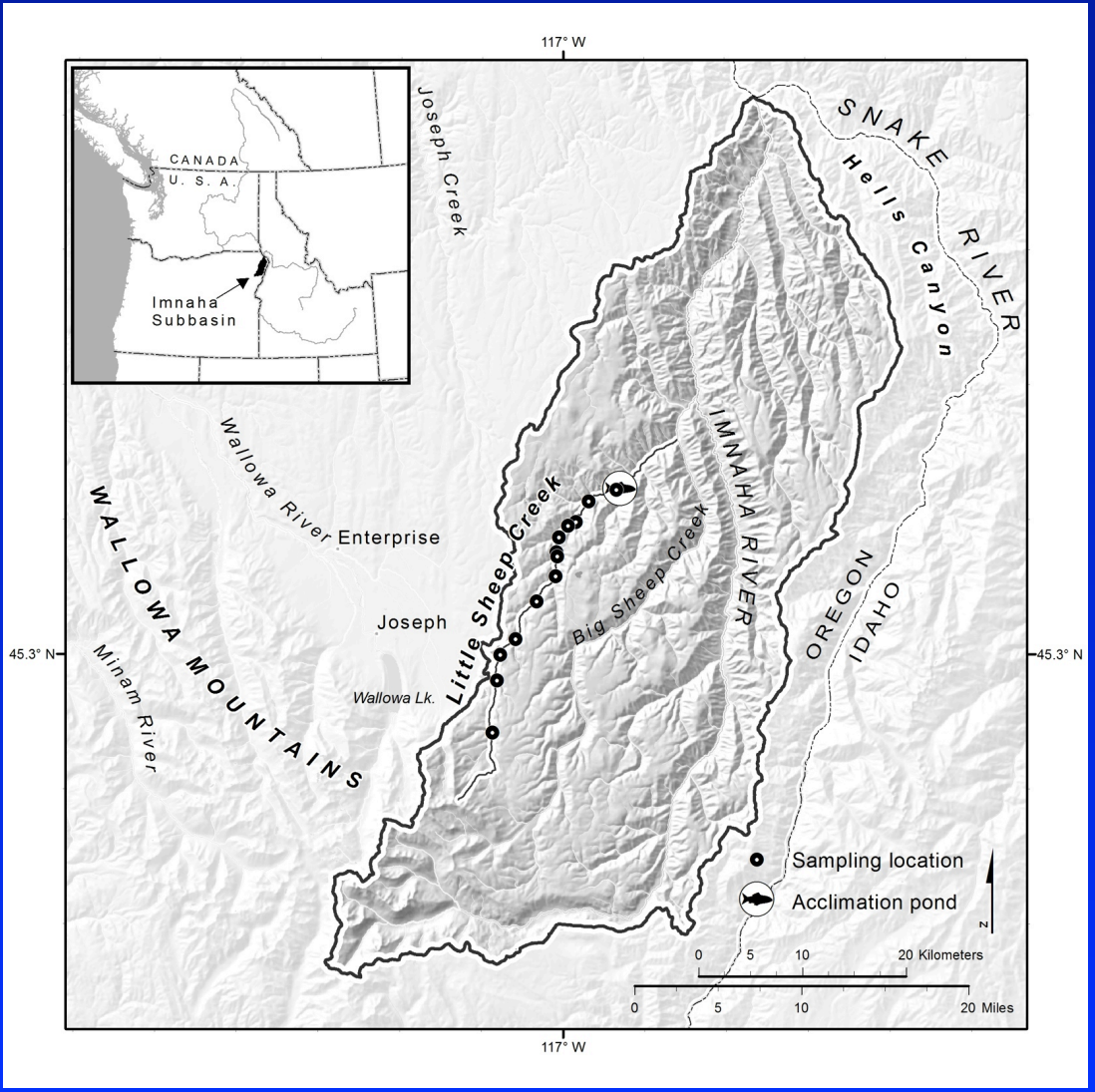
[1] National Marine Fisheries Service, Northwest Fisheries Science Center
[2] Oregon Department of Fish and Wildlife

Little Sheep Creek, Imnaha basin

Pedigree project sampling

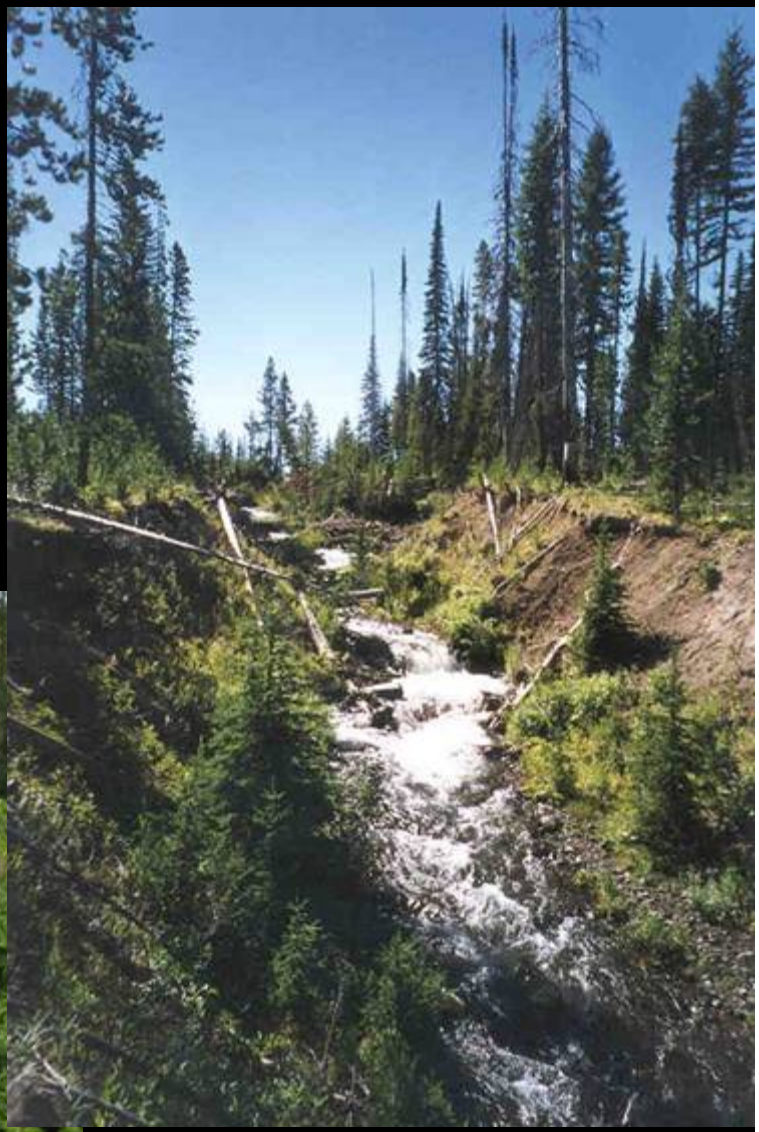


Little Sheep Creek steelhead program



Pedigree analysis

- Genotyped for 15 microsatellites
- Pedigrees reconstructed by exclusion
- Relative Reproductive Success (RRS) calculated
- GLM's compared to determine which factors have the largest effects on RRS



Little Sheep program

- Established 1982, ~6 generations
- Large resident population
- Local broodstock, new influx each year

