Fishery Data Series No. 10-29

Stock Assessment of Sockeye Salmon in the Buskin River, 2007-2009

Final Report for Study 07-402

USFWS, Office of Subsistence Management

Fishery Information Service Division

by

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and

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April 2010

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 1990, the Alaska Department of Fish and Game, Division of Sport Fish, has assessed the annual run of Buskin River sockeye salmon *Oncorhynchus nerka* stock, Kodiak Island, Alaska. This report presents data collected between 2007 and 2009, and a spawner-recruitment analysis using data collected from 1990-2009.

In 2007, the weir count of sockeye salmon for Buskin River was 16,502, the weir count for Lake Louise was 1,676, and the reported subsistence harvest was 11,151. Age-1.3 and -2.3 sockeye salmon comprised 93% of the Buskin River escapement, 98% of the subsistence harvest, but only 68% of the Lake Louise escapement. The male-female ratio was 1.30:1.0 for the Buskin River, 0.92:1.0 for Lake Louise, and 1.02:1.0 for the subsistence harvest. Enumerated sockeye salmon spawning escapement for the entire Buskin River drainage was 18,178.

In 2008, the weir count of sockeye salmon for Buskin River was 5,900, the weir count for Lake Louise was 833, and the reported subsistence harvest was 2,664. Age-1.3 and -2.3 sockeye salmon comprised 53% of the Buskin River escapement, 80% of the subsistence harvest, but only 27% of the Lake Louise escapement. The male-female ratio was 0.97:1.0 for Buskin River, 1.02:1.0 for Lake Louise, and 1.38:1.0 for the subsistence harvest. Enumerated sockeye salmon spawning escapement for the entire drainage was 6,733.

In 2009, the weir count of sockeye salmon for Buskin River was 7,757, and the weir count for Lake Louise was 992. The total reported subsistence harvest was not yet available. Age-1.3 and -2.3 sockeye salmon comprised 73% of the Buskin River escapement, nearly 82% of the subsistence harvest, but only 37% of the Lake Louise escapement. The male-female ratio was 1.16:1.0 for Buskin River, 1.28:1.0 for Lake Louise, and 0.62:1.0 for the subsistence harvest. Enumerated sockeye salmon spawning escapement for the entire drainage was 8,749.

A Bayesian spawner-recruitment analysis estimated the sockeye salmon spawning escapement for maximum sustained yield to be about 6,550 (90% credibility interval of 4,950-8,700). A traditional linear regression analysis yielded similar results. A sustained yield probability analysis suggests lowering the sustainable escapement goal range for the Buskin River system to 5,000-8,000.

Key words: sockeye salmon, *Oncorhynchus nerka*, escapement, Buskin River, age, length, sex composition, sport harvest, spawner recruit, subsistence harvest, stock assessment.

INTRODUCTION

The Buskin River drainage, located on the northeast end of Kodiak Island (Figure 1), contains one of only three native populations of sockeye salmon *Oncorhynchus nerka* found on the Kodiak Island road system. The drainage supports one of the largest subsistence salmon fisheries in the Kodiak Archipelago and the single largest subsistence fishery within the Kodiak/Aleutian Islands Federal Subsistence Region. The subsistence fishery occurs in nearshore marine waters adjacent to the river mouth and targets several species of salmon. Sockeye salmon typically comprise as much as 80% of the total subsistence salmon harvest, with reported harvests ranging from approximately 2,650 to 13,350 fish in 2000–2008 (Table 1, Figure 2). Since 2000, the Buskin River subsistence harvest averaged 53% of the total sockeye salmon subsistence harvest reported for the region. 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 representing approximately 34% of the total freshwater recreational fishing effort in the Kodiak Management Area (Jennings et al. 2004, 2006 a-b, 2007, 2009a). Recreational fishing effort on the Buskin River is directed primarily toward sockeye salmon and coho salmon *O. kisutch*, but also steelhead and rainbow trout (both *O. mykiss*), pink salmon *O. gorbuscha* and Dolly Varden *Salvelinus malma*. From 2000 through 2008, sport harvest of sockeye salmon from the Buskin River ranged from about 800 to 3,000 fish and averaged nearly 1,700 (Table 1; Figure 2). Sport harvest of sockeye salmon and fishing effort on the Buskin River are estimated by the Alaska Department of Fish and Game, Division of Sport Fish, Statewide Harvest Survey (SWHS).

A relatively minor commercial harvest of Buskin River sockeye salmon occurs in adjacent marine waters of Chiniak Bay. These harvests are small and, during some years, nonexistent. Fish ticket harvest receipts available from CF indicate that between 2000 and 2009, the harvest of Buskin River sockeye salmon was 1,098 in 2004 and less than 30 in other years.

Inriver returns of sockeye salmon are usually monitored at two salmon counting weirs (Figure 1) to ensure the sustainability and long-term health of the stock (Schmidt et al. 2005; Schmidt 2007). One weir is usually located at the outlet of Buskin Lake, and has been operated annually by ADF&G since the mid-1980s. Counts of adult salmon entering Buskin Lake are usually obtained between late May and late July, with peak daily escapements typically occurring during the second week of June (Figure 3). The second weir is located on the tributary stream draining both Lake Louise and Lake Genevieve, and has been operated annually by ADF&G since 2002. Counts of adult salmon entering this tributary stream are usually obtained between early June and late August, with peak daily escapements typically occurring during August (Figure 3). The largest daily counts at this weir generally coincide with high water events.

The current sockeye salmon sustainable escapement goal (SEG) for the Buskin River, first determined in 1996 based on historical weir counts between 1985 and 1989, is 8,000–13,000 fish. The SEG is used to guide inseason management of subsistence, sport and commercial fisheries so that a sustained yield from the resource can be ensured. If inseason weir counts indicate the SEG will not be achieved, harvest restrictions are first enacted for sport and commercial fisheries. If these restrictions are not sufficient to ensure the SEG will be achieved, harvest restrictions may also be placed on the subsistence fishery.

