CRITFC

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Age and Length Composition of Columbia Basin Chinook and Sockeye Salmon and Steelhead at Bonneville Dam in 2015

Crystal Chulik, Agnes Strong, Jayson FiveCrows, Aaron Ikemoto, Amber Cate, Joe Nowinski, John Whiteaker, and Jeffrey Fryer PhD

March 2017

Columbia River Inter-Tribal Fish Commission
700 NE Multnomah, Suite 1200
Portland, OR 97232
503.238.0667
www.critfc.org

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Columbia River Inter-Tribal Fish Commission
Technical Report
for the
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Crystal Chulik
Agnes Strong
Jayson FiveCrows
Aaron Ikemoto
Amber Cate
Joe Nowinski
John Whiteaker
Jeffrey K. Fryer, Ph.D.

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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, tissues collected for genetics, revived and released. 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, 88.4%, 47.5% and 41.3% of the runs. Four-year-olds were also the most abundant age group for Sockeye Salmon comprising 93.7% of the run, and steelhead run comprising 43.2% of the run. Steelhead data were analyzed for the salt years regardless of the freshwater phase, the majority of steelhead had one-salt winters (52.6%) in 2015. Using adipose fin clips, scale patterns, and dorsal fin condition for classification, the steelhead migration consisted of 65.9% hatchery- and 34.1% natural-origin steelhead. A-run steelhead, less than 78cm in length, comprised 94.7% of the steelhead run. B-run fish, equal to or greater than 78cm, comprised 5.3% 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 and steelhead where numerous populations can exhibit similar scale growth patterns. The emergence of coast wide genetic databases for Pacific salmon and steelhead populations, and PIT tag detection systems, has provided fisheries managers with more powerful tools to estimate stock composition than scale patterns. This project works in conjunction with genetic stock identification and PIT tag migration studies which provide stock composition and escapement in separate reports found on www.critfc.org.

The primary objectives for the 2015 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 PIT tag and 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 main-stem Columbia River dam encountered by interior populations of salmonids on their adult spawning migration (Figure 1). The collection of salmon and steelhead occurs at the Adult Fish Facility (AFF) located on the Washington shore adult fish-way immediately downstream of the adult count window. This facility uses a picket weir to divert migrating fish, ascending the Washington shore fish ladder, into the adult sampling facility collection pool (Figure 2). Depending on fish density, the picket weir must be raised periodically in accordance to trapping protocols outlined in http://www.nwdwc.usace.army.mil/tmt/documents/fpp/2015/final/FPP15_AppG.pdf. From the 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 at 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 date so data are comparable to past years' reports. The fall Chinook run consists of lower river tule and upriver bright population components. For the age and length composition estimates presented in this study, only upriver bright Chinook data are presented.

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 life history 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 $d=0.05$, $\alpha=0.10$ 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 studies. 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 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 (2015). In addition to collections for this study, all sampled fish received a PIT tag and a genetic sample was collected for related stock identification and migration studies which include tule fall Chinook.

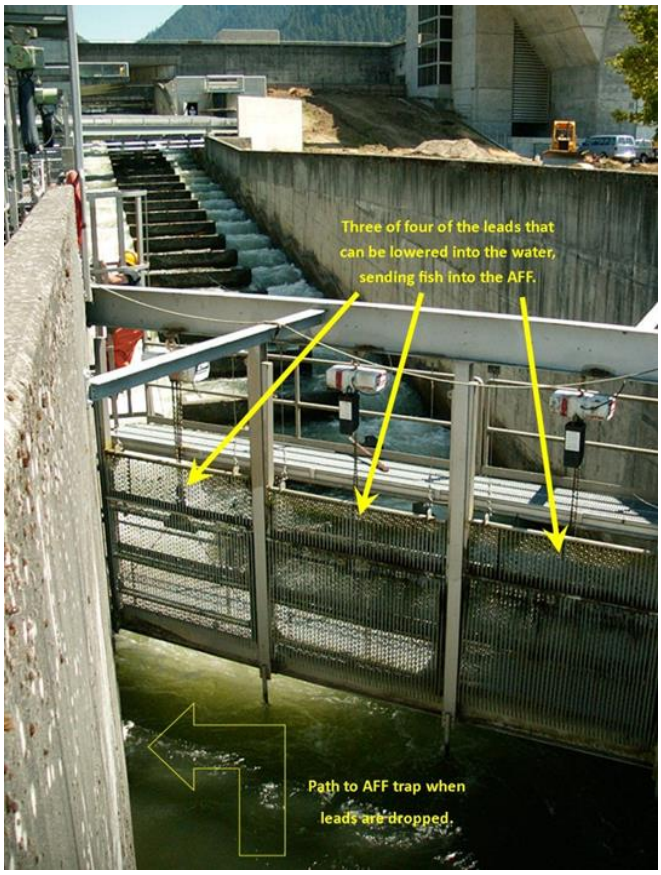

Figure 2. View of Washington Shore Fish Ladder and picket leads that diverted fish into the Bonneville Adult Fish Facility (AFF).

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 which spend no winters in saltwater. Steelhead under 36 cm were also excluded to avoid sampling rainbow trout, and 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 (excluding tule chinook) for aging, and caudal fin tissue was collected for genetic stock composition study that compliments this project. All fish sampled were scanned for PIT tags and any recapture codes were recorded. All fish not previously PIT tagged were tagged for a related migration timing and survival study. All anesthetized fish were revived in a freshwater bath, 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 and include marine mammal injuries, descaling, hook injuries, headburn, bruising, head injuries, fin injuries, fungus, gashes, and a combined category for parasites and disease.

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.

Age and Length-at-Age Composition

Age composition was estimated for spring, summer and fall Chinook salmon, sockeye salmon, and steelhead by weighting the proportion of each age class sampled by the counts of each species passing Bonneville dam during each Statistical Week. Since we were only interested in the upriver bright fall Chinook, tule Chinook were excluded from our sample and fall Chinook weekly run size. Length-at-age composition estimates for each species (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. In addition, hatchery programs generally grow juvenile steelhead at a rate faster than would normally be experienced naturally which results in a scale pattern that dissimilar to natural origin fish. This accelerated growth

results in a wider spacing observed between circuli, and juveniles that characteristically smolt in one year. This is in contrast to natural origin steelhead juvenile which exhibit narrower circuli growth patterns and commonly smolt in two or more years. All these characteristics are used to determine hatchery and wild origin in steelhead.

Steelhead A/B Run Determination

Summer-run steelhead are divided into A and B run life histories. 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 primarily in the Clearwater, Middle Fork Salmon, and South Fork Salmon rivers and typically exceed 77.5 cm (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 followed by additional spawning migrations (Hatch et al. 2003). This life history can be observed in steelhead scale patterns and is noted using 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.

RESULTS

Sampling

Sampling began on April 15 and ended October 17, 2015. A total of 1300 spring Chinook, 618 summer Chinook, and 1696 fall Chinook salmon, 917 Sockeye salmon, and 904 steelhead were sampled. Genetic samples were taken from all fish including 74 tule Chinook which were not included in this age and length composition study. In addition, all fish sampled received a PIT tag for tracking. Genetic stock composition and PIT tag migration studies are reported on an annual basis and are available for download on the CRITFC website.

Age Composition

Based on scale pattern analysis, Four-year-olds were the majority age class for all chinook in 2015 comprising 88.4% of the spring Chinook migration (Figure 3, Table 1), 47.5% of the summer Chinook run (Figure 3, Table 2), and 41.3% of the fall migration (Figure 3, Table 3). The percentage of ocean-type Chinook salmon (age 0.X) increased steadily through the run (Figure 4).

Four-year-olds were also the majority age class for Sockeye Salmon (93.7%) with most the remaining portion of the run consisting of three-year-old at 6.2% (Table 4).

Three-year-olds made up 43.2% of the steelhead run. Three-year-olds comprised 33.5% while the remaining run consisted of five-year-olds (22.9%) and six-year-olds (0.4%) (Table 5). Steelhead with unageable freshwater, but ageable saltwater winters (r.X) comprised 25.8% of the steelhead scales sampled and if these fish were included and the data are analyzed for salt years only, then the majority of steelhead had one-salt winters (52.6%) in 2015.

