Fishery Data Series No. 23-11

Stock Assessment of Buskin River Coho Salmon, 2018–2019

by

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and

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May 2023

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	′
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	″
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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ABSTRACT

The Alaska Department of Fish and Game, Division of Sport Fish has used a weir to assess the annual runs of coho salmon (*Oncorhynchus kisutch*) to the Buskin River on Kodiak Island since 1985. This report presents weir counts, harvest, and age-composition data collected for 2018 and 2019. In 2018, the inriver run estimate was 4,523 fish; the estimated sport and subsistence harvests were 1,793 fish and 1,171 fish, respectively, and the commercial harvest was zero. The estimated escapement was 4,164 coho salmon. Age-2.1 fish composed an estimated 78.9% of the inriver run and the male-to-female ratio was 2.4:1. In 2019, the inriver run estimate was 5,537 fish; the estimated sport and subsistence harvests were 934 fish and 340 fish, respectively, and the commercial harvest was zero. The estimated escapement was 5,350 coho salmon. Age-2.1 fish composed 52.3% of the inriver run and the male-to-female ratio was 1.1:1.

Keywords: coho salmon, *Oncorhynchus kisutch*, escapement, Buskin River, age-sex-length composition, sport harvest, subsistence harvest, stock assessment

INTRODUCTION

The Buskin River drainage, located on the northeast end of Kodiak Island (Figure 1), contains one of the largest wild populations of coho salmon (*Oncorhynchus kisutch*) found on the Kodiak road system. It is the most popular recreational fishing stream on the island, representing 29% (recent 10-year average) of the total freshwater sport fishing effort in the Kodiak Regulatory Area (Alaska Department of Fish and Game [ADF&G] Statewide Harvest Survey[1]). Sport fishing effort on the Buskin River is directed primarily toward coho and sockeye salmon (*O. nerka*), but some effort is also directed at steelhead and rainbow trout (*O. mykiss*), pink salmon (*O. gorbuscha*), and Dolly Varden (*Salvelinus malma*). From 1989 through 2017, estimated sport harvests of coho salmon from the Buskin River ranged from 1,474 fish to 6,567 fish and averaged 3,438 fish (Table 1 and Figure 2).

The Buskin River drainage also supports the largest reported subsistence coho salmon fishery in the Kodiak Archipelago, which takes place in salt water directly adjacent to the mouth of the river. Buskin River coho salmon typically compose about 20% of the total Buskin River subsistence salmon harvest, with reported harvests ranging from approximately 287 fish to 2,414 fish and averaging 1,288 fish from 1989 through 2017 (Table 1). Harvest in this fishery is documented through subsistence permits issued by the ADF&G Division of Commercial Fisheries (CF).

A relatively minor commercial harvest of Buskin River coho salmon occurs periodically in adjacent marine waters of Chiniak Bay. These harvests are typically small and during some years, nonexistent. Fish ticket harvest receipts available from CF Westward Region Fish Ticket Database indicate that between 1989 and 2017, the average annual commercial harvest of Buskin River coho salmon was 79 fish (Table 1).

Buskin River coho salmon runs have been monitored since 1985 at a salmon counting weir operated annually by ADF&G; the weir has been in its current location since 1989, approximately 2 km above the mouth (referred to as the "lower weir"; Figure 1). Results from weir counts at the lower weir are presented in this report (Appendices A1 and A2). A second weir, located at the outlet of Buskin Lake (referred to as the "lake weir"; Figure 1), monitored coho salmon runs annually from 2009 to 2017 and was used to estimate escapement for those years. The goal of the weir monitoring program is to ensure the sustainability and long-term health of the stock through

[1] Alaska Sport Fishing Survey database [Internet]. 1996–present. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish (cited February 2023). Available from: http://www.adfg.alaska.gov/sf/sportfishingsurvey/.

continued refinement of the escapement goal as more brood year returns are assessed. Between 1989 and 2017 (excluding 2015), the average lower weir count was 8,843 coho salmon, and counts have ranged from 2,513 to 16,596 fish (Table 1). In 2016, the lower weir count fell below the escapement goal of 4,700 coho salmon. Weir counts of adult fish entering the Buskin River are obtained from early August through the end of September, with peak daily counts of coho salmon typically occurring during the third week of September.

The Buskin River coho salmon escapement goal is based on a spawner–recruit model that uses escapement and age composition estimates provided by this project along with sport, subsistence, and commercial data collected by the programs described above. The current coho salmon escapement goal range of 4,700–9,600 fish was established as a biological escapement goal (BEG) in 2013 using a Ricker stock recruitment model (Ricker 1954; Fleischman et al. 2013; Sagalkin et al. 2013) and was changed to a sustainable escapement goal (SEG) with the same range in 2019 (McKinley et al. 2019). The escapement goal directs inseason management of the sport, subsistence, and commercial fisheries. Periodic refinement of the escapement goal is possible through continued collection of required data by this project and the sport, subsistence, and commercial harvest programs. This report presents estimates of Buskin River coho salmon spawning escapement, age composition, and sport, subsistence, and commercial harvests for 2018 and 2019.

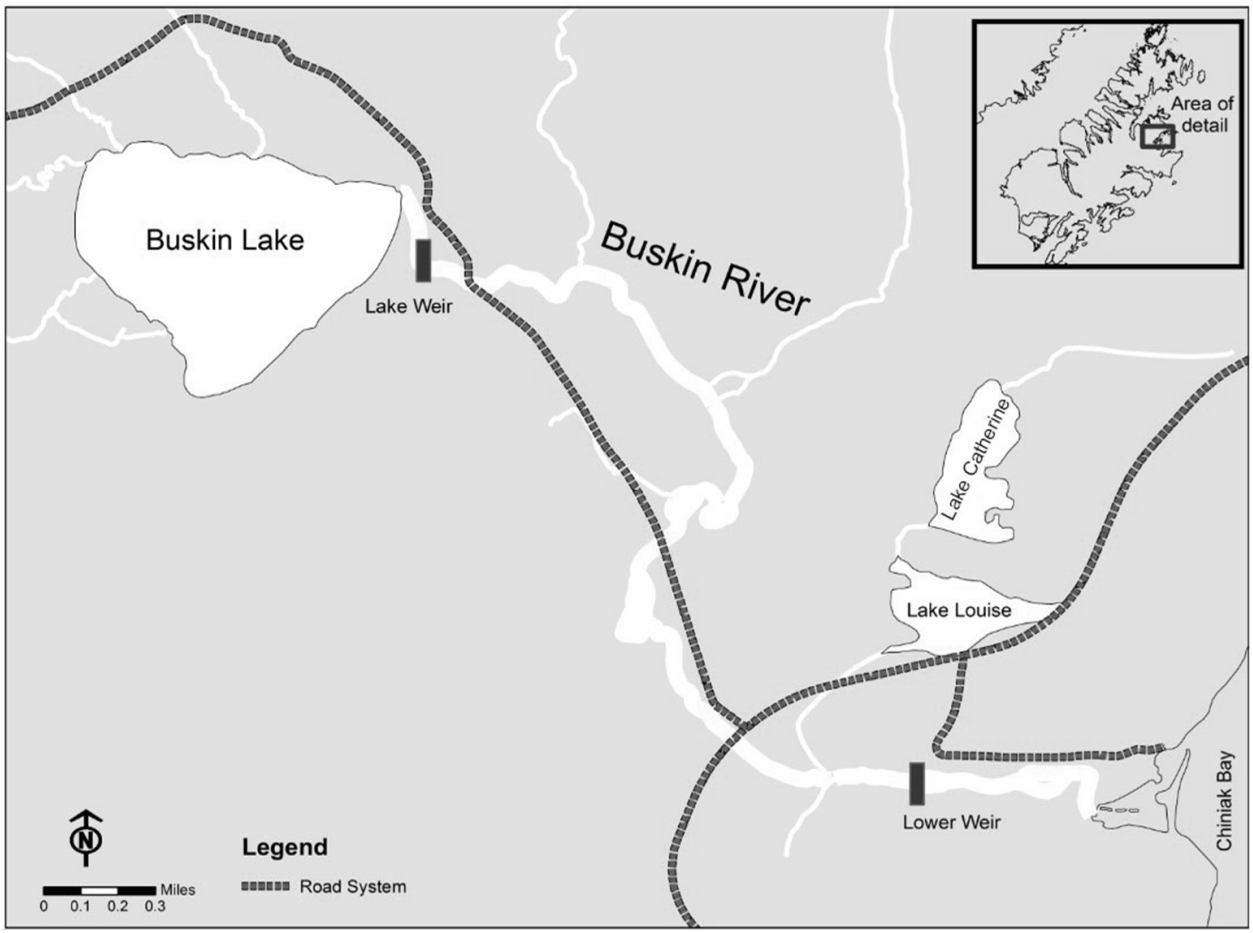

Figure 1.–Map of the Buskin River drainage on Kodiak Island (inset).

