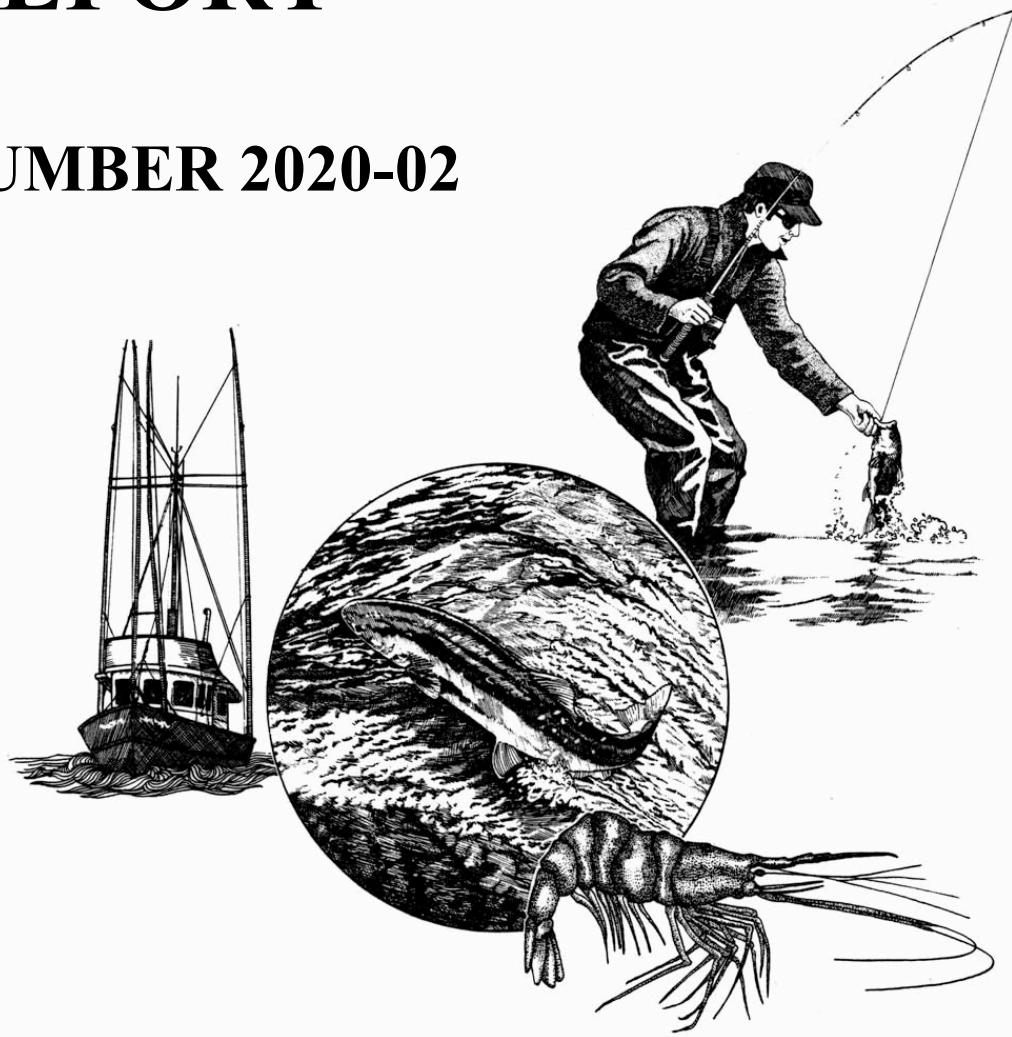


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Oregon Department of Fish and Wildlife

Evaluating the genetics of naturally produced Chinook salmon
(Oncorhynchus tshawytscha) captured in the Lower Rogue River (OR)
fishery

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Evaluating the genetics of naturally produced Chinook salmon (*Oncorhynchus tshawytscha*)
captured in the Lower Rogue River (OR) fishery

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CONTENTS

INTRODUCTION.....	1
METHODS.....	2
RESULTS.....	4
DISCUSSION.....	7
ACKNOWLEDGMENTS.....	8
REFERENCES	8
SUPPLEMENTAL TABLE	9

INTRODUCTION

In the Rogue basin, the Oregon Department of Fish and Wildlife (ODFW) manages spring and fall Chinook salmon as distinct species management units (SMUs). Spring Chinook salmon in the lower river are defined as those adult Chinook salmon that enter freshwater during the period February through mid-July, and also pass Huntley Park (RM 8) by the end of Julian Week 29. The management goals and strategies for spring Chinook are documented in the [Rogue Spring Chinook Salmon Conservation Plan](#) which was adopted by the ODFW Fish and Wildlife Commission on September 7, 2007. The desired biological status for spring Chinook was defined during a stakeholder process associated with the development of the Conservation Plan and includes targets for abundance, migration time, age structure, spawner distribution and composition, and persistence.

To achieve this desired status, the conservation plan outlines management strategies for harvest, hatcheries, and habitat. Consistent with plan goals, ODFW's management strategy for the spring Chinook fishery in the Lower Rogue river protects the early run "spring" Chinook while providing harvest opportunity during this period on hatchery spring Chinook. To achieve this, current regulations prohibit retention of naturally produced (i.e. adipose fin intact) Chinook prior to June 1 from the river mouth upstream to Fishers Ferry boat ramp (old Gold Ray dam site). This date was chosen because it was believed the majority of early run spring Chinook would have passed the fishery by this time. Beginning June 1, and depending on run size projections, anglers are allowed to retain a limited number of naturally produced fish.

