Genetic Estimation of Stock Abundance and Run-timing of Interior Columbia River Steelhead Passing Bonneville Dam

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Introduction

- Columbia River steelhead population viability is a major management concern and new genetic tools are available to estimate abundance and run-timing for effective monitoring.
- Genetic stock identification (GSI) based on 188 single nucleotide polymorphism (SNP) markers, can accurately assign wild and hatchery fish to 17 reporting groups (stocks) in the Columbia River Basin.
- Parentage based tagging (PBT) using a Snake River hatchery broodstock baseline of 95 SNPs can accurately assign offspring back to hatchery parents.

Objectives

- Use GSI to estimate wild and hatchery stock abundance and characterize run-timing.
- Demonstrate utility of PBT for hatchery-level stock discrimination of Snake River steelhead.
- Characterize A-run/B-run life-history by stock proportions.

Methods

- A total of 2468, 1760, and 1394 hatchery and wild steelhead from 2009-2011, respectively, (Table 1) were non-lethally sampled at Bonneville Dam Adult Fish Facility.
- Steelhead were genotyped at 188 single nucleotide polymorphism (SNP) loci.
- Accuracy of GSI baseline was examined and Bonneville Dam mixtures were individually and proportionally assigned to reporting groups (Fig.1) using ONCORv1.0 (S. Kalinowski).
- Abundance was estimated by multiplying biweekly stock proportions with the Bonneville Dam fish counting window tallies (Fig.2a,b).
- Run-timing distributions were characterized using biweekly estimates of reporting group abundance (Fig.3a,b).
- Four-year old (spawn-year) hatchery steelhead collected in 2011 were assigned to 2008 Snake River broodstock with SNPITv1.0 (E. Anderson).

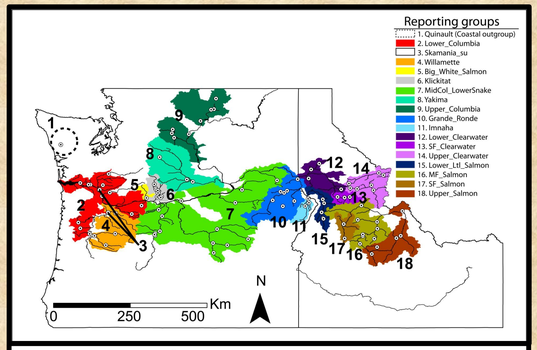

Figure 1. Map of steelhead reporting groups and samples.

Table 1. Steelhead sampled at Bonneville Dam from 2009-2011.

Biweekly strata	Wild 2009	Wild 2010	Wild 2011	Hatchery 2009	Hatchery 2010	Hatchery 2011
22_23	6	10	8	45	36	11
24_25	10	30	12	32	55	20
26_27	40	55	8	68	43	15
28_29	179	154	57	235	114	35
30_31	170	178	90	270	288	66
32_33	54	86	137	132	178	237
34_35	67	24	73	240	51	151
36_37	25	33	46	125	92	115
38_39	56	31	22	244	119	98
40_41	25	21	40	263	73	111
Total	632	622	493	1654	1049	859

Note: gray indicates sample size ≥20 and outlined boxes indicate the time interval used to estimate abundance and run-timing.

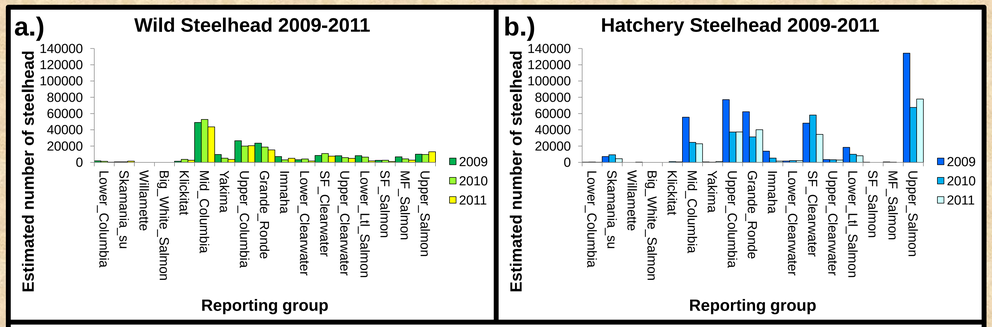

Figure 2. Estimated abundance of (a) wild and (b) hatchery steelhead reporting groups. Estimates based on 2009-2011 steelhead returns at Bonneville Dam.

