CRITFC

TECHNICAL REPORT 13-01

AGE AND LENGTH COMPOSITION OF COLUMBIA BASIN CHINOOK AND SOCKEYE SALMON AND STEELHEAD AT BONNEVILLE DAM IN 2011

Joe Nowinski, Denise Kelsey, John Whiteaker, and Jeffrey K. Fryer, Ph.D.

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Columbia River Inter-Tribal Fish Commission
503.238.0667
www.critfc.org
729 NE Oregon, Suite 200
Portland, OR 97232

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Columbia River Inter-Tribal Fish Commission
Technical Report
for the
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ABSTRACT

The Columbia River Inter-Tribal Fish Commission (CRITFC) conducts a field study at Bonneville Dam which first began in 1985 to assess the age, length-at-age, and stock composition of adult Pacific salmon migrating up the Columbia River. Adult spring, summer, and fall Chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*), and steelhead (*O. mykiss*) were collected, sampled for scales and additional biological data, PIT tagged, revived and released. Caudal fin clips were also taken from Chinook, steelhead, and sockeye for genetic analysis. Scales were examined to estimate age composition; the results contributed to an ongoing database for age structure of Columbia Basin salmon runs. Based on scale pattern analysis of our sample, four-year-olds were the most abundant age group for spring Chinook salmon comprising 65.7% of the run. Three-year-olds were the most abundant age class for the summer Chinook making up 44% of the run, while four-year-olds were the most abundant for fall Chinook, at 54.5%. Four-year-olds were the most abundant age group for sockeye salmon comprising 67.1% of the run, and three-year-olds were the most abundant in the steelhead run comprising 45.6% of the run. Steelhead data were analyzed for the salt years regardless of the freshwater phase, the majority of steelhead had one-salt winter (59%) in 2011. Using adipose fin clips, scale patterns, and dorsal fin condition for classification, the steelhead migration consisted of 69.8% hatchery- and 30.2% natural-origin steelhead. A-run steelhead, less than 78cm in length, comprised 90.7% of the steelhead run. B-run fish, equal to or greater than 78cm, comprised 9.3% of the run.

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INTRODUCTION

In 1985, the US-Canada Pacific Salmon Treaty was signed to manage research and enhance Pacific salmon (PSC 2000). The treaty established the Spawning Escapement-Monitoring program to assess indicator stocks within the Columbia River Basin and improve methods for providing population estimates, escapement monitoring, establishing spawner-recruit relationships and developing harvest management approaches (PST 1985). As part of this program, the Columbia River Inter-Tribal Fish Commission (CRITFC) has developed a comprehensive research strategy to monitor the age and stock composition of adult Pacific salmon returning to the Columbia River. This project has monitored the above Bonneville Dam adult migration of sockeye salmon (*Oncorhynchus nerka*) since 1985, spring Chinook salmon (*O. tshawytscha*) since 1987, summer Chinook salmon since 1990, up-river bright fall Chinook salmon since 1998, and summer steelhead (*O. mykiss*) were added to our sampling regime in 2004. Data on these runs are provided in near real time at www.critfc.org.

Scale pattern analysis, the analysis of concentric rings or circuli to provide records of previous life history, is a common method for age determination in Pacific salmon (Nielsen and Johnson 1983). Fast summer growth widens the distances between circuli on the scale and slow winter growth shortens the distance between circuli. Typically, age can be determined by counting the number of winters observed on the scale (Gilbert 1912, Rich and Holmes 1928). This method is valuable in Pacific salmon management because scales can be collected without sacrificing the fish and scale samples can be collected, processed, and aged promptly. Problems with this method may include variability in scale growth, scale resorption, and difficulties in age validation (Knudsen 1990, Beamish and McFarlane 1983).

Scale pattern analysis can also be used for stock identification if distinctive patterns can be linked to specific stocks. This method has generally been successful in discriminating Columbia River sockeye partly because there are only two major runs of sockeye in the system, which experience dramatically different early rearing environments (Fryer 1995). However, this method was found to be less successful with Chinook salmon where numerous populations can exhibit similar scale growth patterns. Currently a coast wide genetic database is being developed to create baseline microsatellite and Single Nucleotide Polymorphism (SNP) genetic data for individual salmon and steelhead populations throughout the region. This baseline genetic stock information can be utilized in mixed stock sampling to distinguish individual stocks and will be useful for the sampling program at Bonneville Dam.

The primary objectives for the 2011 sampling year were to estimate the age composition and length-at-age composition of Chinook and sockeye salmon, and steelhead using scale pattern analysis, to forecast the future run size of Chinook salmon using the age composition data, to PIT tag Chinook and sockeye, and steelhead and to collect tissue samples for use in the development of a genetic stock monitoring and identification program for Chinook and sockeye, and steelhead.

METHODS

Study Area

Research was conducted at Bonneville Dam (river km 235), which is first dam encountered by salmonids on their migration upriver to spawn (Figure 1). The collection of salmon and steelhead occurs at the Adult Fish Facility (AFF) located on the Washington shore immediately downstream of Bonneville Dam. This facility uses a picket weir to divert migrating fish, ascending the Washington shore fish ladder, into the adult sampling facility collection pool. An attraction flow is used to draw fish through a false weir where they can be selected for sampling. Fish not selected and fish that have recovered from sampling are returned to the Washington Shore Fish ladder above the picket weir.

Figure 1. Map of the Columbia River displaying federal dams. Bonneville Dam (Rkm 235).

Chinook salmon generally migrate between March and November and are typically categorized into three races based on migration timing past Bonneville Dam. Chinook salmon passing Bonneville before June 1 are classified as spring Chinook, from June 1 through July 31 are classified as summer Chinook and fish passing after July are classified as fall Chinook. In recent years, fishery managers have used June 16 rather than June 1 to separate spring and summer Chinook salmon. However, in this report, we use the traditional June 1 cutoff.

The fall Chinook run consists of lower river tule and the upriver bright fall Chinook. Tules are considered a lower river fish with most spawning below Bonneville Dam, although a few return

to hatcheries between Bonneville and The Dalles dams. They return from the ocean in their spawning colors. By contrast upriver brights are still silver in color when returning from the ocean and spawn upstream of Bonneville Dam.

Sockeye salmon typically migrate between May 15 and August 1 and summer-run steelhead between April 1 and October 31. The steelhead run is further divided into A-run and B-run components based on length (equal or greater than 78 cm for B-run).

Sample Design

Adult fish were sampled one to five days per Statistical Week[1] from April through October. A desired minimum sample size of 610 fish each was set for spring, summer, and fall Chinook, and sockeye salmon is required for age composition. This sample size was derived from simulations we conducted based on the work of Thompson (1987) and assumes that the sample is distributed approximately proportional to the weekly run size. It also assumes that our weekly sample represents a random sample of the run passing over Bonneville Dam that week. These sample sizes achieved precision and accuracy levels of $d=0.05$, $\alpha=0.10$ for age composition estimates. Additional samples were collected to buffer for unreadable scales, to provide more precision in weekly age composition estimates, as well as to meet the goals of other projects which deployed PIT tags and collected genetics samples. A steelhead sample size goal of one percent of the run was set by the U.S. v. Oregon Technical Advisory Committee. The composite age and fin clip proportions estimates were calculated from weekly estimates weighted by the number of each species migrating past Bonneville Dam during the sample week (Fryer 1995). Weekly and annual fish passage[2] counts were obtained from Fish Passage Center (2011). In 2011, genetic material was taken for genetic stock monitoring and identification program for all salmon and steelhead, including tules. Tule sample numbers are not representative of the run and scales are not collected.

In the 2011 sampling season a picket lead drop and lift schedule was implemented in the Washington fish ladder to move salmon and steelhead into the AFF trap (Figure 2). Depending on adult salmon migration density, the four picket leads needed to be raised or lowered in varying numbers to allow some fish to bypass the AFF trap, while reducing possible trap related bias. For the exact details see the trapping protocols on the US Army Corps of Engineers website (http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/2011/final/23_APP_G_20110225_TRAP.pdf).

[1] Statistical Weeks are sequentially numbered calendar-year weeks starting with the week that includes January 1 (Week 1). Excepting the first and last weeks of most years, weeks are seven days long, beginning on Sunday and ending on Saturday.

[2] Tule fall Chinook counts are subtracted from the total fall Chinook counts to estimate the upriver bright fall Chinook.

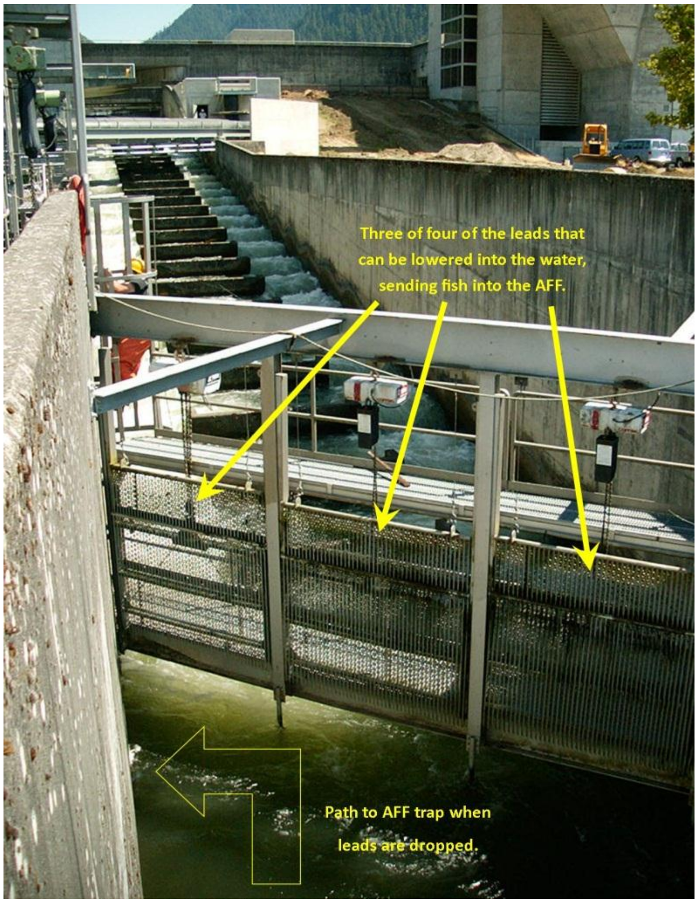

Figure 2. View of Washington Shore Fish Ladder and picket leads that diverted fish into the Bonneville Adult Fish Facility (AFF).

