Fishery Data Series No. 12-10

Stock Assessment of Buskin River Coho Salmon, 2005–2007

by

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and

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March 2012

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)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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

Since 1985, the Alaska Department of Fish and Game, Division of Sport Fish, has assessed the annual runs of coho salmon (*Oncorhynchus kisutch*) to the Buskin River on Kodiak Island. From 2005 through 2007, the Buskin River weir count was 16,596, 13,348, and 9,001 coho salmon, respectively. The estimated sport harvest was 3,010, 6,567, and 5,215 coho salmon, and reported subsistence harvest was 2,505, 1,662, and 1,309 coho salmon, respectively. Overall exploitation rates were estimated as 26%, 43%, and 48%, respectively. In 2005, age-2.1 fish comprised 69% of the run, the male-female ratio of the weir count was 1.4:1, and estimated escapement was 15,994 coho salmon. In 2006, age-2.1 fish comprised 71% of the run, the male-female ratio of the weir count was 1.1:1, and estimated escapement was 12,035 coho salmon. In 2007, age-2.1 fish comprised 77% of the run, the male-female ratio of the weir count was 1.3:1, and estimated escapement was 7,958 coho salmon. The ratio of largest to smallest escapement for brood years 1989 through 2003 was about 3, with an average return per spawner of 1.7 over the time period. Age-2.1 fish contributed an average of 72% to a brood year return, with age-1.1 and -3.1 fish contributing 19% and 8%, respectively. A full spawner-recruit analysis is not presented here but will be presented when returns from the large escapement in 2005 are mostly complete (2010).

Key words: coho salmon, *Oncorhynchus kisutch*, escapement, Buskin River, age, length, sex 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 larger native populations of coho salmon (*Oncorhynchus kisutch*) found on the Kodiak road system. The drainage supports the largest reported subsistence coho salmon fishery in the Kodiak Archipelago and within the Kodiak/Aleutian Islands Federal Subsistence Region. Coho salmon typically comprise 15% of the total subsistence salmon harvest, with reported harvests ranging from approximately 1,300 to 2,500 fish and averaging approximately 1,600 fish from 1998 to 2007 (Table 1). Harvest in this fishery is documented through subsistence permits issued by the Alaska Department of Fish and Game (ADF&G), Division of Commercial Fisheries (CF).

The Buskin River is also the most popular recreational fishing stream on Kodiak Island, recently (1998–2007) representing approximately 30% of the total freshwater recreational fishing effort in the Kodiak Management Area (Howe et al. 2001a, 2001b; Jennings et al. 2004, 2006a-b, 2007, 2009a-b, 2010; Walker et al. 2003). Recreational fishing effort on the Buskin River is directed primarily toward sockeye salmon (*O. nerka*) and coho salmon, but there is also effort directed toward steelhead and rainbow trout (*O. mykiss*), pink salmon (*O. gorbuscha*), and Dolly Varden (S*alvelinus malma*). From 1998 through 2007, estimated sport harvests of coho salmon from the Buskin River ranged from about 2,300 to 6,500 fish and averaged approximately 3,600 (Table 1). Sport harvest of coho salmon and fishing effort on the Buskin River are estimated annually by the Division of Sport Fish (SF) Statewide Harvest Survey (SWHS).

A relatively minor commercial harvest of Buskin River coho salmon periodically occurs in adjacent marine waters of Chiniak Bay. These harvests are typically small and may be nonexistent during some years. Fish ticket harvest receipts available from CF indicate that between 1998 and 2007, the average annual commercial harvest of Buskin River coho salmon was 163 fish (Table 1).

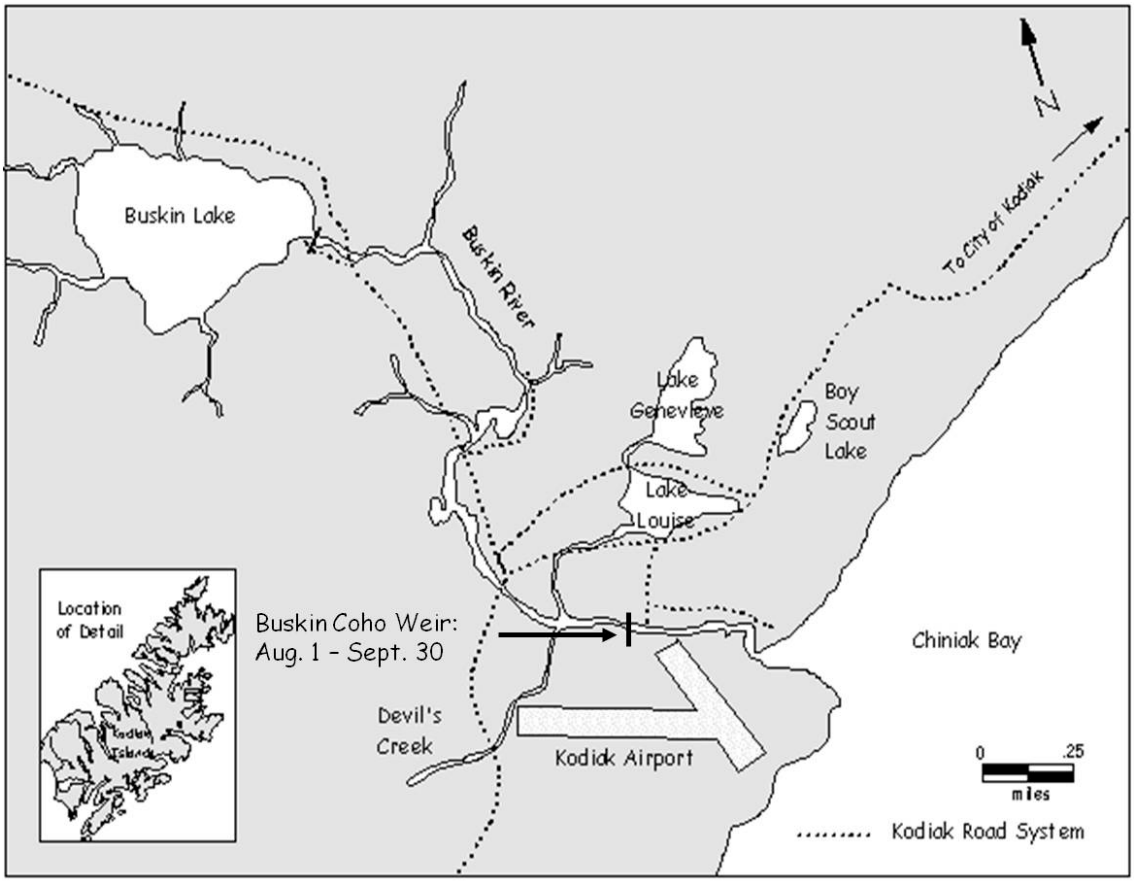

Figure 1.–Map of the Buskin River drainage.

Inriver runs of Buskin River coho salmon have been monitored at a weir operated annually by ADF&G since 1985. The aim of this program is to ensure the sustainability and long-term health of the stock. From 1985 through 2007, weir counts have ranged from 6,222 to 16,596 fish, and have averaged 9,770 fish (Table 1; Schmidt and Evans 2011). Recent inriver runs of Buskin River coho salmon at the weir have been very strong, and the 10-year average (1998–2007) has increased to 11,274 fish. Four of the highest counts ever documented occurred within the past 7 years. Weir counts of adult coho salmon entering Buskin River are obtained from early August through September; peak daily counts typically occur during the third week of September.