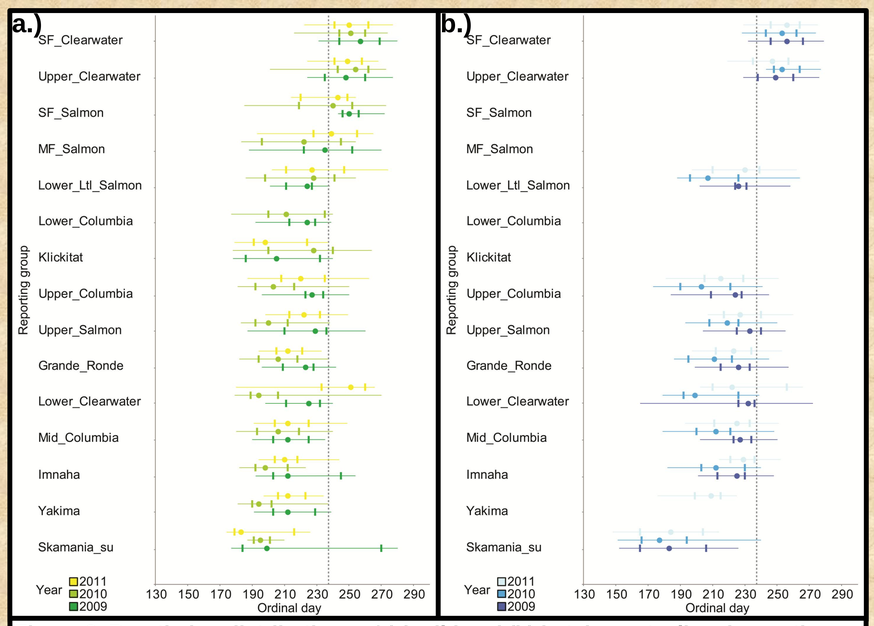

Figure 3. Run-timing distributions of (a) wild and (b) hatchery steelhead reporting groups. August 25th (dashed vertical line) classifies A-run (before 25th) and B-run (after 25th) steelhead. Median = circles, interquartile = vertical bars, 5%-95% = horizontal lines. Reporting groups with less than 0.035% relative abundance were not included.

Results

- Steelhead 188 SNP baseline shows high power to assign fish to 17 Columbia River reporting groups (Avg. 95% for ONCOR 100% mixtures; not shown).
- Estimates of steelhead wild and hatchery abundance show large differences in relative stock proportions and yearly fluctuations (Fig. 2a,b).
- Run-timing distributions of reporting groups indicate three categories: early Skamania summer, intermediate (most reporting groups), and late(SF/Upper Clearwater, SF Salmon) (Fig. 3a,b).
- PBT analyses show most fish were from Dworshak, GSI correct assignment of this group was high (~87%), and scale aging and adipose marking have some error (Fig. 4a-d).
- Steelhead A- versus B- run life-history lack definitive run-timing, length, ocean-age, and geographic origin characteristics (Fig. 5a-d).

Discussion

- GSI has potential to be an important component of wild and hatchery steelhead management.
- The expanding role of PBT will dramatically improve age and source data for hatchery steelhead and other salmonids.
- Steelhead A- and B-run life-history appears to have a large environmental (plastic) trait quality.

Work cited

ONCOR v1.0 Kalinowski ST. 2008. (available at http://www.montana.edu/kalinowski)

SNPITv1.0 Anderson EC. 2010. (details at http://swfsc.noaa.gov/publications/CR/2010/2010Anderson.pdf

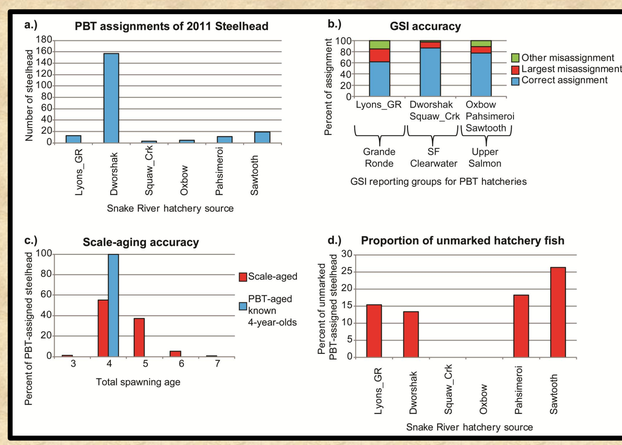

Figure 4. Parentage based tagging results. a.) All 4-year old steelhead returning in 2011 were assigned to Snake River source hatcheries. b.) GSI accuracy could be estimated after classifying hatcheries into reporting groups . c.) PBT-assigned fish were known 4-year olds and tested accuracy of scale-based ages. d.) Wild (unmarked) fish assigned with PBT are due to marking error or supplementation programs.

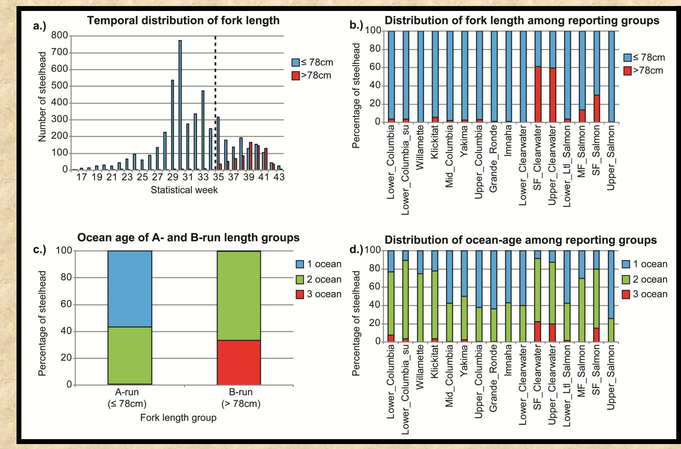

Figure 5. Steelhead A- versus B-run life-history analysis. a.) August 25th delineates run-timing of A-versus B-run fork lengths which are less and greater than 78cm, respectively. b.) GSI reporting groups show highest proportions of B-run(>78cm) in Clearwater and MF/SF Salmon Rivers. c.) Ocean-age composition of B-run consists of 2- and 3-years, but A-run also contains 2-year . d.) 2-year ocean-age is not highly predictive of B-run, however 3-ocean fish mostly found in typical B-run basins.