Fish Collection

Fish of each species were trapped at the AFF and anesthetized. Chinook salmon under 36 cm in length were not sampled to exclude precocious juveniles (known as *minijacks*), which spend no winters in saltwater. We have excluded minijacks because sampling these fish, which can be very numerous in some years, would reduce our sample of larger fish which are of much greater interest for management and research. Steelhead under 36 cm were also excluded to avoid sampling rainbow trout. All sizes of sockeye salmon were sampled. Each fish was measured for fork length to the nearest 0.5 cm, checked for identifying fin marks, tags, coloration and condition. Scale samples were collected from all fish for aging and caudal fin tissue was collected for genetic stock composition analysis. These genetic samples will be used in the development of a genetic stock identification program for Columbia River salmon and steelhead. All fish sampled were scanned for PIT tags and any PIT tag codes recorded. In 2011, our goal was to PIT tag all Chinook and sockeye salmon, and steelhead sampled which had not been previously PIT tagged. Recently CRITFC has been collecting some data from a few tules that pass over Bonneville Dam. Scales were not collected from tules, all other data types and genetic samples were collected. All fish were revived in a freshwater tank or pool and returned to a fishway leading to the Washington shore fish ladder.

Fish Coloration and Condition

Fish coloration and condition were recorded for all species at the time of sampling. Coloration was based on qualitative observations with the categories of Bright, Intermediate and Dark. Overall fish condition was also qualitatively assessed and classified on a scale of 1 to 5. Fish classified as a 5 had no major injuries that break the skin, 4 had injuries that broke the skin, 3 had injuries that penetrate the muscle tissue, 2 had injuries that penetrate a body cavity and 1 are fish missing large sections of the body. In addition to the fish condition classification, specific recognizable injuries or afflictions were recorded. These included percentage of descaling, marine mammal injuries, net damage, parasites, fungus, headburn[3], gas bubble trauma, deformities, and various other injuries.

Age Determination

To minimize the scale sample rejection rate, six scales (three per side) were collected for each Chinook and steelhead sampled (Knudsen 1990) and four scales (two per side) were collected from each sockeye salmon sampled. Scales were mounted and pressed according to methods described by Clutter and Whitesel (1956) and the International North Pacific Fisheries Commission (1963). Individual samples were visually examined and categorized using well-established scale age-estimation methods (Gilbert 1912, Rich and Holmes 1928). Only a subsample of scale ages could be validated (Beamish and McFarlane 1983) by using the tag code of previously PIT tagged fish. The total age from release to recapture at Bonneville Dam could be compared to that estimated from scale patterns.

The European method for fish age description (Koo 1962) is used in this report. The number of winters a fish spent in freshwater (not including the winter of egg incubation) is described by an Arabic numeral followed by a period. The number following the period indicates the number of winters a fish spent in saltwater. Total age, therefore, is equal to one plus the sum of both numerals.

For the fall Chinook run, tules that pass Bonneville Dam are removed from the run counts used in the age composition tables. We only report the upriver brights age data; scales are not collected from tules for age analysis.

Age and Length-at-Age Composition

Age composition was estimated by weighting the proportion of each age class sampled by the total counts of each species passing Bonneville dam during each Statistical Week. Length-at-age composition estimates (tables in the Appendix) were not weighted by weekly run size.

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3. Headburn, the exfoliation of skin and tissues of the jaw and cranial region, has been identified as a possible stress indicator of high river flow conditions or spillway discharge from dams (Elston 1996, Groberg 1996).

Steelhead Hatchery/Wild Determination

Most hatchery reared steelhead in the Columbia River Basin are marked by removing a fin, typically the adipose fin. Crowded hatchery conditions also commonly result in erosion of the dorsal fin which is readily apparent in returning adults. Some hatchery-origin steelhead are released unmarked and to identify these individuals, dorsal fin erosion or scale pattern analysis methods were used. Hatchery steelhead typically experience faster freshwater growth which results in relatively wide spaces between circuli, whereas natural origin fish typically show much slower fresh water growth narrowing the distance between circuli. In addition, hatchery origin fish are reared to smolt in a single year whereas the natural origin fish tend to remain in fresh water for two or more years.

Steelhead A/B Run Determination

Steelhead are divided into A and B run steelhead, where A run steelhead are less than 78 cm in length while B run steelhead are greater than, or equal, to 78 cm in fork length. A-run steelhead occur throughout the Columbia and Snake river basins and rarely exceed the length of 78 cm, whereas B-run steelhead are thought to be produced only in the Clearwater, Middle Fork Salmon, and South Fork Salmon rivers and typically exceed 77.5cm (U.S. v. Oregon 1997). Determination of A-run or B-run was based on length measurement.

Steelhead Kelts

Unlike other species of Pacific salmon *(Oncorhynchus spp.),* anadromous steelhead naturally exhibit varying degrees of iteroparity (repeat spawning). Successful steelhead iteroparity involves downstream migration of kelts (post-spawned steelhead) to the estuary or ocean environments (Hatch et al. 2003). During scale pattern analysis we found a few steelhead scales to have an iteroparous scale pattern. A kelt scale age is indicated through the use of the letter “S” to indicate spawning. For instance, a steelhead of Age 1.2S1 would have one freshwater annulus, two saltwater annuli, a spawning check, followed by one saltwater annulus. Note that scale resorption often occurs in kelts which can eliminate saltwater annuli marks so a kelt is likely older than would be indicated by summing the annuli and is a separate age class in the age composition table.

Chinook Salmon Run-Size Prediction

Salmon mature and return to spawn between two and seven years of age. Age composition, life history and total age vary among species. For this analysis a brood year (BY) is defined as the year in which the eggs are fertilized and a brood is defined as all the returning progeny of a given BY. A run-size prediction model is based on the relationship between the survivors within a single brood returning at different ages in successive years.

Fryer and Schwartzberg (1994) determined that adult returns of Columbia basin Chinook are comprised almost entirely of 3, 4 and 5 year old fish, with the proportions of each age class being

relatively constant across years. As such, the number of three-year-old fish for a given BY is a relatively good predictor of the number of four-year-old fish from the same BY that would return in the subsequent year. The CRITFC uses this relationship and a regression analysis (Neter et al. 1985, Weisberg 1985) to predict the abundance of four-year-old fish for the next year, based on the number of three-year-old fish estimated to have returned in this sample year. Due to the late publish date of this report, this relationship and a regression analysis were not used to predict abundance of Chinook salmon for 2012.

RESULTS

Sampling

Sampling began on April 19 and ended October 11, 2011. A total of 1129 spring Chinook , 836 summer Chinook, and 1372 fall Chinook salmon, 767 sockeye salmon, and 1391 steelhead were sampled. During the fall run, 54 additional Chinook salmon were sampled and identified as tules. Genetic samples were taken and almost all fish sampled were tagged with PIT tags for tracking. The PIT tag study results are also reported on an annual basis and will be available on the CRITFC website in spring, 2013.

We attempted to avoid sampling salmonids that spent no winters in saltwater (such Chinook are known as minijacks) by not selecting fish under 36 cm. However, in 2011, we did sample 16 Chinook salmon (lengths ranging from 38 to 46 cm), which spent no winters in saltwater (ages were 1.0). These fish were treated like other fish at the time of sampling; genetic samples were taken and they were tagged with PIT tags and tracked. For the purposes of this age composition study, these Chinook were considered minijacks and excluded from further analysis (6 were in the spring run and 10 were in the fall run).

Age Composition

Based on scale pattern analysis, four-year-olds were the majority age group for spring Chinook salmon, comprising 65.7% of the spring Chinook migration (Figure 3, Table 1). Three-year-olds were the most abundant group for summer Chinook salmon comprising 44% of the summer Chinook migration (Figure 3, Table 2), and four-year-olds were the most abundant for fall Chinook salmon, at 54.5% of the fall run (Figure 3, Table 3). A portion of the fall run at Bonneville consists of tules, which we do not include in our analysis. Over 122,000 tules passed Bonneville Dam in 2011. Data from Fish Passage Center starts the tule count on August 15^{th} during the fall Chinook run. Tule numbers were removed from the run numbers in Table 3 for fall (upriver bright) Chinook.

The percentage of ocean-type Chinook salmon (age 0.X) increased steadily through the run, from 0% in Statistical Week 17 to 97.2% in Statistical Week 42 (Figure 4). There is a gap in sampling data in Statistical Week 31 when the AFF was closed to facilitate the installation of a new flume and tank. Sampling at the AFF was also shut down August 12-17 for repairs on the Washington shore diffuser, resulting in limited sampling during Statistical Weeks 33 and 34. Sampling hours were also restricted during Statistical Weeks 35, 36 and 38 due to high water temperatures.

Four-year-olds were the majority age group for sockeye salmon (67.1%), with the remaining run equally split and comprised of three-year-old and five-year-old fish (Table 4).

