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Intraspecific competition between hatchery & wild anadromous salmonids: rethinking hatchery practices to reduce negative ecological interactions

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Collaborators: WNFH steelhead study

- Chris Pasley & staff of the USFWS WNFH
- Bill Gale, Matt Cooper, Ben Kennedy, & staff of USFWS MCFRO
- Penny Swanson, Don Larsen & Jeff Atkins: NWFSC
- Jon Dickey & Mollie Middleton: UW
- Funding BPA: Project 1993-056-00



Overview

- Intraspecific competition
 - Experimental designs to measure competition
 - Relative competitive ability of hatchery salmonids
 - Meta-analysis of published competition studies
- How knowledge of H x W ecological interactions can inform hatchery management
 - Steelhead program at Winthrop National Fish Hatchery

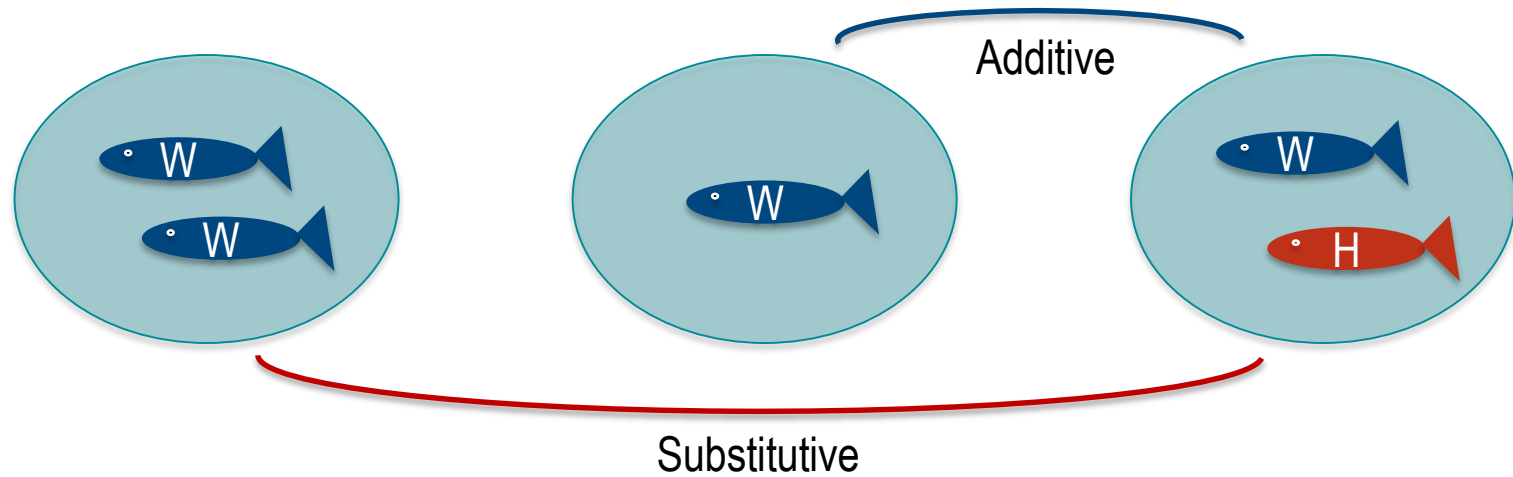


What is intraspecific competition?

- Intraspecific competition occurs when members of the same species attempt to access a common limiting resource.
 - Habitat and/or territories
 - Food
 - Access to mates or spawning sites
- Often stronger than interspecific competition due to 100% overlap of ecological niche for individuals of the same species.