More recently, ODFW completed a Comprehensive Assessment and Update of the Conservation Plan in January 2019. The department concluded that the status of naturally produced spring Chinook relative to these targets had improved as a result of the management actions that were implemented. As a result of the improved status, ODFW proposed a framework for providing additional fishery opportunities if population abundance continues to increase. The proposed regulation changes would shift the date at which wild Chinook can be retained from June 1 to May 21, May 11, or April 1 (date and bag limit tied to abundance trigger-see pg. 32 of the plan review for details:

https://www.dfw.state.or.us/fish/CRP/docs/rogue_spring_chinook/Final%20Rogue%20Spring%20Chinook%20Salmon%20Conservation%20Plan%20Comprehensive%20Assessment%20and%20Update.pdf.

At the time the plan was adopted, genetic data were not available to distinguish spring Chinook from fall Chinook. However, relatively recent research has identified genetic markers on chromosome 28 that are significantly associated with run timing (Prince et al. 2017; Thompson et al. 2019). Research is ongoing to determine which genes may be involved and the potential outcomes when early and late run fish spawning overlaps in time and space. To assess how the current and future angling regulations aligned with the genetic

composition of Chinook at the run timing markers, ODFW initiated this study in 2019 using angler captured fish in the Lower Rogue River.

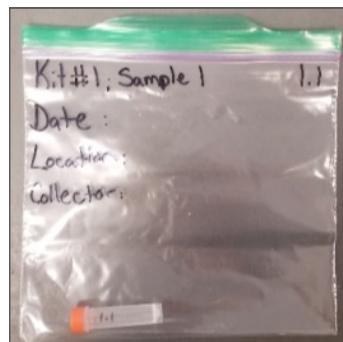
Objective

1. Determine the genetic composition, based on two run timing markers, of naturally produced Chinook salmon captured in the lower Rogue River fishery in 2019.

METHODS

The study period was between March 1 and July 15, 2019. Volunteer anglers were asked to take tissue samples from any naturally produced Chinook salmon captured during this period. The volunteer anglers were issued sampling kits containing written instructions, individually labeled vials containing ethanol, and a paper hole punch for extracting caudal fin tissue. Additionally, the kits contained the following instructions:

- Minimize handling (keep in net on side of boat in/very close to the water surface)
- Work with a partner (one person holds fish, other holds net and collects sample)
- Use paper hole punch to extract fin tissue sample from caudal fin (Imagine the tail fin is a piece of paper)
- Gently release fish back into river
- Very carefully remove tissue sample from the hole punch's "chip guard" and place into sample vial. Be sure that sample is completely immersed in the liquid and close the cap snugly.
- Place vial into resealable bag. With a sharpie, record date, angler (collector), and location on bag's exterior.



- Rinse the hole punch in clean water
- Store sample in safe place away from heat for the duration of the fishing trip

- Drop samples off with Gold Beach ODFW staff directly or at one of the five drop boxes* and then notify ODFW

*Drop boxes were located at Rogue Outdoor Store, ODFW Gold Beach office, Mill Site, Lobster Creek Campground, and Quosatana Creek Campgrounds.



The Drop boxes were setup prior to March 1. ODFW staff collected samples from the boxes daily, or, at a minimum, weekly during the study period. The returned sample vials were organized chronologically and stored at the Gold Beach ODFW office for the duration of the project. All samples were stored at room temperature away from sunlight. The ethanol in each vial was replaced one week after samples were collected. At that time, each vial was labeled externally with a sample-ID number. Additionally, a small piece of Rite-in-the-Rain paper with the sample-ID number recorded with pencil was placed inside the vial with the tissue sample. Data records for each sample were entered in to an Excel spreadsheet and included sample-ID number, collection date, collection area, collector, and collection method.

The 2019 samples were transferred to the State Fisheries Genomics Lab in Newport where DNA was extracted from the fin tissue samples using the method of Ivanova et al. (2006). Using the Genotyping-in-Thousands by sequencing method (GT-seq; Campbell et al. 2015), all samples were genotyped at 298 single nucleotide polymorphisms (SNPs) (Hess et al. 2015), a sex marker (Hess et al. 2015), and two SNPs (positions 640165 and 670329) that are ~30 kb apart and located just upstream of the *Greb1L* gene (Thompson et al. 2019). These latter two SNPs are hereafter referred to as *Greb1L* SNP1 and SNP2, respectively. *Greb1L* SNP1 is reportedly more diagnostic of adult migration phenotype than *Greb1L* SNP2 in Rogue River and Klamath River populations of Chinook salmon (T. Thompson, pers. comm.).

Twelve pairs of SNPs align within 10,000 bp of each other. To avoid possible linkage disequilibrium, we removed the SNP from each pair with a lower number of effective alleles calculated in GENALEX (Peakall and Smouse 2012). In addition, we removed 29 SNPs that had more than 20% missing data and 25 SNPs that were monomorphic in all samples. *Ots_111312-435* significantly deviated from Hardy-Weinberg proportions in the Genepop R package (Rousset 2008) after an FDR correction and was removed. Two pairs of SNPs (*Ots_crRAD12711-37* and *Ots_crRAD13725-51*; *Ots_crRAD48459-74* and *Ots_nkef-192*) showed significant linkage disequilibrium in the Genepop R package after an FDR correction, and the latter SNP from each pair was removed. The final marker set included 229 SNPs previously developed by Hess et al. (2015) and the two *Greb1L* SNPs identified by Thompson et al. (2019).