Three-year-olds comprised 45.6% of the steelhead run. Four-year-olds made up another significant portion at 32.4% while the remaining run consisted of smaller numbers of five-year-

olds (18%) and other age groups (totally about 4%) (Table 5). Steelhead with unageable freshwater, but ageable saltwater winters (r.X) comprised 26.9% of the run. If these fish are included with ageable fish and the data are analyzed for salt years only, then the majority of steelhead had one-salt winter (59%) in 2011.

Aging validation from ageable scale patterns of 34 Chinook salmon that had been previously PIT tagged (most likely as juveniles) were correctly aged as follows: all 13 spring Chinook, all 18 summer Chinook, all 7 fall Chinook salmon, all 3 sockeye salmon, and 24 out of 26 steelhead. Note that only total age since release could be validated; it normally was not possible to validate saltwater and freshwater separately.

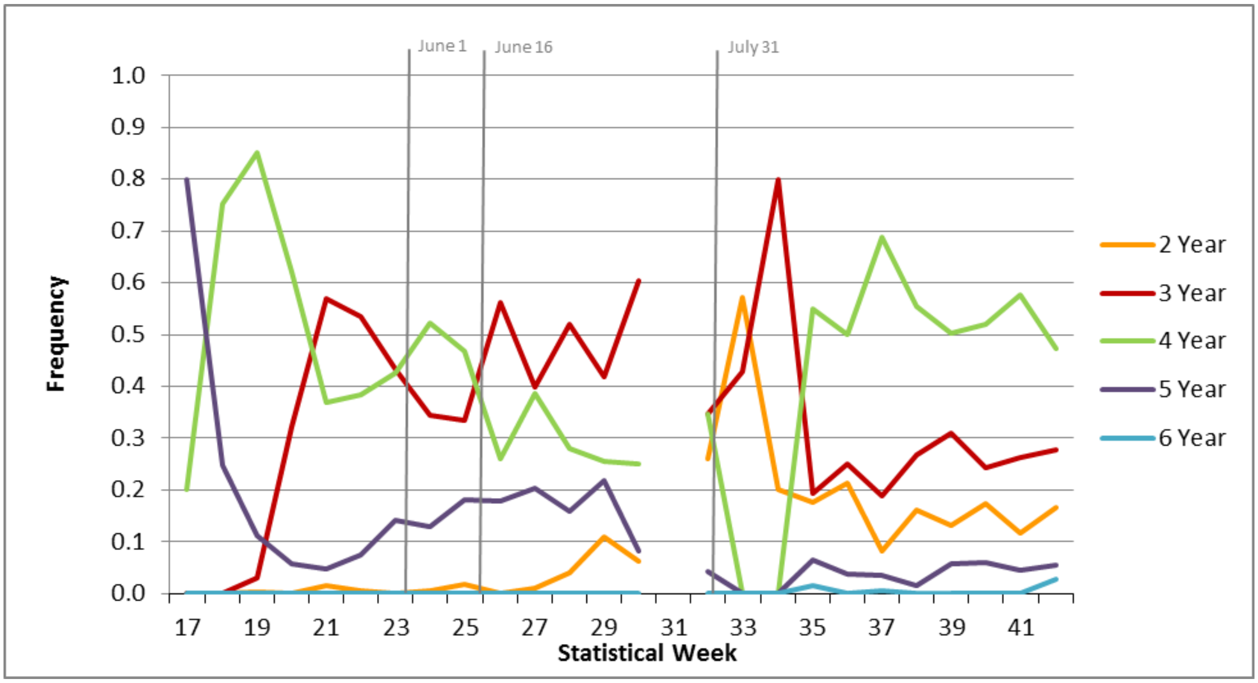

Figure 3. Weekly age composition estimates for age groups of Columbia Basin Chinook salmon sampled at Bonneville Dam in 2011. Sampling was shut down completely in week 31 and partially in weeks 33 and 34 for AFF repairs. Due to high water temperatures, sampling hours were restricted in weeks 35, 36 and 38.

Table 1. Weekly and cumulative age composition of Columbia Basin spring Chinook salmon at Bonneville Dam in 2011. Fin clip data is raw values, not composition.

					Age Composition by Brood Year and Age Class						
Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly Run Size	2009 0.1	2008 1.1	2007 1.2	2006 1.3	Fin Clips AD Only	AD w/other	Other Only
17	4/19	9	5	3306	0.000	0.000	0.200	0.800	7	1	0
18	4/27 - 4/29	130	109	32007	0.000	0.000	0.752	0.248	89	0	0
19	5/2-5/6	288	221	70606	0.005	0.032	0.851	0.113	204	2	0
20	5/9 - 5/13	246	208	65562	0.000	0.322	0.620	0.058	159	1	0
21	5/16 - 5/20	159	125	26172	0.016	0.568	0.368	0.048	103	0	0
22	5/23 - 5/27	214	187	12088	0.005	0.535	0.385	0.075	145	0	0
23	5/30, 5/31	77	67	8351	0.000	0.448	0.433	0.119	49	0	0
Cumulative		**1123**	**922**	**218092**	**0.004**	**0.222**	**0.657**	**0.117**	**756**	**4**	**0**

The weekly run size for Statistical Week 17 includes Chinook salmon passing prior to week 17.
We use May 31 as the end of the spring run, as is generally used in the region (http://www.fpc.org/documents/metadata/FPC_Adult_Metadata.html).
The United States v. Oregon Technical Advisory Committee (http://www.fws.gov/Pacific/fisheries/hatcheryreview/Reports/snakeriver/SR--079.2008-2017.USvOR.Management.Agreement_042908.pdf) uses June 15 as the end of the spring run.

Table 2. Weekly and cumulative age composition of Columbia Basin summer Chinook salmon at Bonneville Dam in 2011. Fin clip data is raw values, not composition.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly Run Size	Age Composition by Brood Year and Age Class									
					2009	2008		2007		2006		Fin Clips		
					0.1	0.2	1.1	0.3	1.2	0.4	1.3	AD Only	AD w/other	Other Only
23	6/03	52	46	12215	0.000	0.000	0.413	0.000	0.413	0.000	0.174	36	0	0
24	6/6 - 6/10	240	209	27108	0.005	0.005	0.340	0.019	0.502	0.005	0.124	155	1	0
25	6/13 - 6/17	190	171	25738	0.018	0.029	0.304	0.041	0.427	0.012	0.170	105	0	0
26	6/20 - 6/23	82	73	22942	0.000	0.041	0.521	0.082	0.178	0.000	0.178	52	0	0
27	6/27 - 7/1	92	88	25765	0.011	0.023	0.375	0.205	0.182	0.023	0.182	53	0	0
28	7/5 - 7/8	57	50	17835	0.040	0.060	0.460	0.200	0.080	0.000	0.160	39	0	0
29	7/11 - 7/14	67	55	11548	0.109	0.073	0.346	0.091	0.164	0.000	0.218	47	0	0
30-32	7/18 - 7/22	56	48	16579	0.063	0.104	0.500	0.188	0.063	0.000	0.083	39	0	0
Cumulative		**836**	**740**	**159730**	**0.024**	**0.038**	**0.402**	**0.103**	**0.268**	**0.006**	**0.159**	**526**	**1**	**0**

June 1 is designated as the start of the summer run and is generally used in the region ((http://www.fpc.org/documents/metadata/FPC_Adult_Metadata.html).
The United States v. Oregon Technical Advisory Committee (http://www.fws.gov/Pacific/fisheries/hatcheryreview/Reports/snakeriver/SR--079.2008-2017.USvOR.Management.Agreement_042908.pdf) uses June 16 as the start of the summer run.
No sampling occurred during week 31 or summer run portion of week 32.
Counts of fish passing Bonneville dam in weeks 30, 31 and 32 (up to the date of July 31 end of the summer run at Bonneville Dam) have been combined.

Table 3. Weekly and cumulative age composition of Columbia Basin fall Chinook salmon at Bonneville Dam in 2011. Fin clip data is raw values, not composition.

					Age Composition by Brood Year and Age Class										
Statistical Week	Sampling Date	Number Sampled	Number Ageable	URB Run Size	2009	2008		2007		2006		2005	Fin Clips		
					0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.05	AD Only	AD w/other	Other Only
32	8/1-8/5	24	23	3957	0.261	0.130	0.217	0.304	0.044	0.000	0.044	0.000	10	0	0
33	8/8-8/11	7	7	5672	0.571	0.143	0.286	0.000	0.000	0.000	0.000	0.000	3	0	0
34	8/18, 8/19	5	5	11700	0.200	0.400	0.400	0.000	0.000	0.000	0.000	0.000	4	0	0
35	8/22-8/25	68	62	18777	0.177	0.097	0.097	0.516	0.032	0.048	0.016	0.016	18	0	0
36	8/29-9/1	87	80	44729	0.213	0.175	0.075	0.463	0.038	0.000	0.038	0.000	25	0	0
37	9/5-9/9	217	196	107891	0.082	0.158	0.031	0.592	0.097	0.015	0.020	0.005	59	0	1
38	9/12-9/16	206	191	90211	0.162	0.220	0.047	0.482	0.073	0.011	0.005	0.000	61	0	0
39	9/19-9/23	262	243	66950	0.132	0.255	0.054	0.449	0.054	0.033	0.025	0.000	63	1	0
40	9/26-9/30	233	217	31095	0.175	0.217	0.028	0.484	0.037	0.037	0.023	0.000	45	0	0
41	10/3 - 10/07	211	198	23162	0.116	0.217	0.046	0.495	0.081	0.030	0.015	0.000	46	0	0
42	10/10, 10/11	42	36	19777	0.167	0.250	0.028	0.472	0.000	0.056	0.000	0.028	10	0	0
Cumulative		**1362**	**1258**	**423921**	**0.149**	**0.204**	**0.061**	**0.483**	**0.062**	**0.020**	**0.018**	**0.003**	**344**	**1**	**1**

August 1 is the start of the fall run at Bonneville Dam.
No sampling occurred August 12-17 (partial weeks 33 and 34) while the AFF was closed for repairs.
Due to high water temperatures, sampling hours were restricted or adjusted during weeks 35, 36 and 38 with limited impact on sample size.
The weekly run size for week 42 includes all Chinook salmon passing Bonneville Dam after the last date of sampling in week 42.
Tule numbers passing Bonneville Dam per week are removed from the Bright run size.