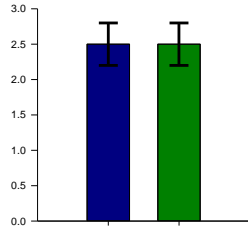
Experimental designs to measure competition



- Additive: Density different among treatments – measures effect of competition
- Substitutive: Density constant among treatments – measures relative competitive ability

Interpretation of substitutive design results

1



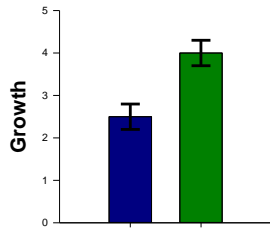
Outcome

$$H = W$$

Relative competitive ability

$$= 1$$

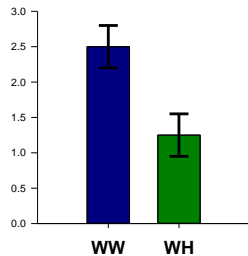
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$$H < W$$

$$< 1$$

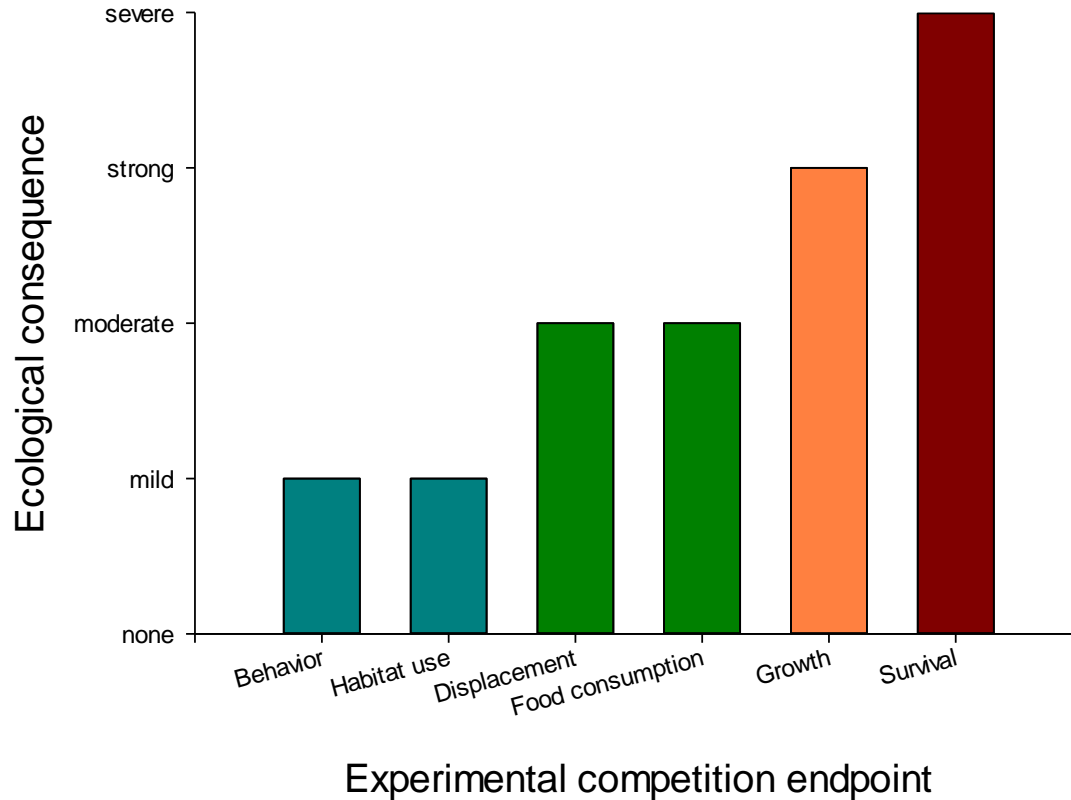
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$$H > W$$