A total of 59 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 18 spring Chinook, 8 summer Chinook, all 10 fall Chinook salmon, and 23 steelhead. Note that only total age since release could be corroborated; it normally is not possible to validate saltwater and freshwater separately.

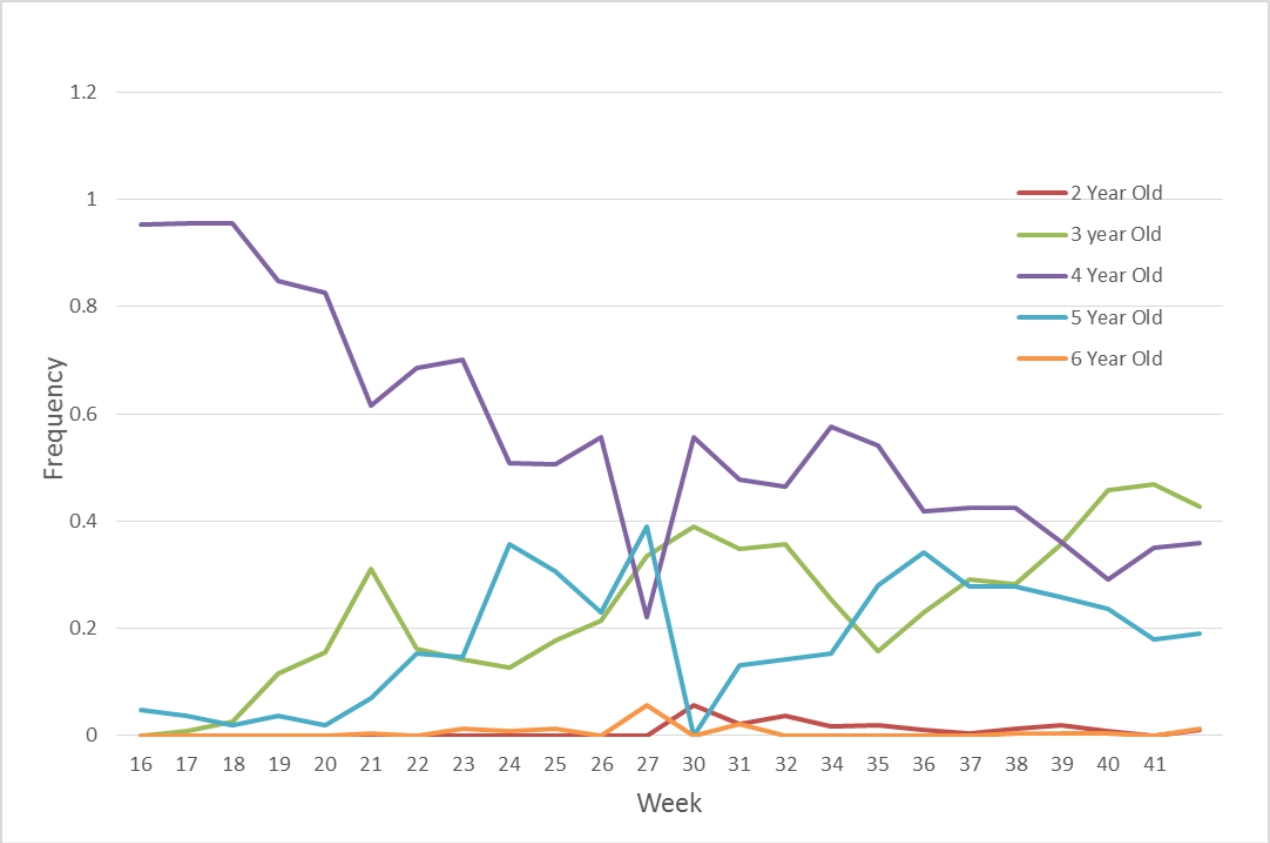

Figure 3. Weekly age composition estimates for age groups of Columbia Basin Chinook Salmon sampled at Bonneville Dam in 2015. Due to high water temperatures, sampling hours and days were restricted in weeks 27-37.

Table 1. Weekly and cumulative age composition of Columbia Basin spring Chinook salmon at Bonneville Dam in 2015.

					Age Composition by Brood Year and Age Class									
Statistical	Weekly	Sampling	Number	Number	2012		2011		2010		2009	Adipose	Adipose	Other
Week	run size	Date	Sampled	Ageable	0.2	1.1	0.3	1.2	0.4	1.3	1.4	Clips	w/Other	Clips
16	30031	4/15, 4/16, 4/17	52	43	0.000	0.000	0.000	0.953	0.000	0.047	0.000	37	0	0
17	52509	4/20, 4/21, 4/22, 4/23, 4/24	158	111	0.000	0.009	0.000	0.955	0.000	0.036	0.000	130	1	0
18	68011	4/27, 4/28, 4/29, 4/30, 5/1	268	203	0.000	0.025	0.000	0.956	0.000	0.020	0.000	194	0	0
19	23358	5/4, 5/5, 5/6, 5/7, 5/8	216	192	0.000	0.115	0.000	0.849	0.000	0.036	0.000	162	1	0
20	18671	5/11, 5/12, 5/13, 5/14	192	155	0.000	0.155	0.000	0.826	0.006	0.013	0.000	131	0	0
21	17270	5/18, 5/19, 5/20, 5/21, 5/22	268	229	0.000	0.310	0.009	0.607	0.009	0.061	0.004	164	0	0
22	20717	5/26, 5/27, 5/28	146	124	0.008	0.153	0.024	0.661	0.073	0.081	0.000	73	3	0
Cumulative	**230567**		**1300**	**1057**	**0.001**	**0.070**	**0.003**	**0.881**	**0.008**	**0.037**	**0.000**	**891**	**5**	**0**

The weekly run size for Statistical Week 16 includes Chinook salmon passing prior to week 16.

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 2015.

					Age Composition by Brood Year and Age Class												
Statistical Week	Weekly run size	Sampling Date	Number Sampled	Number Ageable	2013 0.1	2012 0.2	2012 1.1	2011 0.3	2011 1.2	2010 0.4	2010 1.3	2010 2.2	2009 1.4	2009 2.3	Adipose Clips	Adipose w/Other	Other Clips
23	16688	6/2, 6/3, 6/4, 6/5	196	171	0.000	0.006	0.135	0.012	0.690	0.047	0.088	0.012	0.012	0.000	105	1	0
24	26178	6/8, 6/9, 6/10, 6/11, 6/12	161	126	0.000	0.008	0.119	0.095	0.413	0.190	0.167	0.000	0.000	0.008	68	0	0
25	25372	6/15, 6/16, 6/17, 6/18, 6/19	95	85	0.000	0.012	0.165	0.071	0.435	0.118	0.188	0.000	0.012	0.000	44	0	0
26	32041	6/22, 6/23, 6/24, 6/25, 6/26	71	61	0.000	0.066	0.148	0.049	0.508	0.066	0.164	0.000	0.000	0.000	38	0	0
27-28	41263	6/30, 7/1, 7/2	22	18	0.000	0.056	0.278	0.000	0.222	0.056	0.333	0.000	0.056	0.000	13	0	0
29-30	27954	7/24	20	18	0.056	0.167	0.222	0.056	0.500	0.000	0.000	0.000	0.000	0.000	11	0	0
31	9969	7/27, 7/28, 7/29, 7/30	53	46	0.022	0.196	0.152	0.152	0.326	0.022	0.109	0.000	0.022	0.000	25	0	0
Cumulative	**179465**		**618**	**525**	**0.010**	**0.065**	**0.186**	**0.051**	**0.424**	**0.074**	**0.171**	**0.001**	**0.017**	**0.001**	**304**	**1**	**0**

Due to high water temperatures, sampling hours were restricted in weeks 26 - 31 with no sampling weeks 28-29.

Weeks 27-28 and 29-30 were combined to improve sample size.

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 2015.