RESULTS

Sample Collection

Volunteer anglers captured and sampled 162 naturally produced Chinook salmon. The earliest capture date was March 19, 2019 and the last fish was captured July 8, 2019. The captures were distributed among 10 sites in the lower river (Table S1, Figure 1).

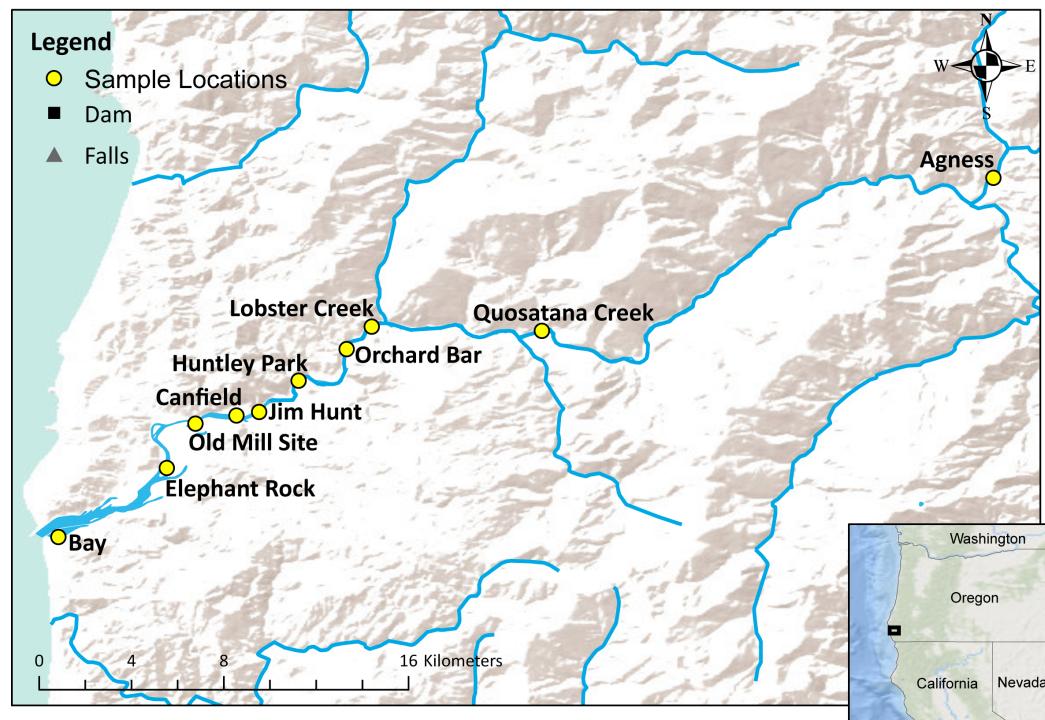


Figure 1. Map of the ten sample locations in the lower Rogue River.

The first sample was collected on March 19th by a guide targeting steelhead. Chinook fishing remained slow until record high river flows receded around the second week of April (Figure 2). Flows peaked at the USGS Agness

gauge at 90,000 cfs on April 9th and these high flows and turbid water resulted in the loss of fishing days from April 8th to April 14th. Once flows reduced to a weekly average of 12,000 cfs and the water temperature rose above 10°C, catch and sample collection rates increased. Fishing pressure remained consistent through the remainder of April. In May and June, fishing effort correlated with changes in water temperatures. For example, river temperatures decreased following rainfall in mid-May resulting in ideal fishing conditions, increased angling effort, catch, and sample collection over the last two weeks of that month.

Catch distribution of unmarked early run Chinook salmon generally began downstream and shifted upriver throughout the spring. During late March, April, and early May, the fishery was most concentrated in the lower stretches (below Lobster Creek) of the river. In mid-May, effort increased substantially at Quosatana Creek boat ramp, with a similar increase in the number of samples being deposited in the drop box at this location.

Beginning June 1, angling regulations changed to allow for retention of unmarked Chinook. ODFW staff monitoring the fishery after this date collected tissue samples during surveys at boat ramps, cleaning stations, and in an angler creel. A number of samples were collected from the Rogue Bay fishery which became active in June, coincident with an increase in water temperature at Agness to above 66°F (19°C) in the morning. This increase in water temperature may increase the incidence of holding by Chinook in the bay. However, when the water temperature decreased below this level, most of the samples were provided by anglers upstream of tidewater suggesting that fish were migrating upstream.