To improve management of Buskin River sockeye salmon for the benefit of all users, it is essential to establish an escapement goal that accurately reflects the production capacity of the stock. Since 2000, ADF&G has obtained funding from the U.S. Fish and Wildlife Service, Office of Subsistence Management, to collect the data needed to evaluate the Buskin River sockeye salmon SEG. Escapement data from these efforts, along with harvest data from subsistence permits and commercial fish tickets (Dinnocenzo 2010; Dinnocenzo and Caldentey 2008), and statewide sport harvest surveys (Walker et al. 2003, Jennings et al. 2004, 2006a-b, 2007, 2009a-b, 2010a-b) are used with associated age composition estimates to construct a brood table, analyze spawner-recruitment, and set escapement goals. The SEG is periodically reevaluated as new information becomes available to help ensure that the fisheries can be maintained while the sockeye salmon resource is sustained.

This report presents 2007-2009 study results, including daily and seasonal sockeye salmon escapement counts, harvests, estimates of age and sex composition and mean length-at-age by sex, and spawner-recruitment analyses.

STUDY OBJECTIVES

During 2007-2009 objectives for the stock assessment of Buskin River sockeye salmon consisted of the following:

1. Census the sockeye salmon escapement into Buskin and Louise lakes from 1 June through 15 August.

2. Estimate the age composition of the combined subsistence harvest in the Buskin River Section of Chiniak Bay and sockeye salmon escapement into Buskin Lake from 1 June to 15 August such that the estimates are within 5 percentage points of the true value 95% of the time.
3. Estimate the age composition of the sockeye salmon run to Louise Lake from 1 June to 15 August such that the estimates are within 7.5 percentage points of the true value 95% of the time.
4. Evaluate the sockeye salmon biological escapement goal.
5. Census participants of the subsistence fishery to determine their residency.
6. Estimate the distribution of subsistence-harvested fish, and the historic and potential future use of the Buskin River subsistence fishery such that all estimates are within 8 percentage points of the true value 95% of the time.

METHODS

DATA COLLECTION

Weir Counts

During the 3 years of this study, up to three weirs were operated each season: (1) at the outlet to Buskin Lake (referred to as the Buskin River weir), (2) on the tributary stream draining Louise and Genevieve lakes (referred to as the Lake Louise weir), and (3) 0.6 miles upstream of the Buskin River mouth (referred to as the lower weir) (Figure 1). The lower weir is operated in August and September, but is not funded by another project. During each year, the weirs were operated continuously and monitored daily. Fish passage was only allowed when counts were made, and all immigrant and emigrant anadromous fishes passing through the weirs were enumerated and identified by species.

From 2007 through 2009, ADF&G operated a picket weir (approximately 125 ft long) at the outlet of Buskin Lake (Figure 1). The Buskin River weir was constructed with a superstructure framework of wooden tripods weighted with sandbags, aluminum cross stringers and a boardwalk. Rigid aluminum panels (10 ft high and 2.5 ft wide, constructed from 1-in diameter schedule-40 pipe sections spaced 1 in apart, and welded into aluminum t-bar) provided structural continuity and created a barrier to uncontrolled fish passage. Four counting gates integrated into the panel array allowed for the controlled passage of fish over a submerged white-colored background medium to assist in species identification. A funnel entrance trap structure constructed of aluminum panels and attached to one of the counting gates was installed to capture fish migrating upstream.

In 2007 and 2008, the Buskin River weir operated at the outlet of Buskin Lake from mid-May to 31 July. The weir was then dismantled and moved downstream about 1.5 miles to a site approximately 0.6 miles upstream from the Buskin River mouth (the lower weir). Sockeye salmon counting was continued at this site from 1 August to 30 September. The 1.5-mile section of river between the Buskin Lake outlet and the lower weir location was surveyed by boat before the weir was installed at the lower site, and all sockeye salmon observed were added to the current weir count. In 2009, the Buskin River weir was operated at the outlet of Buskin Lake from mid-May to 30 September, and an additional weir was operated at the lower site from 3 August to 16 September. Annual sockeye salmon counts obtained from the Buskin River weir were considered a close approximation of total spawning escapement as harvests do not occur within Buskin Lake or its tributaries.

During 2007-2009, a second weir was also operated on a major tributary stream flowing into the Buskin River from Lake Louise (Figure 1). The Lake Louise weir was similar in design to the one used at Buskin Lake. It was approximately 20 feet long with one counting gate and funnel entrance trap structure constructed of aluminum panels. Dates of operation were fairly consistent each year; typically the weir was operated between the first week of June and early September. Annual sockeye salmon counts obtained from the weir provided a close approximation of total spawning escapement into Lake Louise as harvests do not occur upstream of the weir site.

Because sport fish harvests or other known removals of sockeye salmon were very small and did not occur upriver of the weirs at Buskin Lake and Lake Louise, the sum of counts taken at the weirs was considered a census of the spawning escapement (with zero variance). A 3% adjustment was made to the weir counts for the Buskin River system to account for fish migrating before or after weir operation and for weir-leakage during high flow events. No adjustment was made for Lake Louise, because of its smaller run size, lack of weir-leakage, and no spawner-recruitment analysis was performed on this stock.

Fishery Harvests

Annual subsistence harvests of Buskin River drainage sockeye salmon were estimated from returns of completed permits received by the CF Kodiak Office. From 2000 through 2008, annual return rates of completed permits ranged between 84% and 98% and averaged 90% (J. Shaker, ADF&G, Kodiak, personal communication). It was not possible to determine the proportion of permit holders harvesting Buskin River sockeye salmon who failed to return permits.

The sport fishery harvest of sockeye salmon was estimated by the SWHS (Walker et al. 2003, Jennings et al. 2004, 2006a-b, 2007, 2009a-b, 2010a-b). Commercial harvests were obtained from the CF fish ticket database system (Dinnocenzo 2010; Dinnocenzo and Caldentey 2008).

Age, Sex and Length Sampling

During 2007-2009, sockeye salmon age, sex, and length (ASL) sampling was stratified into four temporal intervals. For the Buskin Lake run component, the first interval began in mid-May and the last ended on 31 July. Samples from inriver returns of sockeye salmon to Buskin Lake were obtained from weir traps or beach seines. Sampling typically was conducted 3 days a week. Whenever possible, all sockeye salmon captured in the weir traps or seines were sampled for ASL. For the Lake Louise run component, sample intervals were the same each year: 1 June–15 July, 16–31 July, 1–15 August and 16–31 August. Sampling typically was conducted every other day. Whenever possible, all sockeye salmon captured in the weir trap were sampled.

