CRITFC

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Age and Length Composition of Columbia Basin Chinook and Sockeye Salmon and Steelhead at Bonneville Dam in 2014

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Columbia River Inter-Tribal Fish Commission
Technical Report
for the
Department of Interior
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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, summer and fall Chinook Salmon comprising, respectively, 82.0%, 61.5% and 66.6% of the runs. Four-year-olds were also the most abundant age group for Sockeye Salmon comprising 84.4% of the run, and steelhead run comprising 55.9% of the run. Steelhead data were analyzed for the salt years regardless of the freshwater phase, the majority of steelhead had two-salt winters (68.4%) in 2014. Using adipose fin clips, scale patterns, and dorsal fin condition for classification, the steelhead migration consisted of 61.0% hatchery- and 39.0% natural-origin steelhead. A-run steelhead, less than 78cm in length, comprised 83.9% of the steelhead run. B-run fish, equal to or greater than 78cm, comprised 16.1% 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 2014 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, 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 trapped for sampling. Fish not trapped 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 and utility district 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 (www.fpc.org). 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 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 about June 1 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 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 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, α=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 counts were obtained from Fish Passage Center (2014). In 2014, 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 2014 sampling season a picket lead drop and lift schedule was maintained 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 periodically raised to allow fish to bypass the AFF trap. For the exact details see the trapping protocols at http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/2014/final/FPP14_AppG.pdf

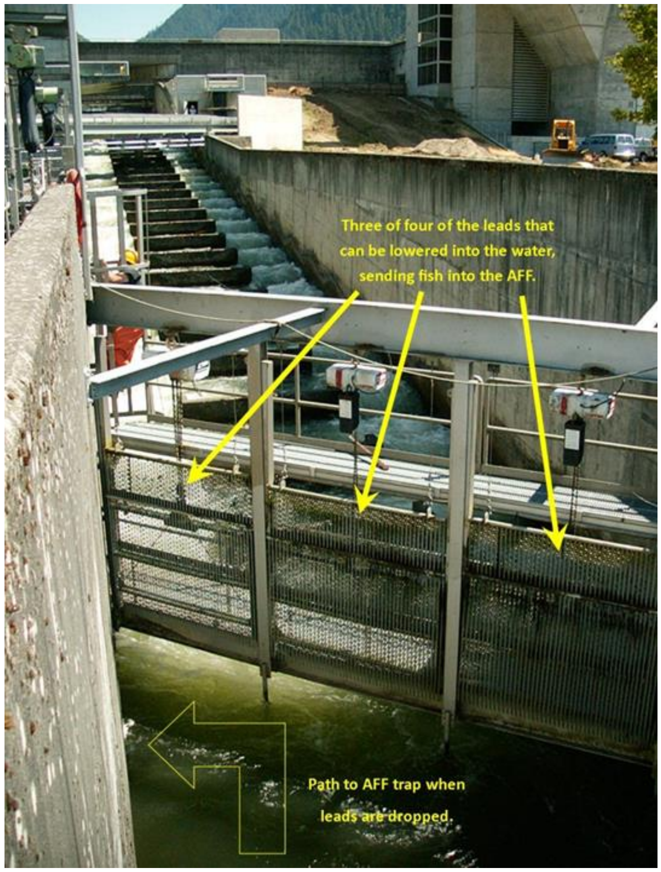

Figure 2. View of Washington Shore Fish Ladder and picket leads that diverted fish into the Bonneville Adult Fish Facility (AFF).

Fish Collection

Fish of each species were trapped at the AFF and anesthetized. Chinook Salmon under 36 cm in length were not sampled to reduce our sample of 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 2014, 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 length data and genetic samples from tules that pass over Bonneville Dam. 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 whenever they were present on the fish and include percentage of descaling, marine mammal injuries, hooking injuries, and net damage. For all other types of injuries, the injury was only recorded if the injury reduced the condition of the fish from a 5 to 4 - 1. This change in protocol from previous years, was necessary to reduce the amount of time spent on each fish so that more fish could be sampled and tagged.

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. If poor scale quality, particularly in the freshwater prevents age determination in all scales collected from a particular fish, no age is assigned. The exception is steelhead, where if saltwater age can be reliably determined, the age is designated as r.X where X is the saltwater age and “r” stands for regenerated.

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 bright 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.

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 for 2015

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 three-, four- and five-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.

RESULTS

Sampling

Sampling began on April 15 and ended October 17, 2014. A total of 1515 spring Chinook, 987 summer Chinook, and 1386 fall Chinook Salmon, 1420 Sockeye Salmon, and 1728 steelhead were sampled. During the fall run, 55 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 are available for download on the CRITFC website.

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 2014, we did sample three Chinook Salmon over 36 cm, which scale analysis indicated spent no winters in saltwater. 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.

Age Composition

Based on scale pattern analysis, four-year-olds were the majority age class for all chinook in 2014 comprising 82.0% of the spring Chinook migration (Figure 3, Table 1), 61.5% of the summer Chinook run (Figure 3, Table 2), and 66.6% of the fall migration (Figure 3, Table 3). A portion of the fall run at Bonneville consists of tules, which we do not include in our analysis. Nearly 100,000 tules passed Bonneville Dam in 2014. Data from Fish Passage Center starts the tule count on August 15th during the fall Chinook run. Tule numbers were removed from the run numbers in Table 3 for the analysis of fall (upriver bright) Chinook.

The percentage of ocean-type Chinook Salmon (age 0.X) increased steadily through the run, from 0% in Statistical Week 16 to a peak of 100.0% in Statistical Week 33 (Figure 4). Sampling hours were restricted during Statistical Weeks 31 to 36 due to high water temperatures.

Four-year-olds were also the majority age class for Sockeye Salmon (84.4%) with most the remaining portion of the run consisting of three-year-old at 14.3% (Table 4).

Four-year-olds comprised 55.9% of the steelhead run. Three-year-olds made up 20.3% while the remaining run consisted of five-year-olds (23.2%) and six-year-olds (0.6%) (Table 5). Steelhead with unageable freshwater, but ageable saltwater winters (r.X) comprised 22.7% of the steelhead sampled and if these fish were included with ageable fish and the data are analyzed for salt years only, then the majority of steelhead had two-salt winters (68.4%) in 2014.

A total of 103 salmon and steelhead sampled were previously PIT tagged as juveniles and their known age was compared with scale age to assist in age validation. The result include the correct aging of the following: all 29 spring Chinook, 21 of 22 summer Chinook, all 6 fall Chinook Salmon, 41 of 42 steelhead and all 4 Sockeye Salmon. Note that only total age since release

could be corroborated; it normally is not possible to validate saltwater and freshwater separately.

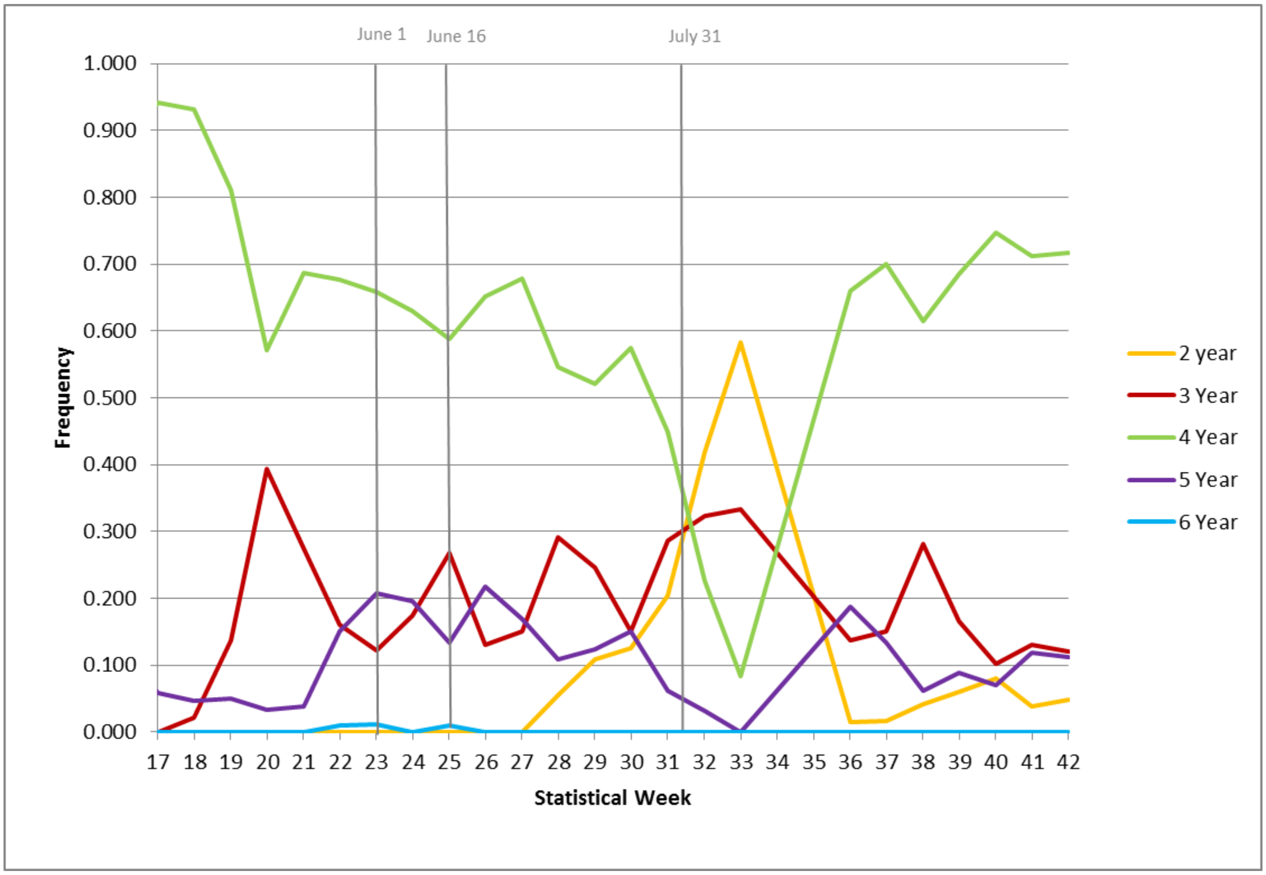

Figure 3. Weekly age composition estimates for age groups of Columbia Basin Chinook Salmon sampled at Bonneville Dam in 2014. Due to high water temperatures, sampling hours were restricted in weeks 31-36. Spring chinook pass Bonneville Dam April 1 to May 31 (Technical Advisory Committee US v. OR (TAC) dates are April 1 to June 15), summer Chinook pass the dam from June 1 to July 31 (TAC dates are June 16 to July 31), and fall Chinook pass Bonneville Dam August 1 to Oct 31.

