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**Presentation Title: Hatchery rearing duration effects on reproductive behavior and breeding success of summer-run steelhead**

Abstract for the 2018 Pacific Coast Steelhead Management Meeting

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Steelhead trout raised in hatcheries typically exhibit lower fitness when spawning naturally than wild steelhead, hampering efforts to use hatcheries as a tool in population maintenance and recovery. Recent studies conducted on Methow River steelhead have suggested that altering rearing strategies by raising fish to a more natural age at smoltification (age-2) may alleviate some of the size-selective mortality after release and potentially reduce domestication selection on correlated traits. The present study estimates the effects of rearing smolts for one year in the hatchery (S1, traditional approach) or two years in the hatchery (S2, experimental approach) on the breeding success of steelhead spawning under experimental conditions to provide a more complete evaluation of these two approaches. Two spawning channels at the US Fish and Wildlife Service Winthrop National Fish Hatchery were stocked with S1 and S2 adult steelhead for each of three consecutive years (2015-2017), creating six independent breeding groups, each containing 11-13 females, 11-13 anadromous males, and 6 precocious male parr (age-2) from the hatchery (72 females and 106 males total). Behavioral observations conducted from dawn until dusk throughout each spawning season were designed to document spawning events, including the order of nest entry at the time of spawning (an indicator of sperm precedence), and to determine male dominance hierarchies within each breeding group. The resulting fry production was estimated using removal-based methods. A random subsample of 700 emergent fry from each breeding group (4,200 total fry) were genotyped and assigned to single-pair matings. The following results should be considered preliminary.

Combined data from all six breeding groups indicated that individual female breeding success (number of fry produced) did not depend on freshwater rearing history (S1 vs S2; P = 0.730) and was significantly, although weakly, correlated with body mass (r2 = 0.07, P = 0.023). Estimated fry production in stream channel 1 was consistently very high, ranging from 34,979 to 42,007 over the three years. Estimated fry production in stream channel 2 was consistently much lower, ranging from 10,683 to 15,610, suggesting some physical characteristic of otherwise seemingly identical spawning channels played a role in egg/fry production.

Combined data from all six breeding groups indicated that individual S1 males sired an average of 10.1% of the sampled fry (range: 8.6% to 11.9% among the six breeding groups), S2 males sired an average 3.5% (range: 1.2% to 5.2%), and precocious parr sired an average of 1.5% (range: 0.7% to 2.6%). Analysis of covariance for just the S1 and S2 males indicated significantly greater breeding success for S1 than for S2 males (P = 0.03) and a non-significant positive correlation between body mass and breeding success (P = 0.322). Considering just S1 and S2 males, the relationship between male body size on breeding success was significant for only one of the six breeding groups. The overall range of male body size was similar for S1 and S2 males, but S2 males were under-represented at the upper end of the size distribution.

Combined data from all six breeding groups indicated that body mass was significantly and positively correlated with position in the male hierarchy (r2 = 0.387, P < 0.01) and the relationships (all positive) were significant for four of the six individual breeding groups. The number of observed spawning participations as the first male to enter the nest during spawning was the strongest proximate factor influencing breeding success (r2 = 0.81, P < 0.001); it was significantly, but weakly, correlated with body size (r2 = 0.18, P < 0.01).

In summary, early rearing history had no detectable influence on female breeding success. Prolonged hatchery rearing in males appears to have a negative effect on breeding success that this caused by competitive asymmetries. These effects are likely to be caused by rearing history, not heritable differences. While body size was important in structuring male dominance hierarchies, and the most dominant individuals tended to have greater breeding success, sneak spawning opportunities were apparently sufficient to allow for subdominant males (including parr) to have measurable and consistent breeding success. The implications of these findings will be more fully assessed after the analyses are finalized.