From 2007 through 2009, ASL sampling of the subsistence harvest was stratified into two 2-week intervals: 1–15 June and 16–30 June. Sampling was conducted on the fishing grounds during good weather, and also dockside at the local boat harbor. Samples were obtained opportunistically within each time interval. No ASL sampling was conducted for either the sport fish or commercial harvests. ASL statistics for these harvests were assumed to be the same as those estimated for escapement counted through the weirs.

Length from mid eye to tail fork (METF) was recorded to the nearest millimeter for each sockeye salmon sampled. Sex was determined through external morphology such as head shape and presence of the ovipositor. Whenever possible, two scales were removed from the left side of the body, at a point on a diagonal line from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin, two rows above the lateral line (Welander 1940). Scales not available from the preferred area were taken from the third or fourth row above the lateral line in the same linear plane. Scales not available in either preferred area on the left side were collected from the same region on the right side of the body. Sampled scales were placed on a gummed card for subsequent analysis. Ages of sampled sockeye salmon were determined from scales using criteria described in Mosher (1969).

Subsistence User Survey

In response to a priority information need identified by the Kodiak/Aleutians Region Subsistence Advisory Council, technicians opportunistically surveyed sockeye salmon subsistence fishers on the fishing grounds adjacent to the Buskin River mouth while concurrently sampling the harvest for ASL. The survey was conducted over the duration of the subsistence fishery each year of the study. Although it probably provided a representative sample of people participating in the fishery, the user survey was not designed to provide bias and precision estimates. The survey provided residency and fishing effort data not currently available from the subsistence permit returns. Following a set of brief introductory remarks, all fishers who agreed to be interviewed were asked a short series of questions to determine their residency (Kodiak Island Borough or elsewhere in Alaska) and traditional subsistence fishing location(s) (Buskin River or elsewhere).

DATA ANALYSIS

AGE AND SEX COMPOSITION

Escapement

The proportion of sockeye salmon of age or sex class j in stratum i for the escapement was estimated as a binomial proportion (Cochran 1977) by:

$$\hat{p}_{ij} = \frac{n_{ij}}{n_i}, \tag{1}$$

and its variance by:

$$\text{var}(\hat{p}_{ij}) = \left[\frac{N_i - n_i}{N_i}\right]\frac{\hat{p}_{ij}(1-\hat{p}_{ij})}{n_i - 1}, \tag{2}$$

where:

n_{ij} = the number of sockeye salmon in age or sex class j during stratum i,

n_i = the total number of sockeye salmon sampled during stratum i, and

N_i = the number of sockeye salmon in the weir count during stratum i.

The number of fish by age or sex class j in stratum i was estimated by:

$$\hat{N}_{ij} = N_i \hat{p}_{ij}, \tag{3}$$

and its variance by:

$$\mathrm{var}(\hat{N}_{ij}) = N_i^2 \ \mathrm{var}(\hat{p}_{ij}). \tag{4}$$

Chi-square tests ($\alpha = 0.05$) were then used to determine if differences in age and sex composition existed among the four temporal sampling strata for each of the weirs. When differences among strata were detected ($P < 0.05$), the estimated total number of sockeye salmon of each age or sex class j ($\hat{N}_j$) in the escapement, and its variance [$\mathrm{var}(\hat{N}_j)$], were calculated as the sum of the individual stratum estimates. The overall proportion of sockeye salmon of age or sex class j was calculated as:

$$\hat{p}_j = \frac{\hat{N}_j}{N}, \tag{5}$$

and its variance was estimated as:

$$\mathrm{var}(\hat{p}_j) = \frac{\mathrm{var}(\hat{N}_j)}{N^2}. \tag{6}$$

When no difference among strata in age/sex composition was detected ($P > 0.05$), data were pooled across strata and the above equations 1-4 used with deletion of subscript i.

Subsistence Harvest

Subsistence harvest estimates could not be stratified because subsistence harvest was only reported seasonally with no reliable method of stratification available. Pooled estimates of age and sex composition were, therefore, calculated using equations 1-4 with deletion of subscript i, as was done for the unstratified escapement estimates.

Sport Harvest

The number of sockeye salmon in the sport harvest by age or sex class j was estimated by:

$$\hat{N}_{SFj} = \hat{N}_{SF} \hat{p}_j, \tag{7}$$

where:

$\hat{N}_{SF}$ = SWHS estimate of total sport harvest, and

$\hat{p}_j$ = the proportion of age or sex class j derived from escapement sampling (sport harvest was not sampled for age or sex).

The variance of the number of fish in the sport harvest of age or sex class j was estimated according to Goodman (1960):

$$\mathrm{var}(\hat{N}_{SFj}) = \hat{N}_{SF}^2 \ \mathrm{var}(\hat{p}_j) + \hat{p}_j^2 \ \mathrm{var}(\hat{N}_{SF}) - \mathrm{var}(\hat{p}_j)\,\mathrm{var}(\hat{N}_{SF}), \tag{8}$$

where:

$\mathrm{var}\left(\hat{N}_{SF}\right)$ = estimated variance of harvest from the SWHS.

RUN SIZE ESTIMATION

For the purpose of estimating sockeye salmon total run size, weir counts, permit returns of subsistence harvests, and fish ticket tallies of commercial harvests were treated as censuses (total counts with zero variance). Harvests from unreturned subsistence permits were anticipated by assuming a harvest rate that was 65% of the returned permits:

$$\tilde{N}_{SUB} = N_{SUB} + \left[\frac{N_{SUB}}{p_{\mathrm{Re}t}} - N_{SUB} \right] * 0.65 \tag{9}$$

where:

N_{SUB} = reported subsistence harvest, and

$p_{\mathrm{Re}t}$ = proportion of issued permits returned.

A value of 65% was assumed reasonable based on estimated harvest rates for unreturned permits in other fisheries in the State of Alaska (0.69 for the Kenai River sockeye salmon dip net fishery and 0.66 for the Chitina sockeye salmon dip net fishery (Patricia Hansen, ADF&G, Anchorage, personal communication). The adjustment is relatively small and no variance component was calculated.

The number of sockeye salmon of age class j in the total run ($\hat{N}_j$) to the Buskin River system and its variance were estimated by summing the component estimates from the escapement, subsistence harvest and sport harvest, with $\mathrm{var}(\hat{N}_j)$ calculated by summing the respective variances estimates. A covariance will exist between the sport harvest estimate of the age class j and the escapement estimates of age class j (through $\hat{p}_j$). However, the covariances will be small because the sport harvest is always a relatively small component of the total run.