					Age Composition by Brood Year and Age Class												
Statistical	Weekly	Sampling	Number	Number	2013	2012		2011		2010			2009		Adipose	Adipose	Other
Week	run size	Date	Sampled	Ageable	0.1	0.2	1.1	0.3	1.2	0.4	1.3	2.2	0.5	1.4	Clips	w/Other	Clips
32-33	19506	8/5, 8/6, 8/7	31	28	0.036	0.286	0.071	0.250	0.214	0.071	0.071	0.000	0.000	0.000	10	0	0
34	23267	8/18, 8/19	67	59	0.017	0.186	0.068	0.407	0.169	0.119	0.017	0.017	0.000	0.000	23	0	0
35	67883	8/24, 8/25, 8/26, 8/27	113	107	0.019	0.121	0.037	0.449	0.093	0.234	0.047	0.000	0.000	0.000	33	0	0
36	162934	9/1, 9/2, 9/3, 9/4	196	179	0.011	0.218	0.011	0.385	0.034	0.324	0.017	0.000	0.000	0.000	60	0	1
37	266367	9/8, 9/9, 9/10, 9/11	200	188	0.005	0.287	0.005	0.335	0.090	0.266	0.011	0.000	0.000	0.000	69	0	0
38	189650	9/14, 9/15, 9/16, 9/17, 9/18	240	231	0.013	0.273	0.009	0.381	0.043	0.277	0.000	0.000	0.004	0.000	78	0	4
39	147672	9/21, 9/22, 9/23, 9/24, 9/25	218	202	0.020	0.347	0.010	0.322	0.040	0.238	0.020	0.000	0.005	0.000	65	0	0
40	71451	9/28, 9/29, 9/30, 10/1, 10/2	221	216	0.009	0.458	0.000	0.278	0.014	0.231	0.005	0.000	0.005	0.000	51	0	0
41	44034	10/5, 10/6, 10/7, 10/8, 10/9	228	211	0.000	0.469	0.000	0.341	0.009	0.180	0.000	0.000	0.000	0.000	55	0	0
42	44658	10/12, 10/13, 10/14, 10/15, 10/16	182	178	0.011	0.404	0.022	0.315	0.045	0.191	0.000	0.000	0.006	0.006	26	0	1
Cumulative	**1037422**		**1696**	**1599**	**0.012**	**0.291**	**0.012**	**0.353**	**0.060**	**0.256**	**0.014**	**0.000**	**0.002**	**0.000**	**470**	**0**	**6**

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 32-36 with no sampling weeks 33.

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.

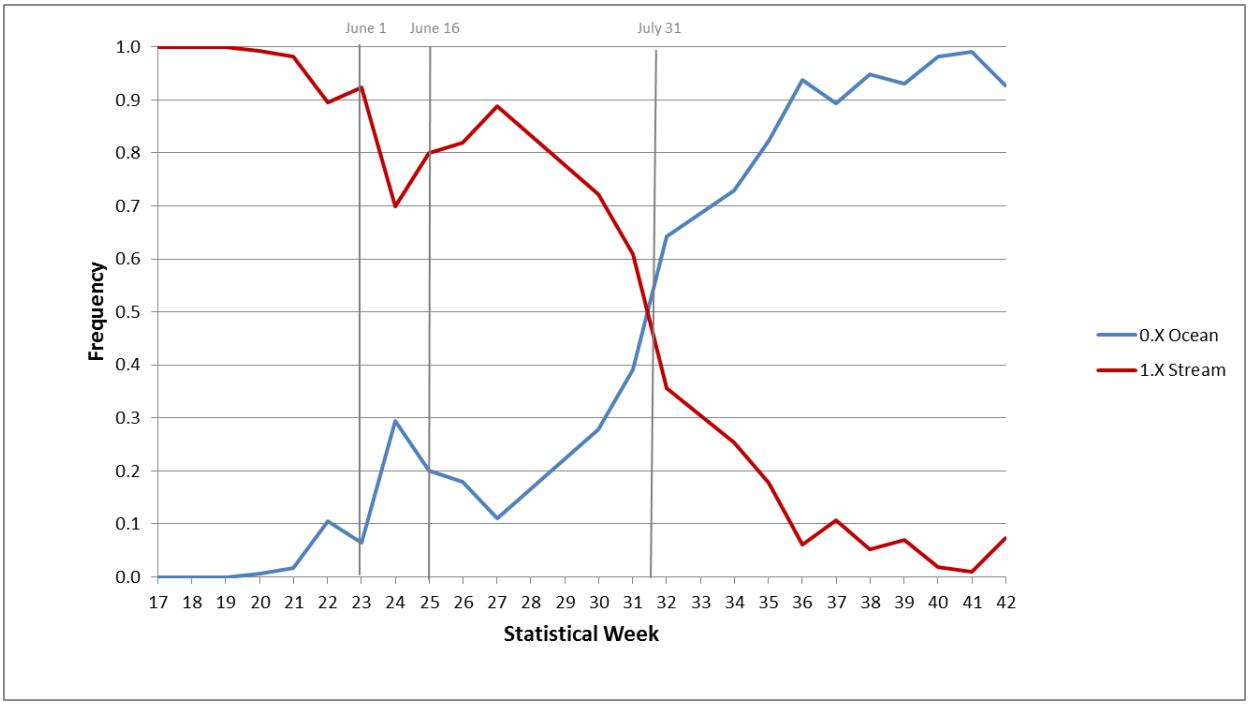

Figure 4. Weekly life history composition estimates for age groups of Columbia Basin Chinook salmon sampled at Bonneville Dam in 2015. Due to high water temperatures, sampling hours were restricted in weeks 27-36 with no sampling in weeks 28, 29, and 33.

Table 4. Weekly and cumulative age composition of Columbia Basin Sockeye salmon at Bonneville Dam in 2015.

					Age Composition by Brood Year and Age Class							
Statistical Week	Weekly run size	Sampling Date	Number Sampled	Number Ageable	2012 1.1	2011 1.2	2011 2.1	2010 1.3	2010 2.2	Adipose Clips	Adipose w/Other	Other Clips
22	182	5/26, 5/27, 5/28	2	2	0.000	1.000	0.000	0.000	0.000	0	0	0
23	2627	6/2, 6/3, 6/4, 6/5	28	28	0.000	0.964	0.000	0.036	0.000	0	0	0
24	21918	6/8, 6/9, 6/10, 6/11, 6/12	125	123	0.000	0.935	0.000	0.065	0.000	4	0	0
25	84383	6/15, 6/16, 6/17, 6/18, 6/19	298	291	0.007	0.948	0.000	0.041	0.003	7	1	0
26	181971	6/22, 6/23, 6/24, 6/25, 6/26	251	250	0.000	0.948	0.004	0.044	0.004	4	0	1
27-28	181696	6/30, 7/1, 7/2	175	168	0.000	0.917	0.000	0.077	0.006	6	0	1
29-30	33423	7/24	15	14	0.000	0.929	0.000	0.071	0.000	0	0	0
31	2932	7/27, 7/28, 7/29, 7/30	20	20	0.000	0.900	0.000	0.100	0.000	0	0	0
32	1574	8/5, 8/6, 8/7	3	2	0.000	1.000	0.000	0.000	0.000	0	0	0
Cumulative	**510706**		**917**	**898**	**0.001**	**0.935**	**0.001**	**0.058**	**0.004**	**21**	**1**	**2**

The weekly run size for week 22 includes Sockeye Salmon passing prior to this week. Similarly the weekly run size for week 32 includes fish passing after this week.
Due to high water temperatures, sampling hours and sampling days were restricted in weeks 27- 32 with no sampling occurred in weeks 28 and 29.
Weeks 27-28 and 29-30 were combined to improve sample size.

Table 5. Weekly and cumulative age composition of Columbia Basin steelhead at Bonneville Dam in 2015.