Table 1.–Buskin River coho salmon weir counts, commercial, subsistence, and sport harvests and effort, and total run estimates, 1989–2019.

Year	Weir count[a]	Commercial harvest[b]	Subsistence harvest[c]	Sport estimate[d]				Total run[g]
				Catch[e]	Harvest	SE (Harvest)	Angler-days[f]	
1989	9,930	0	1,302	NA	4,782	1,278	26,145	15,440
1990	6,222	1	1,774	3,086	1,521	402	19,151	9,335
1991	8,929	15	1,481	5,593	4,121	675	21,991	14,051
1992	6,535	0	1,907	2,097	1,474	308	15,482	9,739
1993	6,813	7	1,720	6,747	4,125	752	17,072	12,170
1994	8,146	15	2,167	3,963	2,429	395	16,534	12,466
1995	8,694	224	1,285	3,505	2,132	476	14,089	12,079
1996	8,439	0	1,263	4,258	2,481	465	14,159	11,885
1997	10,926	0	1,383	5,492	2,864	464	10,734	14,829
1998	9,062	9	1,394	4,288	2,669	486	14,332	12,814
1999	9,794	3	1,320	7,094	3,422	557	19,382	14,128
2000	8,048	0	1,717	5,541	2,589	628	21,002	12,043
2001	13,494	0	1,421	3,928	2,332	477	9,539	16,967
2002	10,649	0	1,517	4,388	2,497	532	18,450	14,363
2003	13,150	6	1,242	4,592	3,302	631	14,311	17,304
2004	9,599	95	1,481	8,562	4,860	822	17,549	15,452
2005	16,596	0	2,414	5,006	3,010	546	17,575	21,659
2006	13,348	763	1,567	11,468	6,567	1,022	19,875	21,457
2007	9,001	757	1,193	8,434	5,215	991	17,124	15,540
2008	9,028	0	1,165	6,469	4,259	760	15,068	13,600
2009	10,624	138	874	8,014	5,207	973	18,695	15,802
2010	6,808	0	679	4,492	2,847	786	13,365	9,765
2011	6,026	197	287	5,376	3,640	714	13,879	9,422
2012	5,291	10	984	2,680	1,926	408	13,996	7,826
2013	5,959	40	611	7,698	4,926	927	21,497	10,551
2014	8,413	1	1,529	7,813	5,388	1,021	20,276	14,253
2015	NA	13	884	7,308	4,889	1,808	13,704	NA
2016	2,513	0	496	2,841	1,895	562	8,141	4,525
2017	5,559	0	300	3,636	2,337	510	19,218	7,729
2018	4,523	0	1,171	3,080	1,793	550	9,471	7,128
2019	5,537	0	340	1,439	934	339	11,508	6,624
Average 1989–2017	8,843	79	1,288	5,513	3,438	703	16,632	13,114

Note: NA = not available.

[a] Source: Schmidt and Evans (2011) for 1989–2004 counts, Fuerst (2017) for 2005–2015 counts, and Stratton and Evans (2020) for 2016–2017 counts. Weir values include estimates.

[b] Source: ADF&G Division of Commercial Fisheries Statewide Harvest Receipt (fish ticket) database. Commercial harvest includes statistical areas 259-22 and 259-26.

[c] Source: Subsistence harvest records maintained by the Division of Commercial Fisheries Westward Region.

[d] Source: Statewide Harvest Survey database [Internet]. 1996–present. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish. Available from: http://www.adfg.alaska.gov/sf/sportfishingsurvey/.

[e] Catch is harvest plus number of fish released.

[f] Angler-days is the total number of days spent fishing by all anglers.

[g] Total run estimation described in Equation 1.

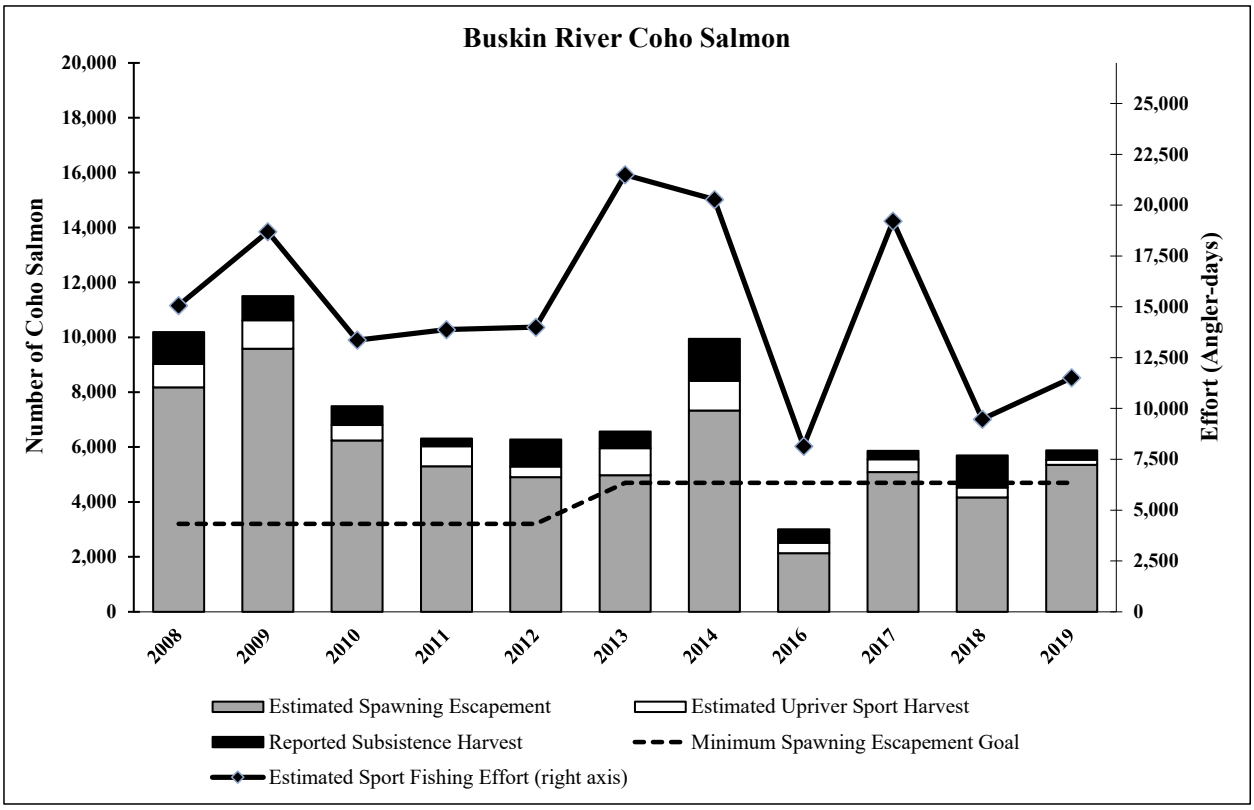

Figure 2.–Buskin River drainage reported coho salmon subsistence harvest, estimated coho salmon upriver sport harvest, and sport fishing effort for all species (angler-days), 2008–2019.