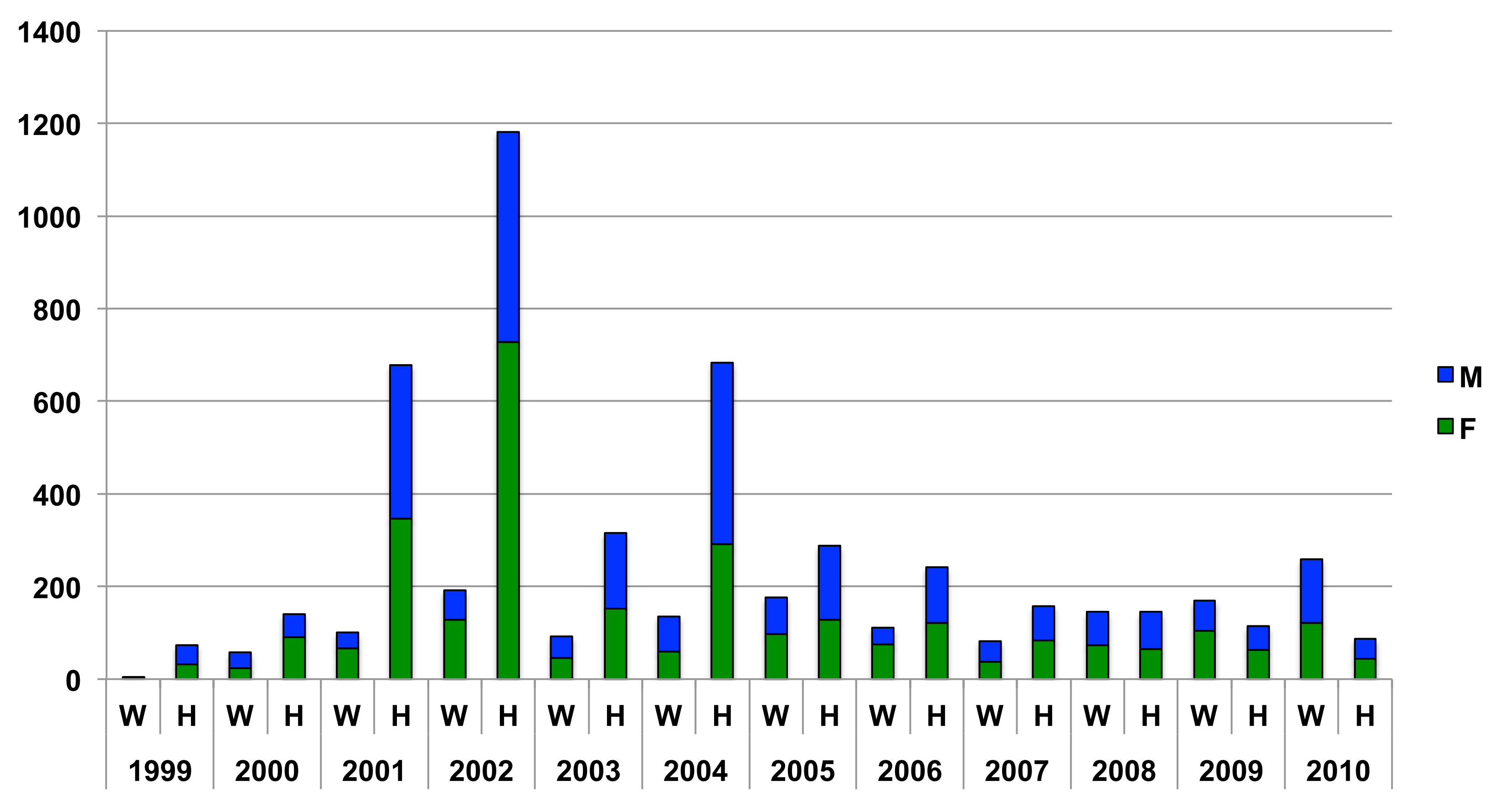
Year	# Broodstock	% Wild
2000	218	13
2001	221	13
2002	216	7
2003	174	5
2004	191	5
2005	191	9
2006	164	7
2007	159	8
2008	133	11
2009	133	22
2010	134	40

← "Wild…"

…a note on "wild" hatchery broodstock…

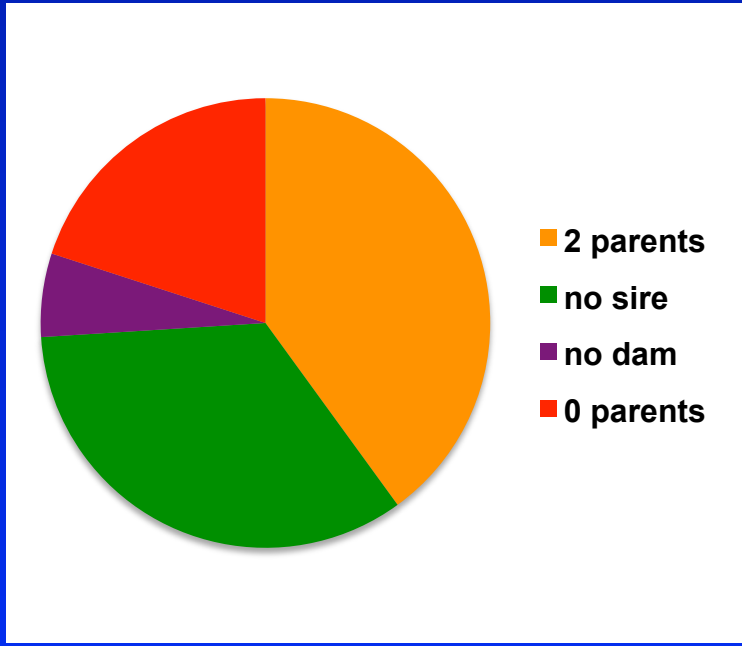
- Analyzed parentage of wild (=unmarked) hatchery broodstock
  - 102 total (55 females, 47 males)
  - Found ≥ 1 parent for 74 of them
  - 2/3 had at least 1 hatchery-origin parent