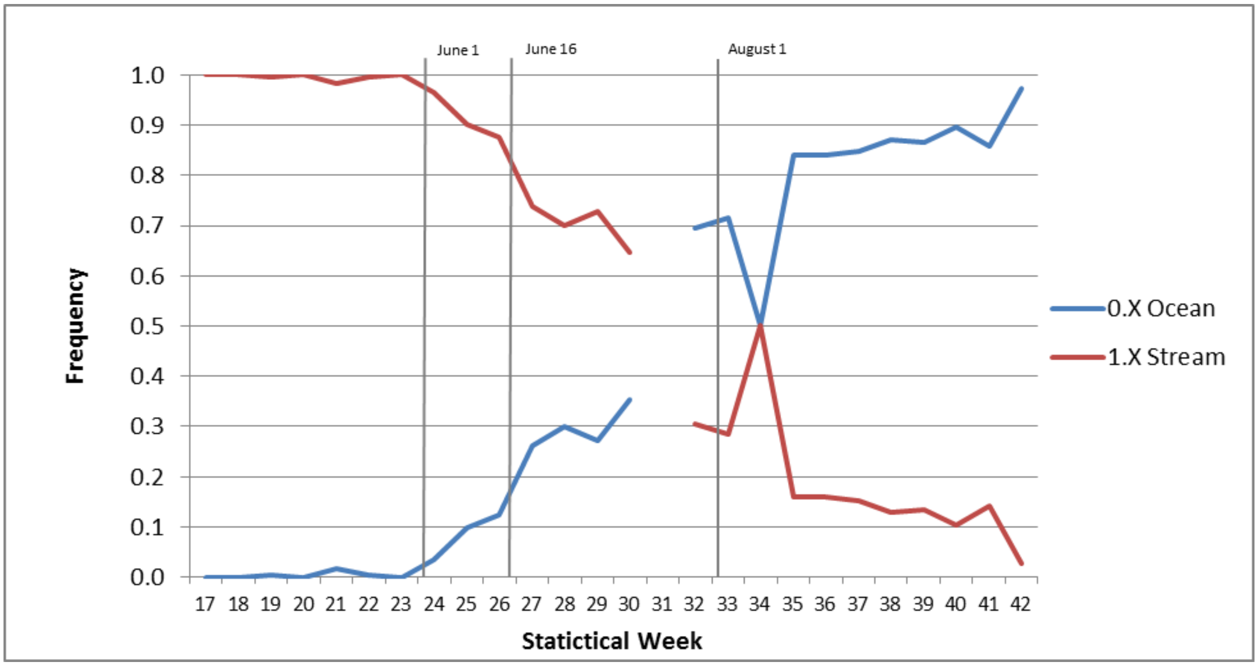

Figure 4. Weekly freshwater age composition estimates of Columbia Basin Chinook salmon sampled at Bonneville Dam in 2011. Sampling was shut down completely in week 31 and partially in weeks 33 and 34 for AFF repairs. Due to high water temperatures, sampling hours were restricted in weeks 35, 36 and 38.

Table 4. Weekly and cumulative age composition of Columbia Basin sockeye salmon at Bonneville Dam in 2011. Fin clip data is raw values, not composition.

					Age Composition by Brood Year and Age Class								
Statistical Week	**Sampling Date**	**Number Sampled**	**Number Ageable**	**Weekly Run Size**	**2008**	**2007**		**2006**		**2005**	**Fin Clips**		
					1.1	**1.2**	**2.1**	**1.3**	**2.2**	**2.3**	**AD Only**	**AD w/other**	**Other Only**
24	6/6 -6/10	19	19	1048	0.158	0.632	0.000	0.158	0.053	0.000	1	0	0
25	6/13-6/17	82	79	9304	0.051	0.608	0.025	0.253	0.063	0.000	4	0	0
26	6/20-6/23	127	125	34753	0.088	0.632	0.024	0.192	0.064	0.000	9	0	0
27	6/27-7/1	211	201	60531	0.110	0.711	0.010	0.114	0.055	0.000	11	2	1
28	7/5-7/8	178	172	53023	0.256	0.640	0.012	0.070	0.023	0.000	10	1	1
29	7/11-7/14	125	123	21521	0.333	0.569	0.057	0.033	0.008	0.000	4	0	0
30	7/18, 7/19	25	24	5616	0.292	0.625	0.042	0.000	0.000	0.042	1	0	0
Cumulative		**767**	**743**	**185796**	**0.176**	**0.651**	**0.020**	**0.110**	**0.041**	**0.001**	**40**	**3**	**2**

The weekly run size for week 24 includes sockeye salmon passing prior to this week. Similarly the weekly run size for week 30 includes fish passing after this week.

Table 5. Weekly and cumulative age composition of Columbia Basin steelhead at Bonneville Dam in 2011. Fin clip data is raw values, not composition.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly Run Size	Age Composition by Brood Year and Age Class: 2008	2007		2006			2005			2004		Repeat Spawner	Ageable Salt-Winters			A-Run	Fin Clips			Wild
					1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	4.1	3.3	4.2		1	2	3		AD Only	AD w/other	Other Only	
18	4/27-4/29	2	1	3721	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.500	0.000	1.000	1	1	0	0.000
19	5/2-5/6	2	0	328	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0	0	0	0.000
20	5/9-5/13	2	1	310	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0	0	0	1.000
21	5/16-5/20	4	1	326	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.500	0.000	1.000	3	1	0	0.000
22	5/23-5/27	12	9	398	0.000	0.556	0.000	0.333	0.111	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.636	0.364	0.667	8	0	0	0.250
23	5/30, 5/31, 6/3	8	5	563	0.200	0.400	0.000	0.200	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.625	0.250	0.875	4	0	0	0.500
24	6/6-6/10	16	11	879	0.182	0.273	0.091	0.000	0.455	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.286	0.643	0.071	0.938	7	0	0	0.375
25	6/13-6/17	16	11	1242	0.455	0.364	0.000	0.000	0.091	0.000	0.091	0.000	0.000	0.000	0.000	0.000	0.333	0.600	0.067	0.938	11	0	0	0.250
26	6/20-6/23	6	2	1745	0.333	0.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.200	0.800	0.000	0.833	3	0	0	0.333
27	6/27-7/1	17	11	4025	0.546	0.273	0.091	0.000	0.000	0.091	0.000	0.000	0.000	0.000	0.000	0.000	0.471	0.529	0.000	1.000	11	1	0	0.235
28	7/5-7/8	29	19	7307	0.368	0.211	0.053	0.000	0.211	0.000	0.000	0.158	0.000	0.000	0.000	0.000	0.310	0.690	0.000	1.000	14	2	0	0.448
29	7/11-7/14	63	53	12195	0.302	0.226	0.151	0.000	0.302	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.436	0.565	0.000	0.984	17	1	1	0.571
30-31	7/18-7/22	156	112	38877	0.316	0.184	0.123	0.000	0.290	0.009	0.000	0.053	0.009	0.000	0.000	0.018	0.513	0.487	0.000	0.994	57	9	0	0.545
31-32	8/1-8/5	212	138	78538	0.565	0.123	0.196	0.000	0.073	0.029	0.007	0.007	0.000	0.000	0.000	0.007	0.759	0.237	0.005	0.995	127	11	0	0.288
33	8/8-8/11	162	124	43456	0.548	0.121	0.113	0.000	0.137	0.032	0.000	0.016	0.008	0.000	0.000	0.024	0.702	0.292	0.006	0.988	90	8	1	0.333
34	8/18, 8/19	73	49	44589	0.531	0.143	0.143	0.000	0.163	0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.708	0.278	0.014	0.945	44	2	1	0.315
35	8/22-8/25	156	110	31166	0.491	0.236	0.146	0.000	0.073	0.036	0.000	0.009	0.000	0.000	0.009	0.000	0.706	0.288	0.007	0.942	98	10	1	0.212
36	8/29-9/1	107	75	22569	0.400	0.320	0.067	0.013	0.093	0.040	0.040	0.027	0.000	0.000	0.000	0.000	0.519	0.406	0.076	0.837	68	5	1	0.252
37	9/5-9/9	57	40	26568	0.400	0.425	0.050	0.050	0.025	0.000	0.050	0.000	0.000	0.000	0.000	0.000	0.446	0.446	0.107	0.825	37	4	0	0.193
38	9/12-9/16	65	50	19796	0.320	0.320	0.040	0.180	0.080	0.000	0.040	0.000	0.020	0.000	0.000	0.000	0.422	0.391	0.188	0.677	46	3	0	0.200
39	9/19-9/23	59	49	14775	0.265	0.306	0.000	0.367	0.020	0.000	0.020	0.020	0.000	0.000	0.000	0.000	0.305	0.305	0.390	0.542	47	6	0	0.102
40	9/26-9/30	81	59	6679	0.271	0.237	0.034	0.356	0.051	0.000	0.051	0.000	0.000	0.000	0.000	0.000	0.329	0.304	0.367	0.580	58	5	0	0.161
41	10/3-10/7	71	53	3653	0.264	0.170	0.057	0.321	0.076	0.000	0.076	0.000	0.000	0.038	0.000	0.000	0.296	0.268	0.437	0.521	45	4	0	0.254
42	10/10, 10/11	15	8	5660	0.375	0.375	0.000	0.125	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.467	0.200	0.667	12	0	0	0.200
Cumulative		**1391**	**991**	**369365**	**0.456**	**0.208**	**0.116**	**0.041**	**0.121**	**0.018**	**0.013**	**0.015**	**0.005**	**0.000**	**0.001**	**0.008**	**0.590**	**0.353**	**0.057**	**0.907**	**808**	**73**	**5**	**0.302**

The weekly run size for week 18 includes steelhead passing prior to this week. Similarly, the weekly run size for week 42 includes fish passing after this week.
No sampling occurred August 12-17 (partial weeks 33 and 34) while the AFF was closed for repairs.
Due to high water temperatures, sampling hours were restricted in weeks 35, 36 and 38.
Number ageable (fresh and salt years) is used to calculate the X.X age classes and repeat spawners.
All fish (except completely unageable and repeat spawners – total of 31) were used in the calculations of Ageable Salt-Winters.
B-run fish are 1 – A-run weekly proportion.