Source: Fuerst (2017); ADF&G Division of Commercial Fisheries (CF) Statewide Harvest Receipt (fish ticket) database; subsistence harvest records maintained by CF Westward Region; Statewide Harvest Survey database [Internet] (1996–present. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish. Available from: http://www.adfg.alaska.gov/sf/sportfishingsurvey/)

Note: Inriver run is the sum of upriver sport harvest and escapement.

OBJECTIVES

The objectives of the 2018–2019 stock assessment of Buskin River coho salmon were as follows:

1) Census the coho salmon inriver run at the lower Buskin River weir from August 1 to September 30 each year.
2) Estimate the age, sex, and length (ASL) composition of the coho salmon run.

METHODS

INRIVER RUN

A floating weir, operated at the lower weir site (Figure 1), was constructed across a channel approximately 40 m wide where the predominantly small rock substrate was suitable for anchoring a weir. The weir was constructed of 2.54 cm, schedule-80 PVC (polyvinyl chloride) pickets connected by riveted rubber straps to form panels approximately 1.6 m wide by 3.3 m long. Panels were connected via a single picket and anchored to the substrate via webbing connected to 2.86 cm chain. Steel pipe posts were driven into the substrate through the overlapping chain links from each panel to provide additional anchoring. To provide additional floatation, polyform L-3

buoys were attached to wooden boards approximately 3 m long. The boards were attached to the panels via bungee cords and placed underneath the downstream side of the panels; this design allowed the weir to float with minimal drag in changing water levels. Two counting gates were used to pass fish, and a trap constructed of aluminum panels, with a funnel-shaped entrance and attached to a counting gate, was installed to capture immigrating coho salmon for sampling (Figure 3).

During each year, the lower weir was monitored daily from the beginning of August through the end of September. Fish passage through the weir was only allowed when counts were made; all immigrating and emigrating anadromous fish were enumerated and identified by species. The lower weir was designed to operate continuously; however, during 2018 and 2019, a portion of the inriver run was estimated, when high water levels precluded the controlled passage of fish. Estimates of coho salmon passing the lower weir during periods of high water were calculated using a variety of methods (Table 2). As a result of periodic interruptions in lower weir counts from high water events and variability in the annual duration of weir operations, the weir counts presented in any given year should be considered an estimate (not a census) of the inriver run, and this estimate should not be considered the escapement because sport fishery harvest of coho salmon occurs upstream of the lower weir.

After removal of the weir, 1 postseason foot survey of the Buskin River was conducted to estimate the number of fish that entered the river after the weir was removed. If a flooding event was not in the forecast and water levels and water clarity were favorable, the postseason foot survey would take place below the weir site immediately after the weir was removed. The number of observed fish would be added as a postseason estimate. If the weir was removed immediately prior to a flooding event, the survey occurred when river conditions were improved (this could take several days), and the entire river was surveyed once to obtain an estimate of the number of fish within the watershed. The difference between the postseason foot survey estimate and weir count would be added as a postseason estimate.

Figure 3.–Buskin River lower weir with counting gates and sampling trap.

Table 2.–Methods used to interpolate Buskin River coho salmon lower weir counts during high water events and postseason estimates, 2018–2019.

Year	Weir dates	Estimates	Total days weir out	Estimated coho salmon per incident	Percent of weir count estimated	Type of failure and estimation methods
2018	2 Aug–8 Oct	Weir out 18–21 Aug	4	500		Flood. Estimates based on expanded last weir count before flood.
		Weir out 2 Oct	0.5	0		Flood. Estimates based on expanded last weir count before flood.
		Postseason	–	1,634		Based on a postseason foot survey and last weir count.
		Total	4.5	2,134	47.2%	
2019	31 Jul–1 Oct	Postseason	0	500	9.0%	Based on a postseason foot survey.

FISHERY HARVESTS

Annual subsistence harvests of Buskin River drainage coho salmon were estimated from returns of subsistence fishing permits received by the CF Kodiak Office. From 2008 through 2019, annual return rates of permits ranged between 82% and 93% and averaged 87% (CF Westward Region Subsistence Database). It was not possible to estimate the proportion of permit holders harvesting Buskin River coho salmon who failed to return permits.

The Statewide Harvest Survey (SWHS) estimates the participation, harvest, and catch of sport-caught species by area and by fishery (Romberg et al. 2020). The sport fishery harvest of Buskin River coho salmon in 2018 and 2019 was estimated by the SWHS. Harvest that occurs above the lower weir is assumed to be 20% of the total SWHS estimate for the Buskin River, based on a creel survey conducted by Murray (1987).

Commercial harvests were obtained from the CF Statewide Harvest Receipt (fish ticket) database. Reported catches of coho salmon from only ADF&G Kodiak Salmon Statistical Chart[2] areas 259-22 and 259-26 (Womens Bay statistical area and Buskin River Section) were assumed to be of Buskin River origin.

AGE, SEX, AND LENGTH COMPOSITION SAMPLING

Coho salmon were sampled for ASL data from the 2018 and 2019 inriver runs. The sampling period was stratified into three 2-week intervals between August 16 and September 30. Whenever possible, all coho salmon captured in the weir trap were sampled. Sampling was typically conducted 3–4 days per week. Sport, subsistence, and commercial harvests were not sampled for ASL composition, and samples from the inriver run were used as proxies for each of these run components.

Length from mid eye to tail fork (METF) was recorded to the nearest millimeter for each sampled fish, and sex was determined from external characteristics. Whenever possible, 4 scales were removed as described by Welander (1940). Sampled scales were taken from the preferred area on the left side of the fish, 2 scale rows above the lateral line, and placed on a gum card for subsequent analysis. Scales not available from the preferred area were taken in the same linear plane but from the third or fourth row below the lateral line. If it was not possible to take scales from the left side of the fish, scales were collected from the opposite side in the same manner as described above. Ages of sampled coho salmon were determined from scales using criteria described in Mosher (1969).

DATA ANALYSIS

Total Run and Escapement

The number of coho salmon in the total run ($\widehat{N}_T$) for each calendar year T was estimated by

$$\widehat{N}_T = \widehat{S} + H_{Sub} + H_{CF} + \widehat{H}_{SF} \quad (1)$$

where $\widehat{S}$ is estimated escapement, H_{Sub} is subsistence harvest, H_{CF} is commercial harvest, and $\hat{H}_{SF}$ is estimated sport harvest. Subsistence and commercial harvests were assumed known with zero

[2] Alaska Department of Fish and Game. 2020. Kodiak Area Salmon Statistical Chart. Available from: https://www.adfg.alaska.gov/static/fishing/PDFs/commercial/kodiak/kodiak_salmon_statisticalareas.pdf (Accessed March 2023).

variance, whereas $\widehat{H}_{SF}$ and its variance were provided by the SWHS. Because sport fishery harvest of coho salmon is not reported by area within the Buskin River drainage, and harvest occurs downriver and upriver of the weir, escapement was estimated as follows:

$$\hat{S} = W - (1-\rho)\widehat{H}_{SF} \tag{2}$$

where W is the inriver run, as measured at the weir, and ρ is the proportion of the sport harvest occurring below the weir. We assumed a value of 0.8 for ρ (Murray 1987). It is recognized that the true value of ρ may vary annually, but the introduced bias was not expected to be large; there was about a 6% increase in escapement estimates associated with 2008 through 2016 if a value for ρ of 0.9 versus 0.8 was used, and a 7% decrease if a value for ρ of 0.7 versus 0.8 is used.