Table 1. Weekly and cumulative age composition of Columbia Basin spring Chinook Salmon at Bonneville Dam in 2014.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly run size	Age Composition by Brood Year and Age Class 2011 0.2	2011 1.1	2010 0.3	2010 1.2	2009 0.4	2009 1.3	2009 2.2	2008 1.4	Adipose Clips	Adipose w/Other	Other Clips
16	4/15, 4/16, 4/17, 4/18	116	92	14289	0.000	0.000	0.000	0.880	0.000	0.120	0.000	0.000	85	0	1
17	4/21, 4/22, 4/23, 4/24, 4/25	251	188	27193	0.000	0.000	0.000	0.941	0.000	0.059	0.000	0.000	193	0	0
18	4/28, 4/29, 4/30, 5/2	233	190	68414	0.000	0.021	0.000	0.932	0.000	0.047	0.000	0.000	160	2	0
19	5/5, 5/6, 5/8, 5/9	182	138	42680	0.000	0.138	0.000	0.812	0.000	0.043	0.007	0.000	113	1	0
20	5/12, 5/13, 5/14, 5/15, 5/16	250	208	27203	0.000	0.394	0.000	0.572	0.000	0.034	0.000	0.000	132	0	0
21	5/19, 5/20, 5/21, 5/22, 5/23	269	233	18398	0.009	0.266	0.021	0.665	0.000	0.039	0.000	0.000	139	1	2
22	5/27, 5/28, 5/29, 5/30	214	186	16000	0.000	0.161	0.000	0.677	0.005	0.145	0.000	0.011	86	0	0
Cumulative		**1515**	**1235**	**214177**	**0.001**	**0.119**	**0.002**	**0.818**	**0.000**	**0.058**	**0.001**	**0.001**	**908**	**4**	**3**

The weekly run size for Statistical Week 16 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 2014.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly run size	2012 0.1	2011 0.2	2011 1.1	2010 0.3	2010 1.2	2009 0.4	2009 1.3	2009 2.2	2008 0.5	2008 1.4	2008 2.3	Adipose Clips	Adipose w/Other	Other Clips
23	6/2, 6/3, 6/4, 6/5, 6/6	275	246	19268	0.000	0.000	0.122	0.122	0.537	0.073	0.126	0.008	0.004	0.004	0.004	1	1	1
24	6/9, 6/10, 6/11, 6/12, 6/13	252	224	21821	0.000	0.004	0.170	0.179	0.451	0.040	0.156	0.000	0.000	0.000	0.000	0	0	0
25	6/16, 6/17, 6/18, 6/19, 6/20	111	97	18867	0.000	0.031	0.237	0.247	0.340	0.052	0.072	0.010	0.000	0.010	0.000	0	1	0
26	6/23, 6/25, 6/26, 6/27	50	46	21406	0.000	0.022	0.109	0.283	0.370	0.065	0.152	0.000	0.000	0.000	0.000	0	0	0
27	6/30, 7/1, 7/2, 7/3	58	53	19642	0.000	0.019	0.132	0.358	0.321	0.019	0.151	0.000	0.000	0.000	0.000	0	0	0
28	7/7, 7/8, 7/9, 7/10, 7/11	60	55	14474	0.055	0.055	0.236	0.345	0.200	0.018	0.091	0.000	0.000	0.000	0.000	0	0	0
29	7/14, 7/15, 7/16, 7/17, 7/18	89	73	9321	0.110	0.041	0.205	0.260	0.260	0.027	0.096	0.000	0.000	0.000	0.000	0	0	0
30	7/21, 7/22, 7/23, 7/24, 7/25	44	40	5610	0.125	0.025	0.125	0.375	0.200	0.075	0.075	0.000	0.000	0.000	0.000	0	0	0
31	7/28, 7/29, 7/30, 7/31	48	38	4667	0.211	0.026	0.211	0.395	0.105	0.026	0.026	0.000	0.000	0.000	0.000	0	0	0
Cumulative		**987**	**872**	**135076**	**0.026**	**0.022**	**0.166**	**0.262**	**0.353**	**0.045**	**0.120**	**0.003**	**0.001**	**0.002**	**0.001**	**1**	**2**	**1**

(Age Composition by Brood Year and Age Class)

Due to high water temperatures, sampling hours were restricted in week 31.

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.

Table 3. Weekly and cumulative age composition of Columbia Basin fall Chinook Salmon at Bonneville Dam in 2014.

					Age Composition by Brood Year and Age Class									
Statistical Week	Sampling Date	Number Sampled	Number Ageable	URB run size	2012	2011		2010		2009		Adipose Clips	Adipose w/Other	Other Clips
					0.1	0.2	1.1	0.3	1.2	0.4	1.3			
31	8/1	12	11	1689	0.182	0.091	0.364	0.182	0.091	0.091	0.000	6	0	0
32	8/5, 8/6, 8/7, 8/8	34	31	3554	0.419	0.097	0.226	0.194	0.032	0.032	0.000	15	0	1
33	8/11, 8/12	12	12	8715	0.583	0.333	0.000	0.083	0.000	0.000	0.000	2	0	0
36	9/2, 9/3, 9/4, 9/5	225	203	202506	0.015	0.133	0.005	0.606	0.054	0.172	0.015	82	2	2
37	9/8	65	60	276645	0.017	0.150	0.000	0.683	0.017	0.117	0.017	30	0	0
38	9/16, 9/17, 9/18, 9/19	210	192	178680	0.042	0.255	0.026	0.594	0.021	0.047	0.016	63	0	0
39	9/22, 9/23, 9/24, 9/25, 9/26	242	235	107021	0.060	0.149	0.017	0.660	0.026	0.081	0.009	62	0	1
40	9/29, 9/30, 10/1, 10/2, 10/3	209	186	52931	0.081	0.102	0.000	0.742	0.005	0.070	0.000	39	0	0
41	10/6, 10/7, 10/8, 10/9, 10/10	248	236	24193	0.038	0.123	0.008	0.695	0.017	0.110	0.008	25	0	0
42	10/13, 10/14, 10/15, 10/16, 10/17	129	124	18868	0.048	0.097	0.024	0.685	0.032	0.097	0.016	17	1	1
Cumulative		**1386**	**1290**	**874802**	**0.039**	**0.164**	**0.011**	**0.639**	**0.027**	**0.106**	**0.014**	**341**	**3**	**5**

August 1 is the start of the fall run at Bonneville Dam.

Weekly run size excludes tule chinook resulting in age estimates for Upriver Bright (URB) fall chinook only.

Due to high water temperatures, sampling hours were restricted in weeks 31-36 with no sampling weeks 34-35.

The weekly run size for weeks 34-35 are included in week 36

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 (URB) run size.

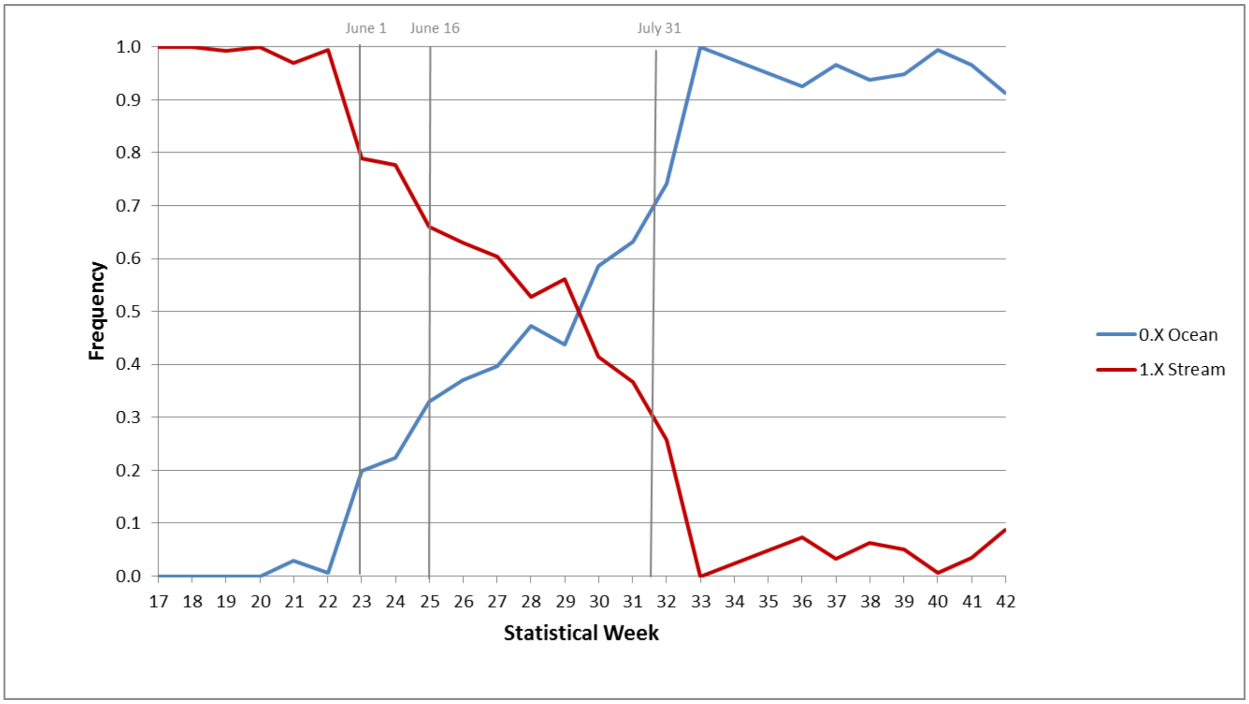

Figure 4. Weekly age composition estimates for age groups of Columbia Basin Chinook Salmon sampled at Bonneville Dam in 2014. Due to high water temperatures, sampling hours were restricted in weeks 31-36 with no sampling in weeks 34-35. Spring chinook pass Bonneville Dam April 1 to May 31 (TAC dates are April 1 to June 15), summer Chinook pass the dam from June 1 to July 31 (TAC dates are June 16 to July 31), and fall Chinook pass Bonneville Dam August 1 to Oct 31.

Table 4. Weekly and cumulative age composition of Columbia Basin Sockeye Salmon at Bonneville Dam in 2014.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly run size	Age Composition by Brood Year and Age Class 2011	2010		2009		Adipose Clips	Adipose w/Other	Other Clips
					1.1	1.2	2.1	1.3	2.2			
19, 22, 23	5/5, 5/6, 5/8, 5/9, 5/27 - 5/30, 6/2 -6/6	16	14	1526	0.000	0.857	0.000	0.143	0.000	0	0	0
24	6/9, 6/10, 6/11, 6/12, 6/13	110	107	17986	0.047	0.935	0.000	0.019	0.000	1	0	2
25	6/16, 6/17, 6/18, 6/19, 6/20	269	265	67754	0.042	0.917	0.000	0.023	0.019	1	0	0
26	6/23, 6/25, 6/26, 6/27	300	295	181833	0.102	0.895	0.000	0.000	0.003	3	0	0
27	6/30, 7/1, 7/2, 7/3	230	225	189166	0.142	0.840	0.000	0.004	0.013	2	0	0
28	7/7, 7/8, 7/9, 7/10, 7/11	259	255	110316	0.235	0.757	0.004	0.004	0.000	2	0	0
29	7/14, 7/15, 7/16, 7/17, 7/18	146	144	33124	0.271	0.722	0.000	0.007	0.000	1	0	2
30	7/21, 7/22, 7/23, 7/24, 7/25	59	58	9465	0.259	0.741	0.000	0.000	0.000	0	0	0
31	7/28, 7/29, 7/30, 7/31, 8/1	22	22	2123	0.318	0.682	0.000	0.000	0.000	0	0	0
32	8/5, 8/6, 8/7, 8/8	9	9	884	0.556	0.333	0.000	0.111	0.000	0	0	0
Cumulative		**1420**	**1394**	**613293**	**0.143**	**0.843**	**0.001**	**0.006**	**0.007**	**10**	**0**	**4**

The weekly run size for week 23 includes Sockeye Salmon passing prior to this week. Similarly the weekly run size for week 32 includes fish passing after this week.

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Table 5. Weekly and cumulative age composition of Columbia Basin steelhead at Bonneville Dam in 2014.