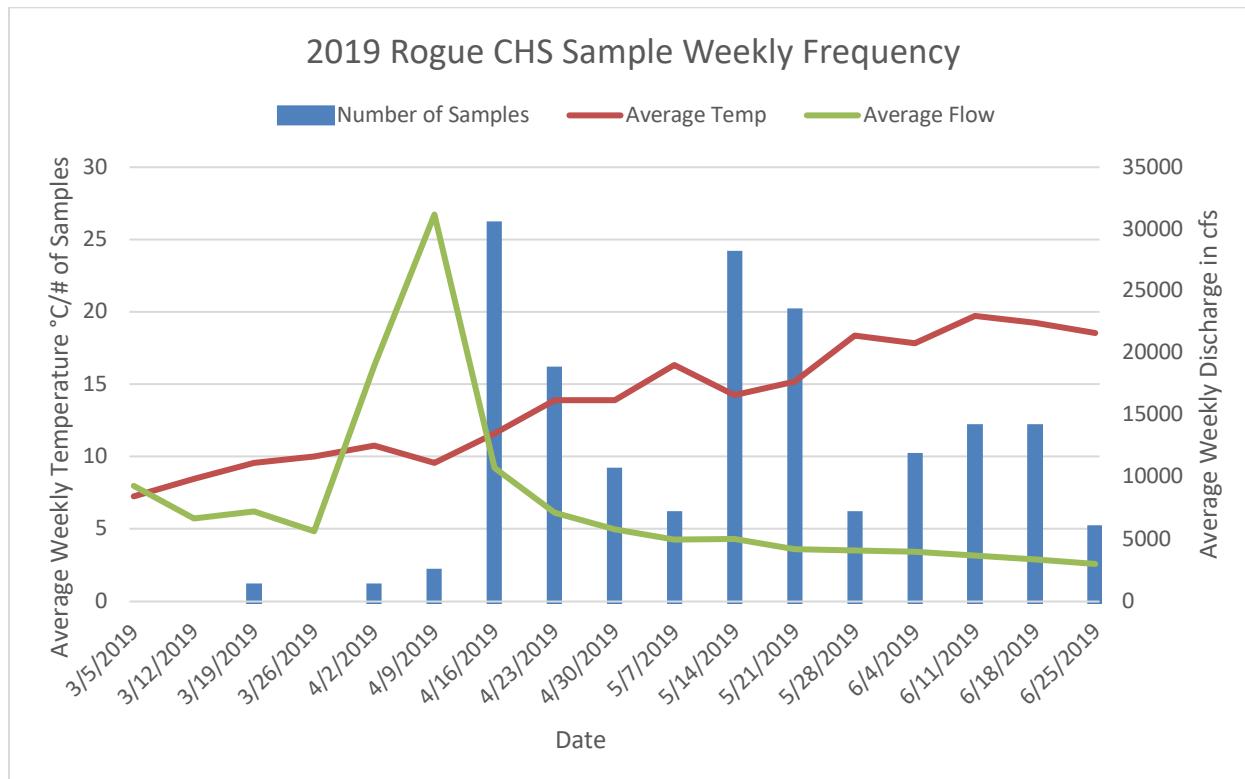


Figure 2. Number of Chinook salmon sampled from March 1st to July 15th relative to the average weekly river temperatures (°C) and average weekly discharge (cfs).

Genotyping

Four of the 162 samples failed to genotype at both *GrebIL* SNPs. Of the remaining 158 samples, nine samples had discordant genotypes (Figure 3). For instance, an individual was genotyped as heterozygous at one SNP and homozygous spring at the other SNP. Of the remaining 149 samples, 115 samples were genotyped homozygous spring, 32 samples were genotyped heterozygous, and 2 samples were genotyped homozygous fall (Table S1, Figure 3).

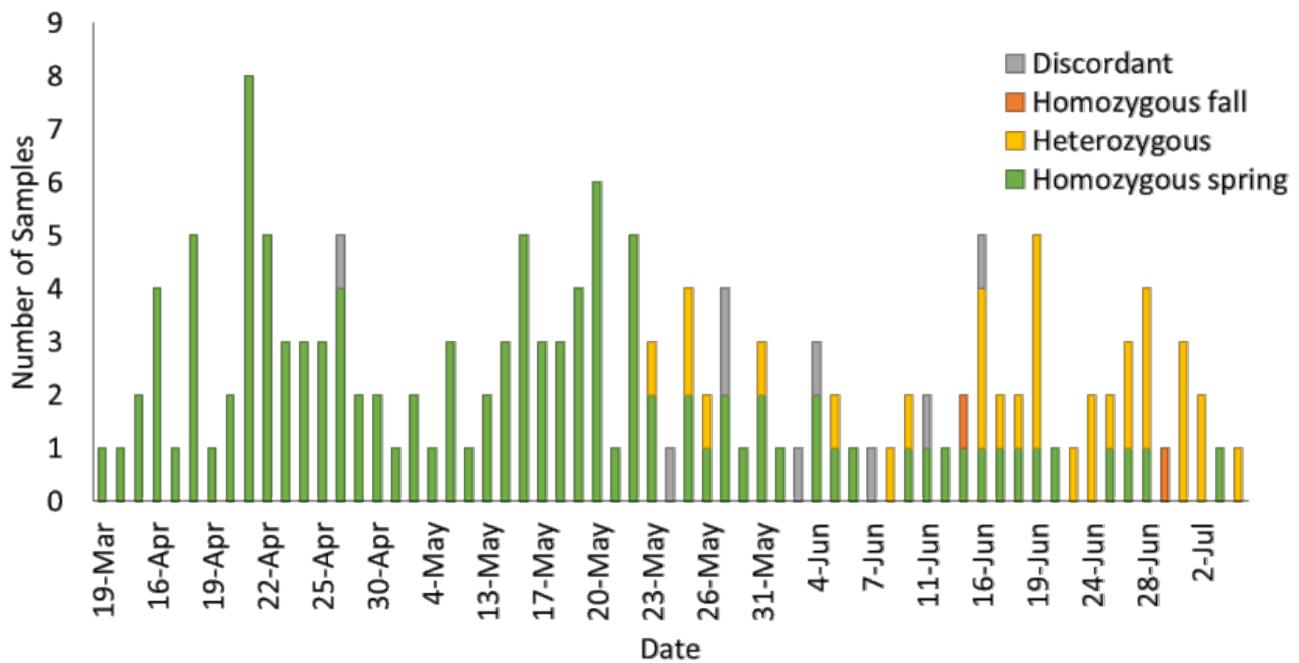


Figure 3. *GrebIL* SNP1 (snp640165) and SNP2 (snp670329) genotypes of Chinook salmon caught in the lower Rogue River in 2019 from March 19th to July 8th. Discordant genotypes are indicated by the gray bars.