The variances of $\hat{s}$ and $\hat{N}_T$ were estimated as follows:

$$\text{var}(\hat{S}) = (1-\rho)^2 \ \text{var}(\widehat{H}_{SF}) \tag{3}$$

and

$$\text{var}(\widehat{N}_T) = \text{var}(\widehat{H}_{SF})\rho^2 \tag{4}$$

Exploitation Rate

The exploitation rate ($\hat{\mu}_i$) for fishery i was estimated as follows:

$$\hat{\mu}_i = \frac{\widehat{H}_i}{\widehat{N}_T} \tag{5}$$

where i is *Sub*, *SF*, or *CF* for the subsistence, sport, or commercial fishery, respectively. For the subsistence or commercial fishery, the variance of the exploitation rate was estimated (delta method; Seber 1982: p. 8) as follows:

$$\text{var}(\hat{\mu}_i) = H_i^2 \frac{\text{var}(\hat{N}_T)}{\hat{N}_T^4} \tag{6}$$

where i is *Sub* or *CF*.

For the sport fishery, the variance of the exploitation rate was estimated (delta method) as follows:

$$\text{var}(\hat{\mu}_{SF}) = \frac{\left[W + H_{Sub} + H_{CF}\right]^2 \text{var}(\hat{H}_{SF})}{\left[W + H_{Sub} + H_{CF} + \rho\hat{H}_{SF}\right]^4} \tag{7}$$

Total exploitation rate was estimated as follows:

$$\hat{\mu}_T = \frac{\sum_{i=1}^{3} \hat{H}_i}{\hat{N}_T} \tag{8}$$

where i is *Sub*, *CF*, or *SF*, with variance estimated by simulation.

Age-Sex Composition

Estimation

Although daily weir counts exist for the inriver run, no overall time-stratified estimate of the age–sex composition of the total run was possible because the sport and subsistence harvests were not available by temporal strata.

The proportions ($\hat{r}_j$) and variances of age or sex class j for each run were estimated from the inriver run samples taken in 2018 and 2019, respectively:

$$\hat{r}_j = \frac{n_j}{n} \tag{9}$$

and

$$\text{var}\left(\hat{r}_j\right) = \frac{\hat{r}_j\left(1-\hat{r}_j\right)}{n-1} \tag{10}$$

where

n_j = the number of coho salmon in the sample for a particular year that were in age or sex class j, and

n = the number of coho salmon sampled in that particular year.

No finite population correction factor was used because it would have been close to 1.0 (population size much greater than sample) and there was uncertainty in the total run because the sport harvest was estimated and flooding periodically compromised the weir count.

The number of coho salmon of age or sex class j in the population of interest i (where i is S, W, SF, Sub, CF, or T) and its variance were estimated as follows:

$$\widehat{N}_{ij} = \widehat{N}_i\hat{r}_j \tag{11}$$

with variance estimated (Goodman 1960) as

$$\text{var}\left(\widehat{N}_{ij}\right) = \widehat{N}_i^2\,\text{var}\left(\hat{r}_j\right) + \hat{r}_j^2\,\text{var}\left(\widehat{N}_i\right) - \text{var}\left(\hat{r}_j\right)\text{var}\left(\widehat{N}_i\right) \tag{12}$$

Length

Mean length-at-age and its standard error were estimated for each age class of the run (Cochran 1977: Chapter 2).

RESULTS

It is important to note that the standard errors reported below for spawning escapement, total run, exploitation rate, and run by age and sex do not account for error in the estimation of the weir count when flooding occurred.

2018 SEASON

Total Run, Harvest, and Escapement

The lower weir was tended from August 1 through October 8. High water conditions (flooding) interrupted operation of the lower weir twice, from August 18 through August 21 and on October 2 (Table 2). For the first event, 500 fish were added to the weir count and zero fish were added for the second event; these numbers were based on expansion of the weir counts just prior to the floods. A postseason foot survey of the Buskin River was conducted below the weir site to count fish, and this added an estimated 1,634 fish to the escapement count. The inriver run (lower weir count plus flood-period estimates and postseason survey estimate) of coho salmon in the Buskin River for 2018 was 4,523 fish, of which approximately 47% was estimated (Tables 1 and 2, Appendix A2).

In 2018, anglers fishing the Buskin River drainage caught an estimated 3,080 coho salmon and harvested 1,793 coho salmon, expending 9,471 angler-days of effort (Table 1). The reported coho salmon subsistence harvest was 1,171 fish, and the commercial harvest of Buskin River coho salmon was zero fish. The estimated spawning escapement was 4,164 coho salmon (SE 110). The estimated total run was 7,128 coho salmon (SE 440).

Exploitation Rate

The estimated subsistence exploitation rate in 2018 was 16.4% (SE 1.0%) and was substantially lower than the sport exploitation rate of 25.2% (SE 6.2%); the commercial fisheries exploitation rate was zero, making the 2018 total estimated exploitation rate 41.6% (SE 5.3%; Table 3).

Table 3.–Estimated exploitation rates (percent of total run) of Buskin River coho salmon subsistence, sport, and commercial fisheries, 2018 and 2019.

Year	Statistic	Subsistence fishery (%)	Sport fishery (%)	Commercial fishery (%)	Total (%)
2018	Exploitation rate	16.4	25.2	0.0	41.6
	SE	1.0	6.2	0.0	5.3
2019	Exploitation rate	5.1	14.1	0.0	19.2
	SE	0.2	4.5	0.0	4.4

Age, Sex, and Length

A total of 98 coho salmon were sampled for sex and length from the inriver run, of which age was determined for 90 samples (Table 4). The run accounted for an estimated 78.9% age-2.1 fish and 13.3% age-1.1 fish. Males represented 70.4% of the run, giving a male to female ratio of 2.4:1. There was no significant difference in length between males and females ($Z = 1.13$, $P = 0.26$).

Comparison between the distribution of the age-sex-length sampling to the lower weir counts in 2018 shows the ASL sample was not well distributed with respect to the weir counts (Figure 4).