					Age Composition by Brood Year and Age Class															
Statistical	Sampling	Number	Number	Weekly	2011	2010		2009			2008	Ageable Salt_Winters				A-Run	Fin Cllips			Wild
Week	Date	Sampled	Ageable	run size	1.1	1.2	2.1	1.3	2.2	3.1	3.2	Repeat	1 ASW	2 ASW	3 ASW		Ad Clips	Ad + Othe	Other	
16	4/15, 4/16, 4/17, 4/18	8	4	313	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.625	0.125	0.875	5	1	0	0.250
17	4/21, 4/22, 4/23, 4/24, 4/25	5	3	255	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.200	0.000	1.000	0.000	1.000	2	1	0	0.200
18	4/28, 4/29, 4/30, 5/2	7	6	288	0.000	0.833	0.000	0.000	0.167	0.000	0.000	0.000	0.000	1.000	0.000	1.000	4	0	0	0.286
19	5/5, 5/6, 5/8, 5/9	8	6	310	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	1.000	7	1	0	0.000
20	5/12, 5/13, 5/14, 5/15, 5/16	17	14	398	0.000	0.857	0.000	0.071	0.071	0.000	0.000	0.063	0.000	0.867	0.133	1.000	12	1	0	0.176
21	5/19, 5/20, 5/21, 5/22, 5/23	15	10	508	0.000	0.900	0.000	0.000	0.100	0.000	0.000	0.000	0.000	1.000	0.000	1.000	11	1	0	0.200
22	5/27, 5/28, 5/29, 5/30	10	7	501	0.000	0.714	0.143	0.000	0.143	0.000	0.000	0.000	0.100	0.900	0.000	1.000	4	1	0	0.300
23	6/2, 6/3, 6/4, 6/5, 6/6	20	16	897	0.063	0.688	0.000	0.000	0.250	0.000	0.000	0.000	0.050	0.950	0.000	1.000	11	4	0	0.250
24	6/9, 6/10, 6/11, 6/12, 6/13	16	12	1684	0.083	0.750	0.083	0.000	0.083	0.000	0.000	0.000	0.125	0.875	0.000	1.000	13	0	0	0.188
25	6/16, 6/17, 6/18, 6/19, 6/20	19	12	2097	0.000	0.917	0.000	0.000	0.083	0.000	0.000	0.000	0.000	1.000	0.000	1.000	11	1	0	0.316
26	6/23, 6/25, 6/26, 6/27	14	6	4173	0.000	0.667	0.000	0.000	0.333	0.000	0.000	0.000	0.000	1.000	0.000	1.000	5	0	0	0.643
27	6/30, 7/1, 7/2, 7/3	28	21	7344	0.095	0.429	0.095	0.000	0.381	0.000	0.000	0.000	0.148	0.852	0.000	0.964	10	1	0	0.571
28	7/7, 7/8, 7/9, 7/10, 7/11	69	55	14910	0.182	0.364	0.127	0.000	0.309	0.000	0.018	0.000	0.333	0.667	0.000	1.000	28	8	0	0.449
29	7/14, 7/15, 7/16, 7/17, 7/18	142	102	19132	0.265	0.284	0.118	0.000	0.324	0.000	0.010	0.014	0.413	0.587	0.000	1.000	56	11	2	0.479
30	7/21, 7/22, 7/23, 7/24, 7/25	280	218	24471	0.257	0.257	0.206	0.000	0.266	0.000	0.014	0.004	0.475	0.525	0.000	0.986	110	27	3	0.479
31	7/28, 7/29, 7/30, 7/31, 8/1	265	201	30938	0.264	0.264	0.119	0.005	0.328	0.010	0.010	0.008	0.422	0.574	0.004	0.996	96	18	2	0.521
32	8/5, 8/6, 8/7, 8/8	201	136	23513	0.390	0.324	0.132	0.000	0.154	0.000	0.000	0.015	0.531	0.469	0.000	1.000	100	18	3	0.363
33	8/11, 8/12	96	68	40006	0.338	0.191	0.191	0.000	0.250	0.015	0.015	0.000	0.542	0.458	0.000	0.990	35	7	1	0.521
36	9/2, 9/3, 9/4, 9/5	54	36	16881	0.194	0.583	0.083	0.000	0.139	0.000	0.000	0.000	0.264	0.717	0.019	0.852	34	4	0	0.296
37	9/8	17	16	31205	0.063	0.625	0.000	0.000	0.313	0.000	0.000	0.000	0.059	0.941	0.000	0.706	11	0	0	0.294
38	9/16, 9/17, 9/18, 9/19	58	49	26771	0.082	0.796	0.020	0.000	0.102	0.000	0.000	0.000	0.143	0.857	0.000	0.483	35	2	0	0.259
39	9/22, 9/23, 9/24, 9/25, 9/26	121	101	17631	0.109	0.802	0.000	0.000	0.089	0.000	0.000	0.000	0.124	0.876	0.000	0.388	89	3	0	0.190
40	9/29, 9/30, 10/1, 10/2, 10/3	105	83	7306	0.120	0.807	0.024	0.000	0.048	0.000	0.000	0.000	0.143	0.857	0.000	0.490	77	6	1	0.143
41	10/6, 10/7, 10/8, 10/9, 10/10	80	66	3607	0.091	0.788	0.030	0.000	0.091	0.000	0.000	0.000	0.113	0.888	0.000	0.418	49	4	1	0.213
42	10/13, 10/14, 10/15, 10/16, 10/17	73	58	2655	0.034	0.862	0.017	0.000	0.086	0.000	0.000	0.000	0.082	0.918	0.000	0.425	44	5	0	0.178
Cumulative		**1728**	**1306**	**277794**	**0.203**	**0.462**	**0.097**	**0.001**	**0.228**	**0.003**	**0.006**	**0.004**	**0.314**	**0.684**	**0.002**	**0.839**	**859**	**125**	**13**	**0.390**

Due to high water temperatures, sampling hours were restricted in weeks 31-36 with no sampling weeks 34-35.

Number ageable (fresh and salt years) is used to calculate the X.X age classes.

All fish (except completely unageable – total of 19) were used in the calculation of Repeat spawners

All fish (except completely unageable and repeat spawners – total of 30) 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 (Tables A2 – 4). Length-at-age tables for Sockeye Salmon and steelhead are also located in the Appendix (Tables A5 and 6).

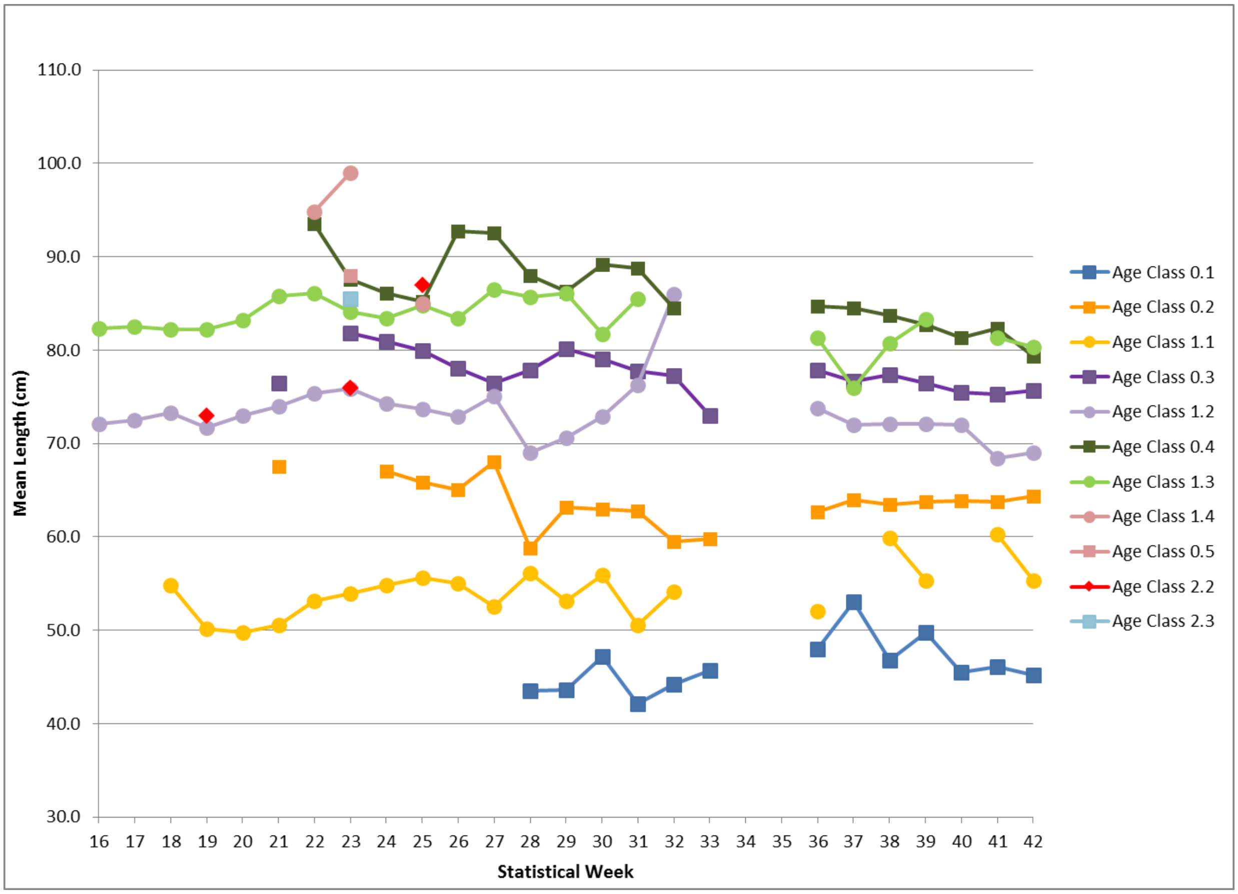

Figure 5. Weekly age composition estimates for age groups of Columbia Basin Chinook Salmon sampled at Bonneville Dam in 2014. Due to high water temperatures, sampling hours were restricted in weeks 31-36 with no sampling in weeks 34-35.

Fish Coloration and Condition

Bright coloration was observed in the majority of each species: 46.1% of spring Chinook Salmon, 61.3% of summer Chinook, 49.8% of fall Chinook, 98.9% of Sockeye Salmon and 73.4% of steelhead. The highest condition rating of 5 was given to 80.4% of spring Chinook, 76.0% of summer Chinook, 65.9% of fall Chinook, 73.9% of Sockeye and 62.6% of steelhead. Additional fish condition data, including injury types, can be found in the Appendix (Table A1).

Chinook Salmon Run-Size Prediction for 2015

Using a linear relationship between the 2014 three- and four-year-old adult returns (Figure 6), the estimated number of four-year-old spring Chinook Salmon returning to Bonneville Dam in 2015 is 172,625 (±98,590, 90% prediction interval [PI]). Using the relationship between four- and five-year-olds to construct the model (Figure 7), we predict that the 2015 five-year-old adult abundance at Bonneville Dam will be 30,893 (±36,621, 90% PI).

For the 2015 summer Chinook Salmon run at Bonneville Dam, the relationship between three- and four-year-olds (Figure 8) results in a prediction of 75,801 (±32,791, 90% PI) four-year-olds. The relationship between four- and five-year-olds (Figure 9), the model predicts a return of 48,645 (±21,419, 90% PI) five-year-olds.

Based on the relationship between three- and four-year-olds (Figure 10), the model results in a prediction of 208,987 (±130,970, 90% PI) four-year-old Upriver Bright fall Chinook Salmon returns for 2015. Using the relationship between four- and five-year-olds (Figure 11), the model results in a prediction of 167,593 (±94,487, 90% PI) returning five-year-olds.

