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### Genetic pedigree analysis of mckenzie river spring Chinook salmon

### Introduction

Adult spring Chinook salmon (*Oncorhynchus tshawytscha*) are released above USACE dams throughout the Upper Willamette River basin to increase the abundance, productivity, and diversity of naturally produced fish, such that this Evolutionarily Significant Unit (ESU) is self-sustaining and provides significant economic, ecological, recreational, cultural, social, and aesthetic benefits to the citizens of Oregon. The McKenzie River is a major tributary of the upper Willamette River and supports both hatchery- and natural-origin spring Chinook salmon.

For almost two decades, spring Chinook salmon have been released above Cougar Dam in an effort to better utilize the species’ historic spawninghabitat. Genetic parentage analysis is currently being used to evaluate the effectiveness of this reintroduction program. Results to date have been summarized in technical reports (Banks et al. 2013, Banks et al. 2014, Banks et al. 2016) and peer-reviewed manuscripts (Sard et al. 2015, Sard et al. 2016, Evans et al. 2019).

**Objectives**

1. Determine the number and proportion of unmarked adult Chinook salmon sampled at various locations in the South Fork McKenzie River (e.g. Cougar Trap and spawning grounds below Cougar dam) in 2016-2020 that can be assigned as progeny of Chinook salmon previously released above Cougar Dam, South Fork McKenzie River in 2011-2017.

2. Estimate the TLF for Chinook salmon reintroduced above Cougar Dam in 2011-2015. These estimates include unmarked adult offspring sampled at Cougar Dam, as well as unmarked spawners encountered on spawning grounds below the dam in 2014-2019.

3. Estimate the effects of release date and release site on the total lifetime fitness of adult spring Chinook salmon released above Cougar Dam in 2011-2015.

4. Estimate cohort replacement rate (CRR), or “the number of future spawners produced by a spawner” for spring Chinook salmon released above Cougar Dam in 2011-2015.

5. Estimate the effective number of breeders (Nb) for the adult salmon population reintroduced above Cougar Dam in 2011-2015.

6. Estimate and report the annual abundance and age structure of adult Chinook salmon that return to the South Fork McKenzie River that can be confidently assigned to parents through genetic pedigree in 2016-2020.

7. Evaluate fitness differences between HOR and NOR Chinook salmon released above Cougar Dam in 2011-2015 through assignment of adult offspring returns in 2014-2020.

**Methods**

### 1. Tissue samples have been collected from unmarked adult spring Chinook salmon sampled at the Trap in 2016 (N = 303), 2017 (N = 244), 2018 (N = 120), 2019 (N = 166) and 2020 (N ~ 225). In addition, a few marked fish were sampled at the Trap and transported above Cougar Dam in 2016 (N = 67), 2017 (N = 6) and 2019 (N = 8). Note, the 2016 and 2017 samples have already been genotyped. Tissue samples from unmarked carcasses found during spawning ground surveys on the South Fork McKenzie river were also collected in 2016 (N = 44 ), 2017 (N = 18), 2018 (N = 36), 2019 (N = 18) and 2020 (N = ?). DNA will be extracted from fin clips collected at the Trap in 2018-2020 (N ~ 592) and during spawning ground surveys from 2016-2020 (N = 116+) using the method of Ivanova et al. (2006). Samples will be genotyped at 11 microsatellite markers and one sex identification marker.

### Tissue samples have also been collected from hatchery spring Chinook collected at the McKenzie Hatchery and outplanted above Cougar Dam in 2014 (N = 683), 2015 (N = 669), 2016 (N =475), 2017 (N = 446), 2018 (N = 541) and 2019 (N = 381). DNA will be extracted from fin clips in 2014-2017 (N = 2,273) using the method of Ivanova et al. (2006). Samples will be genotyped at 11 microsatellite markers and one sex identification marker.

### 2. Genetic-based parentage assignments will be made for all unmarked adult spring Chinook salmon sampled in the South Fork McKenzie River in 2016-2019 using genotypes from salmon previously released above Cougar Dam as potential parents in 2011-2016. Two analytical approaches will be used as implemented in the software programs: CERVUS (Kalinowski et al. 2007), and COLONY (Wang and Santure 2009).

### 3. General Linear Models (GLM) will be used to estimate the effect of alternate release strategies (i.e. site and date), when possible, on the total lifetime fitness of adult spring Chinook salmon transported above Cougar Dam in 2011-2015.

### 4. A Chi-square test will be used to compare the parentage assignment rate of adult Chinook salmon that enter the trap and haul facility prior to and after September 1st.

### 5. Cohort Replacement Rate (CRR) of Chinook salmon outplanted above Cougar Dam in 2011-2015 will be estimated as the mean number of adult Chinook salmon produced per adult spawner.

### 6. Single generation (Waples and Do 2008; Tallmon et al. 2008) and cross generation methods (Waples 1989, 2005; Frankham 1995) will be used to estimate the effective number of breeders of spring Chinook salmon transported above Cougar Dam in 2011-2015.

### 7. The abundance and age structure of assigned adult offspring returns will be determined through genetic parentage analyses.

**References**

Banks, M.A., O’Malley, K.G., Sard, N., Jacobson, D.P., Hogansen, M., Schroeder, K., and

Johnson, M.A. (2013) Genetic pedigree analysis of spring Chinook salmon outplanted

above Cougar Dam, South Fork McKenzie river. U.S. Army Corps of Engineers.

Banks, M.A., O’Malley, K.G., Sard, N., Jacobson, D.P., Hogansen, M., Schroeder, K., and

Johnson, M.A. (2014) Monitoring the spring Chinook salmon reintroduction above

Cougar Dam, South Fork McKenzie River, 2007-2013. U.S. Army Corps of Engineers.

Banks, M.A., Sard, N.M., O’Malley, K.G., Jacobson, D.P., Hogansen, M., Johnson, M.A. (2016) A

genetics-based evaluation of the spring Chinook salmon reintroduction program above Cougar

Dam, South Fork McKenzie River, 2013-2015. U.S. Army Corps of Engineers.

Evans, M.L., Hard, J.J., Black, A.N., Sard, N.M., O’Malley, K.G. (2019) A quantitative genetic analysis of

life-history traits and lifetime reproductive success in reintroduced Chinook salmon.

Conservation Genetics, 20, 781-799.

Sard, N.M., O’Malley, K.G., Jacobson, D.P., Hogansen, M., Schroeder, K., Johnson, M.A., Banks, M.A.

(2015) Factors influencing spawner success in a spring Chinook salmon (*Oncorhynchus*

*tshawytscha*) reintroduction program. Canadian Journal of Fisheries and Aquatic Sciences, 72,

1390-1397.

Sard, N.M., Johnson, M.A., Jacobson, D.P., Hogansen, M.J., O’Malley, K.G., Banks, M.A. (2016) Genetic monitoring guides adaptive management of a migratory fish reintroduction program.

Animal Conservation, 19, 570-577.