Historically, the Buskin River coho salmon escapement goal has been based on the magnitude of long term estimated escapements, derived by subtraction of estimated upriver sport harvests from inriver runs (weir counts). The current coho salmon escapement goal range of 3,200–7,200 fish was established in 2005 as a biological escapement goal (BEG; Nelson et al. 2005) using a Ricker stock recruitment model (Ricker 1954). The escapement goal influences inseason management of subsistence, sport, and commercial fisheries. Periodic refinement of the escapement goal is possible through continued estimation of total annual run, which requires estimation of age composition to identify brood year contributions. The ongoing coho salmon project has facilitated the collection of data necessary for this purpose by providing a census of the inriver run at the weir (weir counts) and total run age composition estimates. This report presents results from 2005 through 2007 and includes estimates of coho salmon age composition by sex and mean length, derived from sampling the inriver run and sport harvest.

Table 1.–Buskin River coho salmon weir counts, and subsistence, commercial, and sport harvests, 1998–2007.

				Sport estimate[d]						
Year	Weir count[a]	Commercial harvest[b]	Subsistence harvest[c]	Harvest	SE	Catch	Angler days	Escapement	Total Run	SE
1998	9,062	9	1,555	2,669	486	4,288	14,332	8,528	12,761	389
1999	9,794	3	1,501	3,422	557	7,094	19,382	9,110	14,036	446
2000	8,048	0	2,041	2,589	628	5,541	21,002	7,530	12,160	502
2001	13,494	0	1,457	2,332	477	3,928	9,539	13,028	16,817	382
2002	10,649	0	1,582	2,497	532	4,388	18,450	10,150	14,229	426
2003	13,150	6	1,362	3,302	631	4,592	14,311	12,490	17,160	505
2004	9,599	95	1,564	4,860	822	8,562	17,549	8,627	15,146	658
2005	16,596	0	2,505	3,010	546	5,006	17,575	15,994	21,509	437
2006	13,348	763	1,662	6,567	1,022	11,468	19,875	12,035	21,027	818
2007	9,001	757	1,309	5,215	991	8,434	17,124	7,958	15,239	793
Average 1998–2007	11,274	163	1,654	3,646		6,330	16,914	10,545	16,008	

[a] Includes estimates for periods when weir was not operating.

[b] Commercial harvest includes only statistical area 259-22 (Woman's Bay).

[c] Subsistence includes harvest from Buskin River and Woman's Bay.

[d] Source: Statewide Harvest Survey (SWHS).

OBJECTIVES

During 2005 through 2007, objectives for the stock assessment study of Buskin River coho salmon consisted of the following:

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

METHODS

DATA COLLECTION

Inriver run

From 2005 through 2007, ADF&G operated a conventional weir in the Buskin River (Figure 1) across a channel approximately 40 m wide located 2 km upstream of the river mouth, where the predominately small rock substrate is suitable for holding a weir. The weir was constructed with a superstructure framework of wooden tripods (weighted with sandbags), aluminum cross stringers, and a boardwalk. Rigid aluminum panels measuring 2.01 m in height and 0.76 m in width and made of 2.54 cm diameter schedule-40 pipe sections spaced 2.54 cm apart welded into an aluminum T-bar channel, provided structural continuity. This structure created a barrier to uncontrolled passage of fish and allowed free passage of water. Four counting gates integrated into the panel array allowed for the controlled passage of fish over a submerged white-colored background medium to visually assist in species identification and fish enumeration. A funnel entrance trap constructed of aluminum panels and attached to 1 of the counting gates was installed to capture upstream-migrating coho salmon.

During each year of the study, all species of immigrant and out-migrant anadromous fish passing through the weir were enumerated whenever possible. The weir was designed to continuously operate from the beginning of August through the end of September, although every year a portion of the inriver run was estimated on more than one occasion when high water levels precluded the controlled passage of fish. Estimates were calculated using a variety of methods described in Table 2. As a result of periodic interruptions in weir counts from high water events, and also variability in the annual duration of weir operations, the weir count in a given year should be considered a minimal indicator of inriver run. The inriver run obtained from the weir should also not be considered the escapement, because removal of fish by the sport fishery occurs upstream of the weir.

Fishery Harvests

Annual subsistence harvests of Buskin drainage coho salmon were estimated from returns of subsistence fishing permits to the CF Kodiak Office. From 2000 through 2006, annual return rates of permits ranged from 84% to 98% and averaged 90% (J. Shaker, ADF&G, Kodiak, personal communication). It was not possible to adequately determine the proportion of permit holders harvesting Buskin River coho salmon who failed to return permits.

The sport fishery harvest of coho salmon for the years 2005–2007 was estimated by the SWHS (Jennings et al. 2009a-b; 2010). Commercial harvests were obtained from the CF Statewide Harvest Receipt (fish ticket) database. Only reported catches of coho salmon from ADF&G Kodiak Salmon Statistical Chart area 259-22 (Womans Bay) were assumed to be of Buskin River origin.

Table 2.–Methods utilized to interpolate Buskin River coho salmon weir counts during high water events, 2005–2007.

Year	Weir-tending dates	Dates weir out	Total days weir out	Percent of weir count that was estimated	Estimated coho per incident	Estimation methods [a]
2005	1 Aug–5 Oct	2–7 Aug	5		0	Early in season, estimate of zero
		28 Sep	0.5		500	Visual estimate
					800	Post weir estimate
Total			5.5	7.8%	1,300	
2006	31 July–21 Sep	14–15 Sept	2.5		822	Ten-year average percent of total weir count for each day multiplied by the projected total weir count for the currrent year on that day. Projected total weir count based on ten-year cumulative distribution of weir count.
		16–20 Sept	3.5		1,789	same as above
		21 Sep			430	same as above
Total			6	23.9%	3,041	
2007	3 Aug–30 Sep	27–29 Aug	2.5		749	Ten-year average percent of total weir count for each day multiplied by the projected total weir count for the currrent year on that day. Projected total weir count based on ten-year cumulative distribution of weir count.
Total			2.5	8.3%	749	

[a] Post weir estimate based on local conditions, visual estimate, and current run timing.

Age, Sex, and Length (ASL) Composition

Between 2005 and 2007, coho salmon from either the inriver run or a combination of the sport harvest and inriver run were sampled for ASL data. In 2005 and 2006, samples were obtained both from the inriver run and sport fishery harvest. In 2007, ASL estimates were derived solely from the inriver run from live fish captured at the weir.

During 2005 and 2006, the inriver run sampling period was stratified into two 3-week intervals between 16 August and 30 September; in 2007 sampling protocol changed to three 2-week intervals (16–31 August, 1–14 September and 15–30 September). Whenever possible, all coho salmon captured in the weir trap were sampled. Sampling was typically conducted 3 days a week. Samples were obtained opportunistically within each time interval.

Subsistence and commercial harvests were not sampled for ASL composition; samples from the inriver run and sport harvests (when available) 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 fish sampled. Sex was determined through external characteristics. Whenever possible, 4 scales were removed as described by Welander (1940). Sampled scales were placed on a gummed card for subsequent analysis. Scales not available from the preferred area were taken in the same linear plane but from the third or fourth scale row above the lateral line. Scales not available in either preferred area on the left side of the fish were collected from the same region on the opposite side. Ages of sampled coho salmon were determined from scales using criteria described in Mosher (1969).

DATA ANALYSIS

Total Run and Escapement

Escapement (E), subsistence harvest (Sub), commercial harvest (CFH), and sport fish harvest (SFH) were summed to estimate the number of coho salmon in the total run (T):

$$\hat{N}_T = \hat{N}_E + N_{Sub} + N_{CFH} + \hat{N}_{SFH}. \quad (1)$$

Subsistence, sport, and commercial harvests were assumed known with zero variance; $\hat{N}_{SFH}$ and $\text{var}(\hat{N}_{SFH})$ were provided by the SWHS. Because sport fishery harvest of coho salmon is not reported by area, and harvest occurs upriver of the weir, escapement was estimated as

$$\hat{N}_E = N_{IR} - \tilde{p}_{Ab}\hat{N}_{SFH} \quad (2)$$

where N_{IR} is the inriver run, and $\tilde{p}_{Ab}$ is the assumed proportion of the sport harvest occurring above the weir; this quantity originates from a creel survey conducted in 1986 (Murray 1987) and more recent field observations. We assumed a value of 0.2 for $\tilde{p}_{Ab}$, with the understanding that bias may be introduced. The bias is not expected to be serious; there is only a 10% increase between escapement estimates over the last 7 years if a value for $\tilde{p}_{Ab}$ of 0.1 versus 0.5 is used.