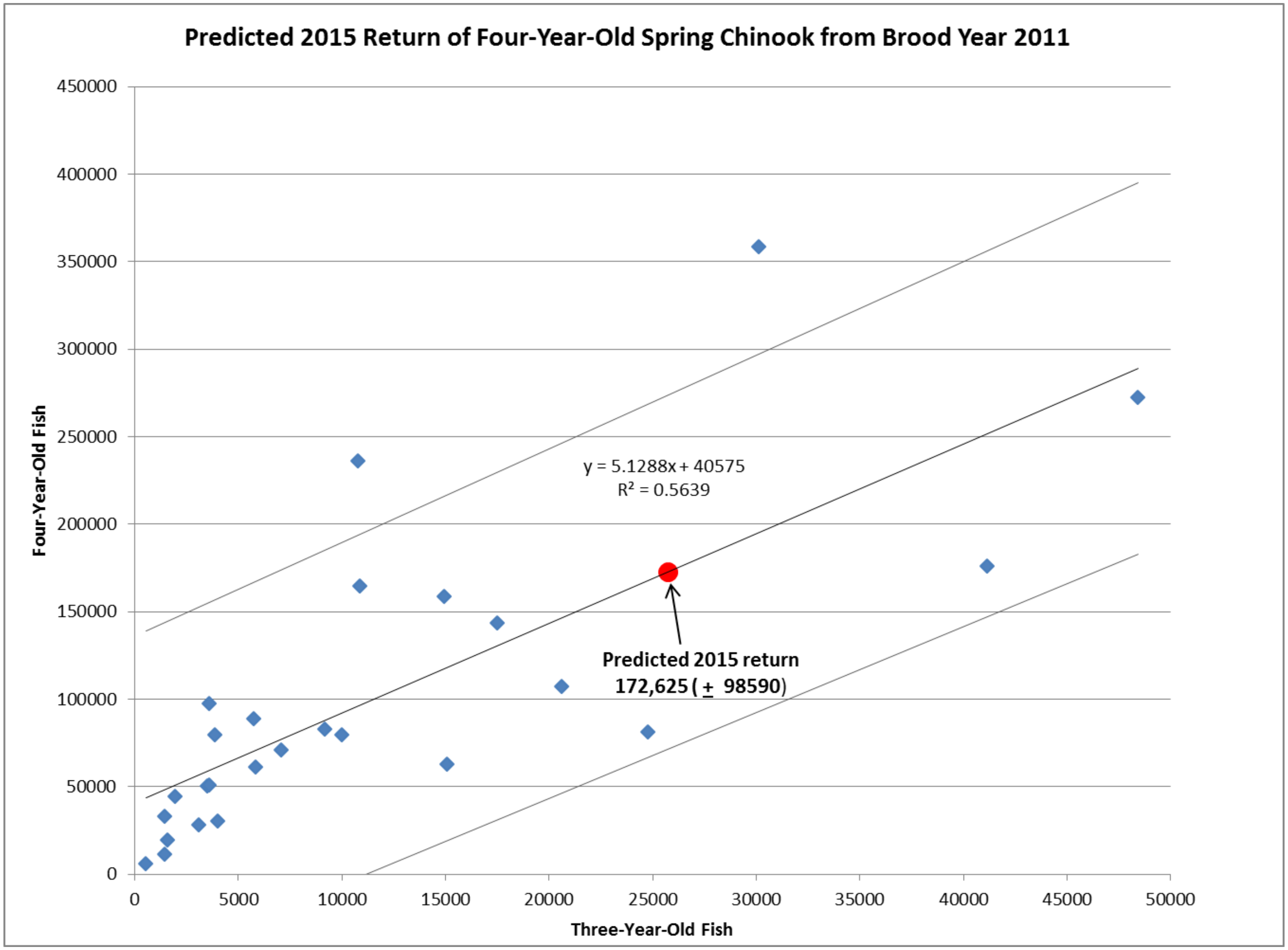

Figure 6. Four-year-old Columbia Basin spring Chinook Salmon abundance (at Bonneville Dam) based on a linear relationship between four-year-old and three-year-old fish abundance during brood years 1984 through 2011. Prediction intervals (90%) are also graphed.

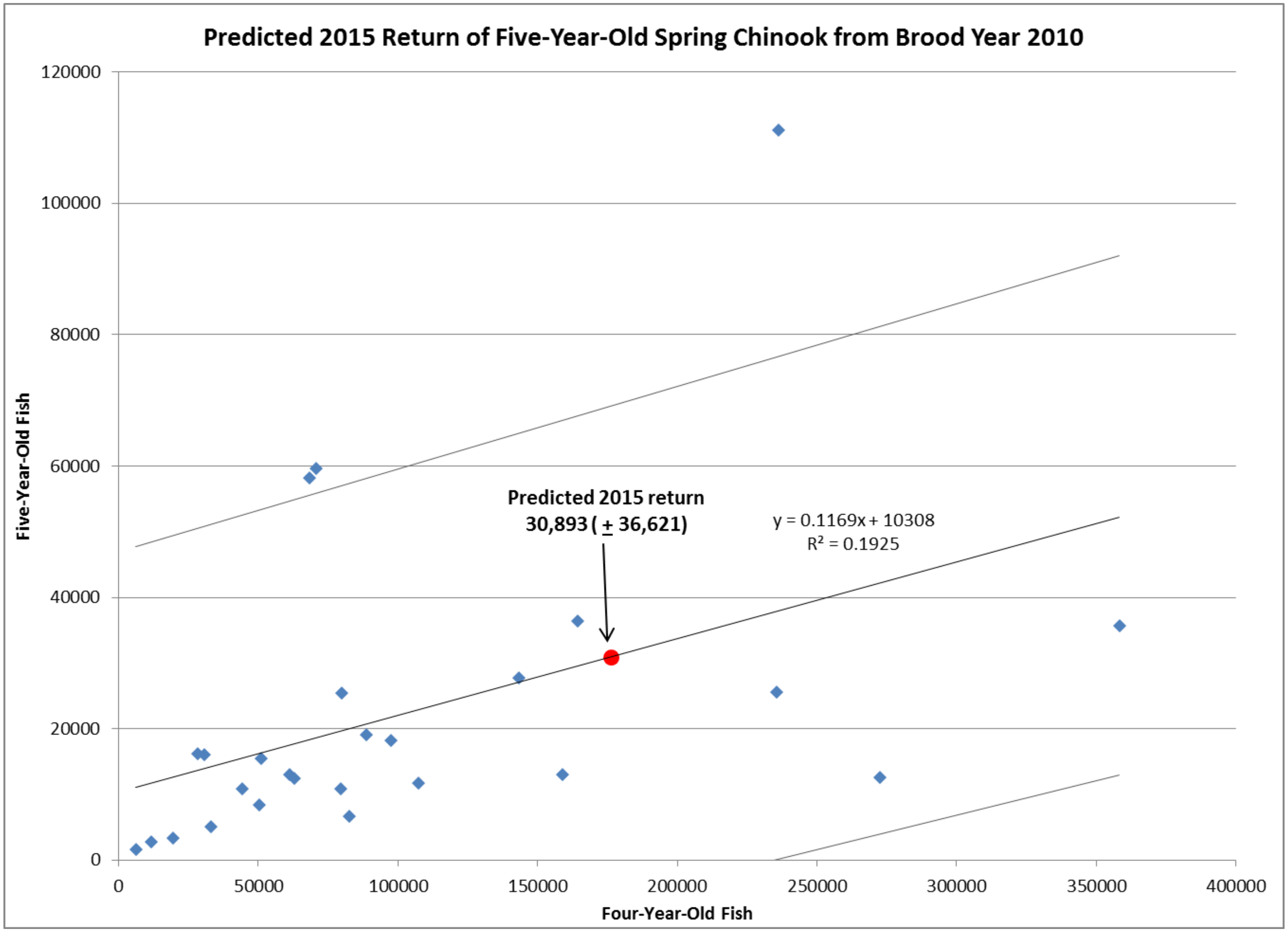

Figure 7. Five-year-old Columbia Basin spring Chinook Salmon abundance (at Bonneville Dam) based on a linear relationship between five-year-old and four-year-old fish abundance during brood years 1983 through 2010. Prediction intervals (90%) are also graphed.

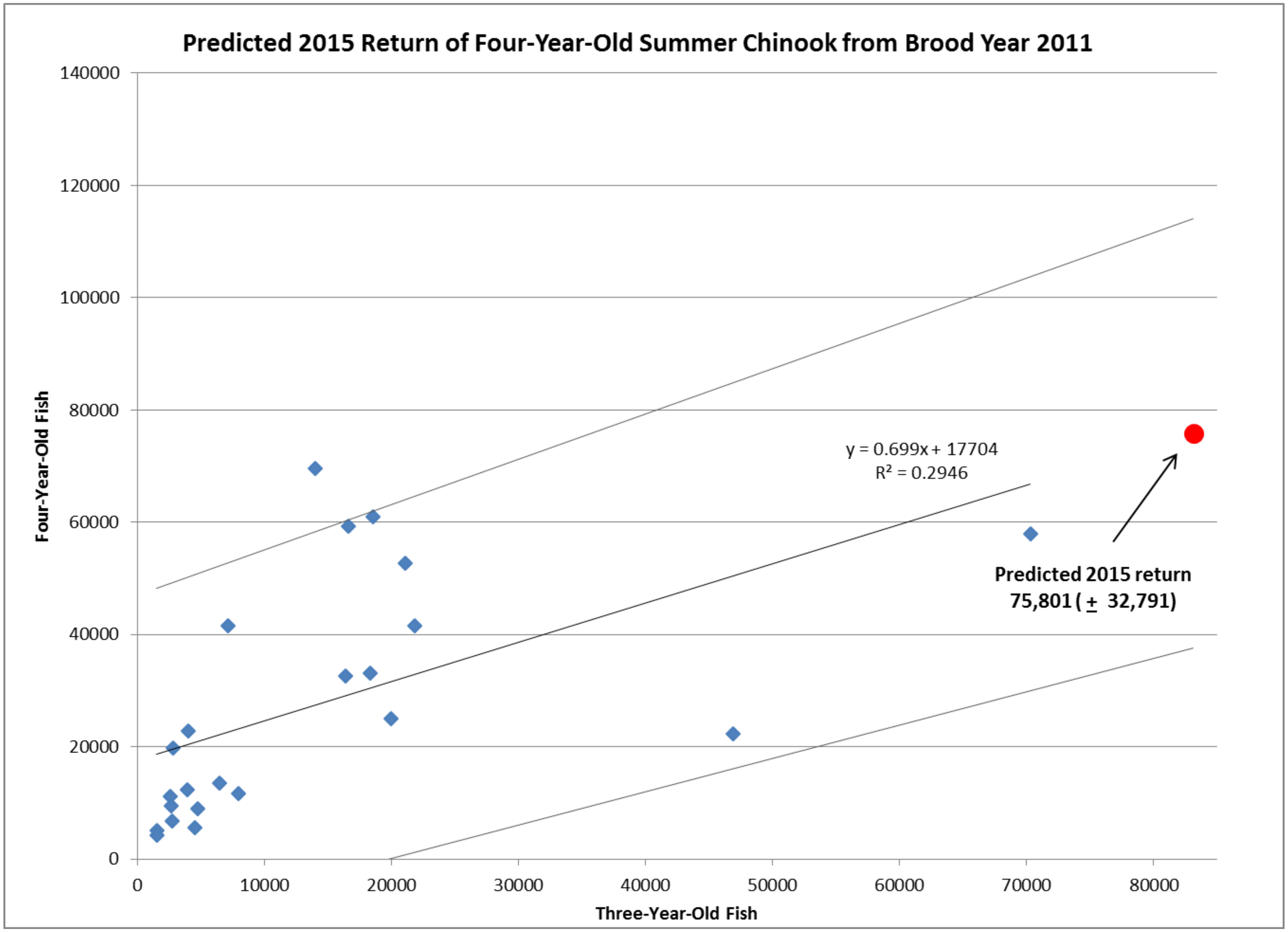

Figure 8. Four-year-old Columbia Basin summer Chinook Salmon abundance (at Bonneville Dam) based on a linear relationship between four-year-old and three-year-old fish abundance during brood years 1987 through 2011. Prediction intervals (90%) are also graphed.

