Genetic evaluation of the spring Chinook salmon reintroduction program above Cougar Dam from 2007-2014: Assessment of genetic diversity and searching for adfluvial Chinook

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Dams within the Willamette River basin have contributed to declines in spring Chinook salmon abundance. Traditionally hatcheries have been used as a means to mitigate the loss of Chinook production; however, managers have also begun to reintroduce Chinook above dams to provide them access to historical spawning and rearing habitat. We have genetically evaluated the reintroduction of Chinook above Cougar Dam on the South Fork of the McKenzie River from 2007-2014. Our past results have focused on assessing the demographic viability of the reintroduction program based on cohort replacement rates, as well as the efficacy of active transport methods. Here we share new results regarding genetic diversity within the reintroduction program, as well as preliminary evidence suggesting the existence of reproductively active adfluvial Chinook above Cougar Dam.

We used microsatellite genotypes originally acquired for genetic parentage assignments among adults reintroduced above Cougar Dam to also determine if genetic diversity has been maintained within and among reintroduced cohorts and their F_1 progeny (age-3 to age-5) that returned in 2010 to 2013. In all comparisons, the average number of alleles observed at each locus decreased between parents and offspring; however observed heterozygosity did not differ. Results suggest that the loss of many of the alleles between parents and offspring was likely driven by random genetic drift. We also assessed if natural origin (NOR) Chinook that were not originally produced above the dam, referred to as migrants, contributed new genetic variation to reintroduced cohorts. We found that migrants in 2012 and 2013 helped to restore genetic variation lost between parents and offspring, as well as contributed new genetic variation not previously observed in the reintroduction program. Our results suggest that gene flow from NOR migrants and/or additional hatchery origin Chinook outplants will be vital to the genetic viability of this reintroduction program, once immediate demographic limitations (i.e. estimated cohort replacement rates are well below one) have been resolved.

Over the past seven years we have assembled two adult-adult and four adult-juvenile genetic pedigrees. Among the adult-juvenile pedigrees the average annual percent of offspring

missing at least one parent was 22%, which is surprisingly high because we have sampled 99.8% of all adults reintroduced, and genotyping error rate was low (2%). Interestingly, the average percent of offspring missing mothers (13.2%) was nearly double that of offspring missing fathers (7%). Using the exclusion algorithm of Christie et al. (2011), we inferred the existence of sexually mature adfluvial Chinook residing above Cougar Dam through grandparent-grandoffspring genetic relationships. Preliminary results suggest that precocial and adfluvial males (age-1 to -4), as well as adfluvial females (age-3 to -4) reside above Cougar Dam because the number of observed grandparent-grandoffspring trios that matched at all 11 loci for each comparison was greater (23 ± 21, mean ± S.D.) than what would be expected by chance (8 ± 5). We will next experimentally verify putative grandparent-grandoffspring trios by genotyping candidate individuals at five additional genetic loci.

Reference:

Christie, M.R., Marine, M.L., and Blouin, M.S. 2011. Who are the missing parents? Grandparentage analysis identifies multiple sources of gene flow into a wild population. Molecular Ecology **20**(6): 1263-1276.