						Age Composition by Brood Year and Age Class																
Statistical	Weekly	Ageable	Sampling	Number	Number	2013	2012		2011			2010	2009	Repeat	1_ASW	2_ASW	3_ASW	A-Run	Adipose	Adipose	Other	Measured
Week	run size	Salt	Date	Sampled	Ageable	1.1	1.2	2.1	1.3	2.2	3.1	2.3	4.2	Spawner					Clips	w/Other	Clips	
16	213	7	4/15, 4/16, 4/17	7	5	0.200	0.600	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.143	0.714	0.143	0.857	5	0	0	7
17	190	6	4/20, 4/21, 4/22, 4/23, 4/24	6	4	0.000	0.750	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.000	1.000	0.000	1.000	2	1	0	6
18	257	3	4/27, 4/28, 4/29, 4/30, 5/1	3	0	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	2	0	0	3
19	166	7	5/4, 5/5, 5/6, 5/7, 5/8	7	4	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.143	0.857	0.000	0.857	6	0	0	7
20	150	7	5/11, 5/12, 5/13, 5/14	7	3	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.143	0.857	0.000	1.000	5	1	0	7
21	298	7	5/18, 5/19, 5/20, 5/21, 5/22	7	4	0.250	0.500	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.143	0.857	0.000	0.857	4	2	0	7
22	314	6	5/26, 5/27, 5/28	6	4	0.000	0.750	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.667	0.333	0.667	4	0	0	6
23	444	11	6/2, 6/3, 6/4, 6/5	11	6	0.000	0.667	0.000	0.000	0.333	0.000	0.000	0.000	0.000	0.000	1.000	0.000	1.000	8	0	0	11
24	780	2	6/8, 6/9, 6/10, 6/11, 6/12	2	1	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0	0	0	2
25	1361	5	6/15, 6/16, 6/17, 6/18, 6/19	6	4	0.000	0.750	0.000	0.000	0.250	0.000	0.000	0.000	0.200	0.000	1.000	0.000	1.000	3	0	0	6
26	2104	3	6/22, 6/23, 6/24, 6/25, 6/26	3	3	0.000	0.333	0.000	0.000	0.667	0.000	0.000	0.000	0.000	0.000	1.000	0.000	1.000	1	0	0	3
27-28	8689	3	6/30, 7/1, 7/2	3	1	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.667	0.333	0.000	1.000	0	0	0	3
29-30	23661	22	7/24	22	16	0.250	0.125	0.250	0.000	0.375	0.000	0.000	0.000	0.000	0.500	0.500	0.000	1.000	7	2	0	22
31	37156	168	7/27, 7/28, 7/29, 7/30	170	129	0.310	0.171	0.279	0.000	0.233	0.008	0.000	0.000	0.000	0.560	0.440	0.000	0.994	58	16	2	170
32-33	67255	93	8/5, 8/6, 8/7	95	66	0.409	0.091	0.288	0.000	0.197	0.000	0.000	0.015	0.000	0.677	0.323	0.000	1.000	41	6	0	95
34	20082	53	8/18, 8/19	54	45	0.444	0.156	0.178	0.000	0.222	0.000	0.000	0.000	0.000	0.642	0.358	0.000	1.000	27	4	0	54
35	12528	97	8/24, 8/25, 8/26, 8/27	100	71	0.437	0.211	0.085	0.000	0.268	0.000	0.000	0.000	0.000	0.505	0.495	0.000	1.000	55	5	0	100
36	23958	58	9/1, 9/2, 9/3, 9/4	61	38	0.447	0.289	0.026	0.000	0.237	0.000	0.000	0.000	0.017	0.483	0.517	0.000	1.000	42	2	0	61
37	19124	11	9/8, 9/9, 9/10, 9/11	11	7	0.143	0.429	0.143	0.000	0.286	0.000	0.000	0.000	0.000	0.364	0.636	0.000	0.909	6	1	0	11
38	13864	57	9/14, 9/15, 9/16, 9/17, 9/18	58	48	0.250	0.521	0.063	0.000	0.167	0.000	0.000	0.000	0.000	0.298	0.702	0.000	0.737	38	3	0	57
39	11200	40	9/21, 9/22, 9/23, 9/24, 9/25	42	28	0.357	0.429	0.000	0.036	0.179	0.000	0.000	0.000	0.000	0.325	0.650	0.025	0.690	30	0	2	42
40	5722	92	9/28, 9/29, 9/30, 10/1, 10/2	92	62	0.274	0.532	0.065	0.000	0.129	0.000	0.000	0.000	0.000	0.326	0.663	0.011	0.663	61	4	1	92
41	5531	77	10/5, 10/6, 10/7, 10/8, 10/9	78	63	0.397	0.508	0.032	0.016	0.048	0.000	0.000	0.000	0.000	0.429	0.558	0.013	0.679	54	3	0	78
42	3582	53	10/12, 10/13, 10/14, 10/15, 10/16	53	39	0.641	0.179	0.026	0.026	0.128	0.000	0.000	0.000	0.000	0.604	0.340	0.057	0.811	35	3	0	53
Cumulative	**182846**			**904**	**651**	**0.335**	**0.224**	**0.208**	**0.002**	**0.226**	**0.001**	**0**	**0.004**	**0.003**	**0.526**	**0.471**	**0.003**	**0.947**	**389**	**31**	**3**	**643**

Due to high water temperatures, sampling hours and sampling days were restricted in weeks 27- 36, no sampling in weeks 28, 29, and 33.

Weeks 27-28, 29-30, and 32-33 were combined to improve sample size for missed sampling days

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

All fish (except completely unageable – total of 14) were used in the calculation of Repeat spawners

All fish (except completely unageable and repeat spawners – total of 16) 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 – A4). Length-at-age tables for Sockeye salmon and steelhead are also located in the Appendix (Tables A5 and A6).

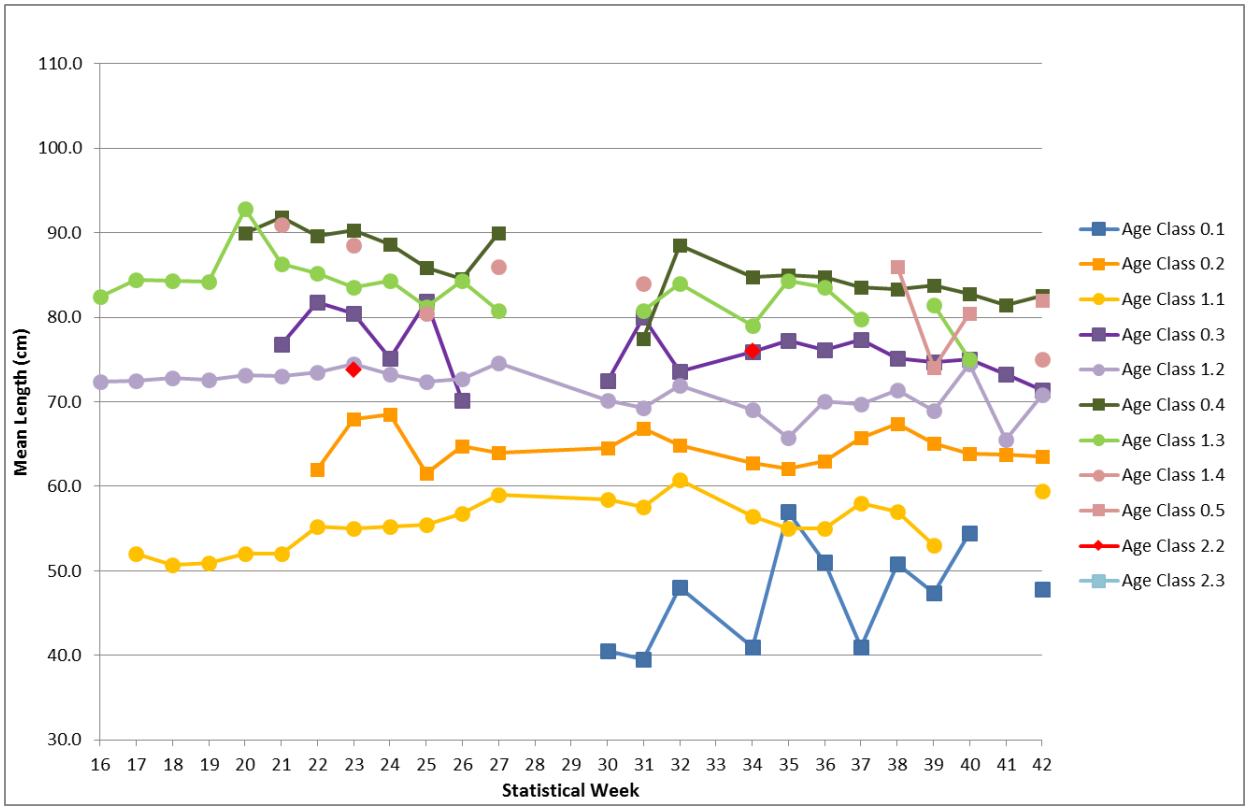

Figure 5. Weekly age composition estimates for age groups of Columbia Basin Chinook salmon sampled at Bonneville Dam in 2015. Due to high water temperatures, sampling hours were restricted in weeks 27- 36 with no sampling weeks 28, 29, & 33.