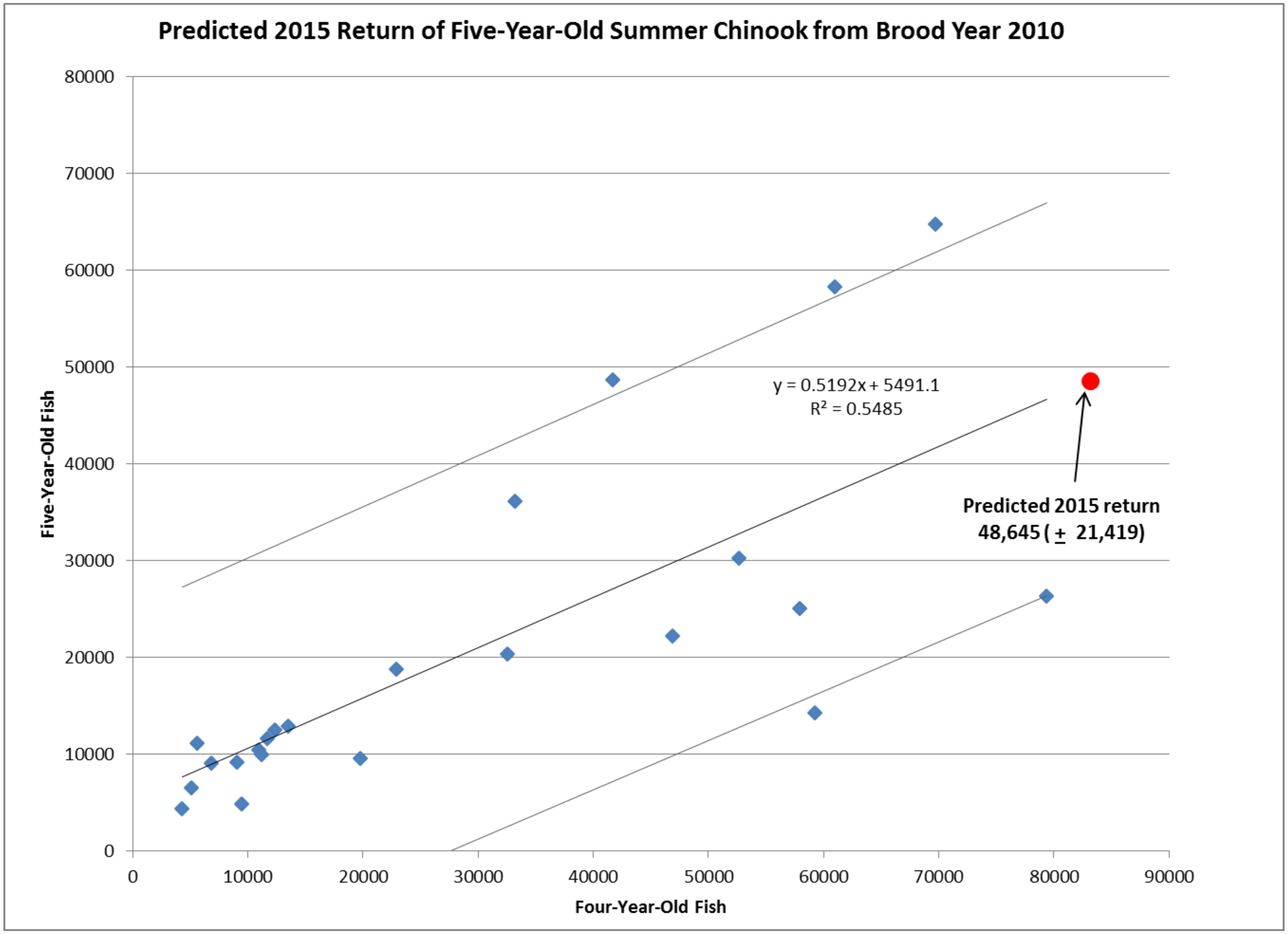

Figure 9. Five-year-old Columbia Basin summer Chinook Salmon abundance (at Bonneville Dam) based on a linear relationship between five-year-old and four-year-old fish abundance during brood years 1986 through 2010. Prediction intervals (90%) are also graphed.

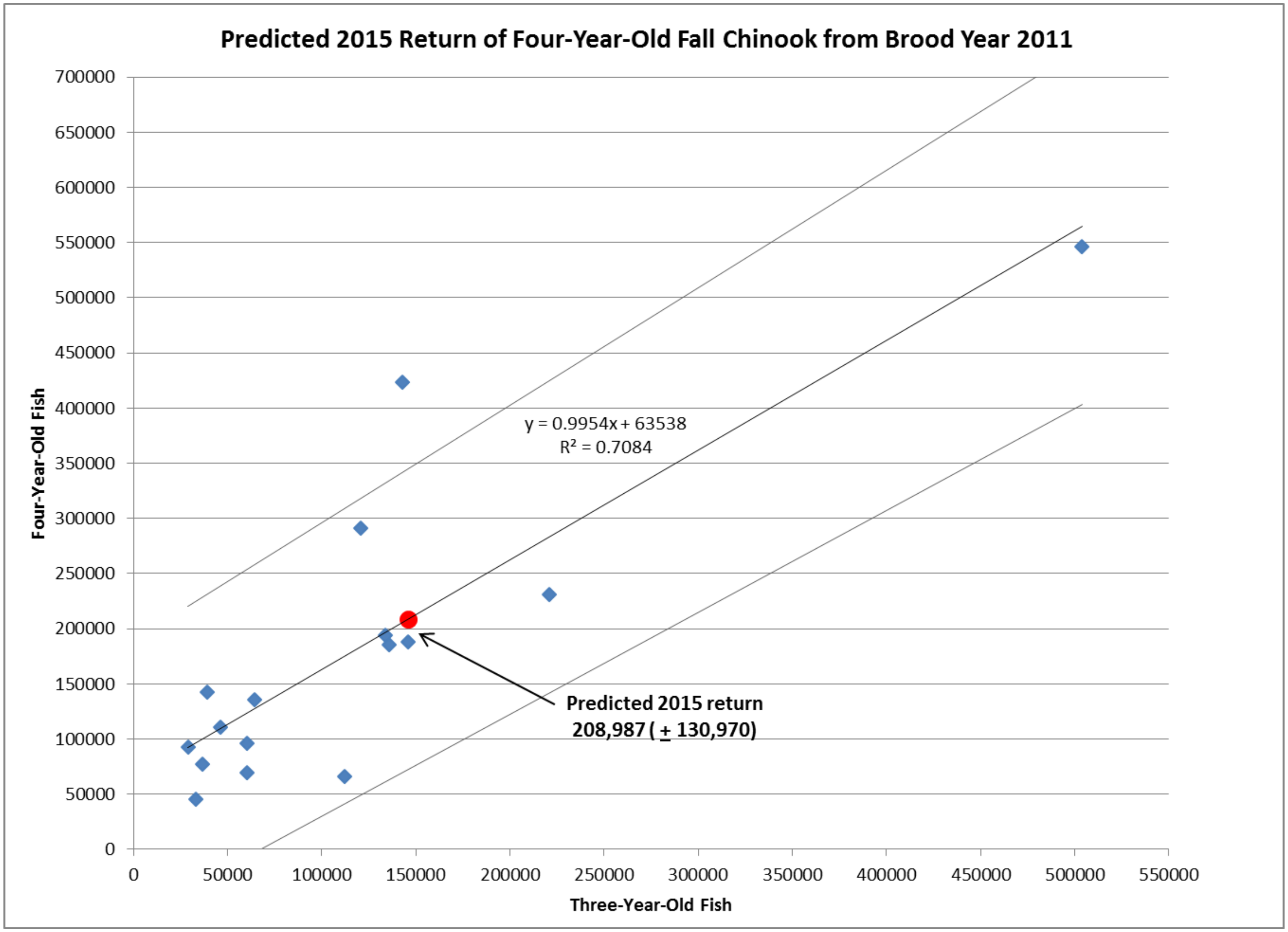

Figure 10. Four-year-old Columbia Basin bright fall Chinook Salmon abundance (at Bonneville Dam) based on a linear relationship between four-year-old and three-year-old fish abundance during brood years 1994 through 2011. Prediction intervals (90%) are also graphed.

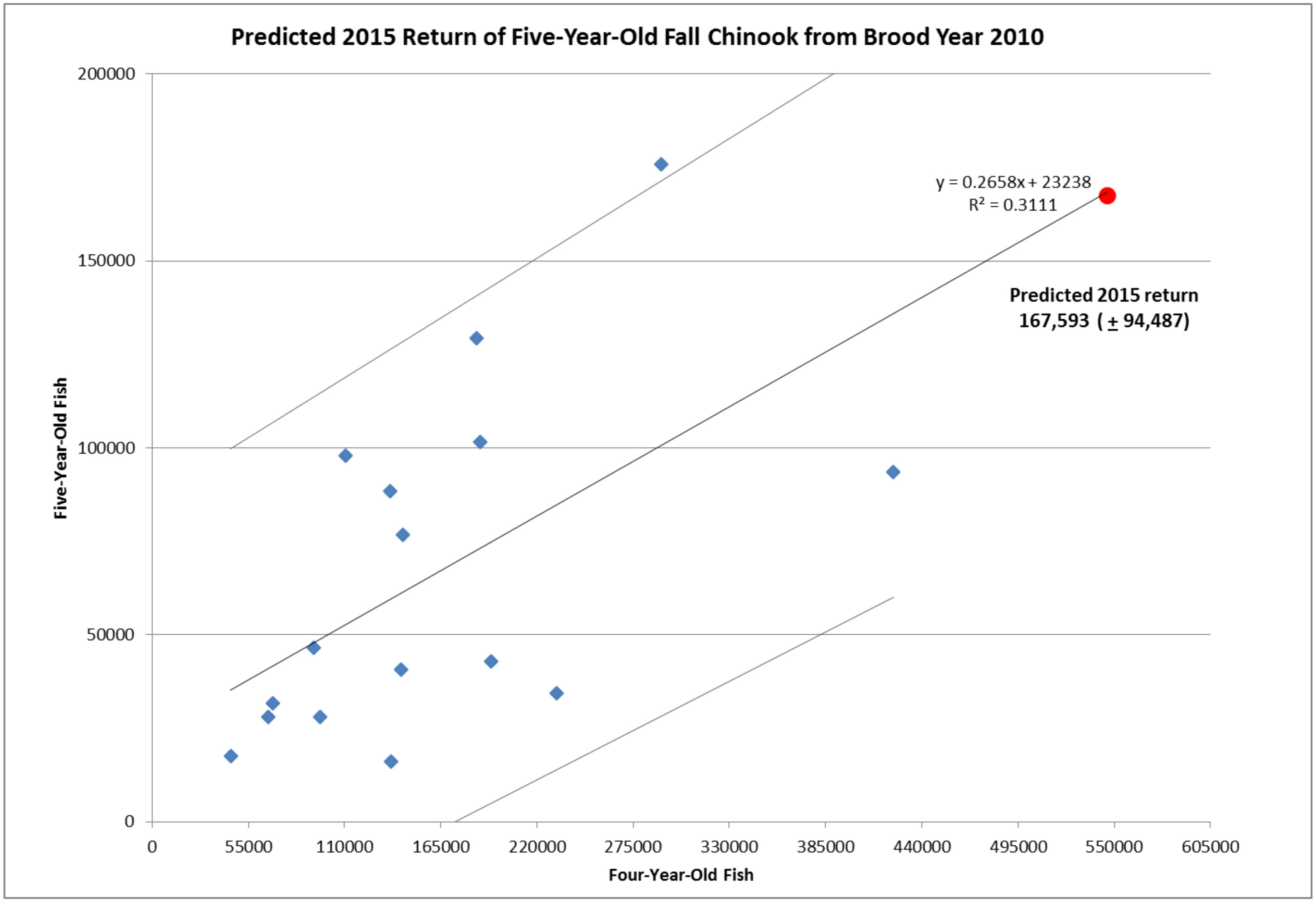

Figure 11. Five-year-old Columbia Basin bright fall Chinook Salmon abundance (at Bonneville Dam) based on a linear relationship between four-year-old and five-year-old fish abundance during brood years 1993 through 2010. Prediction intervals (90%) are also graphed.