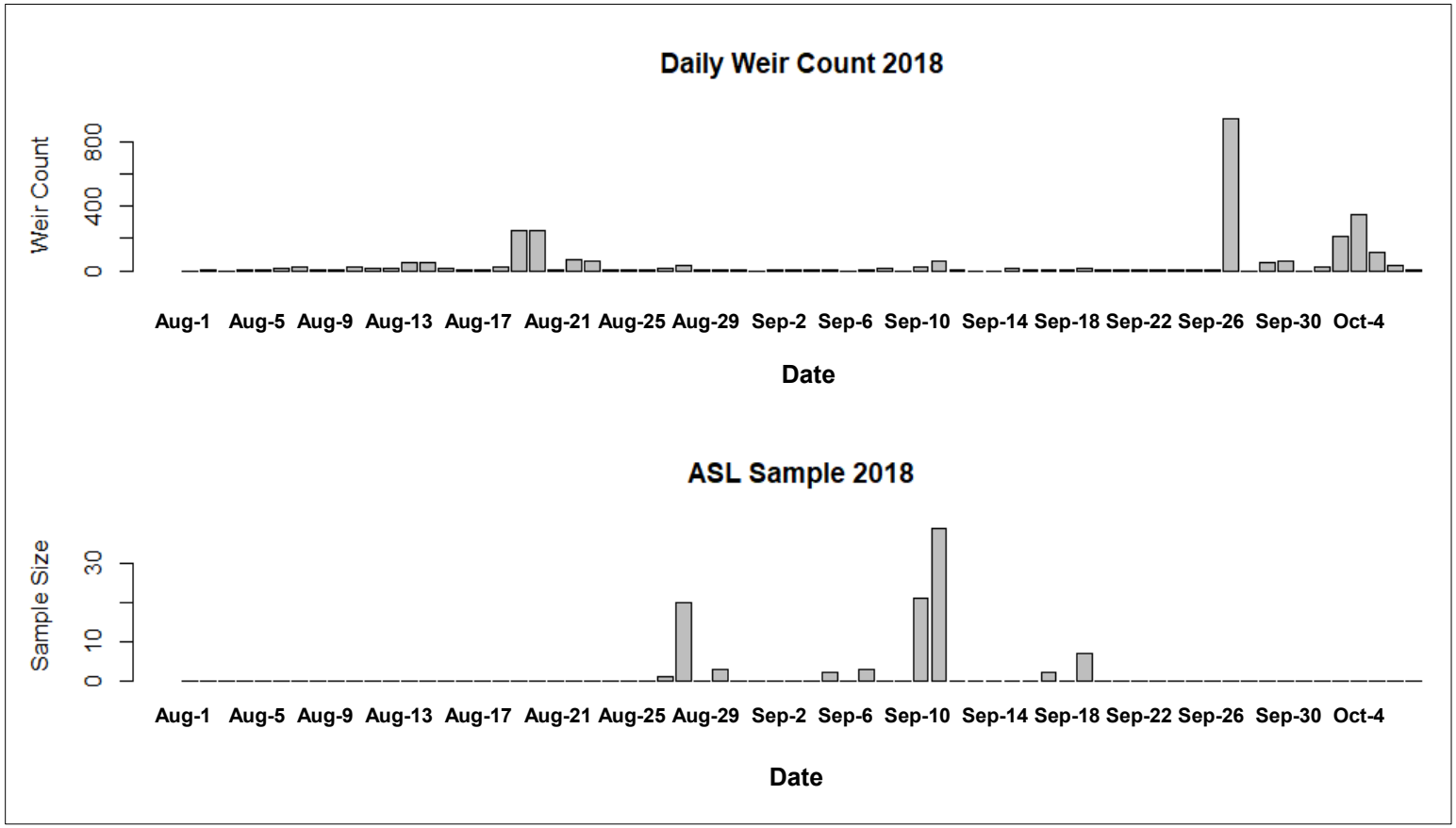

Figure 4.–Daily weir counts and number of age-sex-length (ASL) samples, 2018.

Table 4.–Estimated age, sex, and mean length of the Buskin River coho salmon inriver run, 2018.

		Age class							
Sex	Statistic	1.0	1.1	2.0	2.1	2.2	3.0	3.1	Total
Females									
	Number sampled	0	4	0	20	0	0	2	29
	Percent	0.0	4.4	0.0	22.2	0.0	0.0	2.2	29.6
	SE percent	0.0	2.2	0.0	4.4	0.0	0.0	1.6	4.6
	Total run	0	317	0	1,584	0	0	158	2,109
	SE total run	0	157	0	328	0	0	112	355
	Mean length	–	633	–	619	–	–	708	629
	SE mean length	–	17	–	11	–	–	13	9
	Minimum length	–	605	–	540	–	–	695	540
	Maximum length	–	681	–	690	–	–	720	720
Males									
	Number sampled	0	8	3	51	0	0	2	69
	Percent	0.0	8.9	3.3	56.7	0.0	0.0	2.2	70.4
	SE percent	0.0	3.0	1.9	5.3	0.0	0.0	1.6	4.6
	Total run	0	634	238	4,039	0	0	158	5,019
	SE total run	0	218	136	449	0	0	112	452
	Mean length	–	533	318	636	–	–	688	613
	SE mean length	–	28	23	7	–	–	38	11
	Minimum length	–	416	272	517	–	–	650	272
	Maximum length	–	638	343	777	–	–	725	777
All									
	Number sampled	0	12	3	71	0	0	4	98
	Percent	0.0	13.3	3.3	78.9	0.0	0.0	4.4	100.0
	SE percent	0.0	3.6	1.9	4.3	0.0	0.0	2.2	0.0
	Total run	0	950	238	5,624	0	0	317	7,128
	SE total run	0	263	136	464	0	0	157	440
	Mean length	–	566	318	631	–	–	698	618
	SE mean length	–	24	23	6	–	–	17	8
	Minimum length	–	416	272	517	–	–	650	272
	Maximum length	–	681	343	777	–	–	684	777

Note: Some fish may be sexed but not aged and vice versa. An en dash indicates the statistic is not applicable.

2019 SEASON

Total Run, Harvest, and Escapement

The lower weir was tended from July 31 through October 1. Emergency orders were issued in September 2019 closing Buskin River coho salmon for subsistence, sport, and commercial fishing; however, increased escapements resulted in the emergency orders being rescinded about 2 weeks later. No flooding interrupted operation of the lower weir in 2019 (Table 2). A postseason foot survey of the entire Buskin River was conducted to count fish (flooding occurred after the weir was removed) and this added an estimated 500 fish to the escapement count. The inriver run (lower weir count plus postseason survey estimate) of coho salmon in the Buskin River for 2019 was 5,537 fish, of which approximately 9% was estimated (Tables 1 and 2, Appendix A2).

In 2019, anglers fishing the Buskin River drainage caught an estimated 1,439 coho salmon and harvested 934 coho salmon, expending 11,508 angler-days of effort (Table 1). The reported coho salmon subsistence harvest was 340 fish, and the commercial harvest of Buskin River coho salmon was zero. The estimated spawning escapement was 5,350 (SE 68). The estimated total run was 6,624 (SE 271 coho salmon.

Exploitation Rate

The estimated subsistence exploitation rate in 2019 was 5.1% (SE 0.2%), whereas the sport exploitation rate was 14.1% (SE 4.5%); the commercial fisheries exploitation rate was zero, making the total estimated exploitation rate 19.2% (SE 4.4%; Table 3).

Age, Sex, and Length

A total of 91 coho salmon were sampled for sex and length from the inriver run, of which age was determined for 88 samples (Table 5). The run accounted for an estimated 52.3% age-2.1 fish and 30.7% age-1.1 fish. Males represented 51.6% of the run, giving a male-to-female ratio of 1.1:1. There was a significant difference in length between males and females ($Z = 2.48$, $P = 0.01$).

Comparison between the distribution of the age-sex-length sampling to the lower weir counts in 2019 shows the ASL sample is fairly well distributed with respect to the weir counts (Figure 5).