$$> 1$$

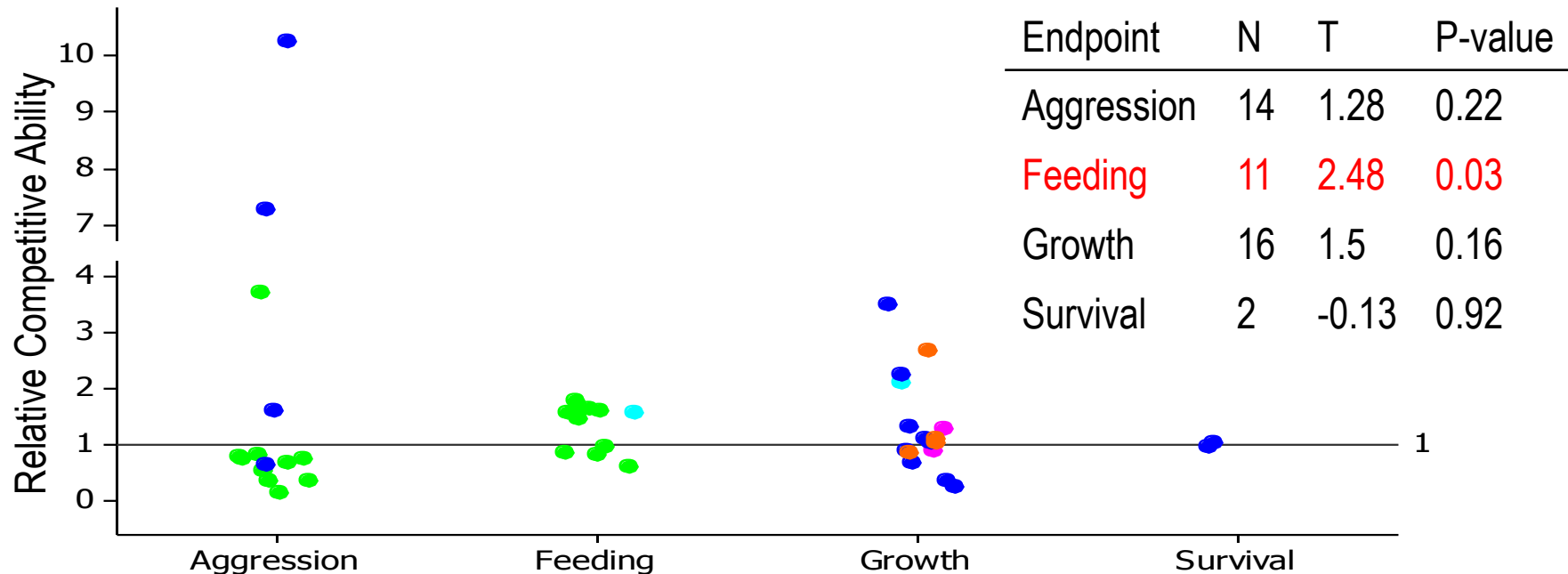
Ecological consequences & experimental endpoints



Calculation of relative competitive ability (RCA)

- Two equations used depending on data reporting
- When endpoints separately reported for hatchery and wild fish:
 1. $RCA = \text{mean Hatchery} / \text{mean Wild}$
- When endpoints only reported for wild fish:
 2. $RCA = \text{mean Wild}_{\text{wild}} / \text{mean Wild}_{\text{hatchery}}$

Relative competitive ability of hatchery and wild fish



Conclusions: Relative competitive ability

- Available data for anadromous salmonids indicates that hatchery and wild fish are not very different in their competitive ability.
- This does not mean that hatchery fish do not compete with wild fish.
- Informed hatchery management can reduce ecological interactions

Winthrop National Fish Hatchery

- Location: Winthrop, WA on Methow River
 - 54 miles from Columbia confluence
- Dual purpose steelhead program
 - Mitigation & Recovery of Upper Columbia steelhead (threatened)
- Transition to Methow River broodstock
 - Two year smolt rearing program (S2)
 - Maintained yearling program (S1) until 2015 release year