Little Sheep returning adults passed over the Weir

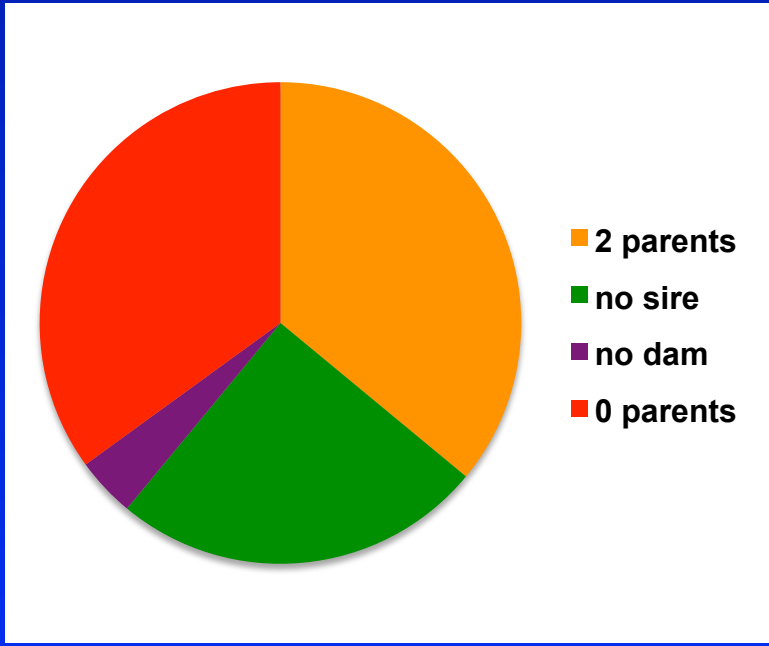


Pedigree matches

Adult to juvenile

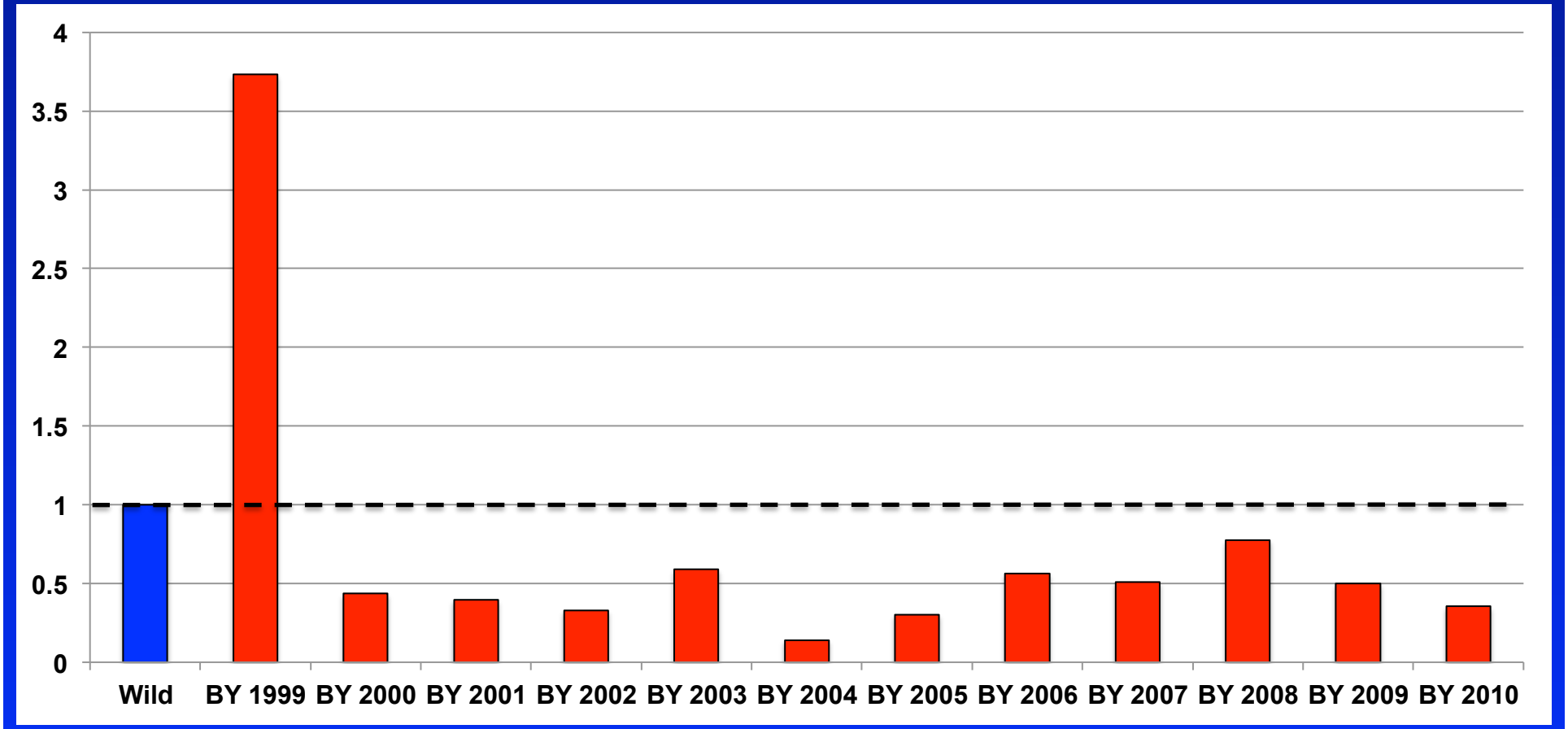


Adult to adult



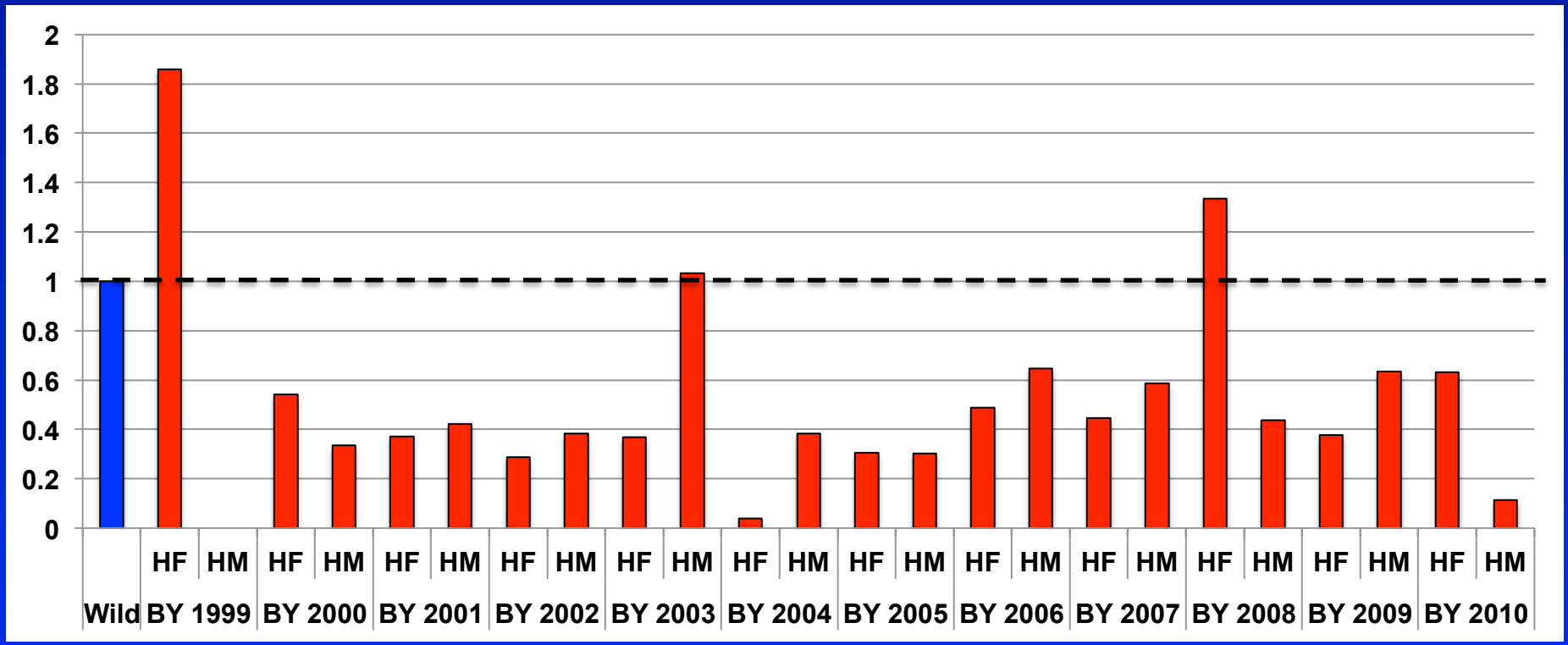
Hatchery vs. Wild RRS

Adult-to-Juvenile (by origin)