Fish Coloration and Condition

Bright coloration was observed in the majority of each species: 88.7% of spring Chinook, 86.1% of summer Chinook, 54.4% of fall Chinook, 99.6% of Sockeye salmon and 71.9% of steelhead. The highest condition rating of 5 was given to 75.1% of spring Chinook, 73.8% of summer Chinook, 72.3% of fall Chinook, 75.9% of Sockeye and 64.5% of steelhead. Additional fish condition data, including injury types, can be found in the Appendix (Table A1).

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. Using a combination of fin clips, dorsal fin condition, and scale pattern analysis, the hatchery component of the 2015 steelhead run consisted of 65.9% hatchery origin and 34.1% wild origin (Table 5).

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 (94.7%) passing Bonneville Dam were A-run, and the remaining 5.3% 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 6).

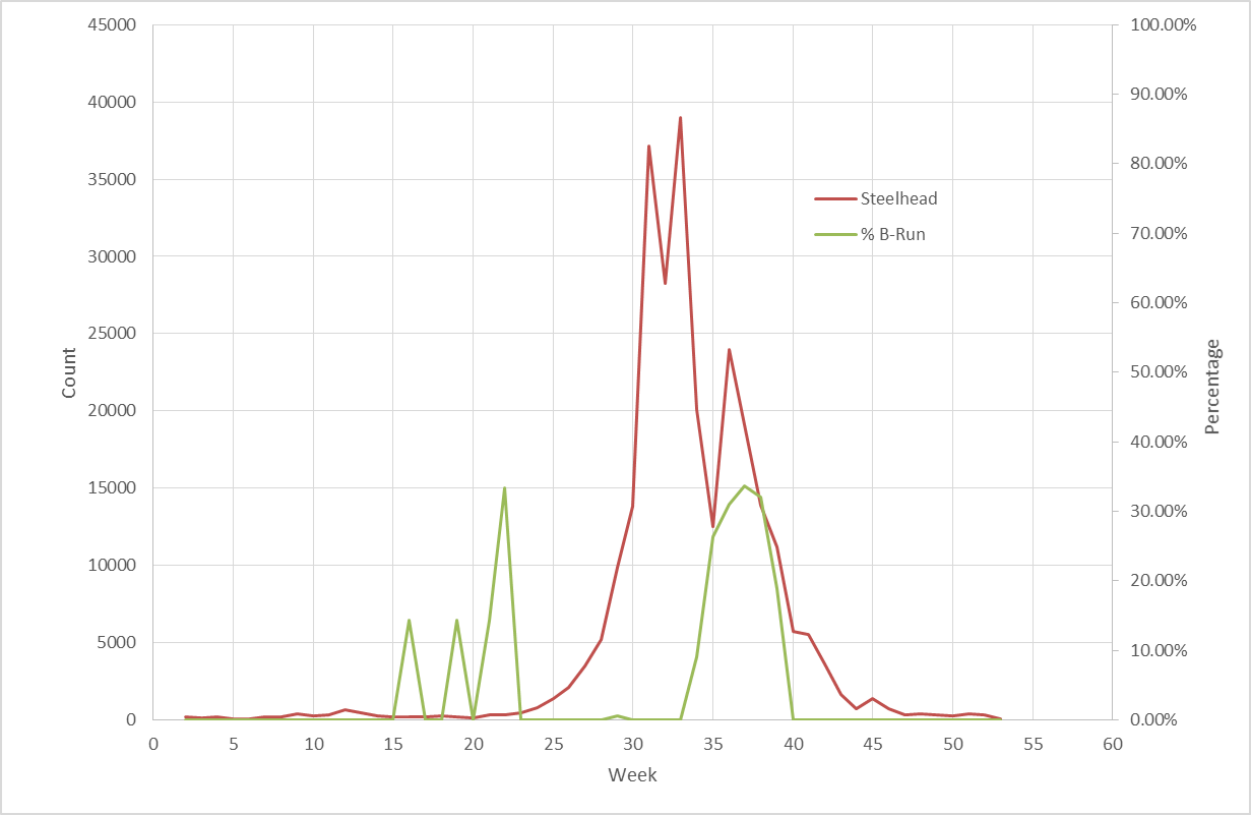

Figure 6. Percentage of B Run steelhead sampled and estimated run size based on B-run proportion of the Bonneville Dam count by Statistical Week in 2015. . Due to high water temperatures, sampling hours were restricted in weeks 28- 37 with no sampling weeks 28, 29, & 33.

Steelhead Repeat Spawners

In 2015, we found 2 steelhead or 0.3% of our sample with spawning check marks in their scale patterns consistent with repeat spawning. Both fish were unmarked and one did not have an ageable freshwater grown.

DISCUSSION

High river water temperature has constrained our sampling efforts during most summer sampling seasons. Restrictions for the number of days and hours sampled are triggered when temperatures exceed 70^{o}F (21.1^{o}C) and no sampling is allowed at 72^{o}F (22.2^{o}C). During the 2015 season, sampling was constrained or ceased during weeks 27-36 (Figure 7) which is unprecedented and significantly affected our sample size and ability to accurately represent the run. Through restricted 4 day sampling weeks and no sampling for temperatures above 72^{o}F, we were unable to sample 29 days between June 29 and Sept. 7. This includes three weeks that no sampling occurred at all (weeks 28, 29, 33).

In 2015, 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 thirteenth year for Chinook salmon, the ninth year for Sockeye Salmon, and the twelfth 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 information for all Columbia River Salmon and steelhead populations and now genetic stock identification analyses for mixed stock sampling at Bonneville Dam are being performed for steelhead, Chinook, and sockeye salmon (Hess et al. Annual Reports) and 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.