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 has resulted in a lower incidence of stubby dorsal fins. 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 winter annuli. Hatchery-origin fish show much greater freshwater growth and have a single 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 49.7% of the run was of wild origin; including scale patterns reduced this to 39.0%.

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 (83.9%) passing Bonneville Dam were A-run, and the remaining 16.1% were B-run. Although A-run steelhead dominated the run, the percentage of the B-run generally increases as the run progresses (Table 5 and Figure 12).

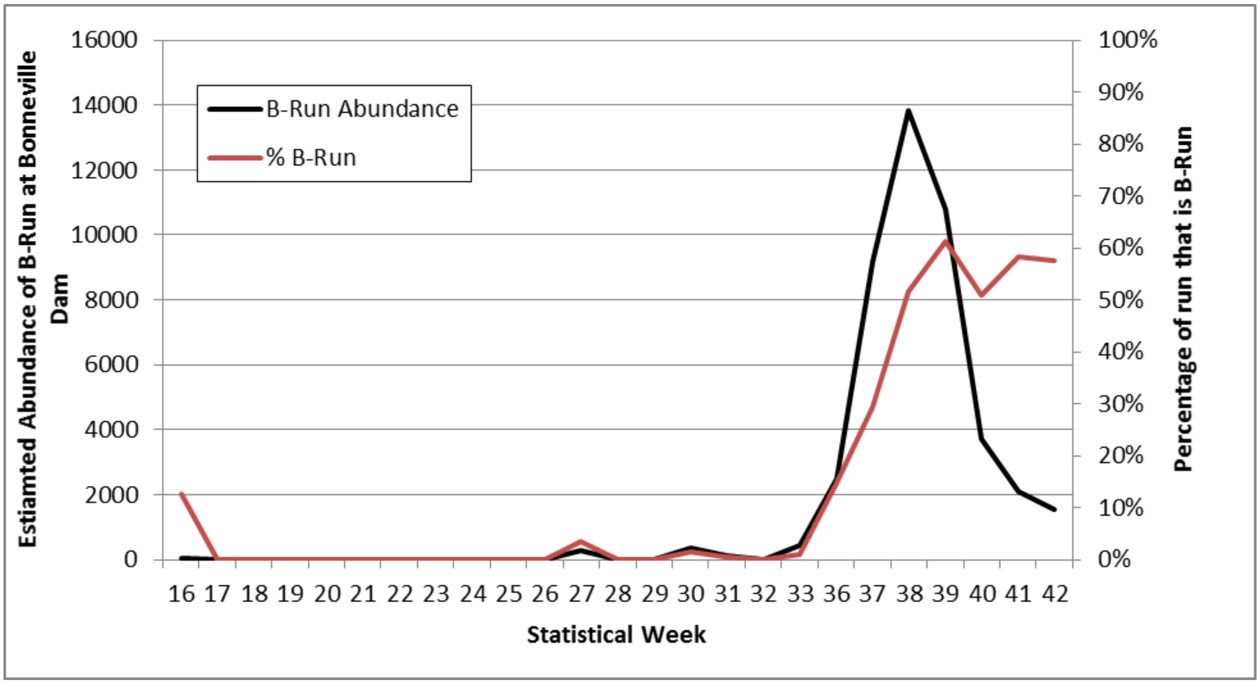

Figure 12. Percentage of B Run steelhead sampled and estimated run size based on B-run proportion of the Bonneville Dam count by Statistical Week in 2014. Due to high water temperatures, sampling hours were restricted in weeks 31-36 with no sampling in weeks 34-35.

Steelhead Repeat Spawners

In 2014, we found 10 steelhead with spawning check marks in their scale patterns consistent with repeat spawning. The freshwater- and saltwater-winter annuli numbers varied greatly and one fish had unageable freshwater annuli. All 10 steelhead were PIT tagged and tracked. Two of the fish had adipose clips and one had a maxillary clip, and three fish in total had had freshwater scale patterns of hatchery fish.

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 exceed 70°F (21.1°C). During the 2014 season, sampling was restricted during weeks 31-36 (Figure 13) and we were unable to sample 12 days between Aug 12 and Aug 29 due to temperatures exceeding 72°F. Chinook and steelhead continued to pass Bonneville Dam in relatively large numbers regardless of temperatures which resulted in 84,026 Chinook and 76,162 steelhead passing the dam during restricted sampling and 52,533 Chinook and 53,935 steelhead passing the dam when we not allowed to sample.

In 2014, tissue samples (for genetic 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 twelfth year for Chinook Salmon, the eighth year for Sockeye Salmon, and the eleventh year for steelhead that we have collected genetic samples. 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. In addition 96 genetic markers for Sockeye Salmon have been developed and samples have been analyzed (Hess et al. Annual Reports). 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.

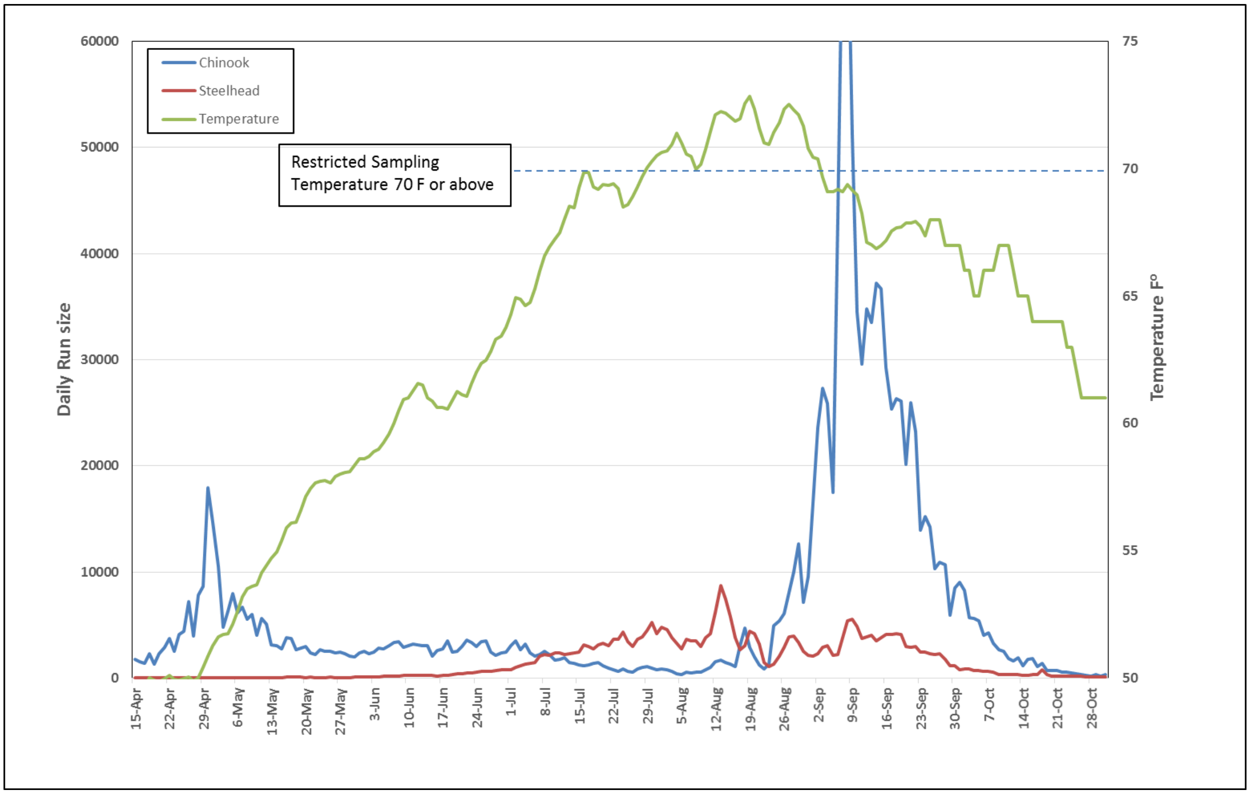

Figure 13. Chinook and steelhead daily run size and daily river temperature at Bonneville Dam for June 1 through October 31, 2014.

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Table A1. Composition (%) of observed injuries of Columbia Basin Chinook and Sockeye Salmon and steelhead sampled at Bonneville Dam in 2014.

Injury Category	Spring	Summer	Fall	Sockeye	Steelhead
Marine Mammal Bites & Scrapes	20.86	8.41	6.57	4.15	15.10
Descaling					
3-19%	18.09	23.51	14.72	22.32	7.06
>20%	1.65	5.37	6.13	3.31	3.70
Net Marks	2.38	3.14	7.72	1.90	7.35
Hook					
Hook Damage	1.98	3.34	0.72	0.07	1.10
Hook Present	0.27	0.31	0.15	0.00	0.23
Headburn	0.00	0.00	0.00	0.00	0.00
Other Injuries					
Bruise	0.00	0.10	0.07	0.28	0.12
Head Injury	1.06	0.41	1.30	0.35	0.58
Fin Injury	4.42	4.36	6.35	3.66	5.61
Fungus	0.59	0.30	0.14	0.14	0.00
Gash	1.45	1.82	3.39	3.24	5.67
Parasite/Dissease	0.59	0.61	2.24	15.21	12.15

Table A2. Length-at-age estimates for Columbia Basin spring Chinook Salmon sampled at Bonneville Dam in 2014.