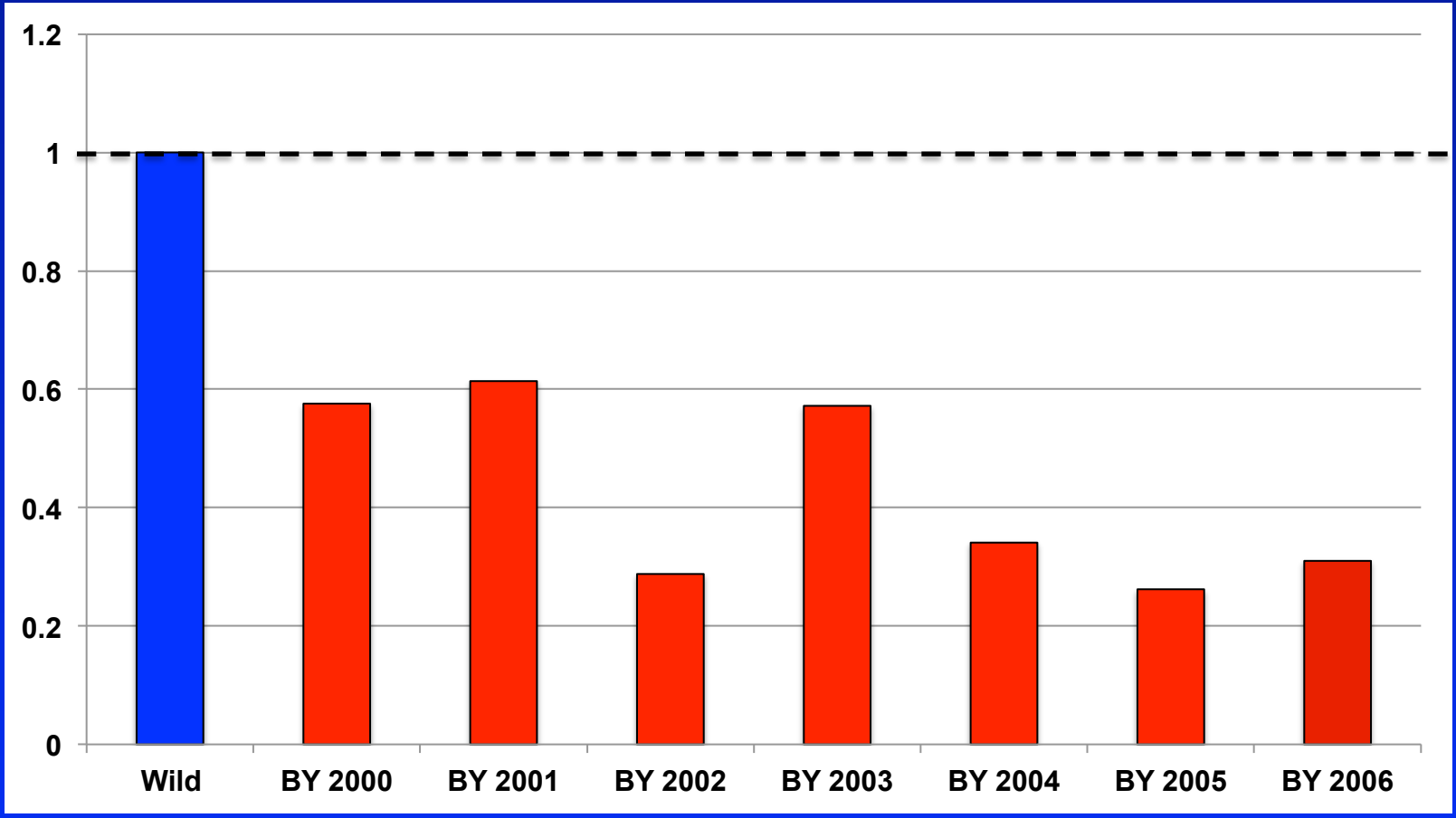
Geomean **= 0.49 (all years)**
= 0.41 (2000-2010)

RRS -- Adult-to-Juvenile (sex/origin)



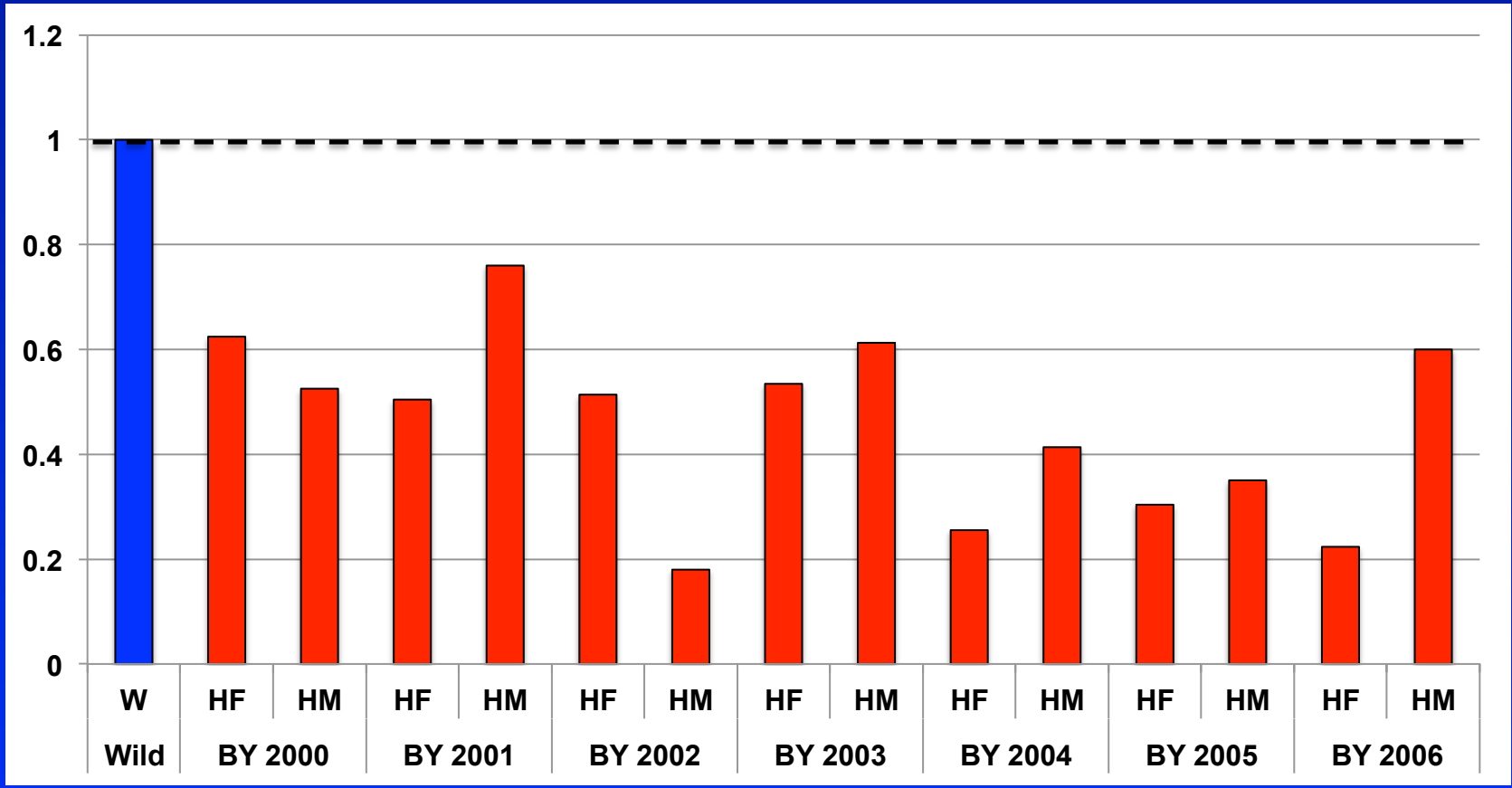
Geomean: **HF = 0.37** **HM = 0.42**

RRS -- Adult-to-Adult (by origin)