EXPLOITATION RATE ESTIMATION

Exploitation rates (E) for the subsistence and sport fisheries were estimated as:

$$\hat{E} = \frac{H}{\hat{T}}, \tag{10}$$

where H was either the subsistence harvest or sport harvest estimate and T was the total run. The variance estimate of the subsistence exploitation rate was calculated as:

$$\mathrm{var}(\hat{E}) = H^2 \frac{1}{\hat{T}^4} \mathrm{var}(\hat{T}). \tag{11}$$

The variance of the sport fish exploitation rate was estimated as:

$$\mathrm{var}(\hat{E}) = \left(\frac{\hat{H}}{\hat{T}} \right)^2 \left(\frac{\mathrm{var}(\hat{H})}{\hat{H}^2} + \frac{\mathrm{var}(\hat{H})}{\hat{T}^2} \right). \tag{12}$$

SPAWNER RECRUIT ANALYSIS

Two different methods were used to model the spawner-recruitment relationship: a widely used traditional method that provides an average relationship (Ricker 1975), and a more recently developed Bayesian Markov Chain Monte Carlo method. The Bayesian method is based on an underlying Ricker-type relationship, but is better able to incorporate the uncertainty associated with the various data sets into the estimated relationship (Ericksen and Fleischman 2006; Szarzi et al. 2007 and Fleischman and Borba 2009).

Traditional Analysis

The first method is based on simple linear regression techniques to fit the linearized Ricker stock-recruitment function:

$$\ln(R_y / S_y) = \ln\alpha - \beta S_y + \varepsilon_y, \tag{13}$$

where R_y is the returns and S_y is spawning abundance relevant to brood year y, α and β describe the shape of the Ricker spawner-recruitment relationship (Ricker 1975), and $\varepsilon_y \sim N(0,\sigma^2)$, with σ^2 representing process error. Spawning abundance yielding maximum sustained yield (S_{MSY}) was modeled using the approximation of Hilborn and Walters (1992):

$$S_{MSY} = \frac{\ln(\alpha)'}{\beta}(0.5 - 0.07\ln(\alpha)'), \tag{14}$$

where:

$$\ln(\alpha)' = \ln(\alpha) + \sigma^2/2 \tag{15}$$

Spawning abundance for which R=S was modeled as:

$$S_{EQ} = \frac{\ln(\alpha)'}{\beta} \tag{16}$$

Estimates of the above quantities were obtained by plugging in the simple linear regression estimates of $\ln(\alpha)$, β, and σ^2.

Confidence intervals for S_{MSY} were estimated using bootstrap data sets (Efron 1982); each iteration of the bootstrap was conducted by resampling the residuals from the regression, creating a bootstrap data set and then refitting the regression model to the bootstrapped data set. A sustained yield probability profile was also created that described the probability of attaining 90% of maximum sustained yield as a function of spawning escapement. A ‘horsetail’ plot of the Ricker relationship was created from the first twenty bootstrap data sets.

Serial correlation was examined through inspection of the autocorrelation and partial autocorrelation functions of the residuals and by the Durbin-Watson statistic. It is noted that the assumption of zero error in the escapement measurement is largely met for this system because of reliable weir counts. The traditional Ricker analysis used data corresponding to the 1990-2003 brood years (14 years); imputed returns were used for the 1999 run year, when no effective age class sampling occurred and the subsistence and sport harvest were anticipated for 2009. We have confidence that the anticipated subsistence and sport harvests will be similar to the final 2009 harvest values.

Bayesian Analysis

The methodology used for the Bayesian analysis has been described (Ericksen and Fleischman 2006; Szarzi et al. 2007 and Fleischman and Borba 2009).

The Bayesian method has several potential advantages over the traditional Ricker stock recruitment model. The Bayesian method is capable of incorporating into parameter estimation the uncertainty associated with incomplete stock-recruit data sets (such as the missing 1999 age composition data); error in spawning escapement measurements (not considered problematic for this analysis); sampling variability in age composition estimation; and serial correlation in returns and other ad hoc sources of variability. Ad hoc sources would include error in the sport harvest and subsistence harvest estimation and the notion that the weir count at Buskin Lake represents minimum escapement. The Bayesian method also allows use of incomplete brood year data.

Markov Chain Monte Carlo (MCMC) methods, which are especially well-suited for modeling complex population and sampling processes, were used to obtain the Bayesian estimates. The MCMC algorithms were implemented in WinBUGS (Gilks et al. 1994).

The Bayesian MCMC analysis considers all the data simultaneously in the context of the following "full-probability" statistical model. Returns of sockeye salmon originating from spawning escapement in brood years y = 1990-2005 are modeled as a Ricker stock-recruit function with autoregressive lognormal errors:

$$\ln(R_y) = \ln(S_y) + \ln(\alpha) - \beta S_y + \phi \nu_{y-1} + \varepsilon_y \quad (17)$$

where α and β are Ricker parameters, ϕ is the autoregressive coefficient, [ν_y] are the model residuals:

$$\nu_y = \ln(R_y) - \ln(S_y) - \ln(\alpha) + \beta S_y, \quad (18)$$

and the [ε_y] are independently and normally distributed process errors with mean zero and variance σ^2_{SR}.

Age proportion vectors $\underline{p}_y = (p_{y4}, p_{y5}, p_{y6})$ from brood year y returning at ages 4-6 are drawn from a common Dirichlet distribution (multivariate analogue of the beta). The Dirichlet is re-parameterized such that the usual parameters:

$$D_a = \pi_a D \quad (19)$$

are written in terms of location (overall age proportions π_a) and inverse scale (D, which governs the inverse dispersion of the $\underline{p}_y$ age proportion vectors among brood years).

The abundance N of age-a sockeye salmon in calendar year t (t = 1990 through 2009) is the product of the age proportion scalar p and the total return R from brood year $y = t\text{-}a$:

$$N_{ta} = R_{t-a}\, p_{t-a,a} \quad (20)$$

Total run during calendar year t is the sum of abundance at age across ages:

$$N_{t\cdot} = \sum_a N_{ta} \quad (21)$$

Spawning abundance is total abundance minus harvest,

$$S_t = N_{t\cdot} - HSF_t - HSub_t \quad (22)$$

where HSF_t is in turn the product of the annual exploitation rate and total run:

$$HSF_t = \mu_t N_{t\cdot} \quad (23)$$

and $HSub_t$ is:

$$HSub_t = HSub_{pt} + \left[\frac{HSub_{pt}}{p_{rt}} - HSub_{pt}\right] p_h . \quad (24)$$

where $HSub_{pt}$ is the (known) harvest from returned permits in year t, p_{rt} is the proportion of issued permits returned and p_h is a discounting proportion which accounts for the reduction in harvest rate associated with unreturned permits. The prior distribution on p_h set as a beta (1.9,1); an informative prior with mean 0.65.