As mentioned above, *GrebIL* SNP1 is reportedly more diagnostic of adult migration phenotype than *GrebIL* SNP2 in Rogue River and Klamath River Chinook salmon populations (T. Thompson, pers. comm.). Focusing only on SNP1, 117 samples were homozygous spring, 30 samples were heterozygous, and two samples were homozygous fall (Figure 4). The first heterozygous sample was collected on April 26th while the second heterozygous sample was collected on May 23rd. The two homozygous fall samples were collected on June 15th and June 30th. Both the total number of homozygous spring Chinook salmon and the daily proportion of samples that were homozygous spring Chinook salmon decreased after May 23rd, however, Chinook salmon that were homozygous for the spring allele were collected through July 5, 2019.

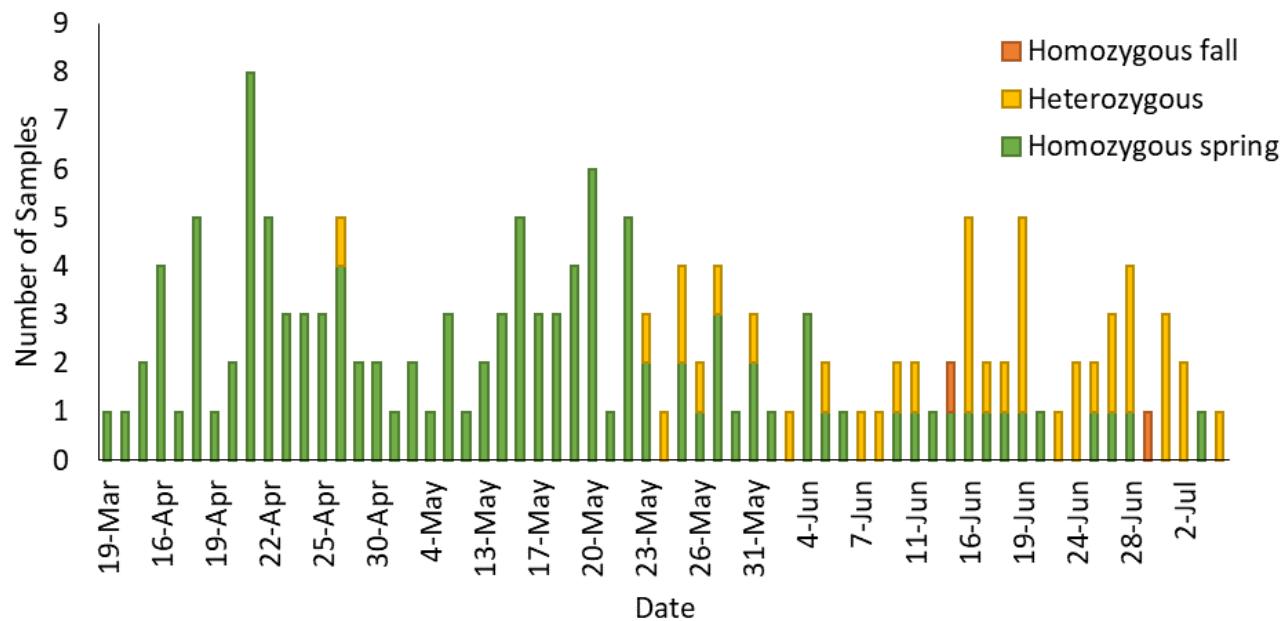


Figure 4. *Greb1L* SNP1 (snp640165) genotypes of Chinook salmon caught in the lower Rogue River in 2019 from March 19th to July 8th.

DISCUSSION

The main findings of the study:

1. All except one naturally produced Chinook salmon caught on or before May 23rd were homozygous spring at both *Greb1L* SNPs
2. Based on *Greb1L* SNP1, the majority of naturally produced homozygous spring Chinook salmon (83.8%; 98 out of 119 fish) genotyped in this study were captured during the period when retention of unmarked Chinook salmon was prohibited (Mar 1-Jun 1). Thus, the current angling regulations are protective of the early run life history genetics.
3. Based on *Greb1L* SNP1, anglers were primarily capturing and retaining heterozygous fish during the period June 1 - July 8 (31 out of 52 fish; or 59.6% of total catch). Of the remaining fish, 19 were homozygous spring and two were homozygous fall.
4. The sample collection protocol, which primarily relied upon volunteer anglers, was an effective way to collect fin clips from naturally produced Chinook salmon in the lower Rogue River.
5. A single seasonal employee was able to collect and manage samples with assistance from District personnel.

Acknowledgments

We appreciate the effort from all participating anglers. Without your contributions, this project would not have been as successful. We thank the Oregon State University Center for Genome Research and Biocomputing for sequencing our samples. This report benefitted from review by Shaun Clements of ODFW. The project was funded by an Oregon Department of Fish and Wildlife Restoration and Enhancement Program Grant (Project #17-065).

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Table S1.