Geomean = 0.40

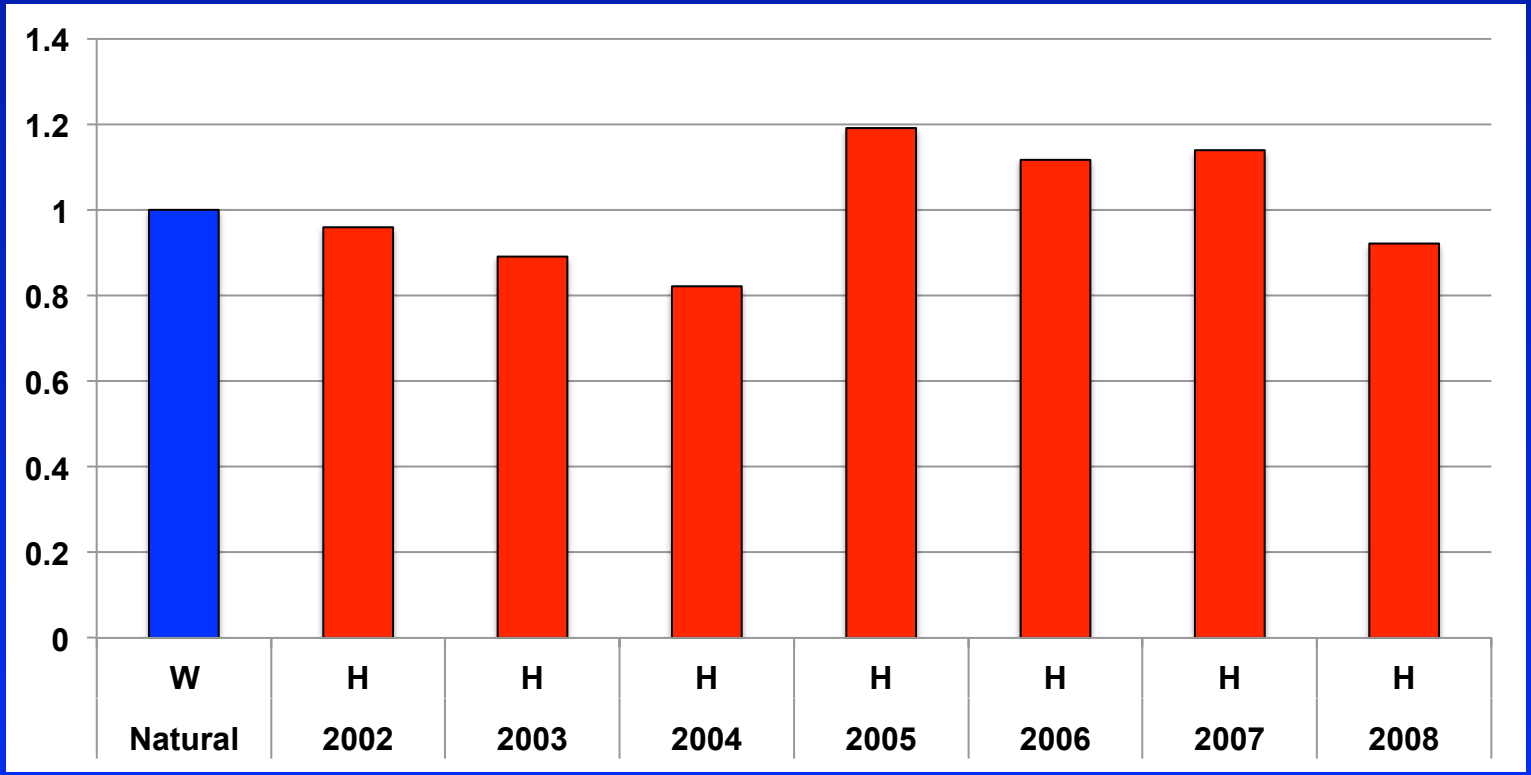
RRS -- Adult-to-Adult (by sex/origin)



Geomean: **HF = 0.40** **HM = 0.45**

Catherine Creek Chinook RRS

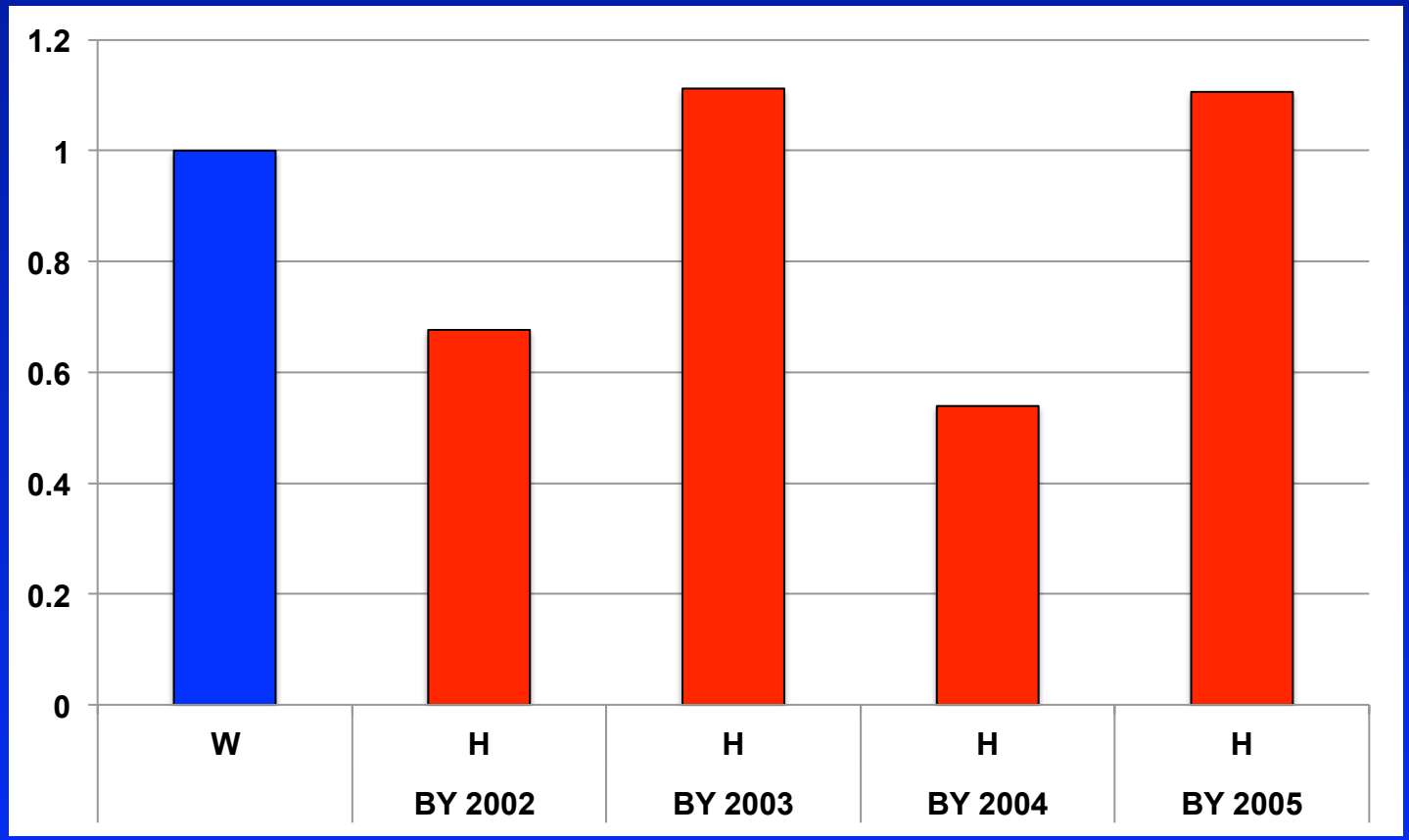
(by Origin—juvenile offspring)