Length-at-Age Composition

Length-at-age composition estimates for all Chinook salmon are presented in Figure 5 and the Appendix. Length-at-age tables for sockeye salmon and steelhead are also located in the Appendix.

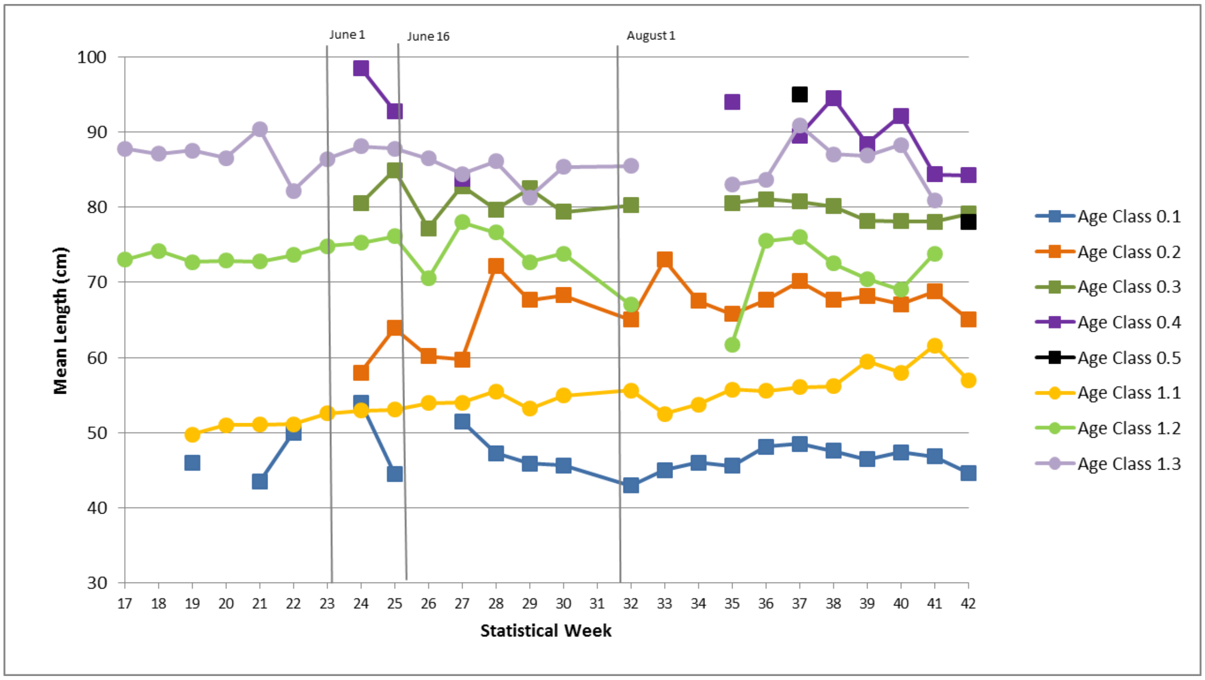

Figure 5. Weekly mean length estimates of Columbia Basin Chinook salmon age classes sampled at Bonneville Dam in 2011. Sampling was shut down completely in week 31 and partially in weeks 33 and 34 for AFF repairs. Due to high water temperatures, sampling hours were restricted in weeks 35, 36 and 38.

Fish Coloration and Condition

Bright coloration was observed in the majority of each species: 81.9% of spring Chinook salmon, 79.8% of summer Chinook, 61.5% of fall Chinook, 99.9% of sockeye salmon and 88.1% of steelhead. The highest condition rating of 5 was given to 89.1% of spring Chinook, 92.1% of summer Chinook, 93.5% of fall Chinook, 94.1% of sockeye and 87.5% of steelhead. Additional fish condition data can be found in the Appendix.

Steelhead Hatchery/Wild Determination

The vast majority of hatchery raised steelhead are released with a clipped fin, typically an adipose fin. This clip is used primarily in harvest management purposes where some fisheries allow adipose clipped fish to be kept, while non-adipose clipped fish (assumed wild) are released. Separate visual counts are made at Columbia Basin mainstem dams for non-clipped steelhead, allowing managers to estimate the percentage wild fish in the run. However, poorly

clipped adipose fins can grow back and there are a small number of hatchery programs that release steelhead unclipped. In the past, steelhead were raised in relatively crowded conditions at hatcheries, which meant that released fish commonly had so-called stubby dorsal fins (and sometimes other fins as well) from other juveniles nipping those fins (Hagerman Hatchery Evaluation Team 2009). This meant that the vast majority of adipose clipped steelhead also had stubby dorsal fins. The stubby dorsal fin was used to determine fish origin in those cases where adipose fins grew back, or where hatcheries released unclipped steelhead. However, steelhead are increasingly raised at lower densities, which should make stubby dorsals more rare in the population. Therefore, we also used scale pattern analysis to classify some unclipped steelhead as hatchery fish. Wild-origin fish typically have freshwater scale patterns showing tight growth with two or more distinct check marks, which are winter annuli. Hatchery-origin fish show much greater freshwater growth and have much less distinct annuli. Our age composition results in Table 5 are based on interpretation of scale patterns. Based on the lack of an adipose fin clip alone, we would have estimated that 36.5% of the run was of wild origin; including scale patterns reduced this to 30.2%.

Steelhead A/B Run Determination

Assuming that A-run (less than 78 cm) and B-run (equal to or greater than 78 cm) steelhead can be differentiated by length alone, the majority of the steelhead run (90.7%) passing Bonneville Dam were A-run, and the remaining 9.3% were B-run. Although A-run steelhead dominate the run, the percentage of the B-run generally increases as the run progresses (Table 5 and Figure 6).

Steelhead Kelts

In 2011, we found seven steelhead with spawning check marks in their scale patterns. The freshwater- and saltwater-winter annuli numbers varied greatly and three fish had unageable freshwater annuli. The age composition was: two 2.1S1 and one each of 2.1S, 2.2S, r.1S1, r.2S and r.2S1. All seven steelhead were PIT tagged and tracked. One of the fish was adipose clipped and the four with ageable freshwater zones appeared to have freshwater scale patterns of wild fish. Forty-nine other steelhead PIT tagged during the 2011 season displayed migration behaviors that identified them as kelts (Jeff Fryer, CRITFC, personal communication) during the months after spawning.

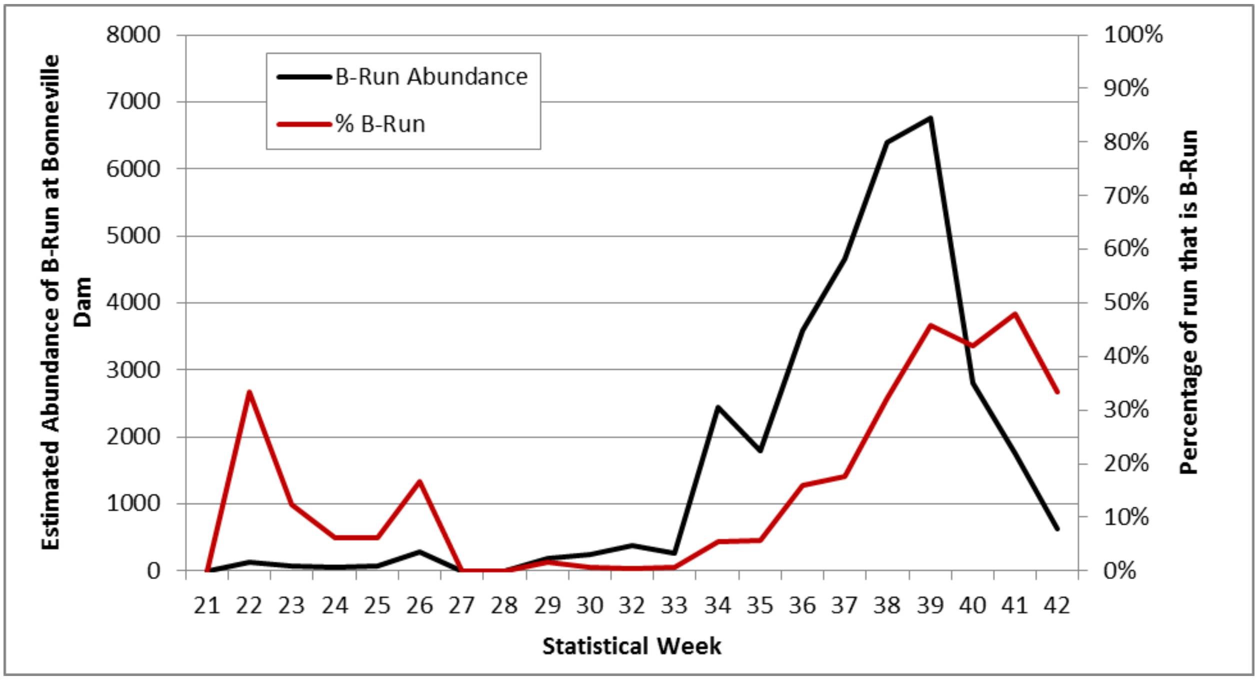

Figure 6. Percentage of B Run steelhead sampled and the estimated B Run size passing Bonneville Dam by Statistical Week in 2011. Sampling was shut down completely in week 31 and partially in weeks 33 and 34 for AFF repairs. Due to high water temperatures, sampling hours were restricted in weeks 35, 36 and 38.