SFGID ID	Kitnumber	Sample #	Date	Feeder	Main Fishing Locations	location	Angler/Guide	Collection Method	Origin	Genotypic Sex		Batch SNPs
										Gretel SNP1		
OnSACLRGR 0001	6.1	1	3/19/19		Mill Site	Willows	John Anderson	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0002	25.2	2	4/3/19		Elephant Rock	Hunley	Gene Garner	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0003	17.1	3	4/15/19		Hunley	Hunley	Burley Williams	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0004	17.2	4	4/15/19		Hunley	Hunley	Grant Brown	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0005	17.4	5	4/16/19		Lobster Creek	Hunley	Grant Brown	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0006	8.1	6	4/16/19		Lobster Creek	Lobster Creek	Shaun Carpenter	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0007	8.3	7	4/16/19		Lobster Creek	Lobster Creek	Shaun Carpenter	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0008	8.4	8	4/16/19		Lobster Creek	Lobster Creek	Shaun Carpenter	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0009	9.2	9	4/17/19		Hunley	Hunley	Steve Crawford	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0010	17.5	10	4/18/19		Lobster Creek	Lobster Creek	Ron Specie	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0011	21.5	11	4/18/19		Lobster Creek	Lobster Creek	Andrew Wells	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0012	5.1	12	4/18/19		Cannery	Cannery	Robin Crier	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0013	24.1	13	4/18/19		Canfield Bar	Canfield Bar	Greg Elie	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0014	20.3	14	4/20/19		Quotsatana	Quotsatana	Steve Ribb	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0015	36.5	15	4/20/19		Hunley	Hunley	John Weber	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0016	1.1	16	4/21/19		Clay Banks	Clay Banks	Greg Elie	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0017	11.2	17	4/21/19		Quotsatana	Quotsatana	Glenn Carpenter	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0018	25.1	18	4/21/19		Elephant Rock	Elephant Rock	Shaun Carpenter	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0019	25.3	19	4/21/19		Elephant Rock	Elephant Rock	Gene Garner	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0020	25.4	20	4/21/19		Elephant Rock	Elephant Rock	Gene Garner	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0021	25.5	21	4/21/19		Canfield Bar	Canfield Bar	Robin Crier	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0022	21.4	22	4/21/19		Quotsatana	Quotsatana	Greg Elie	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0023	11.5	23	4/21/19		Mill Site	Mill Site	John Weber	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0024	5.2	24	4/21/19		Lobster Creek	Lobster Creek	Glenn Carpenter	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0025	8.5	25	4/22/19		Lobster Creek	Lobster Creek	Shaun Carpenter	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0026	8.6	26	4/22/19		Canfield Bar	Canfield Bar	Sam Zueger	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0027	15.1	27	4/22/19		Bay	Bay	John Anderson	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0028	6.2	28	4/22/19		Canfield Bar	Canfield Bar	John Anderson	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0029	29	29	4/23/19		Elephant Rock	Elephant Rock	Gene Garner	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0030	25.3	30	4/23/19		Lobster Creek	Lobster Creek	Steve Mauer	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0031	2.1	31	4/23/19		Canfield Bar	Canfield Bar	Robin Crier	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0032	24.5	32	4/24/19		Rip Rap	Rip Rap	John Weber	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0033	1.5	33	4/24/19		Lobster Creek	Lobster Creek	Shaun Carpenter	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0034	8.7	34	4/24/19		Mill	Mill	Shane Blair	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0035	37.1	35	4/25/19		Mill Site	Mill Site	Shane Blair	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0036	3.7	36	4/25/19		Orchard Bar	Gillespie (Lower River)	John Olsen	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0037	39.1	37	4/25/19		Orchard Bar	Orchard Bar	Robin Crier	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0038	24.9	38	4/26/19		Canfield Bar	Canfield Bar	Jim Beck	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0039	40.1	39	4/26/19		Bay	Bay	John Hunt	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0040	6.5	40	4/26/19		Mill Site	Mill Site	John Hunt	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0041	6.4	41	4/26/19		Bay	Bay	John Anderson	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0042	6.3	42	4/26/19		Quotsatana	Quotsatana	Greg Elie	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0043	11.4	43	4/27/19		Canfield Bar	Canfield Bar	Robin Crier	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0044	24.6	44	4/27/19		Mill Site	Mill Site	Joe Martin	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0045	28.1	45	4/29/19		Willows	Willows	Jay Lander	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0046	23.1	46	4/30/19		Mill Site	Mill Site	Jay Lander	angler	NOR	Failed	Failed	Failed
OnSACLRGR 0047	23.2	47	5/1/19		Mill Site	Mill Site	Jimmy Davis	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0048	23.3	48	5/1/19		Orchard Bar	Orchard Bar	Trans Brown	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0049	41.1	49	5/1/19		Q Creek	Q Creek	Shaun Carpenter	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0050	8.8	50	5/1/19		Quotsatana Creek	Quotsatana Creek	Q Creek	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0051	6.6	51	5/2/19		Quotsatana Creek	Quotsatana Creek	Shaun Carpenter	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0052	8.9	52	5/2/19		Woodruff	Woodruff	Robin Crier	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0053	24.7	53	5/4/19		Quotsatana Creek	Quotsatana Creek	Greg Elie	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0054	11.7	54	5/9/19		Quotsatana Creek	Quotsatana Creek	Greg Elie	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0055	11.9	55	5/9/19		Quotsatana Creek	Quotsatana Creek	Greg Elie	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0056	11.0	56	5/9/19		Quotsatana Creek	Quotsatana Creek	Greg Elie	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0057	11.1	57	5/10/19		Quotsatana Creek	Quotsatana Creek	Greg Elie	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0058	11.8	58	5/13/19		Quotsatana Creek	Quotsatana Creek	Greg Elie	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0059	8.10	59	5/13/19		Quotsatana Creek	Quotsatana Creek	Joe Martin	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0060	11.6	60	5/14/19		Quotsatana Creek	Quotsatana Creek	Joe Martin	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0061	11.1	61	5/14/19		Quotsatana Creek	Quotsatana Creek	Joe Martin	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0062	28.8	62	5/14/19		Elephant Rock	Elephant Rock	Robin Crier	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0063	8.11	63	5/15/19		Q Creek	Q Creek	Shaun Carpenter	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0064	8.12	64	5/15/19		Quotsatana Creek	Quotsatana Creek	Q Creek	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0065	11.12	65	5/15/19		Quotsatana Creek	Quotsatana Creek	Greg Elie	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0066	11.13	66	5/15/19		Quotsatana Creek	Quotsatana Creek	Greg Elie	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0067	24.9	67	5/15/19		Elephant Rock	Elephant Rock	Robin Crier	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0068	28.2	68	5/17/19		Quotsatana Creek	Quotsatana Creek	Q Creek	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0069	21.1	69	5/17/19		Lowery	Lowery	Ross Bell	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0070	6.7	70	5/17/19		Bay	Bay	John Anderson	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0071	28.3	71	5/18/19		Lobster Creek	Lobster Creek	Joe Martin	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0072	8.13	72	5/18/19		Quotsatana Creek	Quotsatana Creek	Q Creek	angler	NOR	Male	Homogeneous	Homogeneous spring
OnSACLRGR 0073	11.14	73	5/18/19		Quotsatana Creek	Quotsatana Creek	Greg Elie	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0074	3.75	74	5/19/19		Elephant Rock	Elephant Rock	Shane Blair	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0075	8.14	75	5/19/19		Quotsatana Creek	Quotsatana Creek	Shaun Carpenter	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0076	11.15	76	5/19/19		Quotsatana Creek	Quotsatana Creek	Greg Elie	angler	NOR	Female	Homogeneous	Homogeneous spring
OnSACLRGR 0077	11.16	77	5/19/19		Quotsatana Creek	Quotsatana Creek	Greg Elie	angler	NOR	Female	Homogeneous	Homogeneous spring