Geomean H = 0.997

Catherine Creek Chinook RRS

(by Origin—adult offspring)



Geomean hatchery = 0.818

GLM analysis
(Adult to adult)

- Factors considered:
  - sex
  - origin (H vs. W)
  - date of return
  - length
  - density

GLM analysis
(Adult to adult)

- Factors considered:
  - sex
  - **origin (H vs. W)**
  - date of return
  - **Length**
  - **density (same-sex competitors)**

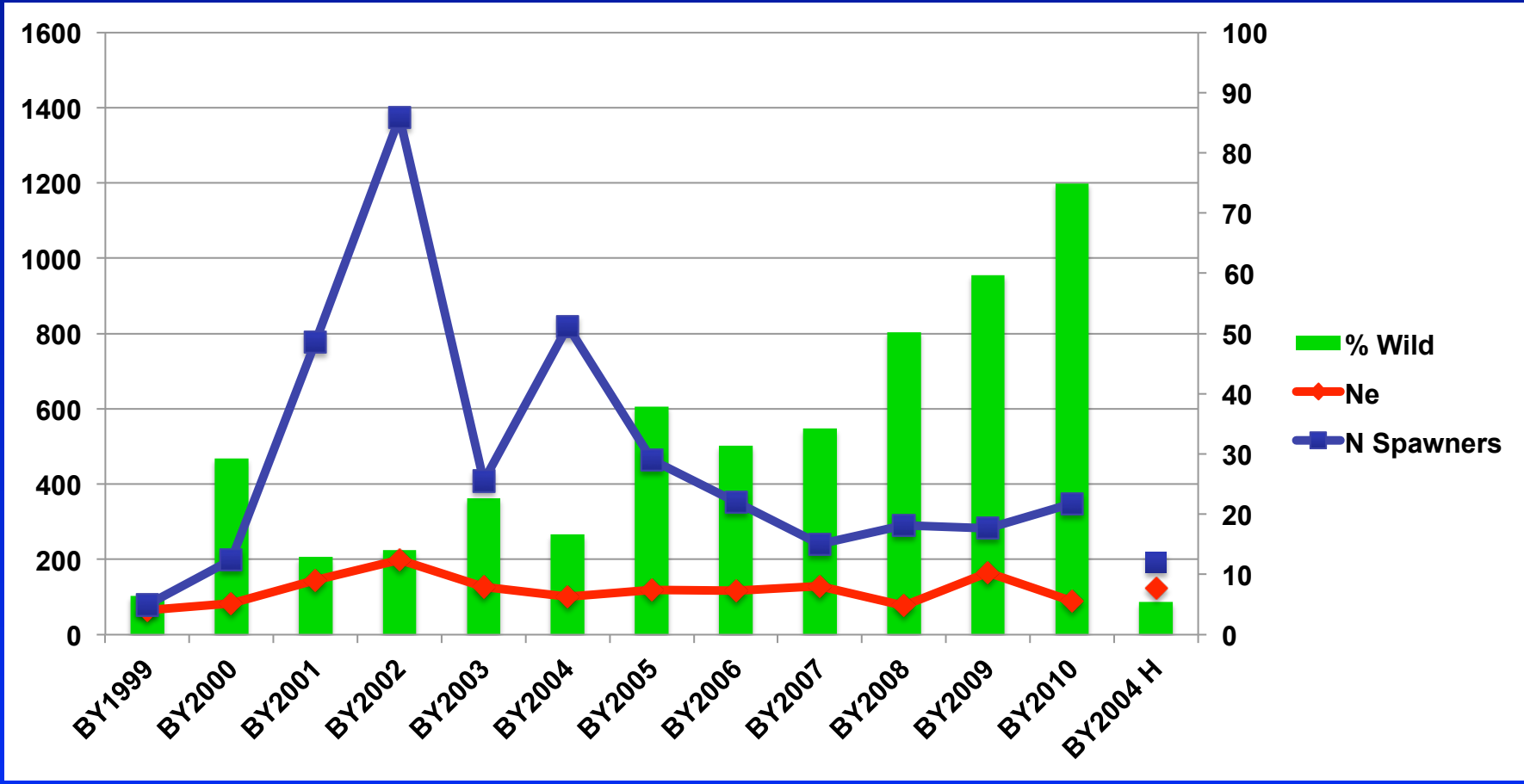
GLM results

- Hatchery fish had significantly lower RRS
- Larger fish had significantly higher RRS
- Lower RRS with more same-sex competitors, particularly hatchery fish
  - Wild fish better able to compete with higher numbers of same-sex competitors
  - Males were better competitors than females with higher numbers of same-sex competitors (females are space-limited?)

Potential causes of lowered hatchery reproductive success

- Inbreeding?

Effective number of breeders



Potential causes of lowered hatchery reproductive success

- Inbreeding?
  - Likely not
- Differential survival of parr?
  - Lower RS evident as early as zeros
  - Same lowered RS as returning adults