The variance of $\hat{N}_E$ was estimated as

$$\text{var}(\hat{N}_E) = \tilde{p}_{Ab}^2 \text{ var}(\hat{N}_{SFH}). \quad (3)$$

The variance of $\hat{N}_T$ was estimated as

$$\text{var}(\hat{N}_T) = \text{var}(\hat{N}_{SFH})(1 - \tilde{p}_{Ab})^2. \quad (4)$$

Exploitation Rate

The exploitation rate for fishery *i* was estimated as

$$\hat{U}_i = \frac{\hat{N}_i}{\hat{N}_T}. \quad (5)$$

For *i* = subsistence or commercial fishery, the variance of the exploitation rate was estimated as

$$\text{var}(\hat{U}_i) = N_i^2 \frac{\text{var}(\hat{N}_T)}{\hat{N}_T^4}. \quad (6)$$

For *i* = sport fishery, the variance of the exploitation rate was estimated as

$$\text{var}(\hat{U}_{SFH}) = \frac{\left[N_{IR} + N_{Subs} + N_{CFH}\right]^2 \text{var}(\hat{N}_{SFH})}{\left[N_{IR} + N_{Subs} + N_{CFH} + (1 - \tilde{p}_{Ab})\hat{N}_{SFH}\right]^4}. \quad (7)$$

Total exploitation rate was estimated as

$$\hat{U}_T = \frac{\sum_{i=1}^{3} \hat{N}_i}{\hat{N}_T}, \quad (8)$$

with variance estimated by simulation.

Age-Sex composition

Contingency table analysis was used to test for 1) differences in age-sex composition over time for each of the inriver run and sport fish harvest populations and 2) differences in age-sex composition between the inriver run and sport harvest populations. The first analysis was conducted to provide baseline information for future sampling designs, as there are currently no reasonable weights available for use in a time-stratified analysis. For the sport harvest, there is only 1 estimate provided annually by SWHS. For the inriver run, there are weir counts, but a significant sport harvest occurs above the weir, which complicates any stratified estimate. The inriver run sample is a hybrid sample of the escapement and sport harvest. The second analysis was conducted to determine whether the sport harvest sample could be pooled with the inriver run sample; it is noted that the inriver run sample is assumed to be representative of the total run as a result of its non-selective sampling technique (weir trap). Stratification (by inriver run/sport harvest) is impossible because of the upriver harvest and also because the sport harvest is estimated with considerable error, violating the assumption of known stratified populations for a traditional stratified analysis.

Proportions and variances of age or sex class *j* for the run were estimated from pooled sport and inriver run samples from 2005–2006 data and from the 2007 inriver run sample as given in equations (1) and (2) (Cochran 1977):

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

with

$$\text{var}(\hat{p}_j) = \frac{\hat{p}_j(1-\hat{p}_j)}{n\ -1}, \tag{10}$$

where

n_j = the number of coho salmon in sample that were in age or sex class *j*, and

n = the number of coho salmon sampled.

The finite population correction factor was negligible (population >>sample) and there was also uncertainty in the total population size because of the estimation of the sport harvest. No correction factor was calculated.

The number of coho salmon of age or sex class *j* in the population of interest *i* (where *i* = E, IR, SFH, Sub, CFH, or T) was estimated by

$$\hat{N}_{ij} = \hat{N}_i\ \hat{p}_j, \tag{11}$$

and its variance (Goodman 1960) by

$$\text{var}(\hat{N}_{ij}) = \hat{N}_i^{\,2}\ \text{var}(\hat{p}_j) + \hat{p}_j^{\,2}\ \text{var}(\hat{N}_i) - \text{var}(\hat{p}_j)\,\text{var}(\hat{N}_i). \tag{12}$$

Length

Mean lengths at age and their standard errors were estimated for each age class of the run. Density plots (Sarkar 2008) were also created for length at age-sex pooled over years and for length at age by year.

RESULTS

2005

Total Run, Harvest, and Escapement

The Buskin River weir was installed on 1 August and remained operational through 5 October. High water conditions interrupted operation of the weir on 2 occasions: between 2 and 7 August and again on 28 September (Table 2).

The inriver run (weir count) of coho salmon in the Buskin River was 16,596 fish, 50% of which were enumerated by 27 September (Appendix A1). Approximately 8% of the total weir count was estimated. Anglers fishing the Buskin drainage caught an estimated 5,006 coho salmon and harvested 3,010 fish (SE = 546), expending 17,575 angler-days of effort for all species (Table 1; Jennings et al. 2009a). The reported coho salmon subsistence harvest was 2,505; no commercial harvest was reported. The estimated escapement was 15,994 fish (SE = 109). The estimated total run was 21,509 (SE = 437).

Exploitation Rate

The estimated annual subsistence exploitation rate of 12% was marginally lower than the sport exploitation rate of 14%; the commercial fisheries exploitation rate was 0%, while the total exploitation rate was estimated as 26% (Table 3).

Table 3.–Estimated exploitation rates (% of total run) of subsistence, commercial, and sport fishery harvests of Buskin River coho salmon, 2005–2007.

Year		Subsistence	Sport	CF	Total
2005	Percentage	12	14	0	26
	SE	0.4	2.3	0.0	2.6
2006	Percentage	8	31	4	43
	SE	0	4	0	5.3
2007 [a]	Percentage	9	34	5	48
	SE	0	5	0	7.0

[a] Estimated age composition based on inriver run sample.

Age-Sex-Length

Sport Harvest

Age was determined for 293 of 332 coho salmon sampled from the sport fishery (Appendix B1). All sampled fish were sexed. Age and sex composition did not differ significantly over time (age: $\chi^2 = 0.88$, $P = 0.64$, df = 2; sex: $\chi^2 = 0.17$, $P = 0.68$, df = 1; age by sex: $\chi^2 = 3.9$, $P = 0.56$, df = 5). A pooled sample was used to increase precision.

Escapement

Age was also determined for 34 of 37 coho sampled from the escapement (Appendix B2). All fish were sexed. Neither age nor sex composition from the pooled sample differed over time (age: $\chi^2 = 1.86$, $P = 0.39$, df = 2; sex: $\chi^2 = 0.12$, $P = 0.73$, df = 1; age by sex: $\chi^2 = 2.31$, $P = 0.80$, df = 5).

Inriver Run

Estimated age, sex, and age-sex composition of the sport harvest did not differ significantly from the inriver run (age: $\chi^2 = 2.80$, $P = 0.25$, df = 2; sex: $\chi^2 = 0.04$, $P = 0.84$, df = 1; age by sex: $\chi^2 = 5.95$, $P = 0.31$, df = 5). Estimates were pooled to increase precision of estimates of age and sex composition of the inriver run.

Age-2.1 fish comprised 69% of the pooled data and 24% were age 1.1 (Table 4). Age was similar between males and females. There were more males (58%) than females (42%), for a male-female ratio of 1.4:1. On average, males were larger than females.

The estimated total run of Buskin River coho salmon for 2005 was 21,509 fish (Table 5). Estimated age composition of the combined subsistence and commercial harvests is given in Appendix C1 and that of the sport harvest upriver is given in Appendix D1.

Table 4.–Estimated age and sex composition and mean length-at-age of Buskin River coho salmon inriver run, 2005.