DISCUSSION

High river water temperature has constrained our sampling efforts during most summer sampling seasons. Restrictions for days of sampling, and hours of the day that sampling can occur, are triggered when temperatures reach 70^{o}F (21.1^{o}C). During the 2011 sampling season, sampling was restricted during weeks 35, 36 and 38 (Figure 7) as temperatures reached a high of 71.06^{o} F on August 24 in week 35 and 69.98^{o} F on September 11 in week 38. The majority of steelhead past prior to temperatures exceeding 70^{o}F, while the Chinook run rapidly increased in week 36 as temperatures declined below 70^{o}F. Any link between temperature and passage numbers is much less apparent in 2011 than in previous years.

In 2011, tissue samples (for DNA analysis) were collected from all Chinook and sockeye salmon, and steelhead that were sampled at the Adult Fish Facility at Bonneville Dam. This was the ninth year for Chinook salmon, the fifth year for sockeye salmon, and the eighth year for steelhead that we have collected genetic samples. In previous years steelhead genetic samples were collected by ODFW and WDFW. Significant progress has been made through the coast wide genetic database to assemble baseline genetic stock identification information for all Columbia River salmon and steelhead populations. The development of genetic reference baselines has been completed and now accurate genetic stock analyses are being performed using 192 genetic markers for both steelhead and Chinook salmon. Although 96 genetic markers for sockeye salmon have been developed, samples have not yet been analyzed. Now that this baseline stock information is readily available, mixed stock sampling at Bonneville Dam will be a valuable tool for fisheries and ESA management within the Columbia River Basin.

It is expected that this stock assessment study will continue to develop an accurate age composition and length-at-age database for Columbia Basin upriver salmon populations, and work towards improving the forecasting of terminal runs, which is important for the calibration of the PSC Chinook Technical Committee's Chinook model. These data will also aid fisheries managers in formulating spawner-return relationships and analyzing productivity. Continued data collection on age composition and length-at-age will allow managers to more accurately monitor the effects of ocean harvest restrictions agreed upon by the Pacific Salmon Treaty. The addition of steelhead to our normal sampling regime provides valuable information for NOAA-Fisheries and TAC for use in steelhead assessments, fisheries forecasting and harvest management. This study will work to improve accurate age determination, hatchery fraction, and stock identification and assessment.

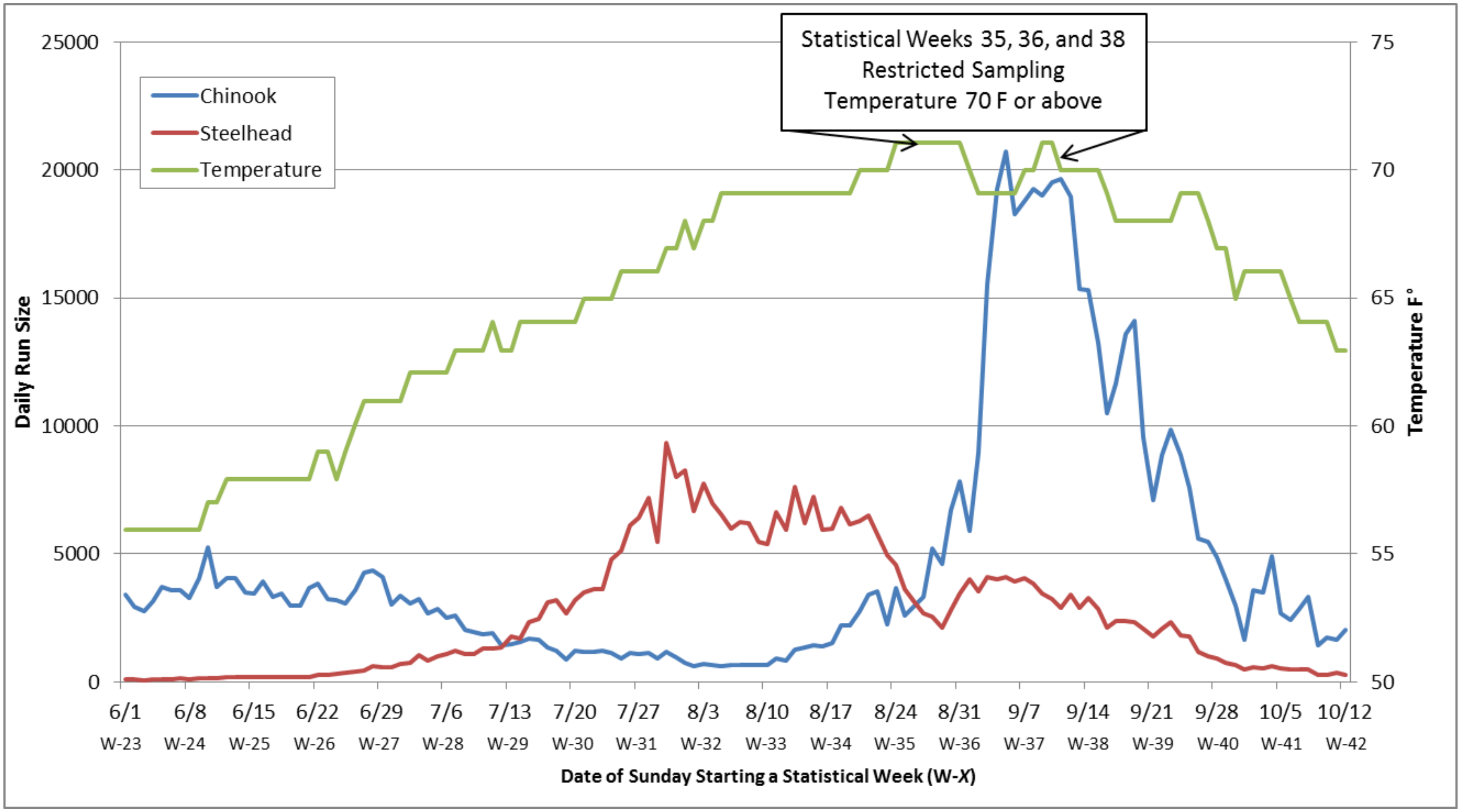

Figure 7. Chinook and steelhead daily run size and daily river temperature at Bonneville Dam for June 1 through October 11, 2011 (statistical weeks 23 through 42).

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APPENDIX

List of Tables

Table A1. Composition (%) of observed injuries of Columbia Basin Chinook and sockeye salmon and steelhead sampled at Bonneville Dam in 2011.

Injury Category	Spring	Summer	Fall	Sockeye	Steelhead	Minijacks
Marine Mammal Bites & Scrapes	30.45	30.45	12.55	16.82	27.32	
Net Marks	0.89	2.27	4.33	0.26	6.40	6.67
Descaling						
3-19%	6.14	5.86	10.64	15.91	4.39	
>20%	2.67	2.27	1.54	3.00	2.59	
Other Injuries						
Bruise	0.62	0.12	0.66	0.39	3.24	
Head Injury	4.81	6.94	13.72	1.96	7.19	13.33
Fin Injury	10.15	9.69	14.53	4.56	14.23	13.33
Fungus	0.27	0.12	0.29	0.13	0.07	
Gash	0.36	0.84	2.49	0.91	4.67	
Parasite	4.10	7.18	14.45	16.04	20.06	6.67
Total	**18.61**	**23.09**	**38.37**	**22.82**	**41.05**	**33.33**

Descaling percent is based on total body and was summarized into only two categories.
Totals under Other Injuries do not represent the sum of the injury subcategories, they are the number of fish with at least one of the injuries in the Other Injury category..

Table A2. Length-at-age estimates for Columbia Basin spring Chinook salmon sampled at Bonneville Dam in 2011.