Although sockeye salmon were counted at a weir, it was usual for some fish to escape to Buskin Lake before the weir was installed and after the weir removed. The spawning escapement available for counting was modeled as:

$$S_{wt} = \rho_t S_t \quad (25)$$

where ρ_t is the proportion of the escapement available for counting in year t; the prior distribution on ρ_t set as a beta (30,1); an informative prior with mean 0.97.

Spawning abundance yielding peak return S_{MAX} is the inverse of the Ricker β parameter. Equilibrium spawning abundance S_{EQ} and spawning abundance leading to maximum sustained yield S_{MSY} are obtained using equations 14 and 16, except that ln(α) is corrected for AR1 serial correlation as well as lognormal process error:

$$\ln(\alpha') = \ln(\alpha) + \frac{\sigma^2_{SR}}{2(1-\phi^2)} . \quad (26)$$

Expected sustained yield at a specified escapement S is calculated by subtracting spawning escapement from the expected return, again incorporating corrections for lognormal process error and AR1 serial correlation:

$$SY = E[R] - S = Se^{\ln(\alpha') - \beta S} - S . \quad (27)$$

The probability that a given level of escapement would produce average yields exceeding 90% of MSY was obtained by calculating the expected sustained yield (SY; Equation 27) at multiple incremental values of S (0 to 10,000) for each Monte Carlo sample, then comparing SY with

90% of the value of MSY for that sample. The proportion of samples in which SY exceeded 0.9 MSY is the desired probability.

Observed data include estimates of spawning abundance (weir counts), estimates of sport harvest, and scale age counts. Likelihood functions for the data are shown below.

Weir counts were modeled as:

$$\hat{S}_{wt} = S_{wt} e^{\varepsilon_{Swt}} \tag{28}$$

where the [ε_{Swt}] are normal ($0, \sigma^2_{Swt}$) with measurement error variance σ^2_{Swt};, and the weir counts were assumed to have a coefficient of variation of 2%.

Estimated sport harvest was modeled as

$$\hat{HSF}_t = HSF_t e^{\varepsilon_{Ht}} \tag{29}$$

where ε_{Ht} are normal ($0, \sigma^2_{Ht}$) with individual variances σ^2_{Ht} assumed known from the SWHS.

Numbers of fish sampled for scales (n) that were classified as age-a in calendar year t (x_{ta}) are assumed multinomially (r_{ta}, n) distributed, with proportion parameters as follows:

$$r_{ta} = \frac{N_{ta}}{N_{t.}} \tag{30}$$

Bayesian analyses require that prior probability distributions be specified for all unknowns in the model. Non-informative priors (chosen to have a minimal effect on the posterior) were used almost exclusively. Initial returns R_{1984}-R_{1989} (those with no linked spawning abundance) were modeled as drawn from a common lognormal distribution with median μ_{LOGR} and variance σ^2_{LOGR}. Normal priors with mean zero, very large variances, and constrained to be positive, were used for ln(α) and β (Millar 2002), as well as for μ_{LOGR}. The initial model residual ν_0 was given a normal prior with mean zero and variance $\sigma^2_{SR}/(1-\phi^2)$. Diffuse conjugate inverse gamma priors were used for σ^2_{SR} and σ^2_{LOGR}. Annual exploitation rates [μ_t] were given beta (0.1, 0.1) prior distributions.

Markov Chain Monte Carlo samples were drawn from the joint posterior probability distribution of all unknowns in the model. For each of two Markov chains initialized, a 10,000-sample burn-in period was discarded; and thinning by a factor of 10 was initiated. A total of 36,000 samples were used to estimate the marginal posterior means, standard deviations, and percentiles. The diagnostic tools of WinBUGS assessed mixing and convergence, and no major problems were encountered. Interval estimates were obtained from the percentiles of the posterior distribution.

The validity of the Bayesian analyses was tested by visually examining the degree of mixing of the MCMC chains, use of the Gelman-Reuban statistic, and monitoring of autocorrelations. For details on these procedures see Gill (2002).

RESULTS

YEAR 2007

Buskin River Weir

The Buskin River weir was installed on 7 May and operated continuously, except for 5 hours, through 3 August 2007. The cumulative sockeye salmon count at the weir through 3 August was 15,948 and 50% of these had passed the weir by 16 June (Appendix A1). The final weir count was 16,502 when the lower weir was removed for the season on 29 September. The 225 sockeye salmon counted at the lower weir site accounted for only 1% of the total escapement.

Age was determined for 324 of 359 sockeye salmon sampled at the weir (Table 2). Chi-square tests indicated no need for temporal stratification (Appendix B1) of age-sex ($P = 0.15$), age ($P = 0.09$) or sex ($P = 0.48$), so data from all strata were pooled.

Over 92% of the sockeye salmon sampled at Buskin River reared in the ocean for 3 years: age 1.3 (79.0%) and age 2.3 (13.9%) (Table 2). Most of the remaining escapement reared in the ocean for 2 years. No significant difference in age composition (1.3 versus 2.3) was found between males and females ($P = 0.59$). The male to female ratio was 1.3:1.0, which was significantly different from 1.0 ($P = 0.01$). Mean METF length of males (564 mm, SE = 2.1 mm) was significantly longer than that of females (529 mm, SE = 2.4) ($P < 0.001$).

Lake Louise Weir

The Lake Louise weir operated from 8 June to 28 September 2007. A total of 1,676 sockeye salmon were counted, and 50% of these had passed the weir by 28 August (Appendix A2).

Age was determined for 229 of 251 sockeye salmon sampled (Table 3). Chi-square tests indicated a need for temporal stratification (Appendix C1) of age-sex ($P = 0.02$) and sex ($P = 0.013$), so stratified estimates were calculated. Age data were not different over temporal strata ($P = 0.15$), so age data were pooled.