	Coho salmon age class						
	1.0	1.1	2.0	2.1	3.0	3.1	Total
Females							
Number sampled		32		94		9	154
Percent		9.8		28.7		2.8	41.7
SE percent		1.6		2.5		0.9	2.6
Inriver run at weir		1,624		4,771		457	6,926
SE inriver run		273		416		150	427
Mean length		638		645		642	641
SE mean length		5		4		10	3
Minimum length		573		472		584	472
Maximum length		710		710		687	710
Males							
Number sampled	1	47	1	132		11	215
Percent	0.3	14.4	0.3	40.4		3.4	58.3
SE percent	0.3	1.9	0.3	2.7		1.0	2.6
Inriver run at weir	51	2,385	51	6,699		588	9,670
SE inriver run	51	322	51	451		175	427
Mean length	332	628	366	663		672	651
SE mean length		4		3		10	4
Minimum length	332	479	366	549		626	332
Maximum length	332	718	366	761		741	761
All							
Number sampled	1	79	1	226		20	369
Percent	0.3	24.2	0.3	69.1		6.1	100.0
SE percent	0.3	2.4	0.3	2.6		1.3	
Inriver run at weir	51	4,009	51	11,470		1,015	16,596[a]
SE Inriver run	51	407	51	521		222	436.8
Mean length	332	632	366	655		658	647
SE mean length		6		3		8	3
Minimum length	332	479	366	472		584	332
Maximum length	332	718	366	761		741	761

Note: Samples obtained at weir and from sport fishery, 24 August through 1 October.

[a] Estimated sport harvest above the weir must be subtracted from inriver run at the weir in order to estimate escapement.

Table 5.–Estimated age composition of Buskin River coho salmon total run, 2005–2007.

		Coho salmon age class						
Year	Statistic	1.0	1.1	2.0	2.1	3.0	3.1	Total[a]
2005	Number	66	5,196	66	14,866	0	1,316	21,509
	SE	66	521	66	628	0	287	
2006	Number	0	4,938	54	14,895	27	1,112	21,027
	SE	0	373	38	673	27	174	
2007	Number	69	2,827	483	11,722	0	138	15,239
	SE	69	425	181	748	0	97	

Note: Estimates based on age-class composition of inriver run at weir in 2007 and a combination of inriver run at weir and sport harvest in 2005 and 2006.

[a] Total is sum of inriver run, 80% of SWHS estimate of harvest, subsistence harvest, and commercial harvest.

2006

Total Run, Harvest and Escapement

The Buskin River weir was installed on 31 July and remained operational through 21 September. High water conditions interrupted operation of the weir on 2 occasions between 14 and 20 September (Table 2).

The inriver run of coho salmon in the Buskin River was 13,348 fish, 50% of which were enumerated by 4 September (Appendix A1). Approximately 24% of the total weir count was estimated. Anglers fishing the Buskin drainage caught an estimated 11,468 coho salmon and harvested 6,567 fish (SE = 1,022), expending 19,875 angler-days of effort for all species (Table 1; Jennings et al. 2009b). The reported coho salmon subsistence harvest was 1,662 and commercial harvest was 763. The estimated spawning escapement was 12,035 fish (SE = 204). The estimated total run was 21,027 (SE = 818).

Exploitation Rate

The estimated annual subsistence exploitation rate of 8% was lower than the sport exploitation rate of 31%; the commercial fisheries exploitation rate was 4%, while the total exploitation rate was estimated as 43% (Table 3).

Age-Sex-Length

Sport Harvest

Age was determined for 393 of 461 coho salmon sampled from the sport fishery (Appendix B3). All fish were sexed. Age and sex composition from the pooled sample did not differ significantly over time (age: $\chi^2 = 2.7$, $P = 0.26$, df = 2; sex: $\chi^2 = 3.6$, $P = 0.06$, df = 1; age by sex: $\chi^2 = 7.89$, $P = 0.16$, df = 5).

Escapement

Age was also determined for 382 of 448 coho sampled from the escapement (Appendix B4). All fish were sexed. Age and sex composition from the pooled sample did not differ significantly over time (age: $\chi^2 = 2.13$, $P = 0.35$, df = 2; sex: $\chi^2 = 3.7$, $P = 0.054$, df = 1; age by sex: $\chi^2 = 10.05$, $P = 0.07$, df = 5).

Inriver Run

Age and sex composition in the sport fishery differed significantly from the inriver run (age: χ^2 = 6.37, P = 0.04, df = 2; sex: χ^2 = 11.6, P = 0.001, df = 1; age by sex: χ^2 = 21.4, P = 0.001, df = 5). However, sport and inriver run samples were pooled due to the relatively minor differences in age-sex composition estimates; it was concluded that the relatively large sample sizes afforded the power to detect small differences.

Age-2.1 fish comprised 71% of the pooled data and 24% were age 1.1 (Table 6). Age composition was similar between males and females. There were more males (51%) than females (49%), for a male-female ratio of 1.05:1. On average, males were larger than females.

The estimated total run of Buskin River coho salmon for 2006 was 21,027 fish (Table 5). Estimated age composition of the combined subsistence and commercial harvests is given in Appendix C1 and that of the sport harvest upriver is given in Appendix D1.

2007

Total Run, Harvest and Escapement

The Buskin River weir was installed on 3 August and remained operational through 30 September.

The inriver run of coho salmon in the Buskin River was 9,001 fish, 50% of which were enumerated by 8 September (Appendix A1). Approximately 8% of the total weir count was estimated (Table 2). Anglers fishing the Buskin drainage caught an estimated 8,434 coho salmon and harvested 5,215 (SE = 991) fish, expending 17,124 angler-days of effort for all species (Table 1; Jennings et al. 2010). The reported coho salmon subsistence harvest was 1,309 and the coho salmon commercial harvest was 757. The estimated spawning escapement was 7,958 (SE = 198). The estimated total run was 15,239 fish (SE = 793).

Exploitation Rate

The estimated annual subsistence exploitation rate of 9% was lower than the sport exploitation rate of 34%; the commercial fisheries exploitation rate was 5%, while the total exploitation rate was estimated as 48% (Table 3).

Age-Sex-Length

Escapement

Age was determined for 221 of 246 coho sampled from the escapement (Table 7). All fish were sexed. Age and sex composition did not differ significantly over time (age: χ^2 = 2.2, P = 0.33, df = 2; sex: χ^2 = 0.31, P = 0.58, df = 1; age by sex: χ^2 = 8.47, P = 0.13, df = 5). A pooled sample was used to increase precision.

Inriver run

The age composition of the inriver run is presented in Table 7. Age-2.1 fish comprised 77% of the inriver run and 19% were age 1.1. Age composition was similar between males and females. There were more males (56%) than females (44%), for a male-female ratio of 1.26:1. On average, males were smaller than females.

The estimated total run of Buskin River coho salmon for 2007 was 15,239 fish (Table 5). Estimated age composition of the combined subsistence and commercial harvests is given in Appendix C1 and that of the sport harvest upriver is given in Appendix D1.

Table 6.–Estimated age and sex composition and mean length-at-age of Buskin River coho salmon inriver run, 2006.

	Coho salmon age class						
	1.0	1.1	2.0	2.1	3.0	3.1	Total
Females							
Number sampled		75		279	1	24	443
Percent		9.7		36.0	0.1	3.1	48.7
SE percent		1.1		1.7	0.1	0.6	1.7
Inriver run at weir		1,292		4,805	17	413	6,505
SE inriver run		142		230	17	83	221
Mean length		656		656	310	670	655
SE mean length		4		2		7	2
Minimum length		539		523	310	600	310
Maximum length		742		755	310	728	755
Males							
Number sampled		107	2	270		17	466
Percent		13.8	0.3	34.8		2.2	51.3
SE percent		1.2	0.2	1.7		0.5	1.7
Inriver run at weir		1,843	34	4,650		293	6,843
SE inriver run		166	24	229		70	221
Mean length		653	345	669		693	665
SE mean length		5	8	3		12	3
Minimum length		524	337	462		601	337
Maximum length		763	353	777		775	840
All							
Number sampled		182	2	549	1	41	909
Percent		23.5	0.3	70.8	0.1	5.3	100.0
SE percent		1.5	0.2	1.6	0.1	0.8	
Inriver run at weir		3,135	34	9,456	17	706	13,348[a]
SE Inriver run		203	24	218	17	107	0
Mean length		655	345	663	310	680	660
SE mean length		3	8	2		6	2
Minimum length		524	337	462	310	600	310
Maximum length		763	353	777	310	775	840

Note: Samples obtained at weir and from sport fishery, 11 August through 24 September.