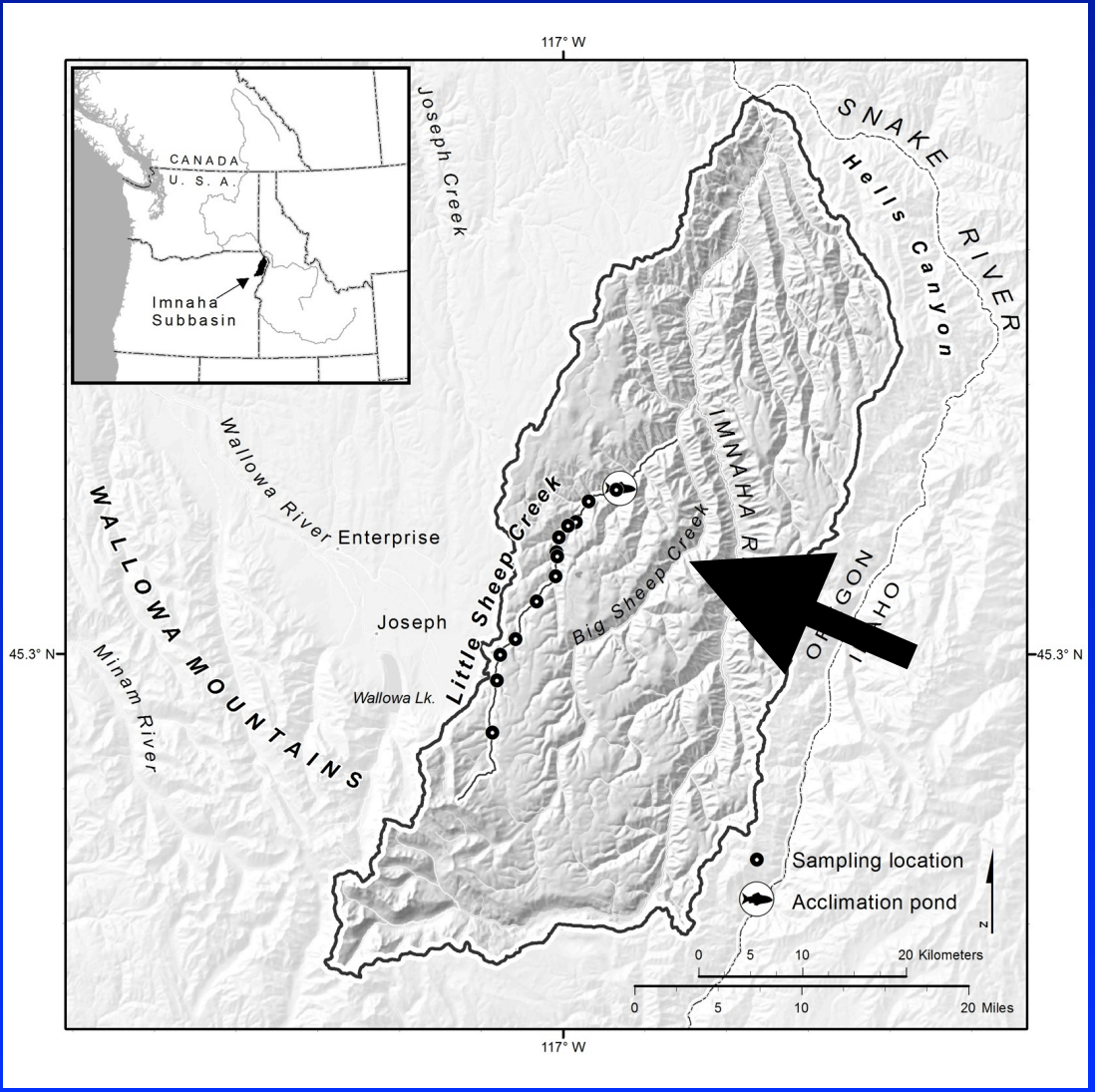
Potential causes of lowered hatchery reproductive success

- Inbreeding?
  - Likely not
- Differential survival of parr?
  - Lowered success as early as zeros
  - Same lowered RS as returning adults
- Changes in life history or behavior?
  - Spawning behavior
  - Spawning location
  - Accelerated rearing programs

Anadromous/Resident Interactions

- Few documented offspring from res x anad parents
  - 43 offspring total (29 parr and 14 adults)
  - Only 1 mating involved residualized hatchery fish
  - Far different from estimated 30% residualized residents
- Large fraction of offspring not matched to two parents
  - Juveniles:
    - 40% with 2 parents
    - 40% with 1 parent
    - 20% no parents
  - Adults:
    - 36% with 2 parents
    - 29% with 1 parent
    - 35% with no parents