Over 67% of the sockeye salmon sampled at Lake Louise reared in the ocean for 3 years: age 1.3 (61.6%) and age 2.3. (6.1%) (Table 3). No significant difference in age composition (1.3 versus 2.3) was found between males and females ($P = 0.22$). The male to female ratio was 0.9:1.0, which was not significantly different from 1.0 ($P = 0.57$). There was no significant difference ($P = 0.81$) between the mean METF lengths of males (505 mm, SE = 7.4) and females (503 mm, SE = 3.7).

Age composition of Lake Louise sockeye salmon was significantly different from Buskin Lake sockeye salmon ($P < 0.001$). The biggest difference was found for age-2.3 sockeye salmon which comprised 14% of the Buskin Lake escapement, but only 6% of the Lake Louise escapement. The mean METF length of Buskin River sockeye salmon (549 mm, SE = 2) was significantly different ($P < 0.001$) from that of Lake Louise (504 mm, SE = 4.2). Sex composition between these run components was not significantly different ($P = 0.26$).

Subsistence Harvest

The reported sockeye salmon subsistence harvest from marine waters of the Buskin system in 2007 was 11,151. About 92% of the permits were returned, resulting in an adjusted harvest of 11,762 (Table 4). Age was determined for 227 of 249 fish sampled from the harvest. No significant differences were found for age-sex (P = 0.53), age (P = 0.96) or sex (P = 0.65) compositions among temporal strata.

Over 98% of sockeye salmon harvested in the subsistence fishery reared in the ocean for 3 years: ages 1.3 (86.3%) and 2.3 (11.0%) comprised the dominant age groups (Table 4). No significant difference in age composition (1.3 versus 2.3) was found between males and females (P = 0.96). The male to female ratio was 1.0:1.0, which was not significantly different from 1.0 (P = 0.85). Mean METF length of males (572 mm, SE = 2) was significantly longer than that of females (542 mm, SE = 2) (P < 0.001).

The age composition of the subsistence harvest was significantly different (P = 0.003) from that of the Buskin Lake escapement. The biggest difference was found for ocean-age-2 sockeye salmon which comprised 6% of the Buskin Lake escapement and 1% of the subsistence harvest. Sex composition between run components was not significantly different (P = 0.16). Sockeye salmon harvested by the subsistence fishery averaged 558 mm (SE = 2) in METF length compared to fish sampled at the Buskin River weir averaging 549 mm (SE = 2), and were significantly different (P < 0.001).

Sport and Commercial Fisheries

In 2007, anglers fishing the Buskin River drainage caught an estimated 3,143 (SE = 1,534) sockeye salmon and harvested 1,509 (SE = 564) sockeye salmon, expending 17,124 (SE = 2,221) angler-days of effort for all species during the entire year (Table 1).

Fish ticket harvest receipts available from CF indicate that 30 sockeye salmon were harvested at the mouth of the Buskin River in Women's Bay, statistical area 259-22, during 2007.

For sockeye salmon harvested in the sport and commercial fisheries combined, 92.9% reared in the ocean for 3 years, and the predominant ages were 1.3 (79.0%) and 2.3 (13.9%) (Table 5).

YEAR 2008

Buskin River Weir

The Buskin River weir was installed on 21 May and operated through 30 July 2008. The weir was breached for approximately 24 hours on 2 June because of high water. Also, for 3 consecutive days during mid-July, a member of the public opened the counting gate, which remained open each day until it was discovered and closed. The cumulative count at the weir through 30 July was 5,441 sockeye salmon, and 50% of these had passed the weir by 28 June (Appendix A1). The final weir count was 5,900 sockeye salmon when the lower weir was removed for the season on 29 September.

Age was determined for 344 of 373 sockeye salmon sampled (Table 6). Significant differences among temporal strata were found for age-sex and age composition (P < 0.001) (Appendix B2), so stratified estimates were calculated. Sex composition did not differ significantly among strata (P = 0.08), so pooled estimates were calculated.

Over 53% of the sockeye salmon sampled at Buskin River reared in the ocean for 3 years: age 1.3 (25.8%) and age 2.3 (26.7%); and over 36% reared in the ocean for 2 years: age 1.2 (25.4%) and 2.2 (10.3%) (Table 6). Conditions for collapsing age-by-sex data over time to assess an overall age-sex association were not met (a significant three-way interaction existed; P = 0.03). The male to female ratio was 0.97:1.0, which was not significantly different from 1.0 (P = 0.79).

There was no statistical difference (P = 0.23) between the mean METF lengths of males (506 mm, SE = 5) and females (499 mm, SE = 3).

Lake Louise Weir

The Lake Louise weir was operated from 8 June to 8 September 2008. The cumulative count at the weir was 833 sockeye salmon, and over 50% had passed through the weir by 13 August (Appendix A2). Similar to other years, escapement peaks coincided with high water events. More than 77% of the total weir count occurred on 13 August.

Age was determined for 75 of 169 sockeye salmon sampled (Table 7). Only 75 fish scales were readable in 2008 because of high re-absorption rates. This was most likely from relatively long inriver residency of sockeye salmon because of low water conditions prior to passing through the Lake Louise weir. Significant differences were found among strata for age-sex (P < 0.001) and sex composition (P =0.001) (Appendix C2), so stratified estimates were calculated. Age composition did not differ significantly among temporal strata (P = 0.125), so pooled estimates were calculated.

About 69% of the sockeye salmon sampled at Lake Louise weir reared in the ocean for 2 years: age 1.2 (42.7%) and age 2.2 (26.7%); and 26.6% reared in the ocean for 3 years: age 1.3 (21.3%) and age 2.3 (5.3%) (Table 7). Age composition differed significantly between males and females (P < 0.001). The male to female ratio was 1.02:1.0, which was not significantly different from 1.0 (P = 0.90). There was no statistical difference (P = 0.37) between the mean METF lengths of males (492 mm, SE = 6) and females (485 mm, SE = 5).

Age composition of Lake Louise sockeye salmon was significantly different from Buskin Lake sockeye salmon (P < 0.001). The biggest difference was found for age-2.3 sockeye salmon which comprised 26.7% of the Buskin Lake escapement, but only 5.3% of the Lake Louise escapement. There was no statistical difference (P = 0.13) between the mean METF lengths of Buskin Lake (502 mm, SE = 3) and Lake Louise (489 mm, SE = 4) sockeye salmon. Sex composition between these run components was also not significantly different (P = 0.11).