Brood Year and	2011		2010		2009			2008
Age Class	0.2	1.1	0.3	1.2	0.4	1.3	2.2	1.4
Statistical Week 16								
Mean Fork Length (cm)	--	--	--	72.08	--	82.27	--	--
Maximum	--	--	--	80.0	--	88.0	--	--
Minimum	--	--	--	60.0	--	76.5	--	--
Standard Deviation	--	--	--	4.44	--	3.44	--	--
Sample Size	--	--	--	81	--	11	--	--
Statistical Week 17								
Mean Fork Length (cm)	--	--	--	72.53	--	82.45	--	--
Maximum	--	--	--	82.0	--	89.5	--	--
Minimum	--	--	--	59.0	--	69.0	--	--
Standard Deviation	--	--	--	3.97	--	6.40	--	--
Sample Size	--	--	--	177	--	11	--	--
Statistical Week 18								
Mean Fork Length (cm)	--	54.75	--	73.32	--	82.17	--	--
Maximum	--	65.0	--	85.5	--	86.0	--	--
Minimum	--	50.0	--	61.0	--	77.0	--	--
Standard Deviation	--	6.91	--	3.72	--	3.00	--	--
Sample Size	--	4	--	177	--	9	--	--
Statistical Week 19								
Mean Fork Length (cm)	--	50.21	--	71.71	--	82.17	73.00	--
Maximum	--	56.0	--	83.0	--	91.0	73.0	--
Minimum	--	43.5	--	60.0	--	75.5	73.0	--
Standard Deviation	--	3.26	--	4.56	--	5.36	--	--
Sample Size	--	19	--	112	--	6	1	--
Statistical Week 20								
Mean Fork Length (cm)	--	49.82	--	73.03	--	83.21	--	--
Maximum	--	58.0	--	85.0	--	88.0	--	--
Minimum	--	39.0	--	58.0	--	78.5	--	--
Standard Deviation	--	3.76	--	4.55	--	3.05	--	--
Sample Size	--	82	--	118	--	7	--	--
Statistical Week 21								
Mean Fork Length (cm)	67.50	50.58	76.50	73.97	--	85.83	--	--
Maximum	69.5	58.0	82.5	87.0	--	95.0	--	--
Minimum	65.5	41.0	70.5	62.0	--	79.5	--	--
Standard Deviation	2.83	3.62	4.78	4.17	--	5.39	--	--
Sample Size	2	62	5	155	--	9	--	--
Statistical Week 22								
Mean Fork Length (cm)	--	53.14	--	75.43	93.50	86.07		94.75
Maximum	--	62.0	--	88.5	93.5	97.5		95.5
Minimum	--	42.0	--	65.0	93.5	74.5		94.0
Standard Deviation	--	4.13	--	5.01	--	4.90		1.06
Sample Size	--	29	--	126	1	27		2
2014 Composoite								
Mean Fork Length (cm)	**67.50**	**50.69**	**76.50**	**73.23**	**93.50**	**84.04**	**73.00**	**94.75**
Maximum	**69.5**	**65.0**	**82.5**	**88.5**	**93.5**	**97.5**	**73.0**	**95.5**
Minimum	**65.5**	**39.0**	**70.5**	**58.0**	**93.5**	**69.0**	**73.0**	**94.0**
Standard Deviation	**2.83**	**3.96**	**4.78**	**4.42**	**--**	**4.92**	**--**	**1.06**
Sample Size	**2**	**196**	**5**	**946**	**1**	**80**	**1**	**2**

Table A3. Length-at-age estimates for Columbia Basin summer Chinook Salmon sampled at Bonneville Dam in 2014.

Brood Year and	2012	2011		2010		2009			2008		
Age Class	0.1	0.2	1.1	0.3	1.2	0.4	1.3	2.2	0.5	1.4	2.3
Statistical Week 23											
Mean Fork Length (cm)	--	--	53.87	81.77	75.89	87.58	84.11	76.00	88.00	99.00	85.50
Maximum	--	--	61.0	89.5	87.0	97.5	98.0	83.5	88.0	99.0	85.5
Minimum	--	--	46.5	72.0	57.0	76.5	74.0	68.5	88.0	99.0	85.5
Standard Deviation	--	--	3.85	4.82	4.62	5.64	4.99	10.61	--	--	--
Sample Size	--	--	30.00	30	132	18	31	2	1	1	1
Statistical Week 24											
Mean Fork Length (cm)	--	67.00	54.78	80.90	74.28	86.11	83.40	--	--	--	--
Maximum	--	67.0	62.5	97.5	88.0	102.0	99.5	--	--	--	--
Minimum	--	67.0	47.0	70.5	59.0	79.0	62.0	--	--	--	--
Standard Deviation	--	--	3.43	6.52	6.11	7.00	6.11	--	--	--	--
Sample Size	--	1	37	40	100	9	35	--	--	--	--
Statistical Week 25											
Mean Fork Length (cm)	--	65.83	55.59	79.88	73.74	85.20	84.79	87.00	--	85.00	--
Maximum	--	71.5	62.0	95.0	83.0	93.0	89.5	87.0	--	85.0	--
Minimum	--	59.5	47.5	66.0	60.5	75.0	79.0	87.0	--	85.0	--
Standard Deviation	--	6.03	3.39	6.08	5.85	7.93	3.70	--	--	--	--
Sample Size	--	3	22	24	33	5	7	1	--	1	--
Statistical Week 26											
Mean Fork Length (cm)	--	65.00	55.00	78.08	72.91	92.67	83.36	--	--	--	--
Maximum	--	65.0	61.0	90.0	87.0	96.0	89.0	--	--	--	--
Minimum	--	65.0	49.0	64.0	61.0	88.0	75.5	--	--	--	--
Standard Deviation	--	--	5.01	7.14	7.90	4.16	4.17	--	--	--	--
Sample Size	--	1	5	13	17	3	7	--	--	--	--
Statistical Week 27											
Mean Fork Length (cm)	--	68.00	52.50	76.47	75.09	92.50	86.50	--	--	--	--
Maximum	--	68.0	64.0	88.0	82.5	92.5	96.0	--	--	--	--
Minimum	--	68.0	45.5	52.5	64.0	92.5	82.5	--	--	--	--
Standard Deviation	--	--	6.20	8.27	5.06	--	4.45	--	--	--	--
Sample Size	--	1	7	19	17	1	8	--	--	--	--
Statistical Week 28											
Mean Fork Length (cm)	43.50	58.83	56.13	77.87	68.95	88.00	85.70	--	--	--	--
Maximum	47.5	62.5	62.5	91.0	75.5	88.0	90.0	--	--	--	--
Minimum	41.0	51.5	46.0	66.5	58.0	88.0	81.0	--	--	--	--
Standard Deviation	3.50	6.35	5.17	6.31	5.09	--	3.91	--	--	--	--
Sample Size	3	3	12	19	11	1	5	--	--	--	--
Statistical Week 29											
Mean Fork Length (cm)	43.56	63.17	53.07	80.05	70.63	86.25	86.07	--	--	--	--
Maximum	49.0	70.0	64.0	87.0	82.0	92.5	88.0	--	--	--	--
Minimum	40.0	58.5	42.0	65.0	60.0	80.0	84.0	--	--	--	--
Standard Deviation	2.73	6.05	7.84	5.17	6.81	8.84	1.59	--	--	--	--
Sample Size	8	3	15	19	19	2	7	--	--	--	--
Statistical Week 30											
Mean Fork Length (cm)	47.20	63.00	55.90	79.00	72.88	89.17	81.67	--	--	--	--
Maximum	53.0	63.0	58.5	84.5	85.0	92.5	84.0	--	--	--	--
Minimum	43.0	63.0	49.5	70.0	61.0	84.5	79.0	--	--	--	--
Standard Deviation	4.02	--	3.66	4.20	8.79	4.16	2.52	--	--	--	--
Sample Size	5	1	5	15	8	3	3	--	--	--	--
Statistical Week 31											
Mean Fork Length (cm)	42.63	65.50	49.00	79.03	75.25	90.00	85.50	--	--	--	--
Maximum	46.5	65.5	54.5	92.5	79.0	90.0	85.5	--	--	--	--
Minimum	40.5	65.5	46.0	70.5	73.0	90.0	85.5	--	--	--	--
Standard Deviation	2.42	--	2.83	5.50	2.63	--	--	--	--	--	--
Sample Size	8	1	8	15	4	1	1	--	--	--	--
2014 Composite											
Mean Fork Length (cm)	**44.00**	**63.71**	**54.25**	**79.61**	**74.43**	**87.58**	**84.20**	**79.67**	**88.00**	**92.00**	**85.50**
Maximum	**53.0**	**71.5**	**64.0**	**97.5**	**88.0**	**102.0**	**99.5**	**87.0**	**88.00**	**99.00**	**85.50**
Minimum	**40.0**	**51.5**	**42.0**	**52.5**	**57.0**	**75.0**	**62.0**	**68.5**	**88.00**	**85.00**	**85.50**
Standard Deviation	**3.30**	**5.17**	**4.68**	**6.19**	**5.85**	**5.97**	**4.98**	**9.83**	**--**	**9.90**	**--**
Sample Size	**24**	**14**	**141**	**194**	**341**	**43**	**104**	**3**	**1.00**	**2.00**	**1.00**

Table A4. Length-at-age estimates for Columbia Basin fall Chinook Salmon sampled at Bonneville Dam in 2014.

Brood Year and	2012	2011		2010		2009	
Age Class	0.1	0.2	1.1	0.3	1.2	0.4	1.3
Statistical Week 31							
Mean Fork Length (cm)	40.25	60.00	53.88	68.50	80.50	87.50	--
Maximum	42.00	60.00	58.50	73.50	80.50	87.50	--
Minimum	38.50	60.00	48.00	63.50	80.50	87.50	--
Standard Deviation	2.47	--	4.42	7.07	--	--	--
Sample Size	2.00	1.00	4.00	2.00	1.00	1.00	--
Statistical Week 32							
Mean Fork Length (cm)	44.19	59.50	54.14	77.33	86.00	84.50	--
Maximum	49.00	61.00	58.50	82.50	86.00	84.50	--
Minimum	40.00	58.50	49.00	64.00	86.00	84.50	--
Standard Deviation	2.63	1.32	3.20	7.31	--	--	--
Sample Size	13.00	3.00	7.00	6.00	1.00	1.00	--
Statistical Week 33							
Mean Fork Length (cm)	45.71	59.75	--	73.00	--	--	--
Maximum	50.00	63.50	--	73.00	--	--	--
Minimum	39.50	54.00	--	73.00	--	--	--
Standard Deviation	3.82	4.17	--	--	--	--	--
Sample Size	7.00	4.00	--	1.00	--	--	--
Statistical Week 36							
Mean Fork Length (cm)	48.00	62.70	52.00	77.86	73.82	84.71	81.33
Maximum	56.00	72.50	52.00	88.00	79.00	98.00	92.00
Minimum	43.50	54.50	52.00	65.50	67.00	68.50	72.00
Standard Deviation	6.95	4.39	--	4.23	4.61	5.67	10.07
Sample Size	3.00	27.00	1.00	122.00	11.00	35.00	3.00
Statistical Week 37							
Mean Fork Length (cm)	53.00	64.00	--	76.67	72.00	84.50	76.00
Maximum	53.00	68.50	--	90.00	72.00	92.50	76.00
Minimum	53.00	56.00	--	67.00	72.00	80.00	76.00
Standard Deviation	--	4.46	--	5.22	--	4.43	--
Sample Size	1	9	--	41	1	7	1
Statistical Week 38							
Mean Fork Length (cm)	46.81	63.51	59.90	77.43	72.13	83.67	80.67
Maximum	54.50	76.50	68.00	94.00	78.00	92.50	84.50
Minimum	42.50	44.00	54.50	62.50	68.50	78.00	78.00
Standard Deviation	3.42	5.75	5.09	5.51	4.27	5.42	3.40
Sample Size	8	49	5	114	4	9	3
Statistical Week 39							
Mean Fork Length (cm)	49.79	63.79	55.25	76.46	72.08	82.68	83.25
Maximum	57.00	76.00	60.00	93.00	77.00	87.00	88.50
Minimum	44.00	53.50	46.50	62.50	66.00	73.50	78.00
Standard Deviation	3.59	5.35	5.98	4.94	3.71	3.81	7.42
Sample Size	14	35	4	155	6	19	2
Statistical Week 40							
Mean Fork Length (cm)	45.50	63.95	--	75.50	72.00	81.35	--
Maximum	54.50	75.00	--	86.50	72.00	97.00	--
Minimum	38.00	50.00	--	56.50	72.00	74.00	--
Standard Deviation	4.43	6.01	--	4.95	--	6.51	--
Sample Size	15	19	--	138	1	13	--
Statistical Week 41							
Mean Fork Length (cm)	46.06	63.81	60.25	75.25	68.38	82.25	81.25
Maximum	52.00	72.00	61.00	87.50	74.50	97.50	84.00
Minimum	43.50	51.50	59.50	61.00	60.00	68.00	78.50
Standard Deviation	2.60	5.41	1.06	4.65	6.07	6.83	3.89
Sample Size	9	29	2	164	4	26	2
Statistical Week 42							
Mean Fork Length (cm)	45.17	64.41	55.33	75.68	69.00	79.33	80.25
Maximum	53.00	69.50	59.00	89.00	78.50	85.00	82.00
Minimum	41.00	60.50	50.00	64.50	60.50	72.00	78.50
Standard Deviation	4.58	3.03	4.73	4.59	7.65	4.30	2.47
Sample Size	6	11	3	84	4	12	2
2014 Composite							
Mean Fork Length (cm)	**46.30**	**63.45**	**55.90**	**76.32**	**72.52**	**82.93**	**80.88**
Maximum	**57.00**	**76.50**	**68.00**	**94.00**	**86.00**	**98.00**	**92.00**
Minimum	**38.00**	**44.00**	**46.50**	**56.50**	**60.00**	**68.00**	**72.00**
Standard Deviation	**4.16**	**5.18**	**4.69**	**4.96**	**5.61**	**5.69**	**5.32**
Sample Size	**78**	**187**	**26**	**827**	**33**	**123**	**13**

Table A5. Length-at-age estimates for Columbia Basin Sockeye Salmon sampled at Bonneville Dam in 2014.