[a] Estimated sport harvest above weir must be subtracted from inriver run at the weir in order to estimate escapement.

Table 7.–Estimated age and sex composition and mean length-at-age of Buskin River coho salmon inriver run, 2007.

	Coho salmon age class						
	1.0	1.1	2.0	2.1	3.0	3.1	Total
Females							
Number sampled		17		80		1	109
Percent		7.7		36.2		0.5	44.3
SE percent		1.8		3.2		0.5	3.2
Inriver run at weir		692		3,258		41	3,988
SE inriver run		162		292		41	286
Mean length		586		612		622	606
SE mean length		12		5			4
Minimum length		475		479		622	475
Maximum length		668		689		622	689
Males							
Number sampled	1	24	7	90		1	137
Percent	0.5	10.9	3.2	40.7		0.5	55.7
SE percent	0.5	2.1	1.2	3.3		0.5	3.2
Inriver run at weir	41	977	285	3,666		41	5,013
SE inriver run	41	189	106	298		41	286
Mean length	327	569	323	606		634	581
SE mean length		13	9	6			8
Minimum length	327	426	306	439		634	306
Maximum length	327	663	375	730		634	730
All							
Number sampled	1	41	7	170		2	246
Percent	0.5	18.6	3.2	76.9		0.9	100.0
SE percent	0.5	2.6	1.2	2.8		0.6	
Inriver run at weir	41	1,670	285	6,924		81	9,001[a]
SE Inriver run	41	236	106	256		57	0
Mean length	327	576	323	609		628	592
SE mean length		9	9	4		6	5
Minimum length	327	426	306	439		622	306
Maximum length	327	668	375	730		634	730

Note: Samples obtained at weir, 17 August through 25 September.

[a] Estimated sport harvest above weir must be subtracted from inriver run at the weir in order to estimate escapement.

Density plots of length-at-age by sex are given in Figure 2 for the data pooled over years 2005 through 2007. Within sex, age-3.1 fish were significantly larger ($P < 0.05$) than age-2.1 fish (males: 682.9 and 656.2 mm; females: 661.3 and 646.1 mm, respectively). Age-1.1 fish were significantly smaller ($P < 0.05$) than age-2.1 fish for males, but not for females (males: 636.7 and 656.2; females: 642.1 and 646.1 mm, respectively). Length-at-age among years is shown in Appendix E1.

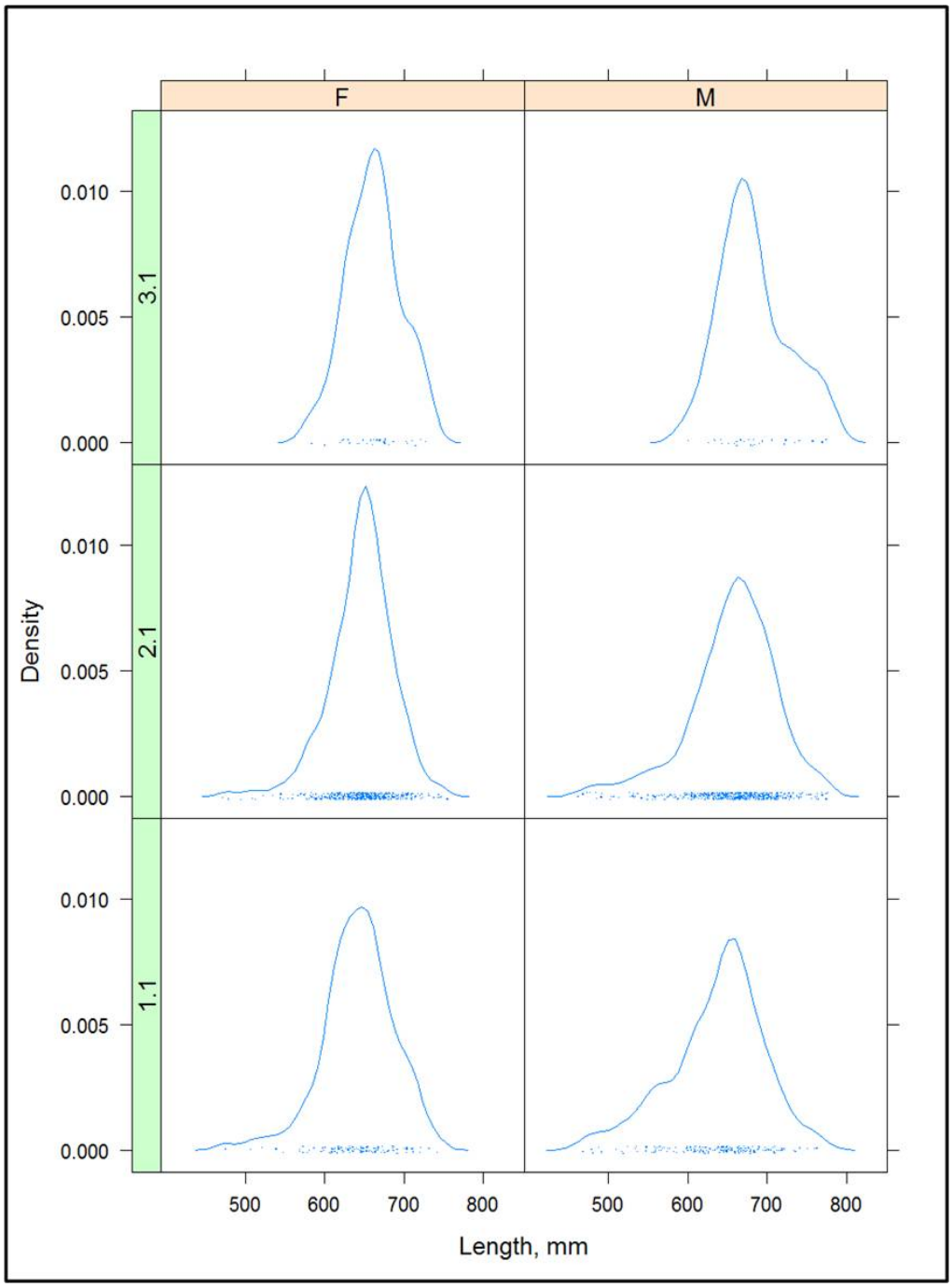

Figure 2.–Density plots for length-at-age by sex for sport harvest (pooled 2005–2007) for female (left) and male (right) Buskin River coho salmon at ages 1.1 (bottom), 2.1 (middle), and 3.1 (top).

DISCUSSION

Collection of age and run data from 2005 through 2007 allows continued construction of the Buskin River coho salmon brood table begun for year 1989 (Table 8). Returns are largely complete for brood year 2003 (age-3.1 fish from brood year 2003 will return in 2008; these fish typically represent about 8% of a brood year return). Return per spawner over brood years 1989 through 2003 has averaged 1.74 fish, and has ranged from 1.1 to 2.5. The range in escapements for brood years 1989 through 2003 is relatively small (6,000–16,000) in the context of utility for spawner–recruit analysis and determination of biological escapement goals. A full spawner-recruit analysis will be presented in a future report, when returns from the largest escapement to date (16,000 fish from brood year 2005) are complete.

Table 8.–Brood table for Buskin River coho salmon, 1989–2007.