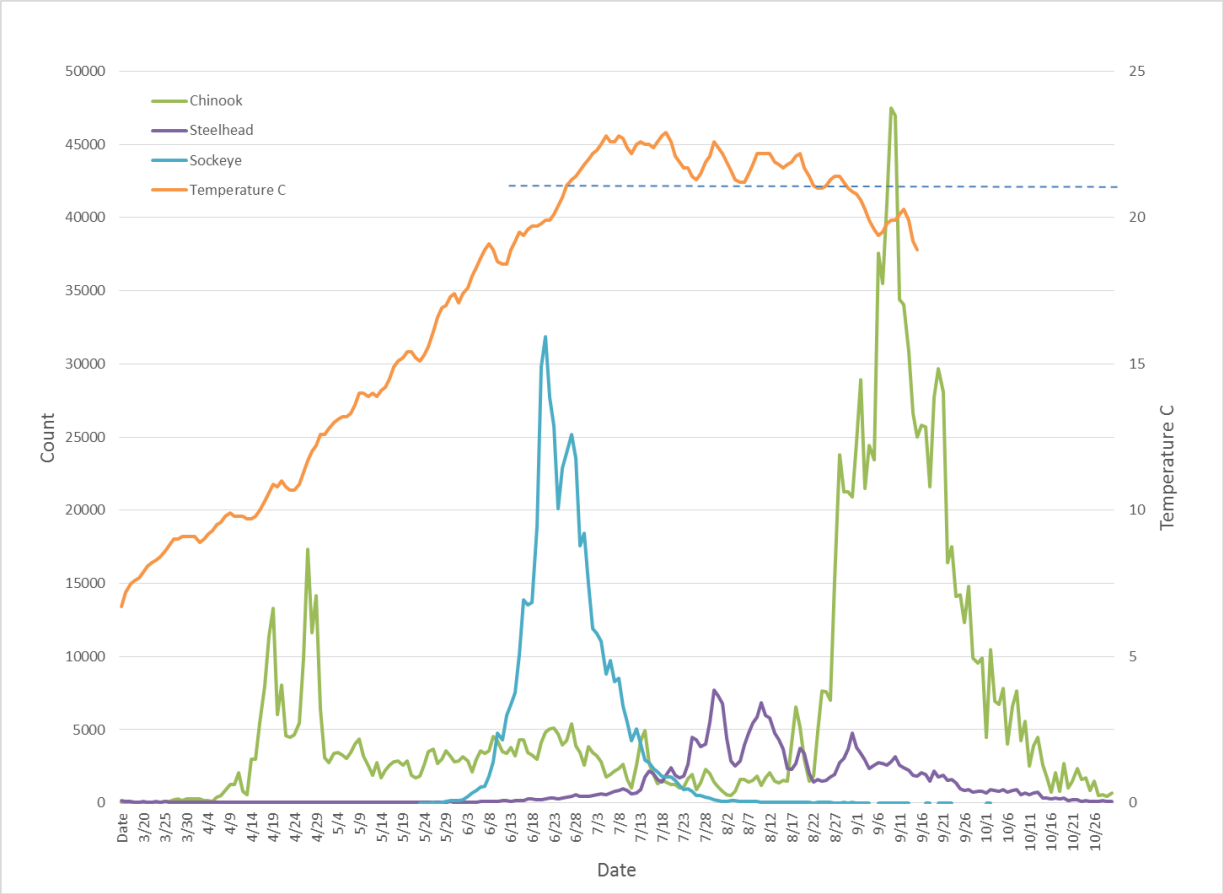

Figure 7. Chinook and steelhead daily run size and daily river temperature at Bonneville Dam for June 1 through October 31, 2015. The dashed line is 21.1°C which is the temperature that initiates sampling restrictions.

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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 2015.

Injury Category	Spring	Summer	Fall	Sockeye	Steelhead
Marine Mammal Bites & Scrapes	29.38	9.55	6.37	5.34	15.49
Descaling					
3-19%	14.54	24.76	14.39	18.97	7.52
>20%	2.77	5.34	8.55	3.16	3.98
Net Marks	4.54	5.83	8.20	2.07	10.62
Hook					
Hook Damage	1.54	3.07	2.77	0.22	0.22
Hook Present	0.08	0.49	0.06	0.00	0.11
Headburn	0.08	0.00	0.00	0.00	0.00
Other Injuries					
Bruise	0.00	0.00	0.00	0.44	0.00
Head Injury	0.54	0.32	0.77	0.11	0.44
Fin Injury	2.54	4.53	6.01	4.58	4.20
Fungus	0.38	0.00	0.29	0.11	0.29
Gash	1.54	3.07	2.77	2.62	6.42
Parasite/Dissease	0.08	0.32	2.06	21.05	18.03

Table A2. Length-at-age estimates for Columbia Basin spring Chinook salmon sampled at Bonneville Dam in 2015.

Brood Year	2012		2011		2010		2009
Age Class	0.2	1.1	0.3	1.2	0.4	1.3	1.4
Statistical week 16							
Average Length	-	-	-	72.4	-	82.5	-
Max Length	-	-	-	84.0	-	82.5	-
Min Length	-	-	-	62.0	-	82.5	-
StdDev Length	-	-	-	4.7	-	0.0	-
Count Length	-	-	-	41.0	-	2.0	-
Statistical week 17							
Average Length	-	52.0	-	72.5	-	84.4	-
Max Length	-	52.0	-	80.5	-	92.0	-
Min Length	-	52.0	-	62.0	-	78.0	-
StdDev Length	-	-	-	3.9	-	5.8	-
Count Length	-	1.0	-	106.0	-	4.0	-
Statistical week 18							
Average Length	-	50.7	-	72.8	-	84.3	-
Max Length	-	57.0	-	85.5	-	86.0	-
Min Length	-	45.0	-	58.5	-	81.5	-
StdDev Length	-	4.9	-	4.1	-	2.0	-
Count Length	-	5.0	-	194.0	-	4.0	-
Statistical week 19							
Average Length	-	50.9	-	72.6	-	84.2	-
Max Length	-	56.5	-	83.5	-	87.5	-
Min Length	-	42.5	-	62.0	-	79.5	-
StdDev Length	-	3.6	-	4.5	-	3.0	-
Count Length	-	22.0	-	163.0	-	7.0	-
Statistical week 20							
Average Length	-	52.0	-	73.2	90.0	92.8	-
Max Length	-	56.5	-	82.5	90.0	101.0	-
Min Length	-	46.5	-	59.0	90.0	84.5	-
StdDev Length	-	3.3	-	4.6	-	11.7	-
Count Length	-	24.0	-	128.0	1.0	2.0	-
Statistical week 21							
Average Length	-	52.0	76.8	73.0	91.8	86.3	91.0
Max Length	-	61.0	81.0	85.0	93.5	101.5	91.0
Min Length	-	43.0	72.5	53.0	90.0	80.0	91.0
StdDev Length	-	3.7	6.0	4.9	2.5	6.5	-
Count Length	-	71.0	2.0	139.0	2.0	14.0	1.0
Statistical week 22							
Average Length	62.0	55.2	81.8	73.5	89.6	85.2	-
Max Length	62.0	61.5	85.5	83.0	98.0	96.5	-
Min Length	62.0	50.0	79.5	60.0	82.5	77.5	-
StdDev Length	-	3.5	3.2	5.1	4.3	6.4	-
Count Length	1.0	19.0	3.0	82.0	9.0	10.0	-
Total							
Total Average Length	62.0	52.2	79.8	72.9	90.0	85.4	91.0
Total Max Length	62.0	61.5	85.5	85.5	98.0	101.5	91.0
Total Min Length	62.0	42.5	72.5	53.0	82.5	77.5	91.0
Total StdDev Length	-	3.8	4.7	4.5	3.9	5.7	-
Total Count Length	1.0	142.0	5.0	853.0	12.0	43.0	1.0

Table A3. Length-at-age estimates for Columbia Basin summer Chinook salmon sampled at Bonneville Dam in 2015.

Brood Year	2013	2012		2011		2010			2009	
Age Class	0.1	0.2	1.1	0.3	1.2	0.4	1.3	2.2	1.4	2.3
Statistical week 23										
Average Length	-	68.0	55.0	80.5	74.5	90.3	83.6	73.8	88.5	-
Max Length	-	68.0	63.0	87.0	86.0	99.0	91.5	75.5	88.5	-
Min Length	-	68.0	50.0	74.0	63.0	85.5	77.0	72.0	88.5	-
StdDev Length	-	-	3.0	9.2	4.9	5.1	4.2	2.5	0.0	-
Count Length	-	1.0	23.0	2.0	118.0	8.0	15.0	2.0	2.0	-
Statistical week 24										
Average Length	-	68.5	55.2	75.2	73.3	88.6	84.3	-	-	80.0
Max Length	-	68.5	64.5	83.0	82.0	99.0	95.0	-	-	80.0
Min Length	-	68.5	49.0	61.0	61.0	80.5	75.0	-	-	80.0
StdDev Length	-	-	4.4	6.2	5.1	5.1	5.6	-	-	-
Count Length	-	1.0	15.0	12.0	52.0	24.0	21.0	-	-	1.0
Statistical week 25										
Average Length	-	61.5	55.5	81.9	72.4	85.9	81.2	-	80.5	-
Max Length	-	61.5	63.5	93.0	83.5	99.0	88.0	-	80.5	-
Min Length	-	61.5	45.5	71.5	54.0	75.5	73.5	-	80.5	-
StdDev Length	-	-	5.3	7.5	6.3	7.5	3.9	-	-	-
Count Length	-	1.0	14.0	6.0	37.0	10.0	16.0	-	1.0	-
Statistical week 26										
Average Length	-	64.8	56.8	70.2	72.7	84.6	84.4	-	-	-
Max Length	-	67.0	62.5	77.5	85.0	90.5	90.5	-	-	-
Min Length	-	62.0	49.5	62.0	61.0	80.0	75.5	-	-	-
StdDev Length	-	2.1	3.8	7.8	6.3	4.8	5.2	-	-	-
Count Length	-	4.0	9.0	3.0	31.0	4.0	10.0	-	-	-
Statistical week 27										
Average Length	-	64.0	59.0	-	74.6	90.0	80.8	-	86.0	-
Max Length	-	64.0	63.0	-	78.5	90.0	85.0	-	86.0	-
Min Length	-	64.0	56.0	-	71.5	90.0	74.0	-	86.0	-
StdDev Length	-	-	2.5	-	3.4	-	3.7	-	-	-
Count Length	-	1.0	5.0	-	4.0	1.0	6.0	-	1.0	-
Statistical week 30										
Average Length	40.5	64.5	58.5	72.5	70.2	-	-	-	-	-
Max Length	40.5	67.5	64.0	72.5	81.0	-	-	-	-	-
Min Length	40.5	62.0	50.5	72.5	63.5	-	-	-	-	-
StdDev Length	-	2.8	5.7	-	5.6	-	-	-	-	-
Count Length	1.0	3.0	4.0	1.0	9.0	-	-	-	-	-
Statistical week 31										
Average Length	39.5	66.8	57.6	80.0	69.3	77.5	80.8	-	84.0	-
Max Length	39.5	78.5	65.0	83.0	79.5	77.5	88.0	-	84.0	-
Min Length	39.5	61.0	49.5	76.5	60.0	77.5	75.0	-	84.0	-
StdDev Length	-	5.6	5.6	2.5	5.9	-	5.6	-	-	-
Count Length	1.0	9.0	7.0	7.0	15.0	1.0	5.0	-	1.0	-
Total										
Total Average Length	40.0	65.8	56.0	77.3	73.3	87.8	83.0	73.8	85.5	80.0
Total Max Length	40.5	78.5	65.0	93.0	86.0	99.0	95.0	75.5	88.5	80.0
Total Min Length	39.5	61.0	45.5	61.0	54.0	75.5	73.5	72.0	80.5	80.0
Total StdDev Length	0.7	4.2	4.3	6.8	5.5	5.8	4.9	2.5	3.4	-
Total Count Length	2.0	20.0	77.0	31.0	266.0	48.0	73.0	2.0	5.0	1.0