Brood Year and	2011	2010		2009	
Age Class	1.1	1.2	2.1	1.3	2.2
Statistical Week 22					
Mean Fork Length (cm)	--	47.00	--	--	--
Maximum	--	47.00	--	--	--
Minimum	--	47.00	--	--	--
Standard Deviation	--	--	--	--	--
Sample Size	0.00	1.00	0.00	0.00	0.00
Statistical Week 23					
Mean Fork Length (cm)	--	46.59	--	54.75	--
Maximum	--	49.5	--	55.5	--
Minimum	--	44.0	--	54.0	--
Standard Deviation	--	1.97	--	1.06	--
Sample Size	0	11	0	2	0
Statistical Week 24					
Mean Fork Length (cm)	40.00	47.47	--	56.25	--
Maximum	43.0	53.0	--	57.5	--
Minimum	37.5	42.0	--	55.0	--
Standard Deviation	2.03	2.40	--	1.77	--
Sample Size	5	100	0	2	0
Statistical Week 25					
Mean Fork Length (cm)	39.45	48.08	--	56.25	50.00
Maximum	41.0	54.5	--	59.5	53.0
Minimum	37.0	41.0	--	49.5	47.5
Standard Deviation	1.25	2.36	--	3.64	2.42
Sample Size	11	243	0	6	5
Statistical Week 26					
Mean Fork Length (cm)	39.98	48.09	--	--	48.00
Maximum	43.0	55.5	--	--	48.0
Minimum	37.0	42.0	--	--	48.0
Standard Deviation	1.47	2.12	--	--	--
Sample Size	30	264	0	0	1
Statistical Week 27					
Mean Fork Length (cm)	40.16	48.43	--	59.00	49.33
Maximum	42.0	54.0	--	59.0	53.5
Minimum	37.5	42.0	--	59.0	47.0
Standard Deviation	1.20	2.18	--	--	3.62
Sample Size	32	189	0	1	3
Statistical Week 28					
Mean Fork Length (cm)	40.21	48.06	42.50	57.50	--
Maximum	44.0	55.0	42.5	57.5	--
Minimum	37.5	41.5	42.5	57.5	--
Standard Deviation	1.57	2.24	--	--	--
Sample Size	60	193	1	1	0
Statistical Week 29					
Mean Fork Length (cm)	40.19	48.58	--	51.00	--
Maximum	44.0	53.5	--	51.0	--
Minimum	37.0	42.5	--	51.0	--
Standard Deviation	1.44	2.28	--	--	--
Sample Size	39	104	0	1	0
Statistical Week 30					
Mean Fork Length (cm)	39.70	48.94	--	--	--
Maximum	43.0	54.5	--	--	--
Minimum	37.5	45.5	--	--	--
Standard Deviation	1.46	2.45	--	--	--
Sample Size	15	43	0	0	0
Statistical Week 31					
Mean Fork Length (cm)	39.29	49.60	--	--	--
Maximum	41.5	54.0	--	--	--
Minimum	37.5	46.0	--	--	--
Standard Deviation	1.32	2.49	--	--	--
Sample Size	7	15	0	0	0
Statistical Week 32					
Mean Fork Length (cm)	41.70	51.67	--	54.00	--
Maximum	44.0	54.0	--	54.0	--
Minimum	40.0	49.5	--	54.0	--
Standard Deviation	1.72	2.25	--	--	--
Sample Size	5	3	0	1	0
2014 Composite					
Mean Fork Length (cm)	**40.09**	**48.18**	**42.50**	**55.79**	**49.56**
Maximum	**44.0**	**55.5**	**42.50**	**59.50**	**53.5**
Minimum	**37.0**	**41.0**	**42.50**	**49.50**	**47.0**
Standard Deviation	**1.48**	**2.29**	**--**	**2.96**	**2.58**
Sample Size	**204**	**1166**	**1**	**14**	**9**

Table A6. Length-at-age estimates for Columbia Basin steelhead sampled at Bonneville Dam in 2014.

Ocean	Salt-Winters		
Age Class	1	2	3
Statistical Week 16			
Mean Fork Length (cm)	50.00	61.70	86.00
Maximum	55.00	66.50	86.00
Minimum	45.00	57.50	86.00
Standard Deviation	7.07	3.21	--
Sample Size	2.00	5.00	1.00
Statistical Week 17			
Mean Fork Length (cm)	--	65.88	--
Maximum	--	71.0	--
Minimum	--	59.0	--
Standard Deviation	--	5.04	--
Sample Size	--	4	--
Statistical Week 18			
Mean Fork Length (cm)	--	66.93	--
Maximum	--	76.0	--
Minimum	--	61.0	--
Standard Deviation	--	5.47	--
Sample Size	--	7	--
Statistical Week 19			
Mean Fork Length (cm)	--	67.71	--
Maximum	--	75.5	--
Minimum	--	61.5	--
Standard Deviation	--	5.55	--
Sample Size	--	7	--
Statistical Week 20			
Mean Fork Length (cm)	--	66.42	75.75
Maximum	--	75.5	76.0
Minimum	--	59.0	75.5
Standard Deviation	--	4.80	0.35
Sample Size	--	13	2
Statistical Week 21			
Mean Fork Length (cm)	--	68.37	--
Maximum	--	76.0	--
Minimum	--	59.5	--
Standard Deviation	--	4.61	--
Sample Size	--	15	--
Statistical Week 22			
Mean Fork Length (cm)	57.00	66.17	--
Maximum	57.0	76.0	--
Minimum	57.0	62.0	--
Standard Deviation	--	4.64	--
Sample Size	1	9	--
Statistical Week 23			
Mean Fork Length (cm)	49.50	65.71	--
Maximum	49.5	73.0	--
Minimum	49.5	57.5	--
Standard Deviation	--	4.32	--
Sample Size	1	19	--

Ocean	Salt-Winters		
Age Class	1	2	3
Statistical Week 24			
Mean Fork Length (cm)	53.50	67.57	--
Maximum	54.5	73.0	--
Minimum	52.5	59.5	--
Standard Deviation	1.41	3.62	--
Sample Size	2	14	--
Statistical Week 25			
Mean Fork Length (cm)	--	66.89	--
Maximum	--	73.5	--
Minimum	--	58.5	--
Standard Deviation	--	4.08	--
Sample Size	--	19	--
Statistical Week 26			
Mean Fork Length (cm)	--	68.00	--
Maximum	--	77.5	--
Minimum	--	63.0	--
Standard Deviation	--	4.19	--
Sample Size	--	13	--
Statistical Week 27			
Mean Fork Length (cm)	55.63	68.59	--
Maximum	61.0	78.0	--
Minimum	52.0	58.5	--
Standard Deviation	4.07	4.10	--
Sample Size	4	23	--
Statistical Week 28			
Mean Fork Length (cm)	56.00	67.51	--
Maximum	63.0	75.5	--
Minimum	49.0	58.0	--
Standard Deviation	3.28	3.77	--
Sample Size	23	46	--
Statistical Week 29			
Mean Fork Length (cm)	55.12	67.29	--
Maximum	64.0	76.0	--
Minimum	49.5	60.5	--
Standard Deviation	2.86	3.72	--
Sample Size	57	80	--
Statistical Week 30			
Mean Fork Length (cm)	55.63	68.23	--
Maximum	64.0	78.5	--
Minimum	49.5	54.5	--
Standard Deviation	2.81	4.33	--
Sample Size	132	145	--
Statistical Week 31			
Mean Fork Length (cm)	55.39	68.26	65.50
Maximum	64.5	80.0	65.5
Minimum	48.5	54.5	65.5
Standard Deviation	2.69	3.85	--
Sample Size	109	148	1
Statistical Week 32			
Mean Fork Length (cm)	54.92	67.93	--
Maximum	62.5	75.5	--
Minimum	49.0	59.5	--
Standard Deviation	2.77	3.62	--
Sample Size	103	91	--

Ocean	Salt-Winters		
Age Class	1	2	3
Statistical Week 33			
Mean Fork Length (cm)	55.47	68.72	--
Maximum	61.0	82.5	--
Minimum	50.0	61.5	--
Standard Deviation	2.68	3.81	--
Sample Size	52	44	--
Statistical Week 36			
Mean Fork Length (cm)	57.89	72.37	75.00
Maximum	64.5	87.5	75.0
Minimum	51.5	59.5	75.0
Standard Deviation	3.83	7.29	--
Sample Size	14	38	1
Statistical Week 37			
Mean Fork Length (cm)	54.50	75.53	--
Maximum	54.5	83.5	--
Minimum	54.5	64.5	--
Standard Deviation	--	5.52	--
Sample Size	1	16	--
Statistical Week 38			
Mean Fork Length (cm)	57.81	78.24	--
Maximum	65.5	89.5	--
Minimum	52.5	61.0	--
Standard Deviation	4.85	5.64	--
Sample Size	8	48	--
Statistical Week 39			
Mean Fork Length (cm)	58.93	80.18	--
Maximum	67.5	89.5	--
Minimum	54.5	64.5	--
Standard Deviation	4.10	5.31	--
Sample Size	15	106	--
Statistical Week 40			
Mean Fork Length (cm)	56.57	78.52	--
Maximum	64.0	90.0	--
Minimum	49.5	60.0	--
Standard Deviation	4.05	5.78	--
Sample Size	15	89	--
Statistical Week 41			
Mean Fork Length (cm)	57.63	79.58	--
Maximum	62.0	90.5	--
Minimum	51.0	64.0	--
Standard Deviation	3.40	5.39	--
Sample Size	8	71	--
Statistical Week 42			
Mean Fork Length (cm)	56.42	78.90	--
Maximum	62.0	89.5	--
Minimum	53.5	68.0	--
Standard Deviation	3.12	5.06	--
Sample Size	6	67	--
2014 Composite			
Mean Fork Length (cm)	55.60	71.90	75.60
Maximum	67.5	90.5	86.0
Minimum	45.0	54.5	65.5
Standard Deviation	3.08	7.11	7.26
Sample Size	553	1137	5