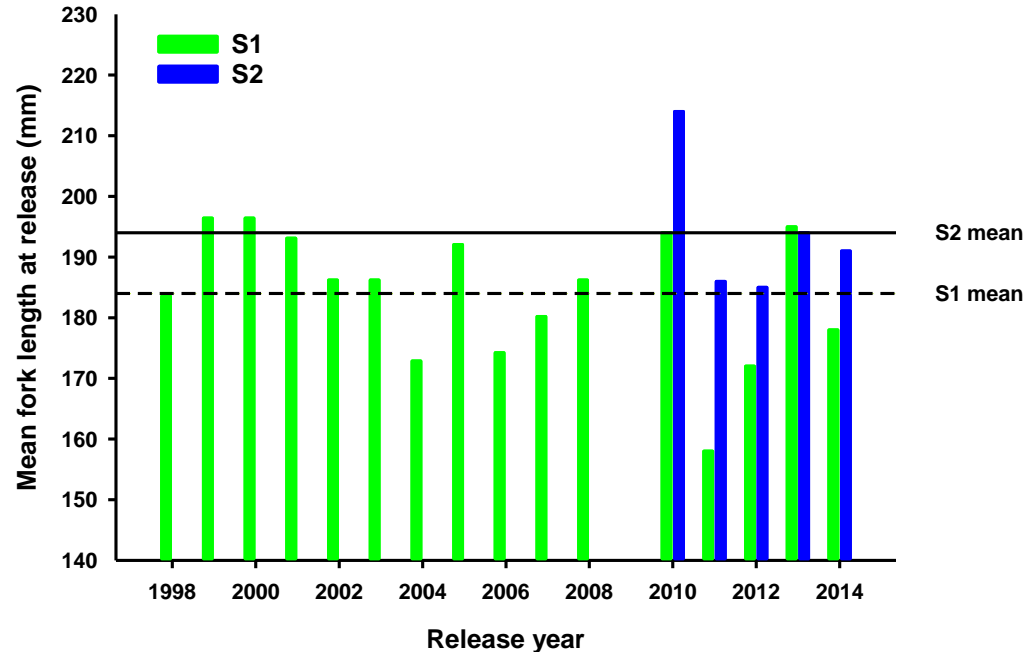
Hatchery management to reduce H x W interactions

- S2 program uses local wild broodstock to reduce genetic effects from hatchery introgression
- S2 rearing cycle closer to natural age of smoltification
- S2 growth is regulated to minimize the incidence and release of parr and precociously mature males



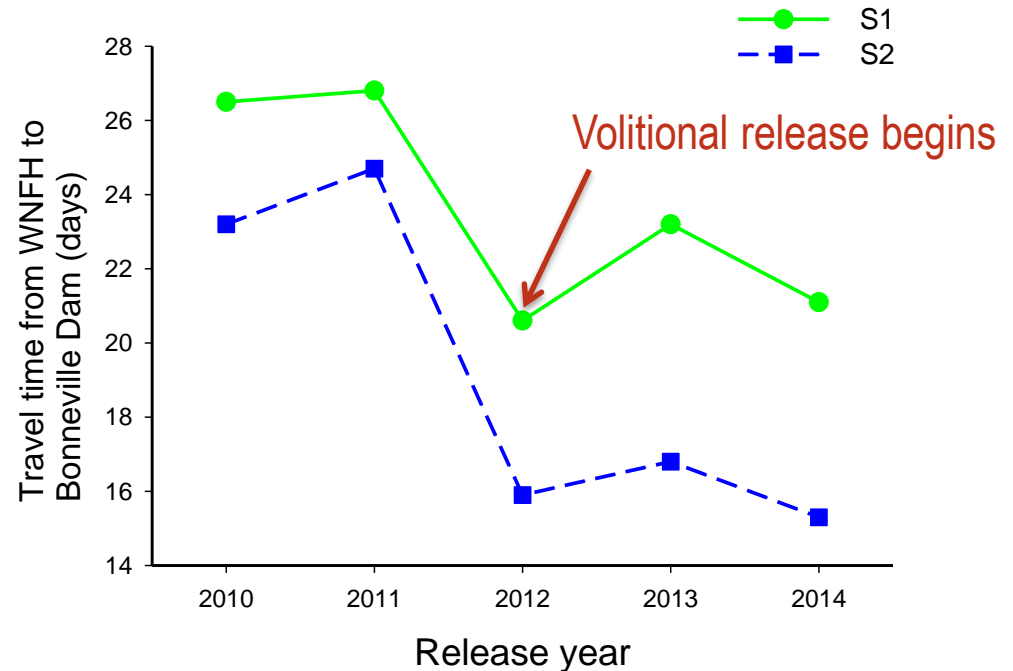
Advantages of S2 rearing are related to size at release