Table A4. Length-at-age estimates for Columbia Basin fall Chinook salmon sampled at Bonneville Dam in 2015.

Brood Year	2013	2012		2011		2010			2009	
Age Class	0.1	0.2	1.1	0.3	1.2	0.4	1.3	2.2	0.5	1.4
Statistical week 32										
Average Length	48.0	64.9	60.8	73.6	71.9	88.5	84.0	-	-	-
Max Length	48.0	72.0	62.0	83.5	79.5	91.5	86.0	-	-	-
Min Length	48.0	55.5	59.5	62.0	64.5	85.5	82.0	-	-	-
StdDev Length	-	5.2	1.8	7.1	5.8	4.2	2.8	-	-	-
Count Length	1.0	8.0	2.0	7.0	6.0	2.0	2.0	-	-	-
Statistical week 34										
Average Length	41.0	62.8	56.5	75.9	69.1	84.8	79.0	76.0	-	-
Max Length	41.0	78.0	60.5	83.0	78.0	88.5	79.0	76.0	-	-
Min Length	41.0	51.5	54.0	69.0	61.5	75.0	79.0	76.0	-	-
StdDev Length	-	7.4	3.1	3.9	5.6	4.9	-	-	-	-
Count Length	1.0	11.0	4.0	24.0	10.0	7.0	1.0	1.0	-	-
Statistical week 35										
Average Length	57.0	62.1	55.0	77.2	65.7	85.0	84.3	-	-	-
Max Length	59.5	70.5	57.0	96.0	73.5	95.5	90.0	-	-	-
Min Length	54.5	51.5	51.0	59.0	59.0	69.0	81.5	-	-	-
StdDev Length	3.5	5.2	2.7	6.2	5.6	5.6	3.5	-	-	-
Count Length	2.0	13.0	4.0	48.0	10.0	25.0	5.0	-	-	-
Statistical week 36										
Average Length	51.0	63.0	55.0	76.1	70.1	84.8	83.5	-	-	-
Max Length	51.5	78.0	57.5	88.0	77.0	100.0	84.5	-	-	-
Min Length	50.5	47.0	52.5	62.5	61.5	74.0	82.0	-	-	-
StdDev Length	0.7	7.5	3.5	5.6	5.0	5.9	1.3	-	-	-
Count Length	2.0	39.0	2.0	69.0	6.0	58.0	3.0	-	-	-
Statistical week 37										
Average Length	41.0	65.8	58.0	77.4	69.7	83.5	79.8	-	-	-
Max Length	41.0	79.0	58.0	88.0	81.5	98.5	80.5	-	-	-
Min Length	41.0	56.0	58.0	65.0	55.0	58.0	79.0	-	-	-
StdDev Length	-	6.1	-	4.8	7.1	6.1	1.1	-	-	-
Count Length	1.0	54.0	1.0	63.0	17.0	50.0	2.0	-	-	-
Statistical week 38										
Average Length	50.8	67.4	57.0	75.1	71.4	83.3	-	-	86.0	-
Max Length	54.5	84.0	58.0	93.0	79.0	95.5	-	-	86.0	-
Min Length	48.0	55.5	56.0	54.5	57.5	75.0	-	-	86.0	-
StdDev Length	3.3	6.2	1.4	5.2	6.2	4.6	-	-	-	-
Count Length	3.0	63.0	2.0	88.0	10.0	64.0	-	-	1.0	-
Statistical week 39										
Average Length	47.4	65.1	53.0	74.7	69.0	83.8	81.4	-	74.0	-
Max Length	53.5	82.0	54.5	84.5	76.5	95.5	83.5	-	74.0	-
Min Length	41.0	53.0	51.5	62.0	60.5	75.5	78.0	-	74.0	-
StdDev Length	5.4	4.7	2.1	4.4	5.1	4.8	2.4	-	-	-
Count Length	4.0	70.0	2.0	65.0	8.0	48.0	4.0	-	1.0	-
Statistical week 40										
Average Length	54.5	63.9	-	75.0	74.5	82.8	75.0	-	80.5	-
Max Length	58.0	77.5	-	92.0	79.0	95.0	75.0	-	80.5	-
Min Length	51.0	45.5	-	65.0	67.0	67.5	75.0	-	80.5	-
StdDev Length	4.9	5.0	-	5.2	6.5	5.6	-	-	-	-
Count Length	2.0	99.0	-	59.0	3.0	50.0	1.0	-	1.0	-
Statistical week 41										
Average Length	-	63.8	-	73.3	65.5	81.5	-	-	-	-
Max Length	-	73.5	-	85.0	67.5	92.5	-	-	-	-
Min Length	-	51.0	-	60.5	63.5	74.5	-	-	-	-
StdDev Length	-	4.6	-	5.2	2.8	4.3	-	-	-	-
Count Length	-	99.0	-	72.0	2.0	38.0	-	-	-	-
Statistical week 42										
Average Length	47.8	63.5	59.4	71.4	70.8	82.6	-	-	82.0	75.0
Max Length	52.0	72.0	64.0	83.0	79.0	97.0	-	-	82.0	75.0
Min Length	43.5	50.0	55.5	58.0	59.5	70.0	-	-	82.0	75.0
StdDev Length	6.0	4.4	3.5	5.2	6.6	6.2	-	-	-	-
Count Length	2.0	72.0	4.0	56.0	8.0	34.0	-	-	1.0	1.0
Total										
Total Average Length	49.6	64.5	56.8	75.0	69.6	83.5	82.2	76.0	80.6	75.0
Total Max Length	59.5	84.0	64.0	96.0	81.5	100.0	90.0	76.0	86.0	75.0
Total Min Length	41.0	45.5	51.0	54.5	55.0	58.0	75.0	76.0	74.0	75.0
Total StdDev Length	5.6	5.5	3.3	5.5	6.1	5.4	3.3	-	5.0	-
Total Count Length	18.0	528.0	21.0	551.0	80.0	376.0	18.0	1.0	4.0	1.0

Table A5. Length-at-age estimates for Columbia Basin Sockeye salmon sampled at Bonneville Dam in 2015.