Little Sheep Creek steelhead program

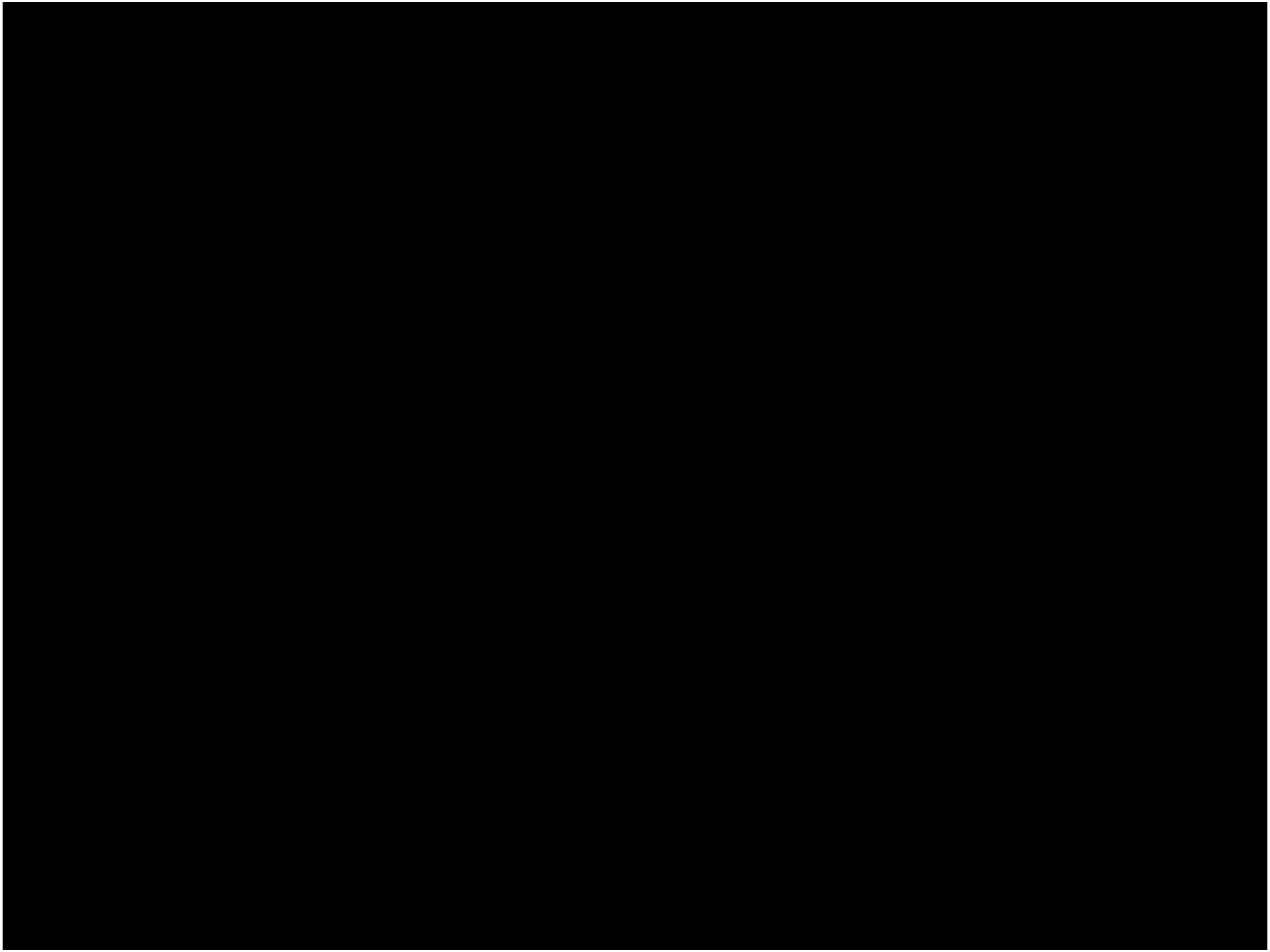


Conclusions from Little Sheep

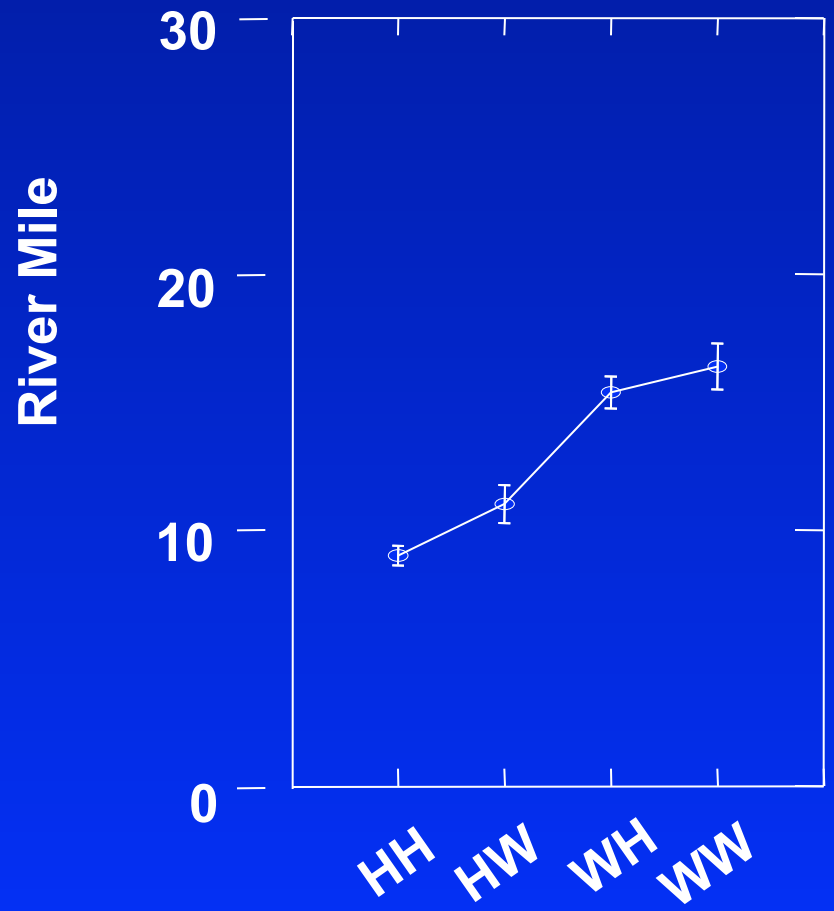
- Hatchery steelhead have significantly lower RRS than wild counterparts in Little Sheep Creek.
  - Hatchery males slightly more successful than hatchery females.
  - Lower hatchery RS seen at both parr and adult stages.
  - Hatchery spawners least able to compete with high numbers same-sex competitors.
  - Females less competative than males with high numbers same-sex competitors (space-limited?).

Acknowledgements

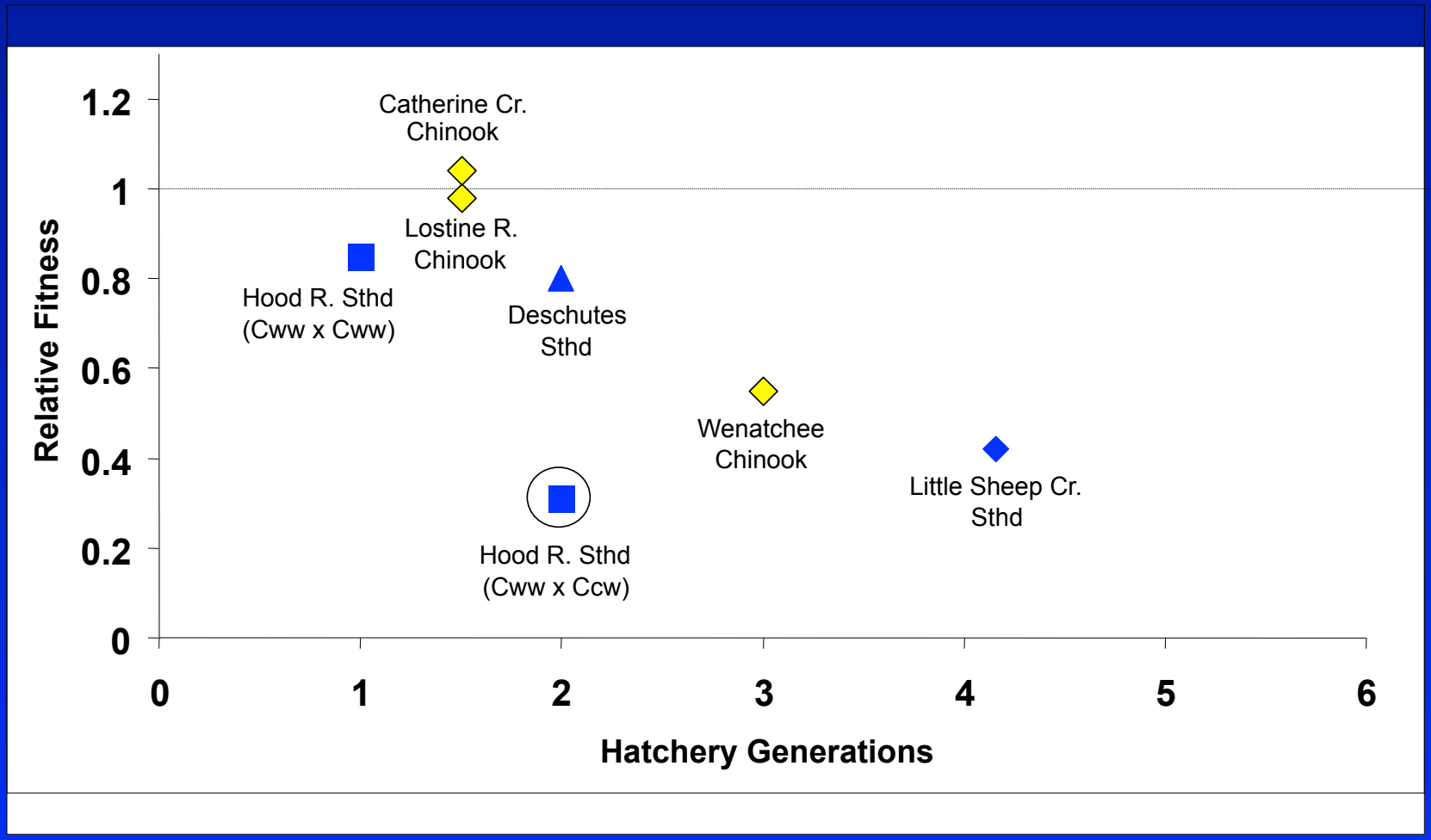
- This project was funded through BPA contract # 198909600
- Sampling, fieldwork and encouragement by ODFW



Spawning location vs. parental cross



Supplementation programs in the Columbia River basin



Triangles = egg-to-parr/smolt, **Diamonds** = adult-to-parr/smolt, **Squares** = lifetime

Species: ***Dark blue*** = steelhead, ***yellow*** = Chinook