	Escapement	Age class										Return
Brood Year	(S)	1.0	1.1	1.2	2.0	2.1	2.2	3.0	3.1	3.2	4.1	(R)
1989	8,974	0	2,268	0	213	8,591	0	0	639	0	0	11,711
Proportion		0.00	0.19	0.00	0.02	0.73	0.00	0.00	0.05	0.00	0.00	
Sample Year		1991	1992	1993	1992	1993	1994	1993	1994	1995	1995	
1990	5,918	0	2,098	38	40	7,972	37	38	259	0	0	10,481
Proportion		0.00	0.20	0.00	0.00	0.76	0.00	0.00	0.02	0.00	0.00	
Sample Year		1992	1993	1994	1993	1994	1995	1994	1995	1996	1996	
1991	8,105	0	3,385	0	226	8,829	43	0	1,041	0	68	13,592
Proportion		0.00	0.25	0.00	0.02	0.65	0.00	0.00	0.08	0.00	0.01	
Sample Year		1993	1994	1995	1994	1995	1996	1995	1996	1997	1997	
1992	6,240	0	2,734	0	37	8,153	0	0	1,500	0	0	12,424
Proportion		0.00	0.22	0.00	0.00	0.66	0.00	0.00	0.12	0.00	0.00	
Sample Year		1994	1995	1996	1995	1996	1997	1996	1997	1998	1998	
1993	5,970	37	2,559	0	0	10,025	55	68	1,260	44	44	14,091
Proportion		0.00	0.18	0.00	0.00	0.71	0.00	0.00	0.09	0.00	0.00	
Sample Year		1995	1996	1997	1996	1997	1998	1997	1998	1999	1999	
1994	7,660	0	2,864	0	136	9,037	176	110	2,376	0	0	14,699
Proportion		0.00	0.19	0.00	0.01	0.61	0.01	0.01	0.16	0.00	0.00	
Sample Year		1996	1997	1998	1997	1998	1999	1998	1999	2000	2000	
1995	8,268	0	2,300	0	0	9,020	161	44	926	0	0	12,451
Proportion		0.00	0.18	0.00	0.00	0.72	0.01	0.00	0.07	0.00	0.00	
Sample Year		1997	1998	1999	1998	1999	2000	1999	2000	2001	2001	
1996	7,943	0	2,288	0	44	8,818	42	40	42	0	0	11,274
Proportion		0.00	0.20	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	
Sample Year		1998	1999	2000	1999	2000	2001	2000	2001	2002	2002	

-continued-

Table 8.–Part 2 of 2.

Brood year	Escapement (S)	Age class 1.0	1.1	1.2	2.0	2.1	2.2	3.0	3.1	3.2	4.1	Return (R)
1997	10,353	0	2,174	0	40	8,450	0	42	418	0	0	11,125
Proportion		0.00	0.20	0.00	0.00	0.76	0.00	0.00	0.04	0.00	0.00	
Sample Year		1999	2000	2001	2000	2001	2002	2001	2002	2003	2003	
1998	8,528	0	8034	0	208	11,532	0	46	1,364	0	0	21,184
Proportion		0.00	0.38	0.00	0.01	0.54	0.00	0.00	0.06	0.00	0.00	
Sample Year		2000	2001	2002	2001	2002	2003	2002	2003	2004	2004	
1999	9,110	0	2,139	0	93	11,748	0	88	2,094	0	0	16,162
Proportion		0.00	0.13	0.00	0.01	0.73	0.00	0.01	0.13	0.00	0.00	
Sample Year		2001	2002	2003	2002	2003	2004	2003	2004	2005	2005	
2000	7,530	0	3,652	0	308	9,462	0	0	1,316	0	0	14,737
Proportion		0.00	0.25	0.00	0.02	0.64	0.00	0.00	0.09	0.00	0.00	
Sample Year		2002	2003	2004	2003	2004	2005	2004	2005	2006	2006	
2001	13,028	0	3553	0	0	14,866	0	0	1,112	0	0	19,531
Proportion		0.00	0.18	0.00	0.00	0.76	0.00	0.00	0.06	0.00	0.00	
Sample Year		2003	2004	2005	2004	2005	2006	2005	2006	2007	2007	
2002	10,150	37	5,196	0	66	14,895	0	27	138			20,360
Proportion		0.00	0.26	0.00	0.00	0.73	0.00	0.00	0.01	0.00	0.00	
Sample Year		2004	2005	2006	2005	2006	2007	2006	2007	2008	2008	
2003	12,490	66	4,938	0	54	11,722		0				16,780
Proportion		0.00	0.29	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.00	
Sample Year		2005	2006	2007	2006	2007	2008	2007	2008	2009	2009	
2004	8,627	0	2,827		483							3,310
Proportion		0.00	0.85	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	
Sample Year		2006	2007	2008	2007	2008	2009	2008	2009	2010	2010	
2005	15,994	69										69
Proportion												
Sample Year		2007	2008	2009	2008	2009	2010	2009	2010	2011	2011	
2006	12,035											0
Proportion												
Sample Year		2008	2009	2010	2009	2010	2011	2010	2011	2012	2012	
2007	7,958											
Proportion												
Sample Year		2009	2010	2011	2010	2011	2012	2011	2012	2013	2013	
Average 1989–2003	8,684	0.00	0.22	0.00	0.01	0.70	0.00	0.00	0.07	0.00	0.00	14,707

There are a number of sources of bias in the estimates of total run. The first source of bias results from unreturned subsistence permits. This bias is not thought to be severe; however, applying the worst rate of return of subsistence permits for this period of 60% to each year's harvest shows that at least 92% of the total run is accounted for with the current methods. It is noted also that this adjustment assumes harvest associated with unreturned permits is equal to that of returned permits; it is often lower because many unreturned-permit holders do not fish, such that the real bias is probably lower still. A second source of unquantifiable bias is associated with the assumption that 20% of the sport harvest occurs upstream of the weir; this number originated from a creel survey by Murray (1987) and likely fluctuates annually, with a possible unknown trend over years. The third, and possibly the most important, source of bias lies in the estimation of weir counts for periods when the weir was inoperable due to high water. During 2006, the proportion of the inriver run represented by interpolated counts (Table 2) was 24%. Coho salmon entry to the Buskin River is highly variable both within and between years (Appendix A1) and interpolation is difficult. Furthermore, the weir may have been removed before the run was complete in 2005 (based on historic run timing), resulting in probable underestimation of the run. Finally, the inriver run and proportion of sport harvest are assumed constants in variance calculations, resulting in an underestimation of the variance of total run, escapement, exploitation rates, and brood year returns involving sampling in 2005.

No change was found in age-sex composition over time in the analyses for samples obtained from the sport harvest and/or the inriver run in 2005 through 2007, with reasonably large sample sizes. This finding is fortuitous, given our inability to stratify effectively over time. However, an analysis of previous years' data (Schmidt and Evans 2011) shows that while there is a general tendency for age-sex composition to remain constant through the run, it does occasionally change. For this reason, it is recommended that the current sampling protocol be maintained where fish are sampled throughout the run; such a sample will be more representative of the total run should age-sex composition change through the season.

Between 2005 and 2007, the exploitation rate of Buskin River coho salmon varied from 26% in 2005 to 48% in 2007 (Table 3). Sport exploitation in 2005 was considerably lower than in 2006 or 2007, due to a large run and smaller harvest.

It is recommended that sampling of the Buskin river coho salmon run be continued, allowing an updated spawner-recruit analysis that will inform managers with respect to suitability of the current BEG and whether current exploitation rates are in line with those associated with maximum sustainable yield.

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APPENDIX A: BUSKIN RIVER COHO SALMON WEIR COUNTS, 1998–2007

Appendix A1.–Immigration of coho salmon through the Buskin River weir, 1998–2007.