Table S1.

SFGID	ID	Kit number	Sample #	Date	Feeder	Main Fishing Locations	Location	Angler/Guide	Collection Method	Origin	Genotypic sex	Greb1 SNP1	Greb1 SNP2	Bath SNPs
OSAC9R0GR_0078	21.4	78	5/20/19	Agnes		Quesatare Creek	Bacon Flat	Ross Bell	angler	NOR	Male	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0079	28.4	79	5/20/19	Agnes		Quesatare Creek	Agnes	Joe Martin	angler	NOR	Female	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0080	11.17	80	5/20/19	Cannery		Quesatare Creek	226	Greg Eide	angler	NOR	Male	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0081	24.1	81	5/20/19	Carfield Bar		Quesatare Creek	Cannery	Robin Cramer	angler	NOR	Male	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0082	5.3	82	5/20/19	Orchard Bar		Quesatare Creek	Carfield Bar	Travis Bowman	angler	NOR	Female	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0083	8.3	83	5/20/19	Bay		Quesatare Creek	Orchard Bar	John Anderson	angler	NOR	Male	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0084	41.4	84	5/21/19	Lobster Creek		Quesatare Creek	Bay	Mike Becker	angler	NOR	Female	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0085	40.2	85	5/22/19	Carfield Bar		Quesatare Creek	Lobster Creek	Rich Burgess	angler	NOR	Male	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0086	41.2	86	5/22/19	Orchard Bar		Quesatare Creek	Carfield Bar	Travis Bowman	angler	NOR	Male	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0087	41.5	87	5/22/19	Orchard Bar		Quesatare Creek	Orchard Bar	Travis Bowman	angler	NOR	Female	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0088	25.6	88	5/22/19	Elephant Rock		Quesatare Creek	Orchard Bar	Gene Garner	angler	NOR	Male	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0089	8.15	89	5/22/19	Q Creek		Quesatare Creek	Elephant Rock	Shawn Carpenter	angler	NOR	Female	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0090	8.3	90	5/23/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Male	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0091	21.3	91	5/23/19	Q Creek		Quesatare Creek	Q Creek	Ross Bell	angler	NOR	Female	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0092	3.6	92	5/23/19	Mill Site		Quesatare Creek	Mill Site	Shane Blair	angler	NOR	Female	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0093	24.11	93	5/24/19	Mill Site		Quesatare Creek	Mill Site	Robin Cramer	angler	NOR	Male	Homozygous spring	Homozygous spring	Discordant
OSAC9R0GR_0094	3.77	94	5/25/19	Elephant Rock		Quesatare Creek	Mill Site	Shane Blair	angler	NOR	Male	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0095	43.2	95	5/25/19	Elephant Rock		Quesatare Creek	Elephant Rock	Verne Tarwater	angler	NOR	Female	Homozygous spring	Homozygous spring	Homozygous spring
OSAC9R0GR_0096	11.18	96	5/25/19	Q Creek		Quesatare Creek	Elephant Rock	Greg Eide	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0097	11.19	97	5/25/19	Q Creek		Quesatare Creek	Q Creek	Greg Eide	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0098	11.20	98	5/26/19	Quesatare Creek		Quesatare Creek	Q Creek	Greg Eide	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0099	11.26	99	5/26/19	Quesatare Creek		Quesatare Creek	Q Creek	Greg Eide	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0100	11.21	100	5/27/19	Quesatare Creek		Quesatare Creek	Q Creek	Greg Eide	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0101	11.22	101	5/27/19	Quesatare Creek		Quesatare Creek	Q Creek	Greg Eide	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0102	11.27	102	5/27/19	Quesatare Creek		Quesatare Creek	Q Creek	Greg Eide	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0103	21.7	103	5/27/19	Lobster Creek		Quesatare Creek	Lobster Creek	Ross Bell	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0104	26.1	104	5/29/19	Quesatare Creek		Quesatare Creek	Lobster Creek	Jeff Bonito	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0105	8.21	105	5/31/19	Quesatare Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0106	11.28	106	5/31/19	Quesatare Creek		Quesatare Creek	Q Creek	Greg Eide	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0107	11.23	107	5/31/19	Quesatare Creek		Quesatare Creek	Q Creek	Greg Eide	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0108	8.22	108	6/1/19	*tBAY**		Quesatare Creek	Q Creek	Jay Landry	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0109	5.4	109	6/3/19	Bay		Quesatare Creek	Bay	Racheals	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0110	11.0	110	6/4/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0111	8.23	111	6/4/19	Q Creek		Quesatare Creek	Q Creek	Steve Crawford	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0112	8.24	112	6/4/19	Q Creek		Quesatare Creek	Q