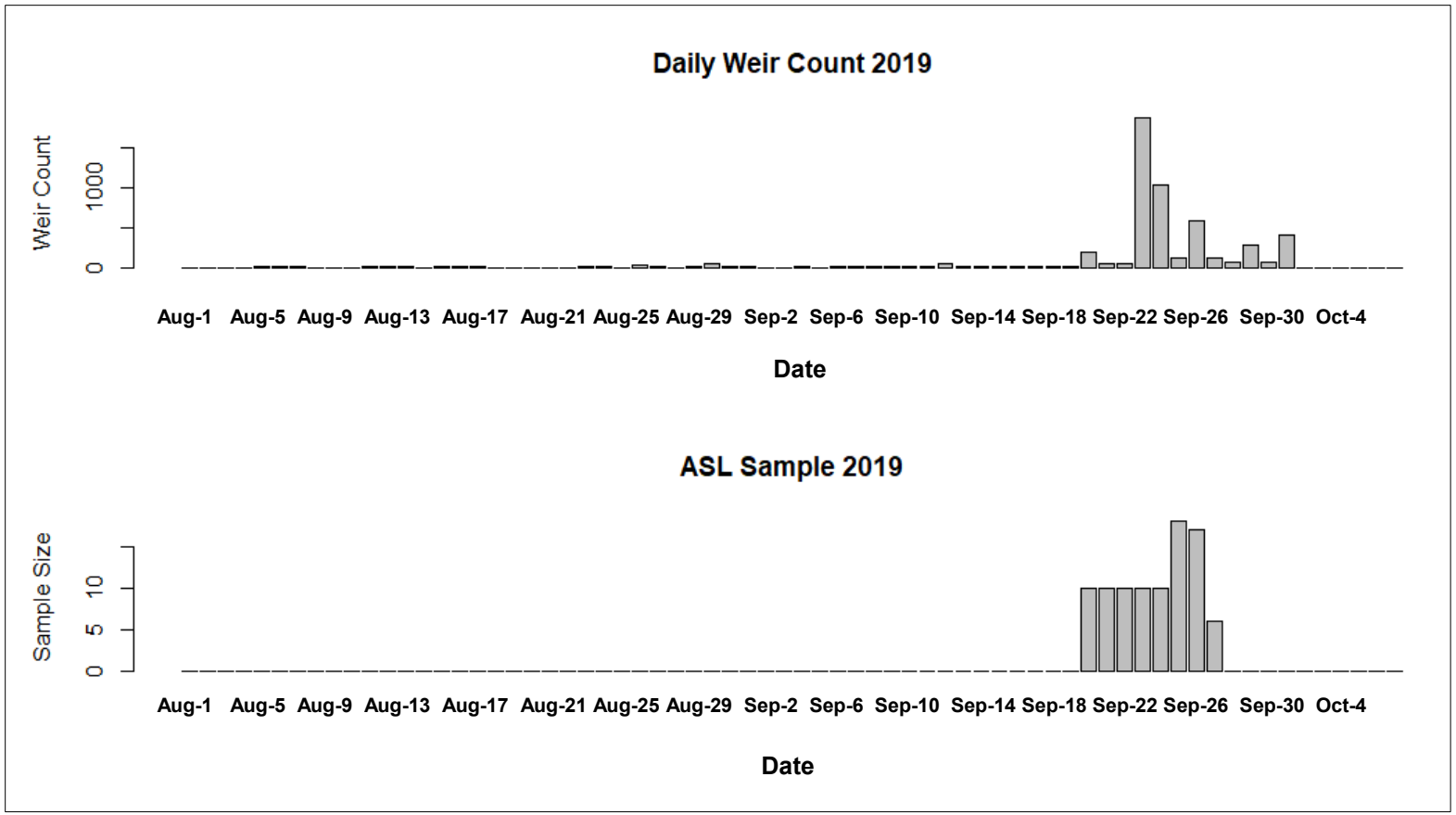

Figure 5.–Daily weir counts and number of age-sex-length (ASL) samples, 2019.

Table 5.–Estimated age, sex, and mean length of the Buskin River coho salmon inriver run, 2019.

		Age class							
Sex	Statistic	1.0	1.1	2.0	2.1	2.2	3.0	3.1	Total
Females									
	Number sampled	0	13	0	23	0	0	5	44
	Percent	0.0	14.8	0.0	26.1	0.0	0.0	5.7	48.4
	SE percent	0.0	3.8	0.0	4.7	0.0	0.0	2.5	5.3
	Total run	0	1,142	0	2,020	0	0	439	3,737
	SE total run	0	300	0	379	0	0	193	452
	Mean length	–	614	–	628	–	–	635	624
	SE mean length	–	11	–	7	–	–	8	5
	Minimum length	–	511	–	581	–	–	605	511
	Maximum length	–	664	–	704	–	–	650	704
Males									
	Number sampled	0	14	3	23	0	0	7	47
	Percent	0.0	15.9	3.4	26.1	0.0	0.0	8.0	51.6
	SE percent	0.0	3.9	1.9	4.7	0.0	0.0	2.9	5.3
	Total run	0	1,230	263	2,020	0	0	615	3,992
	SE total run	0	310	151	379	0	0	226	458
	Mean length	–	587	364	614	–	–	643	594
	SE mean length	–	12	15	10	–	–	14	11
	Minimum length	–	525	336	511	–	–	595	336
	Maximum length	–	684	385	676	–	–	716	716
All									
	Number sampled	0	27	3	46	0	0	12	91
	Percent	0.0	30.7	3.4	52.3	0.0	0.0	13.6	100.0
	SE percent	0.0	4.9	1.9	5.4	0.0	0.0	3.7	0.0
	Total run	0	2,371	263	4,040	0	0	1,054	7,729
	SE total run	0	402	151	465	0	0	289	408
	Mean length	–	600	364	621	–	–	640	609
	SE mean length	–	9	15	6	–	–	8	7
	Minimum length	–	511	336	511	–	–	595	336
	Maximum length	–	684	385	704	–	–	716	716

Note: Some fish may be sexed but not aged and vice versa. An en dash indicates the statistic is not applicable.

DISCUSSION

TOTAL RUN

There are several sources of bias and unaccounted variability in the estimates of total run for both 2018 and 2019. One source of bias lies in unreturned subsistence permits. This bias is not thought to be large because the subsistence harvest typically represents only about 10% of the total run and the average rate of permit return in 2018 and 2019 was 87.9%.

A second source of unquantifiable bias comes from the assumption that 20% of the sport harvest occurs upstream of the lower weir. This number originated from a creel survey in 1986 by Murray (1987) and probably fluctuates annually, with a possible (unknown) trend over time.

A third and probably the most important source of bias and variability is the estimation of lower weir counts for periods when the weir was inoperable due to floods (2018) and the estimation via a postseason foot survey of the fish that entered the river after the weir was removed (2018 and 2019). It is important to note that the reported standard errors of the total run, escapement, age-sex composition estimates, exploitation rates, and brood year returns are therefore biased low because they only account for variance in the estimates of sport harvest and age composition and not in the estimation of counts during flood periods and postseason counts.

An updated brood table for Buskin River coho salmon, incorporating returns from brood years 2012 through 2015, was also developed using all available Buskin River weir data. The latest run data will be used in the next evaluation of the escapement goal in coordination with the Kodiak Board of Fish cycle.

AGE, SEX, AND LENGTH

For both 2018 and 2019, age 2.1 fish were dominant, with age 1.1 fish representing most of the remainder. Age 3.1 was a substantial contributor (13.6%) in 2019, however. Males were smaller than females, although not significantly so for 2018. As noted above, standard errors of the age-sex composition of the total run are biased low due to the unaccounted variability in the estimation of the inriver run and therefore the total run for each year. Sampling did not occur throughout the migration for 2018 and focused on the middle of the run, whereas the bulk of the weir counts occurred in the tail ends of the run. Sampling was dictated by fish availability and could not occur on days when the weir was inoperable due to flooding; therefore, age class estimates may not be representative of the total run for 2018. Sampling in 2019 generally followed inriver run timing.

EXPLOITATION RATE

The total exploitation rate of Buskin River coho salmon ranged from 19.2% in 2019 to 41.6% in 2018. Exploitation in the sport fishery ranged from 1.5 to 2.7 times higher than that of the subsistence fishery (Table 3).

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APPENDIX A: BUSKIN RIVER WEIR COUNTS, 2010–2019

Appendix A1.–Daily counts, cumulative counts, and percent of total counts of coho salmon through the Buskin River lower weir; inseason and postseason estimates included, 2010–2014.

	2010			2011			2012			2013			2014		
Weir in	29 Jul			6 Aug			10 Aug			13 Aug			14 Aug		
Weir out	29 Sep			16 Sep			30 Sep			28 Sep			29 Sep		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
29 Jul	0	0	0	–	–	–	–	–	–	–	–	–	–	–	–
30 Jul	0	0	0	–	–	–	–	–	–	–	–	–	–	–	–
31 Jul	0	0	0	–	–	–	–	–	–	–	–	–	–	–	–
1 Aug	0	0	0	–	–	–	–	–	–	–	–	–	–	–	–
2 Aug	0	0	0	–	–	–	–	–	–	–	–	–	–	–	–
3 Aug	0	0	0	–	–	–	–	–	–	–	–	–	–	–	–
4 Aug	0	0	0	–	–	–	–	–	–	–	–	–	–	–	–
5 Aug	0	0	0	–	–	–	–	–	–	–	–	–	–	–	–
6 Aug	0	0	0	0	0	0	–	–	–	–	–	–	–	–	–
7 Aug	0	0	0	0	0	0	–	–	–	–	–	–	–	–	–
8 Aug	5	5	0	0	0	0	–	–	–	–	–	–	–	–	–
9 Aug	15	20	0	0	0	0	–	–	–	–	–	–	–	–	–
10 Aug	11	31	0	0	0	0	0	0	0	–	–	–	–	–	–
11 Aug	9	40	1	0	0	0	3	3	0	–	–	–	–	–	–
12 Aug	4	44	1	0	0	0	14	17	0	59[a]	59	1	–	–	–
13 Aug	5	49	1	0	0	0	33	50	1	16	75	1	–	–	–
14 Aug	11	60	1	0	0	0	59	109	2	4	79	1	463	463	6
15 Aug	19	79	1	0	0	0	38	147	3	14	93	2	0	463	6
16 Aug	30	109	2	0	0	0	19	166	3	17	110	2	10	473	6
17 Aug	30	139	2	0	0	0	41	207	4	19	129	2	38	511	6
18 Aug	82	221	3	10	10	0	6	213	4	36	165	3	10	521	6
19 Aug	46	267	4	3	13	0	87	300	6	12	177	3	19	540	6
20 Aug	17	284	4	8	21	0	34	334	6	16	193	3	33	573	7
21 Aug	14	298	4	10	31	1	5	339	6	13	206	3	0	573	7
22 Aug	100	398	6	25	56	1	7	346	7	74	280	5	3	576	7
23 Aug	21	419	6	13	69	1	1	347	7	87	367	6	10	586	7
24 Aug	42	461	7	12	81	1	11	358	7	119	486	8	92	678	8
25 Aug	31	492	7	174	255	4	5	363	7	127	613	10	84	762	9