	1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
Date	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
1 Aug	0	0	0	0	0	0	0	0	1	0	0	0	7	0	1	0	0	0	2	0
2 Aug	0	0	0	0	0	0	0	0	1	0	0	0	9	0	1	0	0	0	2	0
3 Aug	0	0	0	0	0	0	0	0	1	0	0	0	23	0	1	0	0	0	2	0
4 Aug	0	0	0	0	0	0	0	0	1	0	0	0	31	0	1	0	2	0	2	0
5 Aug	0	0	0	0	0	0	0	0	1	0	0	0	34	0	1	0	7	0	2	0
6 Aug	0	0	0	0	0	0	0	0	2	0	0	0	45	0	1	0	9	0	2	0
7 Aug	0	0	0	0	0	0	0	0	3	0	0	0	57	1	1	0	20	0	4	0
8 Aug	0	0	0	0	0	0	0	0	3	0	0	0	75	1	5	0	34	0	4	0
9 Aug	0	0	0	0	0	0	0	0	3	0	2	0	79	1	10	0	61	0	5	0
10 Aug	0	0	0	0	0	0	0	0	3	0	2	0	101	1	24	0	82	1	5	0
11 Aug	0	0	0	0	0	0	0	0	3	0	2	0	139	1	39	0	103	1	7	0
12 Aug	0	0	0	0	0	0	0	0	3	0	4	0	165	2	53	0	121	1	11	0
13 Aug	0	0	0	0	0	0	0	0	9	0	4	0	220	2	63	0	154	1	14	0
14 Aug	13	0	0	0	0	0	0	0	59	1	8	0	282	3	69	0	195	1	29	0
15 Aug	77	1	0	0	0	0	0	0	81	1	27	0	344	4	92	1	208	2	34	0
16 Aug	113	1	0	0	0	0	0	0	84	1	52	0	406	4	127	1	220	2	38	0
17 Aug	151	2	0	0	0	0	14	0	119	1	86	1	467	5	185	1	256	2	42	0
18 Aug	237	3	0	0	0	0	68	1	126	1	133	1	630	7	244	1	327	2	98	1
19 Aug	269	3	0	0	0	0	110	1	178	2	156	1	891	9	315	2	414	3	120	1
20 Aug	385	4	0	0	17	0	131	1	216	2	408	3	1,112	12	360	2	520	4	122	1
21 Aug	463	5	46	0	60	1	366	3	306	3	493	4	1,274	13	448	3	910	7	131	1
22 Aug	508	6	67	1	96	1	509	4	358	3	599	5	1,333	14	539	3	1,059	8	160	2
23 Aug	633	7	125	1	168	2	627	5	429	4	670	5	1,458	15	647	4	1,138	9	232	3
24 Aug	748	8	176	2	208	3	667	5	602	6	769	6	1,683	18	681	4	1,370	10	299	3
25 Aug	761	8	320	3	311	4	892	7	688	6	826	6	1,875	20	735	4	1,554	12	346	4
26 Aug	780	9	398	4	432	5	935	7	753	7	1,153	9	2,257	24	775	5	1,726	13	415	5
27 Aug	797	9	522	5	665	8	1,292	10	905	8	1476	11	2,749	29	789	5	2,038	15	701	8
28 Aug	801	9	590	6	935	12	1,593	12	1,022	10	1,859	14	3,377	35	803	5	2,318	17	1,250	14
29 Aug	807	9	722	7	1,298	16	1,934	14	1,361	13	2,180	17	3,999	42	823	5	2,639	20	1,450	16
30 Aug	822	9	985	10	1,505	19	2,144	16	1,466	14	2,452	19	4,498	47	834	5	3,907	29	1,700	19
31 Aug	1,017	11	1,053	11	1,606	20	2,311	17	1,579	15	2,791	21	5,250	55	834	5	4,270	32	1,839	20
1 Sep	1,565	17	1,228	13	1,719	21	2,413	18	1,612	15	3,006	23	5,832	61	850	5	4,815	36	2,121	24
2 Sep	2,294	25	1,412	14	1,767	22	2,563	19	1,637	15	3,148	24	6,081	63	866	5	5,302	40	2,205	24
3 Sep	2,949	33	1,581	16	1,796	22	2,651	20	1,651	16	3,243	25	6,545	68	870	5	6,028	45	2,632	29
4 Sep	3,117	34	1,668	17	1,814	23	2,798	21	1,711	16	3,300	25	6,672	70	872	5	6,579	49	3,437	38
5 Sep	3,194	35	1,825	19	1,842	23	2,975	22	1,786	17	3,351	25	6,722	70	873	5	7,166	54	3,670	41
6 Sep	3,401	38	1,872	19	1,863	23	3,065	23	1,853	17	3,408	26	6,793	71	873	5	7,705	58	3,961	44
7 Sep	3,536	39	1,937	20	1,877	23	3,112	23	2,000	19	3,482	26	6,808	71	880	5	8,365	63	4,281	48

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Appendix A1.–Part 2 of 2.

	1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
Date	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
8 Sep	3,663	40	2,005	20	1,888	23	3,135	23	2,080	20	3,591	27	6,824	71	883	5	8,940	67	4,598	51
9 Sep	3,893	43	2,132	22	1,892	24	3,162	23	2,221	21	4,681	36	6,828	71	907	5	9,237	69	4,819	54
10 Sep	4,293	47	3,422	35	1,917	24	3,404	25	2,344	22	5,427	41	6,864	72	916	6	9,467	71	4,981	55
11 Sep	4,693	52	3,925	40	1,961	24	4,313	32	2,382	22	5,770	44	6,891	72	928	6	9,632	72	5,327	59
12 Sep	5,051	56	4,396	45	1,972	25	5,507	41	2,441	23	6,067	46	6,927	72	944	6	9,663	72	5,701	63
13 Sep	5,192	57	4,889	50	2,190	27	6,285	47	2,547	24	6,332	48	6,962	73	964	6	9,697	73	5,856	65
14 Sep	5,233	58	5,281	54	2,459	31	6,714	50	3,565	33	6,553	50	6,972	73	968	6	10,114	76	5,999	67
15 Sep	5,255	58	5,673	58	2,603	32	7,126	53	3,653	34	6,881	52	6,985	73	1,016	6	10,523	79	6,272	70
16 Sep	5,284	58	6,065	62	2,855	35	7,390	55	3,792	36	7,216	55	7,003	73	1,178	7	10,729	80	6,439	72
17 Sep	5,366	59	6,457	66	3,126	39	7,918	59	3,909	37	7,650	58	7,056	74	1,439	9	11,131	83	6,487	72
18 Sep	5,468	60	6,849	70	3,262	41	8,554	63	3,985	37	7,877	60	7,086	74	2,169	13	11,530	86	6,536	73
19 Sep	6,647	73	7,241	74	3,440	43	9,487	70	4,091	38	8,297	63	7,815	81	2,466	15	12,093	91	6,619	74
20 Sep	7,325	81	7,633	78	3,554	44	10,124	75	4,153	39	8,420	64	7,921	83	2,663	16	12,770	96	6,713	75
21 Sep	7,854	87	8,025	82	3,949	49	10,830	80	4,323	41	8,528	65	8,101	84	2,781	17	13,348	100	6,810	76
22 Sep	8,086	89	8,417	86	4,044	50	11,313	84	5,912	56	8,343	63	8,253	86	2,906	18			6,911	77
23 Sep	8,377	92	8,809	90	4,350	54	11,808	88	6,640	62	8,448	64	8,421	88	3,161	19			7,448	83
24 Sep	8,581	95	9,201	94	4,591	57	12,308	91	7,528	71	9,595	73	8,542	89	3,371	20			8,171	91
25 Sep	8,690	96	9,259	95	4,993	62	12,854	95	8,859	83	10,836	82	8,733	91	3,475	21			8,292	92
26 Sep	8,871	98	9,349	95	5,499	68	13,156	97	9,834	92	11,512	88	9,290	97	3,559	21			8,366	93
27 Sep	8,929	99	9,419	96	5,904	73	13,308	99	10,293	97	11,878	90	9,359	97	8,168	49			8,444	94
28 Sep	8,977	99	9,529	97	5,983	74	13,392	99	10,516	99	12,440	95	9,492	99	12,909	78			8,752	97
29 Sep	9,062	100	9,606	98	6,038	75	13,494	100	10,616	100	13,150	100	9,555	100	14,515	87			9,000	100
30 Sep			9,626	98	6,079	76			10,649	100			9,599	100	14,910	90			9,001	100
Season Total	9,062		9,794		8,048		13,494		10,649		13,150		9,599		16,596		13,348		9,001	
Number (%) Estimated	1,300	(14)	4,312	(44)	300	(4)	2,911	(22)	81	(1)	932	(7)	233	(2)	1,300	(8)	3,189	(24)	749	(8)
Lower weir in	14 Aug		20 Aug		20 Aug		17 Aug		12 Aug		16 Aug		30 Jul		1 Aug		31 Jul		1 Aug	
Lower weir out	29 Sep		4 Oct		4 Oct		29 Sep		30 Sep		29 Sep		30 Sep		5 Oct		21 Sep		30 Sep	