Brood Year and Age Class	2009 0.1	2008 1.1	2007 1.2	2006 1.3
Statistical Week 17				
Mean Fork Length (cm)			73.00	87.75
Maximum			73.0	99.0
Minimum			73.0	81.5
Standard Deviation				8.15
Sample Size			1	4
Statistical Week 18				
Mean Fork Length (cm)			74.19	87.08
Maximum			90.0	95.0
Minimum			64.0	74.0
Standard Deviation			4.17	5.33
Sample Size			82	26
Statistical Week 19				
Mean Fork Length (cm)	46.00	49.79	72.70	87.52
Maximum	46.0	52.0	84.0	98.0
Minimum	46.0	47.0	62.0	79.0
Standard Deviation		1.65	3.85	4.59
Sample Size	1	7	188	25
Statistical Week 20				
Mean Fork Length (cm)		51.01	72.85	86.50
Maximum		59.0	86.5	98.0
Minimum		43.0	59.0	78.5
Standard Deviation		3.10	3.81	5.62
Sample Size		67	129	12
Statistical Week 21				
Mean Fork Length (cm)	43.50	51.10	72.76	90.42
Maximum	45.0	59.0	82.5	97.5
Minimum	42.0	40.5	53.5	85.0
Standard Deviation	2.12	3.96	5.54	4.34
Sample Size	2	71	46	6
Statistical Week 22				
Mean Fork Length (cm)	50.00	51.12	73.63	82.14
Maximum	50.0	62.5	83.0	95.0
Minimum	50.0	41.0	53.5	58.5
Standard Deviation		3.84	4.57	10.47
Sample Size	1	98	71	14
Statistical Week 23				
Mean Fork Length (cm)		52.30	74.48	88.50
Maximum		59.5	81.5	98.0
Minimum		48.0	68.5	76.0
Standard Deviation		3.44	3.74	7.09
Sample Size		30	29	8
2011 Composite				
Mean Fork Length (cm)	**45.75**	**51.18**	**73.18**	**86.75**
Maximum	**50.0**	**62.5**	**90.0**	**99.0**
Minimum	**42.0**	**40.5**	**53.5**	**58.5**
Standard Deviation	**3.30**	**3.63**	**4.17**	**6.57**
Sample Size	**4**	**273**	**546**	**95**

Table A3. Length-at-age estimates for Columbia Basin summer Chinook salmon sampled at Bonneville Dam in 2011.

Brood Year and	2009	2008		2007		2006	
Age Class	0.1	0.2	1.1	0.3	1.2	0.4	1.3
Statistical Week 23							
Mean Fork Length (cm)			52.95		75.32		84.25
Maximum			57.5		82.0		93.0
Minimum			45.0		66.0		78.0
Standard Deviation			2.84		3.67		4.46
Sample Size			19.00		19		8
Statistical Week 24							
Mean Fork Length (cm)	54.00	58.00	52.97	80.50	75.23	98.50	88.12
Maximum	54.0	58.0	61.5	87.5	85.5	98.5	97.0
Minimum	54.0	58.0	43.5	74.0	60.5	98.5	75.5
Standard Deviation			3.77	5.96	4.36		5.42
Sample Size	1	1	71	4	105	1	26
Statistical Week 25							
Mean Fork Length (cm)	44.50	63.90	53.05	84.93	76.13	92.75	87.78
Maximum	47.5	65.0	61.5	94.5	87.0	95.0	97.5
Minimum	42.0	63.0	45.0	79.5	59.0	90.5	76.0
Standard Deviation	2.78	0.74	3.90	5.18	5.38	3.18	5.16
Sample Size	3	5	52	7	73	2	29
Statistical Week 26							
Mean Fork Length (cm)		60.17	53.93	77.17	70.54		86.46
Maximum		63.0	61.0	80.5	84.0		92.5
Minimum		57.5	45.0	73.0	45.5		80.0
Standard Deviation		2.75	3.60	2.64	9.99		3.80
Sample Size		3	38	6	13		13
Statistical Week 27							
Mean Fork Length (cm)	51.50	59.75	53.98	82.78	77.97	83.75	84.41
Maximum	51.5	66.5	61.0	91.5	89.0	89.5	91.5
Minimum	51.5	53.0	43.5	71.5	68.5	78.0	73.5
Standard Deviation		9.55	3.65	5.33	6.11	8.13	5.31
Sample Size	1	2	33	18	16	2	16
Statistical Week 28							
Mean Fork Length (cm)	47.25	72.17	55.48	79.70	76.63		86.06
Maximum	50.0	79.0	62.0	88.0	80.5		98.5
Minimum	44.5	62.5	48.5	72.0	68.5		80.0
Standard Deviation	3.89	8.61	3.83	5.23	5.51		6.01
Sample Size	2	3	23	10	4		8
Statistical Week 29							
Mean Fork Length (cm)	45.92	67.63	53.18	82.50	72.72		81.29
Maximum	53.0	74.0	59.5	88.0	88.5		89.0
Minimum	41.0	61.5	46.5	78.0	62.0		61.0
Standard Deviation	5.60	5.66	3.72	3.91	8.04		8.11
Sample Size	6	4	19	5	9		12
Statistical Week 30							
Mean Fork Length (cm)	45.67	68.30	54.94	79.39	73.83		85.38
Maximum	55.0	73.0	62.5	87.5	81.0		92.5
Minimum	40.0	62.0	50.0	61.0	61.0		80.5
Standard Deviation	8.14	4.60	3.54	8.10	11.14		5.07
Sample Size	3	5	24	9	3		4
2011 Composite							
Mean Fork Length (cm)	**46.63**	**65.48**	**53.63**	**81.25**	**75.35**	**90.30**	**86.13**
Maximum	**55.0**	**79.0**	**62.5**	**94.5**	**89.0**	**98.5**	**98.5**
Minimum	**40.0**	**53.0**	**43.5**	**61.0**	**45.5**	**78.0**	**61.0**
Standard Deviation	**5.28**	**6.21**	**3.73**	**5.75**	**5.56**	**7.77**	**5.76**
Sample Size	**16**	**23**	**279**	**59**	**242**	**5**	**116**

Table A4. Length-at-age estimates for Columbia Basin fall Chinook salmon sampled at Bonneville Dam in 2011.

Brood Year and	2009	2008		2007		2006		2005
Age Class	0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5
Statistical Week 32								
Mean Fork Length (cm)	43.00	65.00	55.60	80.21	67.00		85.50	
Maximum	52.0	66.5	60.0	97.5	67.0		85.5	
Minimum	38.0	63.5	49.0	73.0	67.0		85.5	
Standard Deviation	5.01	1.50	4.16	7.94				
Sample Size	6	3	5	7	1		1	
Statistical Week 33								
Mean Fork Length (cm)	45.00	73.00	52.50					
Maximum	50.0	73.0	53.0					
Minimum	43.0	73.0	52.0					
Standard Deviation	3.37		0.71					
Sample Size	4	1	2					
Statistical Week 34								
Mean Fork Length (cm)	46.00	67.50	53.75					
Maximum	46.0	70.0	59.5					
Minimum	46.0	65.0	48.0					
Standard Deviation		3.54	8.13					
Sample Size	1	2	2					
Statistical Week 35								
Mean Fork Length (cm)	45.59	65.75	55.75	80.53	61.75	94.00	83.00	109.00
Maximum	53.0	72.0	60.0	90.0	69.5	99.0	83.0	109.0
Minimum	39.0	61.0	53.0	70.0	54.0	89.0	83.0	109.0
Standard Deviation	4.50	3.82	2.82	4.22	10.96	5.00		
Sample Size	11	6	6	32	2	3	1	1
Statistical Week 36								
Mean Fork Length (cm)	48.13	67.65	55.58	81.04	75.50		83.67	
Maximum	58.0	77.5	59.5	92.5	79.5		87.0	
Minimum	41.0	57.0	51.0	67.0	71.0		81.0	
Standard Deviation	4.50	5.17	3.06	4.98	4.27		3.06	
Sample Size	16	13	6	36	3		3	
Statistical Week 37								
Mean Fork Length (cm)	48.50	70.15	56.08	80.76	76.00	89.50	90.88	95.00
Maximum	58.0	84.0	64.5	100.5	87.5	99.5	98.0	95.0
Minimum	42.0	60.0	52.5	62.0	64.0	80.5	85.0	95.0
Standard Deviation	4.54	6.53	4.58	5.84	6.09	9.54	5.36	
Sample Size	16	31	6	115	19	3	4	1
Statistical Week 38								
Mean Fork Length (cm)	47.58	67.67	56.17	80.13	72.54	94.50	87.00	
Maximum	58.0	80.0	62.5	91.0	81.5	95.0	87.0	
Minimum	40.0	55.0	50.5	65.5	59.0	94.0	87.0	
Standard Deviation	3.90	6.26	4.05	4.66	6.63	0.71		
Sample Size	31	42	9	92	14	2	1	
Statistical Week 39								
Mean Fork Length (cm)	46.44	68.17	59.50	78.20	70.46	88.38	86.83	
Maximum	55.5	81.0	68.0	90.0	79.5	100.0	92.0	
Minimum	38.0	57.0	48.5	59.0	59.0	79.0	78.5	
Standard Deviation	3.92	5.71	5.40	5.33	6.98	6.79	4.48	
Sample Size	32	62	12	109	13	8	6	
Statistical Week 40								
Mean Fork Length (cm)	47.37	67.09	58.00	78.13	69.00	92.13	88.30	
Maximum	58.5	77.5	65.0	93.5	77.0	104.5	96.0	
Minimum	39.0	51.5	52.0	68.0	65.0	84.5	84.0	
Standard Deviation	4.30	5.46	5.76	4.80	3.81	7.22	4.86	
Sample Size	38	47	6	104	8	8	5	
Statistical Week 41								
Mean Fork Length (cm)	46.80	68.77	61.61	78.08	73.81	84.33	80.83	
Maximum	65.5	79.0	68.5	91.0	81.0	90.5	82.0	
Minimum	38.0	52.0	56.5	63.0	63.0	74.5	79.5	
Standard Deviation	5.60	5.40	3.26	4.56	6.45	5.85	1.26	
Sample Size	23	43	9	98	16	6	3	
Statistical Week 42								
Mean Fork Length (cm)	44.67	65.11	57.00	79.09		84.25		78.00
Maximum	46.0	72.0	57.0	89.0		89.5		78.0
Minimum	43.0	60.0	57.0	70.0		79.0		78.0
Standard Deviation	1.40	4.03		5.20		7.42		
Sample Size	6	9	1	17		2		1
2011 Composite								
Mean Fork Length (cm)	**46.94**	**68.02**	**57.41**	**79.28**	**72.70**	**89.31**	**86.46**	**94.00**
Maximum	**65.5**	**84.0**	**68.5**	**100.5**	**87.5**	**104.5**	**98.0**	**109.0**
Minimum	**38.0**	**51.5**	**48.0**	**59.0**	**54.0**	**74.5**	**78.5**	**78.0**
Standard Deviation	**4.40**	**5.70**	**4.71**	**5.20**	**6.74**	**7.04**	**4.80**	**15.52**
Sample Size	**184**	**259**	**64**	**610**	**76**	**32**	**24**	**3**

Table A5. Length-at-age estimates for Columbia Basin sockeye salmon sampled at Bonneville Dam in 2011.