-continued-

Appendix A1.–Page 2 of 3.

	2010			2011			2012			2013			2014		
Weir in	29 Jul			6 Aug			10 Aug			13 Aug			14 Aug		
Weir out	29 Sep			16 Sep			30 Sep			28 Sep			29 Sep		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
26 Aug	31	523	8	141	396	7	5	368	7	114	727	12	92	854	10
27 Aug	23	546	8	283	679	11	4	372	7	96	823	14	218	1,072	13
28 Aug	15	561	8	147	826	14	3	375	7	32	855	14	40	1,112	13
29 Aug	17	578	8	137	963	16	9	384	7	678	1,533	26	34	1,146	14
30 Aug	6	584	9	158	1,121	19	13	397	8	500	2,033	34	57	1,203	14
31 Aug	21	605	9	129	1,250	21	18	415	8	406	2,439	41	105	1,308	16
1 Sep	7	612	9	117	1,367	23	13	428	8	49	2,488	42	29	1,337	16
2 Sep	7	619	9	95	1,462	24	5	433	8	198	2,686	45	80	1,417	17
3 Sep	15	634	9	121	1,583	26	10	443	8	59	2,745	46	163	1,580	19
4 Sep	85	719	11	128	1,711	28	7	450	9	105	2,850	48	862	2,442	29
5 Sep	203	922	14	103	1,814	30	19	469	9	161	3,011	51	337	2,779	33
6 Sep	21	943	14	93	1,907	32	2	471	9	343	3,354	56	218	2,997	36
7 Sep	148	1,091	16	115	2,022	34	2	473	9	343	3,697	62	46	3,043	36
8 Sep	80	1,171	17	126	2,148	36	1	474	9	143	3,840	64	185	3,228	38
9 Sep	270	1,441	21	161	2,309	38	5	479	9	233	4,073	68	77	3,305	39
10 Sep	30	1,471	22	130	2,439	40	3	482	9	233	4,306	72	122	3,427	41
11 Sep	4	1,475	22	135	2,574	43	24	506	10	135	4,441	75	393	3,820	45
12 Sep	13	1,488	22	146	2,720	45	20	526	10	119	4,560	77	478	4,298	51
13 Sep	4	1,492	22	113	2,833	47	3	529	10	203	4,763	80	619	4,917	58
14 Sep	46	1,538	23	155	2,988	50	3	532	10	25	4,788	80	131	5,048	60
15 Sep	7	1,545	23	121	3,109	52	256	788	15	52	4,840	81	1,349	6,397	76
16 Sep	6	1,551	23	82	3,191	53	235	1,023	19	9	4,849	81	543	6,940	82
17 Sep	2	1,553	23	–	–	–	56	1,079	20	7	4,856	81	463	7,403	88
18 Sep	3	1,556	23	–	–	–	345	1,424	27	34	4,890	82	308	7,711	92
19 Sep	20	1,576	23	–	–	–	550	1,974	37	59	4,949	83	206	7,917	94
20 Sep	2	1,578	23	–	–	–	387	2,361	45	60	5,009	84	127	8,044	96
21 Sep	20	1,598	23	–	–	–	230	2,591	49	115	5,124	86	148	8,192	97
22 Sep	303	1,901	28	–	–	–	300	2,891	55	145	5,269	88	3	8,195	97
23 Sep	45	1,946	29	–	–	–	300	3,191	60	15	5,284	89	19	8,214	98

-continued-

	2010			2011			2012			2013			2014		
Weir in	29 Jul			6 Aug			10 Aug			13 Aug			14 Aug		
Weir out	29 Sep			16 Sep			30 Sep			28 Sep			29 Sep		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
24 Sep	873	2,819	41	–	–	–	300	3,491	66	1	5,285	89	2	8,216	98
25 Sep	245	3,064	45	–	–	–	300	3,791	72	38	5,323	89	3	8,219	98
26 Sep	110	3,174	47	–	–	–	300	4,091	77	4	5,327	89	3	8,222	98
27 Sep	86	3,260	48	–	–	–	300	4,391	83	80	5,407	91	110	8,332	99
28 Sep	41	3,301	48	–	–	–	300	4,691	89	184	5,591	94	81(50)[b]	8,413	100
29 Sep	6	3,307	49	–	–	–	300	4,991	94	–	–	–	0	8,413	100
30 Sep	–	–	–	–	–	–	300	5,291	100	–	–	–	–	–	–
Total estimated inseason[c]	NA	79	1	NA	2,936	49	NA	2,700	51	NA	3,741	63	NA	3,941	47
Total estimated postseason[d]	NA	3,501	51	NA	2,835	47	NA	0	0	NA	368	6	NA	0	0
Season total[e]	NA	6,808	100	NA	6,026	100	NA	5,291	100	NA	5,959	100	NA	8,413	100

Note: Shaded values are inseason estimates. NA means not applicable. An en dash indicates dates when counts or estimates were not made for the lower weir.

[a] Count for 12 August comes from the lake weir.

[b] Daily total (weir count plus estimate) followed by inseason estimate in parentheses.

[c] Source: Schmidt et al. (2014) for 2010 estimates, Polum and Evans (2017) for 2011–2013 estimates, Stratton and Evans (2020) for 2014–2017 estimates. Inseason estimates were made due to high water events.

[d] Source: Schmidt et al. (2014) for 2010 estimates, Polum and Evans (2017) for 2011–2013 estimates, Stratton and Evans (2020) for 2014–2017 estimates. Postseason estimates were made after the weir was pulled.

[e] Season total is cumulative weir count plus postseason estimate.

Appendix A2.–Daily counts, cumulative counts, and percent of total counts of coho salmon through the Buskin River lower weir; inseason and postseason estimates included, 2015–2019.