APPENDIX B: AGE-SEX COMPOSITION AND MEAN LENGTH-AT-AGE OF BUSKIN RIVER COHO SALMON INRIVER RUNS AND SPORT HARVESTS, 2005–2006

Appendix B1.–Age-sex composition and mean length-at-age of Buskin River coho salmon sport harvest, 2005.

	Coho salmon age class						
	1.0	1.1	2.0	2.1	3.0	3.1	Total
Females							
Number sampled		29		85		8	138
Percent		9.9		29.0		2.7	41.6
SE percent		1.7		2.7		1.0	2.7
Mean length		639		649		643	645
SE mean length		6		3.0		11	3
Minimum length		573		554		584	526
Maximum length		710		710		687	710
Males							
Number sampled	1	38	1	120		11	194
Percent	0.3	13.0	0.3	41.0		3.8	58.4
SE percent	0.3	2.0	0.3	2.9		1.1	2.7
Mean length	332	647	366	667		672	657
SE mean length		7		3		10	4
Minimum length	332	558	366	549		626	332
Maximum length	332	718	366	761		741	761
All							
Number sampled	1	67	1	205		19	332
Percent	0.3	22.9	0.3	70.0		6.5	100.0
SE percent	0.3	2.5	0.3	2.7		1.4	
Mean length	332	643	366	660		660	652
SE mean length		5		2		8	2
Minimum length	332	558	366	549		584	332
Maximum length	332	718	366	761		741	761

Note: Samples obtained during sport fishery, 24 August through 1 October.

Appendix B2.–Age-sex composition and mean length-at-age of Buskin River coho salmon inriver run, 2005.

	Coho salmon age class						
	1.0	1.1	2.0	2.1	3.0	3.1	Total
Females							
Number sampled		3		9		1	16
Percent		8.8		26.5		2.9	43.2
SE percent		4.9		7.7		2.9	8.3
Mean length		634		604		632	611
SE mean length		17		21			13
Minimum length		599		472		632	472
Maximum length		655		682		632	682
Males							
Number sampled		9		12			21
Percent		26.5		35.3			56.8
SE percent		7.7		8.3			8.3
Mean length		550		620			590
SE mean length		19		12			13
Minimum length		479		556			479
Maximum length		654		698			698
All							
Number sampled		12		21		1	37
Percent		35.3	0.0	61.8	0.0	2.9	100.0
SE percent		8.3	0.0	8.5	0.0	2.9	
Mean length		571		614		632	599
SE mean length		18		11			9
Minimum length		479		472		632	472
Maximum length		655		698		632	698

Note: Samples obtained at weir, 24 August through 23 September.

Appendix B3.–Age-sex composition and mean length-at-age of Buskin River coho salmon sport harvest, 2006.

	Coho salmon age class						
	1.0	1.1	2.0	2.1	3.0	3.1	Total
Females							
Number sampled		32		122	1	14	199
Percent		8.1		31.0		3.6	43.2
SE percent		1.4		2.3		0.9	2.3
Mean length		664		664	310	689	662
SE mean length		9		3		9	3
Minimum length		539		566	310	600	310
Maximum length		742		755	310	728	755
Males							
Number sampled		53		157		14	262
Percent		13.5		39.9		3.6	56.8
SE percent		1.7		2.5		0.9	2.3
Mean length		675		687		699	685
SE mean length		6		3		12	3
Minimum length		570		579		643	570
Maximum length		763		777		775	777
All							
Number sampled		85		279	1	28	461
Percent		21.6	0.0	71.0		7.1	100.0
SE percent		2.1	0.0	2.3		1.4	
Mean length		671		677	310	689	678
SE mean length		5		2		8	2
Minimum length		539		566	310	600	310
Maximum length		763		777	310	775	777

Note: Samples obtained during sport fishery, 17 August through 21 September.

Appendix B4.–Age-sex composition and mean length-at-age of Buskin River coho salmon inriver run, 2006.

	Coho salmon age class						
	1.0	1.1	2.0	2.1	3.0	3.1	Total
Females							
Number sampled		43		157		10	244
Percent		11.3		41.1		2.6	54.5
SE percent		1.6		2.5		0.8	2.4
Mean length		651		650		658	650
SE mean length		4		3		9	2
Minimum length		598		523		620	523
Maximum length		722		724		711	724
Males							
Number sampled		54	2	113		3	204
Percent		14.1		29.6			45.5
SE percent		1.8		2.3			2.4
Mean length		632	345	644		669	639
SE mean length		7	8	5		36	4
Minimum length		524	337	462		601	337
Maximum length		710	353	775		722	840
All							
Number sampled		97	2	270		13	448
Percent		25.4	0.5	70.7	0.0	3.4	100.0
SE percent		2.2	0.4	2.3	0.0	0.9	
Mean length		640	345	648		660	645
SE mean length		4	8	3		9	2
Minimum length		524	337	462		601	337
Maximum length		722	353	775		722	840

Note: Samples obtained at weir, 11 August through 24 September.

APPENDIX C: ESTIMATED AGE COMPOSITION OF BUSKIN RIVER COHO SALMON

Appendix C1.–Estimated age composition of Buskin River coho salmon subsistence and commercial harvests, 2005–2007.

		Coho salmon age class						
Year	Statistic	1.0	1.1	2.0	2.1	3.0	3.1	Total
2005	Estimate	8	605	8	1,731	0	153	2,505
	SE	8	59	8	64	0	33	
2006	Estimate	0	569	6	1,718	3	128	2,425
	SE	0	37	4	40	3	20	
2007	Estimate	9	383	65	1,589	0	19	2,066
	SE	9	54	24	59	0	13	

Note: Estimated age composition based on pooled inriver run and sport harvest samples.

Appendix C2.–Estimated age composition of Buskin River coho salmon in sport harvest, 2005–2007.

		Coho salmon age class						
Year	Statistic	1	1.1	2	2.1	3	3.1	Total
2005 [a]	Estimate	9	727	9	2,080		184	3,010
	SE	9.2	149.4	9.2	384.9		51.6	
2006 [a]	Estimate	0	1,542	17	4,652	8	347	6,567
	SE	0	259.6	12.1	731.7	8.5	75.1	
2007 [b]	Estimate	24	967	165	4,012		47	5,215
	SE	23.6	227.6	68.1	776.1		33.9	

[a] 2005–2006 estimated age composition based on pooled sport harvest and inriver run samples.

[b] 2007 estimated age composition based on inriver run sample.

APPENDIX D: DENSITY PLOTS OF LENGTH-AT-AGE BY YEAR, 2005–2007

Appendix D1.–Density plots of length-at-age by year (2005–2007) for Buskin River coho salmon at ages 1.1 (bottom), 2.1 (middle), and 3.1 (top).