Creek	Ron Spee	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0113	1.76	113	4/18/19	Hunley		Quesatare Creek	Hunley	Greg Eide	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0114	17.9	114	4/19/19	Q Creek		Quesatare Creek	Hunley	Shawn Carpenter	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0115	8.25	115	6/15/19	Q Creek		Quesatare Creek	Q Creek	Q Creek	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0116	8.26	116	6/15/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0117	8.16	117	6/16/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0118	2.17	118	6/17/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0119	8.17	119	6/18/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0120	17.8	120	6/10/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0121	8.18	121	6/10/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0122	4.13	122	6/11/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0123	11.25	123	6/11/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0124	43.4	124	6/14/19	*tBAY**		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0125	11.24	125	6/15/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0126	8.2	126	6/15/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0127	11.29	127	6/16/19	Q Creek		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0128	8.27	128	6/16/19	*tBAY**		Quesatare Creek	Q Creek	Shawn Carpenter	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0129	50.4	129	6/16/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0130	50.5	130	6/16/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0131	50.1	131	6/16/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0132	50.2	132	6/17/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0133	45.1	133	6/17/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0134	8.29	134	6/18/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0135	50.6	135	6/18/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0136	50.7	136	6/18/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0137	11.30	137	6/19/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0138	11.31	138	6/19/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0139	11.32	139	6/19/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0140	8.31	140	6/20/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0141	50.3	141	6/20/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0142	35.1	142	6/21/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0143	35.2	143	6/21/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0144	50.5	144	6/24/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0145	50.6	145	6/24/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0146	6.9	146	6/26/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0147	50.7	147	6/26/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0148	148	148	6/27/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0149	35.2	149	6/27/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0150	150	150	6/27/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0151	6.10	151	6/28/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Male	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0152	6.11	152	6/28/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous
OSAC9R0GR_0153	6.12	153	6/28/19	*tBAY**		Quesatare Creek	Q Creek	Ryan Gerstl (Joey leftebne)	angler	NOR	Female	Homozygous	Homozygous	Homozygous

Table S1.

SFGI ID	Kit number	Sample #	Date	Federer	Main Fishing Locations	Location	Angler/Guide	Collection Method	Origin	Genotypic Sex	Greb1L SNP1	Greb1L SNP2	Bath SNPs
OisAC9R0GR 0154	6.13	154	6/28/19		Mill Site	Clay Banks	John Anderson	NOR	Male	Heterozygous	Heterozygous	Heterozygous	
OisAC9R0GR 0155	11.35	155	6/30/19		Quoatsata Creek	226	Greg Elie	angler	Female	Homozygous fall	Homozygous fall	Homozygous fall	
OisAC9R0GR 0156	11.36	156	7/1/19		Quoatsata Creek	226	Greg Elie	angler	Male	Homozygous fall	Homozygous fall	Homozygous fall	
OisAC9R0GR 0157	11.37	157	7/1/19		Quoatsata Creek	226	Greg Elie	angler	Male	Homozygous	Homozygous	Homozygous	
OisAC9R0GR 0158	11.38	158	7/1/19		Quoatsata Creek	226	Greg Elie	angler	Female	Homozygous	Homozygous	Homozygous	
OisAC9R0GR 0159	11.4	159	7/2/19		Quoatsata Creek	226	Greg Elie	angler	Male	Homozygous	Homozygous	Homozygous	
OisAC9R0GR 0160	11.41	160	7/2/19		Quoatsata Creek	226	Greg Elie	angler	Female	Homozygous	Homozygous	Homozygous	
OisAC9R0GR 0161	49.4	161	7/5/19	**BAY**	Rouge Bay	Rouge Bay	Ryan Genasi	angler	Male	Homozygous spring	Homozygous spring	Homozygous spring	
OisAC9R0GR 0162	49.2	162	7/8/19	**BAY**	Rouge Bay	Rouge Bay	Ryan Genasi	angler	Male	Homozygous	Homozygous	Homozygous	



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