	2015			2016			2017			2018[a]			2019[b]		
Weir in	14 Aug			5 Aug			7 Aug			1 Aug			31 Jul		
Weir out	7 Oct			29 Sep			27 Sep			8 Oct			1 Oct		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
29 Jul	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
30 Jul	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
31 Jul	–	–	–	–	–	–	–	–	–	–	–	–	0	0	0
1 Aug	–	–	–	–	–	–	–	–	–	0	0	0	0	0	0
2 Aug	–	–	–	–	–	–	–	–	–	1	1	0	0	0	0
3 Aug	–	–	–	–	–	–	–	–	–	0	1	0	0	0	0
4 Aug	–	–	–	–	–	–	–	–	–	4	5	0	0	0	0
5 Aug	–	–	–	2	2	0	–	–	–	4	9	0	1	1	0
6 Aug	–	–	–	1	3	0	–	–	–	17	26	1	4	5	0
7 Aug	–	–	–	7	10	0	0	0	0	23	49	1	5	10	0
8 Aug	–	–	–	2	12	0	0	0	0	3	52	1	0	10	0
9 Aug	–	–	–	0	12	0	0	0	0	7	59	1	0	10	0
10 Aug	–	–	–	4	16	1	0	0	0	23	82	2	0	10	0
11 Aug	–	–	–	0	16	1	0	0	0	14	96	2	1	11	0
12 Aug	–	–	2	2	18	1	0	0	0	10	106	2	1	12	0
13 Aug	70[c]	70	2	3	21	1	0	0	0	48	154	3	1	13	0
14 Aug	2	72	2	30	51	2	0	0	0	46	200	4	0	13	0
15 Aug	2	74	2	12	63	3	0	0	0	17	217	5	1	14	0
16 Aug	0	74	2	6	69	3	1	1	0	3	220	5	3	17	0
17 Aug	1	75	2	17	86	3	0	1	0	4	224	5	2	19	0
18 Aug	3	78	2	35	121	5	0	1	0	21	245	5	0	19	0
19 Aug	4	82	2	16	137	5	0	1	0	250	495	11	0	19	0
20 Aug	3	85	2	23	160	6	1	2	0	250	745	16	0	19	0
21 Aug	2	87	2	29	189	8	2	4	0	7	752	17	0	19	0
22 Aug	0	87	2	31	220	9	4	8	0	65	817	18	0	19	0
23 Aug	1	88	2	104	324	13	1	9	0	58	875	19	1	20	0
24 Aug	4	92	2	34	358	14	4	13	0	4	879	19	2	22	0
25 Aug	10	102	2	52	410	16	12	25	0	3	882	20	0	22	0

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	2015			2016			2017			2018[a]			2019[b]		
Weir in	14 Aug			5 Aug			7 Aug			1 Aug			31 Jul		
Weir out	7 Oct			29 Sep			27 Sep			8 Oct			1 Oct		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
26 Aug	6	108	2	8	418	17	17	42	1	4	886	20	19	41	1
27 Aug	9	117	3	62	480	19	12	54	1	14	900	20	3	44	1
28 Aug	16	133	3	7	487	19	7	61	1	29	929	21	0	44	1
29 Aug	4	137	3	87	574	23	0	61	1	4	933	21	1	45	1
30 Aug	4	141	3	86	660	26	0	61	1	8	941	21	44	89	2
31 Aug	3	144	3	9	669	27	0	61	1	2	943	21	17	106	2
1 Sep	3	147	3	18	687	27	2	63	1	0	943	21	2	108	2
2 Sep	2	149	3	20	707	28	1	64	1	2	945	21	0	108	2
3 Sep	2	151	3	38	745	30	0	64	1	2	947	21	0	108	2
4 Sep	2	153	4	118	863	34	0	64	1	1	948	21	2	110	2
5 Sep	0	153	4	20	883	35	0	64	1	2	950	21	0	110	2
6 Sep	0	153	4	87	970	39	0	64	1	0	950	21	2	112	2
7 Sep	5	158	4	5	975	39	0	64	1	7	957	21	1	113	2
8 Sep	2	160	4	17	992	39	30	94	2	15	972	21	1	114	2
9 Sep	5	165	4	15	1,007	40	20	114	2	0	972	21	4	118	2
10 Sep	15	180	4	10	1,017	40	5	119	2	26	998	22	2	120	2
11 Sep	9	189	4	268	1,285	51	3,052 (3,000)[d]	3,171	57	61	1,059	23	5	125	2
12 Sep	7	196	5	44	1,329	53	33	3,204	58	7	1,066	24	44	169	3
13 Sep	1	197	5	31	1,360	54	46	3,250	58	0	1,066	24	8	177	3
14 Sep	4	201	5	17	1,377	55	160	3,410	61	0	1,066	24	2	179	3
15 Sep	8	209	5	64	1,441	57	105	3,515	63	10	1,076	24	2	181	3
16 Sep	3	212	5	42	1,483	59	178	3,693	66	4	1,080	24	14	195	4
17 Sep	2	214	5	24	1,507	60	25	3,718	67	4	1,084	24	2	197	4
18 Sep	3	217	5	4	1,511	60	13	3,731	67	6	1,090	24	15	212	4
19 Sep	0	217	5	19	1,530	61	67	3,798	68	13	1,103	24	9	221	4
20 Sep	2	219	5	21	1,551	62	91	3,889	70	2	1,105	24	192	413	7
21 Sep	1	220	5	383 (167)[d]	1,934	77	15	3,904	70	2	1,107	24	46	459	8
22 Sep	1	221	5	180	2,114	84	25	3,929	71	4	1,111	25	44	503	9
23 Sep	0	221	5	211	2,325	93	24	3,953	71	1	1,112	25	1,865	2,368	43

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Weir in / Weir out / Date	2015 14 Aug – 7 Oct Daily	Cum.	%	2016 5 Aug – 29 Sep Daily	Cum.	%	2017 7 Aug – 27 Sep Daily	Cum.	%	2018[a] 1 Aug – 8 Oct Daily	Cum.	%	2019[b] 31 Jul – 1 Oct Daily	Cum.	%
24 Sep	0	221	5	35	2,360	94	70	4,023	72	3	1,115	25	1,030	3,398	61
25 Sep	0	221	5	91	2,451	98	40	4,063	73	3	1,118	25	122	3,520	64
26 Sep	2	223	5	35 (25)[d]	2,486	99	2	4,065	73	1	1,119	25	580	4,100	74
27 Sep	3	226	5	27	2,513	100	846	4,911	88	946	2,065	46	123	4,223	76
28 Sep	6	232	5	0	2,513	100	–	–	–	0	2,065	46	64	4,287	77
29 Sep	742	974	22	0	2,513	100	–	–	–	47	2,112	47	274	4,561	82
30 Sep	13	987	23	–	–	–	–	–	–	56	2,168	48	65	4,626	84
1 Oct	0	987	23	–	–	–	–	–	–	0	2,168	48	411	5,037	91
2 Oct	236	1,223	28	–	–	–	–	–	–	19	2,187	48	–	–	–
3 Oct	667	1,890	44	–	–	–	–	–	–	209	2,396	53	–	–	–
4 Oct	30	1,920	44	–	–	–	–	–	–	348	2,744	61	–	–	–
5 Oct	0	1,920	44	–	–	–	–	–	–	115	2,859	63	–	–	–
6 Oct	300	2,220	51	–	–	–	–	–	–	29	2,888	64	–	–	–
7 Oct	432	2,652	61	–	–	–	–	–	–	1	2,889	64	–	–	–
8 Oct	–	–	–	–	–	–	–	–	–	0	2,889	177	–	–	–
Total estimated inseason[e]	NA	2,447	56	NA	192	8	NA	3,000	54	NA	500	11	NA	0	0
Total estimated postseason[f]	NA	1,689	39	NA	0	0	NA	648	12	NA	1,634	36	NA	500	9
Season total[g]	NA	4,341	100	NA	2,513	100	NA	5,559	100	NA	4,523	100	NA	5,537	100

Note: Shaded values are inseason estimates. NA means not applicable. An en dash indicates dates when counts or estimates were not made for the lower weir.

[a] In 2018, estimates were based on extrapolated daily counts and a postseason foot survey (Table 2).

[b] In 2019, estimates were based on a postseason foot survey (Table 2).

[c] Count for August 13 comes from a preseason raft survey.

[d] Daily total (weir count plus estimate) followed by inseason estimate in parentheses.

[e] Source: Stratton and Evans (2020) for 2014-2017 estimates. Inseason estimates were made due to high water events.

[f] Source: Stratton and Evans (2020) for 2014-2017 estimates. Postseason estimates for 2018 and 2019 come from foot surveys described in this report.

[g] Season total is cumulative weir count plus postseason estimate.