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**Presentation Title: Optimizing Steelhead Smolt Production from Natural-Origin**

 **Broodstock**

Abstract for the 2018 Pacific Coast Steelhead Management Meeting

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Hatchery programs designed to conserve and recover natural steelhead populations use natural-origin broodstocks to maintain natural spawn timing, minimize fitness loss, and reduce genetic impacts. However, hatcheries attempting to produce yearling steelhead smolts from natural-origin broodstocks, may result in selection for rapid growth, increased residualism, and reduced post-release survival. We describe a series of hatchery and laboratory experiments that show how changes to hatchery rearing practices for steelhead smolts can facilitate use of natural origin broodstocks.

Hatchery assessments conducted at the Winthrop National Fish Hatchery (WNFH, Methow River, WA) compared PIT tagged steelhead reared to smolt at age-1 (S1) and age-2 (S2). In some release years, the S1 steelhead showed strong size selection for migratory behavior and survival after release. S2 steelhead were not subject to size selection, but consistently exhibited higher levels of precocious male maturation than S1 steelhead. Residuals near WNFH were dominated by non-maturing S1 steelhead and sexually maturing male S2 steelhead.

Laboratory experiments were conducted at Manchester Research Station using natural-origin steelhead broodstock from the Methow River to produce S1 and S2 smolts. The first experiment found that S1 smolts were smaller and suffered higher mortality during a seawater challenge than S2 smolts. Body size positively and significantly correlated with survival. The second experiment found that body size of individual steelhead varied considerably within weeks of ponding and was predictive of body size at age-1. A third experiment found that sorting steelhead into groups based on size did not improve growth of small fish, suggesting that growth rate (and age at smoltification) was an individual characteristic and that growth suppression of smaller individuals was not a caused by competition from larger fish. An ongoing experiment is investigating whether metabolic phenotypes established at the embryonic stage are responsible for growth rate and age at smoltification.

The combined results from the hatchery and laboratory experiments suggest that production of steelhead smolts using natural-origin broodstock can be optimized by sorting slower growing individuals shortly after ponding and rearing them as S2 smolts. The faster growing individuals would have a high likelihood of smolting at age-1 using traditional S1 rearing procedures. We hypothesize this approach would reduce selection for rapid growth, increase the rate of smoltification, reduce the prevalence of precocious male maturation, and lower the potential for residualism. Other advantages would include reduced costs and rearing space requirements in comparison to exclusively using an age-2 smolt rearing regime.

We are currently testing our size sorting hypothesis with a laboratory experiment using 20 half-sib families of natural-origin steelhead spawned at WNFH in broodyear 2017. We sorted steelhead fry by fork length 9 weeks after ponding into either a low-growth S2 (smallest 33%) or a high-growth S1 (largest 67%) rearing regime. The fry in the sorting treatment groups will be compared to an unsorted control group reared as yearling smolts. From the time of sorting, fry in the sorted treatment groups exhibited lower coefficients of variation for fork length than the control group. We will measure growth, smoltification rates, and incidence of precocious maturation for all groups prior to conducting a seawater challenge assays. The control and sorted S1 groups will be challenged in April 2018 and the S2 group in 2019. The size sorting protocol will be tested at the production scale at the WNFH in broodyear 2018 to test whether the approach improves out-migration survival and reduces the incidence of residualism (caused by precocious male maturation) relative to the unsorted S2 production group.