Brood Year	2012	2011		2010	
Age Class	1.1	1.2	2.1	1.3	2.2
Statistical week 22					
Average Length	-	49.5	-	-	-
Max Length	-	50.0	-	-	-
Min Length	-	49.0	-	-	-
StdDev Length	-	0.7	-	-	-
Count Length	-	2.0	-	-	-
Statistical week 23					
Average Length	-	49.5	-	53.0	-
Max Length	-	54.0	-	53.0	-
Min Length	-	44.5	-	53.0	-
StdDev Length	-	2.1	-	-	-
Count Length	-	27.0	-	1.0	-
Statistical week 24					
Average Length	-	49.7	-	53.9	-
Max Length	-	55.0	-	56.5	-
Min Length	-	43.0	-	52.0	-
StdDev Length	-	2.4	-	1.7	-
Count Length	-	115.0	-	8.0	-
Statistical week 25					
Average Length	41.5	50.0	-	54.0	50.5
Max Length	42.0	58.5	-	56.0	50.5
Min Length	41.0	43.0	-	50.5	50.5
StdDev Length	0.7	2.2	-	1.7	-
Count Length	2.0	276.0	-	12.0	1.0
Statistical week 26					
Average Length	-	50.0	40.5	53.7	54.0
Max Length	-	55.0	40.5	55.5	54.0
Min Length	-	42.5	40.5	49.0	54.0
StdDev Length	-	2.2	-	1.9	-
Count Length	-	237.0	1.0	11.0	1.0
Statistical week 27					
Average Length	-	49.8	-	55.2	52.0
Max Length	-	56.0	-	59.0	52.0
Min Length	-	40.5	-	50.5	52.0
StdDev Length	-	2.3	-	2.8	-
Count Length	-	154.0	-	13.0	1.0
Statistical week 30					
Average Length	-	49.2	-	53.0	-
Max Length	-	54.0	-	53.0	-
Min Length	-	44.0	-	53.0	-
StdDev Length	-	3.0	-	-	-
Count Length	-	13.0	-	1.0	-
Statistical week 31					
Average Length	-	50.2	-	55.3	-
Max Length	-	53.0	-	57.0	-
Min Length	-	47.5	-	53.5	-
StdDev Length	-	1.6	-	2.5	-
Count Length	-	18.0	-	2.0	-
Statistical week 32					
Average Length	-	48.0	-	-	-
Max Length	-	49.5	-	-	-
Min Length	-	46.5	-	-	-
StdDev Length	-	2.1	-	-	-
Count Length	-	2.0	-	-	-
Total					
Total Average Length	41.5	49.9	40.5	54.3	52.2
Total Max Length	42.0	58.5	40.5	59.0	54.0
Total Min Length	41.0	40.5	40.5	49.0	50.5
Total StdDev Length	0.7	2.3	-	2.1	1.8
Total Count Length	2.0	844.0	1.0	48.0	3.0

Table A6. Length-at-age estimates for Columbia Basin steelhead sampled at Bonneville Dam in 2015.

Brood Year	Salt-Winters			Brood Year	Salt-Winters			Brood Year	Salt-Winters		
Age Class	1	2	3	Age Class	1	2	3	Age Class	1	2	3
Statistical week 16				Statistical week 24				Statistical week 35			
Average Length	52.5	64.3	84.5	Average Length	-	65.3	-	Average Length	57.8	68.0	-
Max Length	52.5	71.0	84.5	Max Length	-	68.0	-	Max Length	64.5	77.5	-
Min Length	52.5	60.5	84.5	Min Length	-	62.5	-	Min Length	51.0	55.0	-
StdDev Length	-	4.1	-	StdDev Length	-	3.9	-	StdDev Length	2.8	4.8	-
Count Length	1.0	5.0	1.0	Count Length	-	2.0	-	Count Length	49.0	48.0	-
Statistical week 17				Statistical week 25				Statistical week 36			
Average Length	-	64.4	-	Average Length	-	67.7	-	Average Length	58.4	68.4	-
Max Length	-	67.5	-	Max Length	-	70.5	-	Max Length	66.5	77.5	-
Min Length	-	61.0	-	Min Length	-	63.0	-	Min Length	52.0	58.5	-
StdDev Length	-	2.9	-	StdDev Length	-	3.2	-	StdDev Length	3.0	5.0	-
Count Length	-	6.0	-	Count Length	-	5.0	-	Count Length	29.0	29.0	-
Statistical week 18				Statistical week 26				Statistical week 37			
Average Length	-	70.2	-	Average Length	-	66.0	-	Average Length	58.3	70.2	-
Max Length	-	72.5	-	Max Length	-	69.5	-	Max Length	61.5	78.0	-
Min Length	-	67.0	-	Min Length	-	63.5	-	Min Length	52.5	63.0	-
StdDev Length	-	2.8	-	StdDev Length	-	3.1	-	StdDev Length	4.0	4.9	-
Count Length	-	3.0	-	Count Length	-	3.0	-	Count Length	4.0	7.0	-
Statistical week 19				Statistical week 27				Statistical week 38			
Average Length	57.5	70.4	-	Average Length	56.0	68.5	-	Average Length	61.2	74.6	-
Max Length	57.5	85.0	-	Max Length	60.0	68.5	-	Max Length	68.5	85.0	-
Min Length	57.5	66.5	-	Min Length	52.0	68.5	-	Min Length	55.0	35.0	-
StdDev Length	-	7.2	-	StdDev Length	5.7	-	-	StdDev Length	3.5	8.6	-
Count Length	1.0	6.0	-	Count Length	2.0	1.0	-	Count Length	17.0	40.0	-
Statistical week 20				Statistical week 30				Statistical week 39			
Average Length	-	68.3	-	Average Length	56.5	66.3	-	Average Length	59.8	75.8	89.0
Max Length	-	74.0	-	Max Length	59.0	72.5	-	Max Length	67.5	84.0	89.0
Min Length	-	62.0	-	Min Length	53.5	59.0	-	Min Length	56.5	60.0	89.0
StdDev Length	-	3.8	-	StdDev Length	2.0	3.8	-	StdDev Length	3.1	5.7	-
Count Length	-	7.0	-	Count Length	11.0	11.0	-	Count Length	13.0	26.0	1.0
Statistical week 21				Statistical week 31				Statistical week 40			
Average Length	60.5	72.6	-	Average Length	57.1	67.0	-	Average Length	60.5	76.5	-
Max Length	60.5	80.0	-	Max Length	64.0	86.5	-	Max Length	67.5	90.0	-
Min Length	60.5	66.5	-	Min Length	51.5	57.5	-	Min Length	52.0	60.5	-
StdDev Length	-	4.8	-	StdDev Length	2.5	4.6	-	StdDev Length	3.8	6.0	-
Count Length	1.0	6.0	-	Count Length	93.0	75.0	-	Count Length	30.0	62.0	-
Statistical week 22				Statistical week 32				Statistical week 41			
Average Length	-	65.4	80.5	Average Length	57.3	67.4	-	Average Length	60.5	77.0	86.8
Max Length	-	67.0	81.5	Max Length	63.0	75.0	-	Max Length	68.5	88.0	93.5
Min Length	-	63.0	79.5	Min Length	52.0	62.5	-	Min Length	51.0	61.5	80.0
StdDev Length	-	2.0	1.4	StdDev Length	2.4	3.0	-	StdDev Length	4.1	6.9	9.5
Count Length	-	4.0	2.0	Count Length	63.0	30.0	-	Count Length	33.0	42.0	2.0
Statistical week 23				Statistical week 34				Statistical week 42			
Average Length	-	65.0	-	Average Length	58.3	68.1	-	Average Length	59.7	74.7	83.8
Max Length	-	74.0	-	Max Length	67.5	74.0	-	Max Length	67.0	86.0	88.0
Min Length	-	62.0	-	Min Length	52.0	62.0	-	Min Length	52.0	61.5	78.0
StdDev Length	-	3.6	-	StdDev Length	3.2	3.8	-	StdDev Length	3.7	7.6	5.2
Count Length	-	11.0	-	Count Length	33.0	20.0	-	Count Length	33.0	17.0	3.0
								Total			
								Total Average Length	58.4	70.9	84.4
								Total Max Length	68.5	90.0	93.5
								Total Min Length	51.0	35.0	78.0
								Total StdDev Length	3.3	6.9	5.1
								Total Count Length	413.0	466.0	9.0