Subsistence Harvest

The reported sockeye salmon subsistence harvest from marine waters of the Buskin system in 2008 was 2,664 fish. Nearly 85% of the permits were returned, resulting in an adjusted harvest of 2,954 (Table 8).

Age was determined for 121 of 133 sockeye salmon sampled from the harvest. No significant differences were found among temporal strata for age-sex (P = 0.08), age (P = 0.66), or sex (P = 0.17) compositions.

Over 80% of sockeye salmon harvested in the subsistence fishery reared in the ocean for 3 years: age 1.3 (46.3%) and age 2.3 (33.9%) fish were the predominant age groups (Table 8). Most of the remaining sockeye salmon harvests had reared in the ocean for 2 years. Age composition did not differ significantly between males and females (P = 0.75). The male to female ratio was 1.38:1.0, which was not significantly different from 1.0 (P = 0.06). A statistically significant difference (P = 0.01) was found between the mean METF lengths of males (549 mm, SE = 5) and females (534 mm, SE = 3).

Age composition of sockeye salmon harvested in the subsistence fishery was significantly different ($P < 0.001$) from that of the Buskin Lake escapement. The biggest difference was found for ocean-age-2 sockeye salmon which comprised 36.5% of the Buskin Lake escapement and 13.2% of the subsistence harvest. The mean METF length of sockeye salmon harvested by subsistence fishers (543 mm, SE = 3) was significantly longer ($P < 0.001$) than that of the Buskin Lake escapement (502 mm, SE = 3).

Sport and Commercial Fisheries

In 2008, anglers fishing the Buskin River drainage caught an estimated 1,560 (SE = 563) sockeye salmon and harvested 1,160 (SE = 500) of these, expending 15,180 (SE = 1,993) angler-days of effort for all species during the entire year (Table 1).

Fish ticket harvest receipts available from CF indicate that no sockeye salmon were harvested adjacent to the Buskin River in Women's Bay, statistical area 259-22, during 2008.

Over 52.5% of sockeye salmon harvested by the sport fishery reared in the ocean for 3 years, and the predominant ages were 1.3 (25.8%) and 2.3 (26.7%) (Table 9).

YEAR 2009

Buskin River Weir

The Buskin River weir was installed on 22 May and operated continually through 30 September 2009. The cumulative count at the weir through 31 July was 7,502 sockeye salmon, and 50% of these passed the weir by 22 June (Appendix A1). The final weir count was 7,757 sockeye salmon when the weir was removed for the season on 30 September.

Age was determined for 307 of 334 sockeye salmon sampled (Table 10). Age-sex composition was significantly different ($P < 0.001$) among temporal strata (Appendix B3). No significant difference was found among strata for either age ($P = 0.08$) or sex ($P = 0.88$) composition, so pooled estimates were calculated.

Over 73% of the sockeye salmon sampled reared in the ocean for 3 years: age 1.3 (45.3%) and age 2.3 (28%) (Table 10). Most of the remaining sockeye salmon sampled (22.4%) reared in the ocean for 2 years. Age composition differed between males and females ($P < 0.001$). The male to female ratio was 1.16:1.0, which was not significantly different from 1.0 ($P = 0.14$). The mean METF length of males (540 mm, SE = 5) and females (511 mm, SE = 4) was significantly different ($P < 0.001$).

Lake Louise Weir

The Lake Louise weir was operated from 3 June to 1 September 2009. The cumulative count at the weir was 992 sockeye salmon, and over 50% of these passed the weir by 5 August (Appendix A2).

Age was determined for 96 of 182 sockeye salmon sampled (Table 11). No significant differences were found among strata for age-sex ($P = 0.60$), age ($P = 0.98$), or sex ($P = 0.24$) compositions (Appendix C3), so pooled estimates were calculated.

About 37.5% of the sockeye salmon harvested reared in the ocean for 3 years: age 1.3 (27.1%) and age 2.3 (10.4%); and 62.5% reared in the ocean for 2 years: age 1.2 (15.6%) and age 2.2 (46.9%) (Table 11). Age composition was significantly different between males and females

($P = 0.01$). The male to female ratio was 1.28:1.0, which was not significantly different from 1.0 ($P = 0.07$). A significant difference ($P < 0.001$) was found in the mean METF lengths of males (538 mm, SE = 4) and females (502 mm, SE = 5).

Age composition of Lake Louise sockeye salmon was significantly different ($P < 0.001$) from Buskin Lake sockeye salmon. Age-1.3 sockeye salmon comprised 45.3% of the Buskin Lake escapement, but only 27.1% of the Lake Louise escapement. There was no statistical difference ($P = 0.88$) between the mean METF lengths of Buskin Lake (527 mm, SE = 3) and Lake Louise (522 mm, SE = 3) sockeye salmon. Sex composition between these run components was also not significantly different ($P = 0.64$).

Subsistence Harvest

A complete estimate of the sockeye salmon subsistence harvest from the marine waters of the Buskin system was not yet available for 2009. The 2009 season was very similar to that of 2008 with respect to fishing effort and run size and the 2009 harvest is anticipated to equal the 2008 harvest. Age was determined for 96 of 112 sockeye salmon sampled from the 2009 harvest (Table 12). Only 96 scales were readable because of high re-absorption rates. No temporal comparison of age and sex compositions could be made because all samples came from one temporal strata due to a subsistence fishery closure.

About 82.3% of the sockeye salmon harvested reared in the ocean for 3 years: age 1.3 (63.7%) and age 2.3 (18.6%) (Table 12). Most of the remaining sockeye salmon harvested reared in the ocean for 2 years. Age composition was not significantly different between males and females ($P = 0.51$). The male to female ratio was 0.62:1.0, which was significantly different from 1.0 ($P = 0.01$). A significant difference ($P < 0.001$) was also found between the mean METF lengths of males (564 mm, SE = 6) and females (541 mm, SE = 3).

Age composition of sockeye salmon harvested in subsistence fishery was significantly different ($P < 0.001$) than that of the Buskin Lake escapement. The mean METF length of sockeye salmon harvested by subsistence fishers (550 mm, SE = 3) was also significantly different ($P < 0.001$) than that of Buskin Lake sockeye salmon (527 mm, SE = 3).

Sport and Commercial Fisheries

The 2009 harvest estimate of sockeye salmon from the Buskin River drainage was not yet available from the SWHS. The 2009 season was very similar to 2008 with respect to fishing effort and run size, and the 2009 harvest is anticipated to equal that in 2008.