Brood Year and	2009	2008		2007		2006
Age Class	1.1	1.2	2.1	1.3	2.2	2.3
Statistical Week 24						
Mean Fork Length (cm)	37.67	52.13		58.50	50.50	
Maximum	40.5	55.5		59.0	50.5	
Minimum	35.0	49.0		57.5	50.5	
Standard Deviation	2.75	2.11		0.87		
Sample Size	3	12		3	1	
Statistical Week 25						
Mean Fork Length (cm)	39.00	50.34	44.00	56.97	51.50	
Maximum	42.0	55.0	44.5	63.0	54.0	
Minimum	37.0	44.5	43.5	53.0	49.5	
Standard Deviation	2.45	2.55	0.71	2.48	1.66	
Sample Size	4	47	2	19	5	
Statistical Week 26						
Mean Fork Length (cm)	39.27	51.08	42.50	57.81	51.44	
Maximum	41.5	56.0	43.0	61.5	55.0	
Minimum	36.5	45.0	42.0	55.5	49.0	
Standard Deviation	1.85	2.25	0.50	1.51	2.38	
Sample Size	11	79	3	24	8	
Statistical Week 27						
Mean Fork Length (cm)	39.55	51.18	39.25	57.22	50.64	
Maximum	43.5	56.5	40.5	61.0	53.0	
Minimum	37.0	45.0	38.0	53.5	46.5	
Standard Deviation	1.67	2.27	1.77	1.68	2.12	
Sample Size	22	143	2	23	11	
Statistical Week 28						
Mean Fork Length (cm)	40.01	50.52	42.25	54.58	52.13	
Maximum	43.0	55.0	44.0	58.5	55.5	
Minimum	37.0	44.5	40.5	52.0	48.5	
Standard Deviation	1.47	2.20	2.47	2.73	3.04	
Sample Size	44	110	2	12	4	
Statistical Week 29						
Mean Fork Length (cm)	39.88	50.50	42.36	55.50	52.00	
Maximum	43.0	57.0	45.5	57.5	52.0	
Minimum	37.5	45.5	40.0	53.5	52.0	
Standard Deviation	1.58	2.35	1.77	1.68		
Sample Size	41	70	7	4	1	
Statistical Week 30						
Mean Fork Length (cm)	39.86	49.77	42.00			57.50
Maximum	44.0	54.5	42.0			57.5
Minimum	37.0	43.5	42.0			57.5
Standard Deviation	2.36	2.72				
Sample Size	7	15	1			1
2011 Composite						
Mean Fork Length (cm)	**39.74**	**50.81**	**42.18**	**56.92**	**51.23**	**57.50**
Maximum	**44.0**	**57.0**	**45.50**	**63.00**	**55.5**	**57.5**
Minimum	**35.0**	**43.5**	**38.00**	**52.00**	**46.5**	**57.5**
Standard Deviation	**1.69**	**2.33**	**1.83**	**2.24**	**2.14**	
Sample Size	**132**	**476**	**17**	**85**	**30**	**1**

Table A6. Length-at-age estimates for Columbia Basin steelhead sampled at Bonneville Dam in 2011.

Ocean	Salt-Winters		
Age Class	1	2	3
Statistical Week 18			
Mean Fork Length (cm)	62.00	62.00	
Maximum	62.0	62.0	
Minimum	62.0	62.0	
Standard Deviation			
Sample Size	1	1	
Statistical Week 19			
Mean Fork Length (cm)		68.25	
Maximum		70.5	
Minimum		66.0	
Standard Deviation		3.18	
Sample Size		2	
Statistical Week 20			
Mean Fork Length (cm)		71.50	
Maximum		76.0	
Minimum		67.0	
Standard Deviation		6.36	
Sample Size		2	
Statistical Week 21			
Mean Fork Length (cm)	63.00	65.50	
Maximum	64.0	70.0	
Minimum	62.0	61.0	
Standard Deviation	1.41	6.36	
Sample Size	2	2	
Statistical Week 22			
Mean Fork Length (cm)		67.36	85.38
Maximum		71.0	88.0
Minimum		64.0	82.0
Standard Deviation		2.50	2.50
Sample Size		7	4
Statistical Week 23			
Mean Fork Length (cm)	57.00	69.20	76.75
Maximum	57.0	76.0	78.0
Minimum	57.0	65.5	75.5
Standard Deviation		3.98	1.77
Sample Size	1	5	2
Statistical Week 24			
Mean Fork Length (cm)	61.88	68.83	78.00
Maximum	68.5	73.5	78.0
Minimum	53.0	64.0	78.0
Standard Deviation	6.91	3.72	
Sample Size	4	9	1
Statistical Week 25			
Mean Fork Length (cm)	56.80	67.94	82.00
Maximum	66.0	77.5	82.0
Minimum	51.0	64.5	82.0
Standard Deviation	5.60	3.84	
Sample Size	5	9	1
Statistical Week 26			
Mean Fork Length (cm)	50.00	69.83	
Maximum	50.0	71.0	
Minimum	50.0	68.5	
Standard Deviation		1.26	
Sample Size	1	3	

Ocean	Salt-Winters		
Age Class	1	2	3
Statistical Week 27			
Mean Fork Length (cm)	55.88	67.89	
Maximum	61.5	70.5	
Minimum	49.5	62.5	
Standard Deviation	4.27	2.58	
Sample Size	8	9	
Statistical Week 28			
Mean Fork Length (cm)	56.28	69.20	
Maximum	59.0	76.0	
Minimum	54.0	61.5	
Standard Deviation	1.92	4.08	
Sample Size	9	20	
Statistical Week 29			
Mean Fork Length (cm)	57.17	69.06	
Maximum	63.0	79.0	
Minimum	52.0	63.5	
Standard Deviation	3.43	3.38	
Sample Size	27	35	
Statistical Week 30			
Mean Fork Length (cm)	56.86	68.32	
Maximum	64.0	78.5	
Minimum	49.5	61.0	
Standard Deviation	2.88	3.37	
Sample Size	78	76	
Statistical Week 32			
Mean Fork Length (cm)	57.97	68.78	79.00
Maximum	70.5	77.0	79.0
Minimum	49.5	60.0	79.0
Standard Deviation	2.96	3.71	
Sample Size	154	48	1
Statistical Week 33			
Mean Fork Length (cm)	57.36	69.26	76.00
Maximum	65.0	83.0	76.0
Minimum	52.0	61.5	76.0
Standard Deviation	2.52	4.55	
Sample Size	112	44	1
Statistical Week 34			
Mean Fork Length (cm)	58.04	70.75	76.00
Maximum	66.0	78.5	76.0
Minimum	51.5	62.0	76.0
Standard Deviation	2.79	5.13	
Sample Size	51	20	1
Statistical Week 35			
Mean Fork Length (cm)	58.15	73.35	84.00
Maximum	66.5	83.0	84.0
Minimum	48.0	65.0	84.0
Standard Deviation	3.07	4.68	
Sample Size	108	44	1

Ocean	Salt-Winters		
Age Class	1	2	3
Statistical Week 36			
Mean Fork Length (cm)	58.06	73.54	82.06
Maximum	66.5	82.0	89.5
Minimum	50.0	64.0	72.5
Standard Deviation	3.17	4.71	5.23
Sample Size	53	42	8
Statistical Week 37			
Mean Fork Length (cm)	57.90	73.88	80.75
Maximum	63.0	85.5	84.5
Minimum	50.0	64.0	75.5
Standard Deviation	3.12	5.05	3.17
Sample Size	25	25	6
Statistical Week 38			
Mean Fork Length (cm)	58.52	75.68	82.13
Maximum	65.0	83.5	88.0
Minimum	54.0	67.0	77.5
Standard Deviation	2.51	4.11	3.35
Sample Size	27	25	12
Statistical Week 39			
Mean Fork Length (cm)	59.25	74.53	83.65
Maximum	65.0	85.0	91.5
Minimum	54.5	66.0	77.0
Standard Deviation	3.68	5.43	3.91
Sample Size	18	18	23
Statistical Week 40			
Mean Fork Length (cm)	59.38	73.65	82.86
Maximum	65.5	78.5	89.0
Minimum	51.5	67.0	75.0
Standard Deviation	3.52	3.60	3.48
Sample Size	26	24	29
Statistical Week 41			
Mean Fork Length (cm)	61.48	73.34	83.50
Maximum	68.0	82.5	98.5
Minimum	52.5	65.0	76.5
Standard Deviation	4.38	5.72	4.82
Sample Size	21	19	31
Statistical Week 42			
Mean Fork Length (cm)	60.40	71.50	83.83
Maximum	65.0	81.0	85.5
Minimum	56.0	63.5	82.0
Standard Deviation	3.34	6.20	1.76
Sample Size	5	7	3
2011 Composite			
Mean Fork Length (cm)	57.96	70.88	82.77
Maximum	70.5	85.5	98.5
Minimum	48.0	60.0	72.5
Standard Deviation	3.19	4.91	4.10
Sample Size	736	496	124