- Greater variation in size at release for S1 than S2
- S1 smaller than S2
- Size at release affects
 - Survival
 - Travel time
 - Residualism



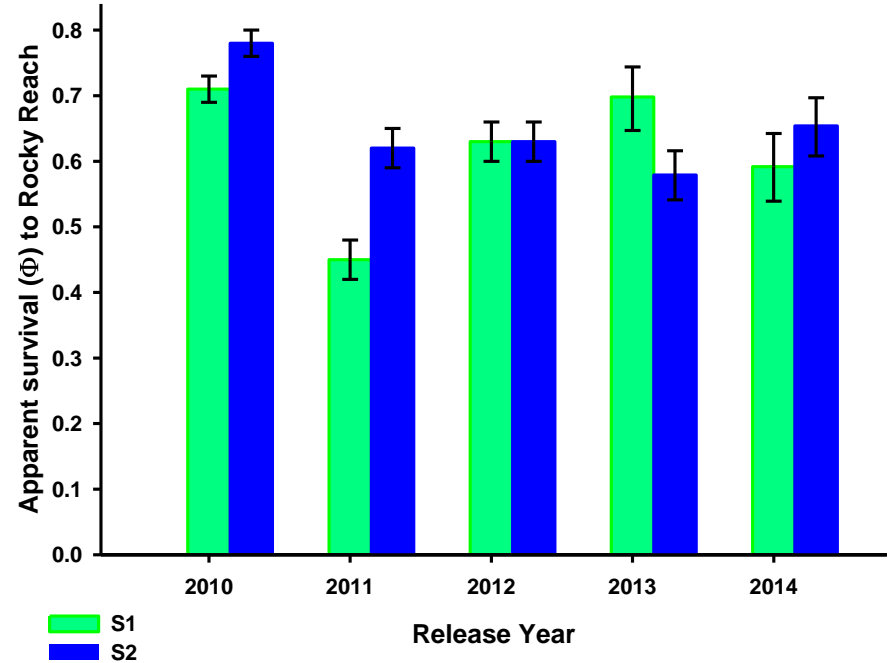
Travel time of S1 and S2 smolts to Bonneville Dam

- S2 migrate faster than S1 all years
- S2 spend less time in the Methow and Columbia Rivers
- Decreased potential for interaction



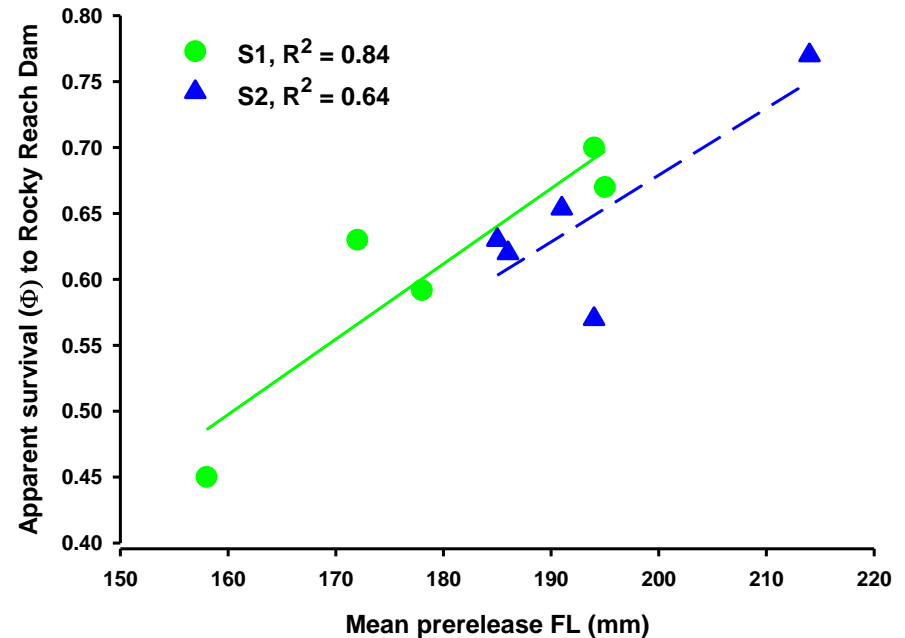
Apparent survival of S1 & S2 to Rocky Reach Dam

- Apparent survival of S2 \geq S1 in 4 of 5 years
- S2 program could release fewer fish than S1 and possibly expect fewer residuals
- Decreased interaction



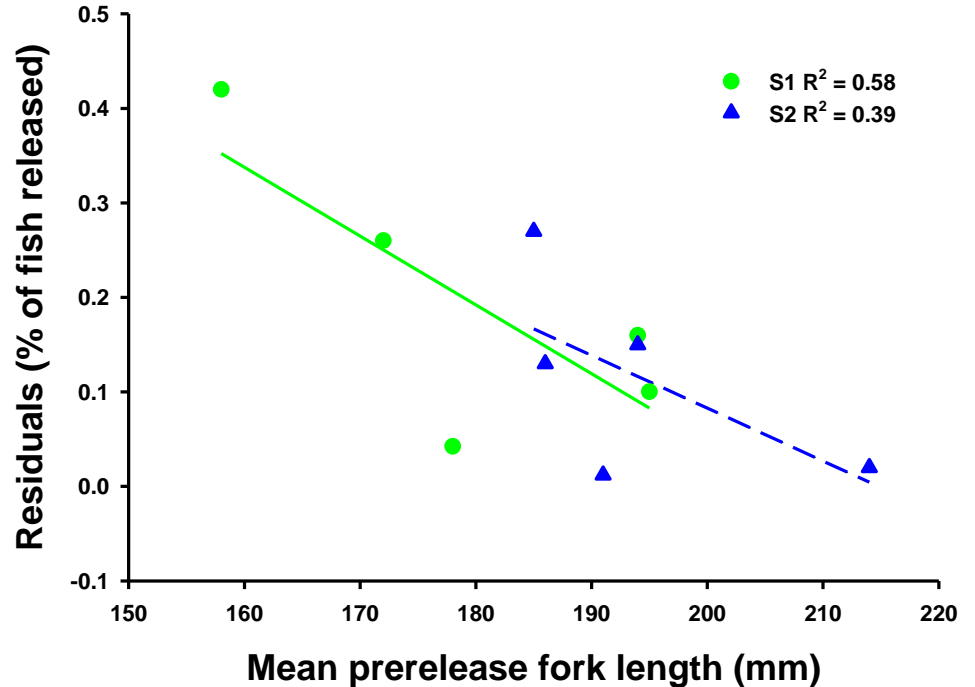
Body size effects on apparent survival

- Positive correlation between mean body size and apparent survival to Rocky Reach
- S2 fish are larger than S1 fish in most years
- S2 program decreases interaction through increased survival
- Corresponding apparent mortality combines actual mortality & residualism



Residualism

- The incidence of residualism decreased as mean body size increased for S1 & S2
- S2 steelhead are larger than S1 steelhead in most years
- Expect lower incidence of residualism in S2 steelhead and reduced hatchery by wild ecological interactions



Conclusions: informed hatchery management

- Our knowledge of competition between hatchery and wild salmonids can inform changes to hatchery programs that reduce the likelihood of ecological interactions.
- Use of a local broodstock & a 2-year rearing cycle reduced outmigration travel time, increased survival, and reduced residualism relative to a 1-year rearing cycle for steelhead.
- Implementation of 2-year smolt rearing reduced the potential for ecological interactions, the reduction was associated with increased body size at release and lower annual variation in body size of S2 steelhead.