Fish ticket harvest receipts available from CF indicate that no sockeye salmon were harvested near the Buskin River mouth in Women's Bay, statistical area 259-22, during 2009 (Table 1).

TOTAL RUN, EXPLOITATION RATES, AND BROOD TABLE

The estimated total sockeye salmon runs, incorporating subsistence harvest and escapement adjustments, were 30,314 in 2007, 9,979 in 2008, and 11,871 in 2009 (using anticipated 2009 subsistence and sport harvests) (Table 13). Ocean-age-3 sockeye salmon (ages 2.3 and 1.3) were consistently predominate in the runs, followed by ocean-age-2 fish (ages 2.2 and 1.2).

Annual subsistence fishery exploitation rates were 38.8% in 2007, 29.6% in 2008, and 24.9% (anticipated) in 2009, while annual sport and commercial fishery exploitation rates combined, were 5.0% in 2007, 11.6% in 2008, and 9.8% (anticipated) in 2009 (Table 14). Standard errors of total exploitation rates were low (about 2-5%) and were driven by variability in SWHS harvest estimates.

The brood table for Buskin River sockeye salmon, which was developed using all available Buskin Lake data through 2009, showed that the predominant age classes within most brood years were age 5 (52% of 1991-2003 year class mean) and age 6 (35% of 1991-2003 year class mean) sockeye salmon (Table 15). Lake Louise data are not included in exploitation rates or the construction of the brood table.

SUBSISTENCE USER SURVEY

The number of subsistence users who agreed to be interviewed diminished over time, with 103 interviewed in 2007 and 3 in 2009 (Table 16). Most of the subsistence fishermen interviewed on marine waters adjacent to the Buskin River were residents of Kodiak Island and listed the area as their traditional sockeye salmon subsistence fishing location. Approximately 50% of those interviewed indicated they also fished for sockeye salmon in other locations, with the two most popular locations being Pasagshak and Litnik.

STOCK RECRUIT MODEL ESTIMATION

Traditional Analysis

The traditional analysis using data from brood years 1990 through 2003 (Table 15), provided Ricker stock-recruitment function estimates of $\ln(\alpha) = 2.16$ (90% bootstrapped confidence intervals [BCI] of 1.63 to 2.75) and β of 0.00012 (90% BCI of 0.00008 to 0.00016) (Figure 4).

The estimated number of spawners (S_{MSY}) required for maximum sustained yield was about 6,650 sockeye salmon (90% BCI of 5,350 to 8,300). The estimated exploitation at maximum sustained yield was 0.77 (90% BCI of 0.65 to 0.85). The estimated spawning escapement at replacement (S_{EQ}) was 19,450 sockeye salmon (90% BCI of 17,350 to 22,300). The sustained yield probability calculations suggest that an escapement goal range of 5,000-8,000 sockeye salmon would provide a sustained yield that is 90% of MSY.

The Durbin Watson indicated there was no serial correlation among the residuals ($P > 0.05$). Plots of the residuals against brood year and of the autocorrelation and partial autocorrelation functions also showed little evidence of autocorrelation (Figures 5 and 6).

Bayesian Analysis

The median of the posterior distribution of S_{MSY} is 6,550 sockeye salmon (Figure 7). The value of S_{MSY} lies between 4,950 and 8,700 with 90% certainty.

The Bayesian analysis suggests there is probably some positive autocorrelation (ϕ), although the 80% interval extends into the negative (Table 17).

The spawner-recruit relationship determined by the median values of $\ln(\alpha)$ and beta from the Bayesian analysis was not much different than the estimate from the traditional Ricker model fit to the spawner-recruitment data (Figure 8).

DISCUSSION

The average timing of the Lake Louise sockeye salmon run has consistently been about 1½ months later than the Buskin Lake run (Figure 3). This raises an interesting question about whether this run is distinct from the Buskin Lake run and, consequently, warrants a separate management strategy and its own escapement goal. However, unless Lake Louise sockeye salmon arrive in the fishing district at the same time as Buskin Lake sockeye, but take longer to pass the Lake Louise weir, the long-held assumption that the subsistence fishery primarily targets Buskin Lake sockeye salmon appears to be correct. This is because the subsistence fishery is over long before the Lake Louise run begins to pass the weir. Anecdotal evidence of more net-marked fish at the Buskin River weir than at the Lake Louise weir also supports the view that few Lake Louise fish are harvested by the subsistence fishery.

In early 2008, the Gene Conservation Laboratory at ADF&G conducted analyses of Buskin Lake and Lake Louise sockeye salmon escapement samples collected in 2005. Genetic differences are distinct enough to hypothesize that these run components could constitute separate populations (C. Habicht, ADF&G Gene Conservation Laboratory, Anchorage, personal communication). The allele frequencies are very different between the two populations and the 100% simulations show that at least 99.8% of the mixtures allocate to the correct populations. In 2008 and 2009, sockeye salmon were sampled from the Buskin subsistence harvest to genetically apportion Buskin Lake and Lake Louise harvest components for more precise run reconstruction. Analysis of these samples is pending and dependent on additional funding for the stock assessment project. If we find that the subsistence fishery harvests the Lake Louise run to any significant measure, then the current spawner-recruitment analysis will have to be adjusted. The net result would be that the Buskin Lake stock would be less productive. However, current indications are that any effect of such an adjustment would be small.

Both the traditional regression and Bayesian spawner recruitment analyses estimate that S_{MSY} falls below the current escapement goal range of 8,000-13,000 sockeye salmon. Examination of the sustained yield plot in Figure 9 suggests a reduction in the upper and lower bounds of the escapement goal may be warranted, and that a SEG range of 5,000-8,000 would ensure sustained yield is within 90% of MSY with 90% probability.

This stock assessment project will continue through at least 2013, and spawner-recruit analyses will continue as data from these years are collected.

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TABLES

Table 1.-Total weir counts and sources of harvest for Buskin River drainage sockeye salmon, 2000-2009.

Year	Commercial Harvest[a]	Subsistence Harvest[b]	Weir Count[c]		Estimated Sportfishing Effort[d]		
			Buskin Lake	Louise Lake	Harvest	Catch	Angler-days[e]
2000	0	7,315	11,233	ND	2,041	3,322	21,002
2001	0	10,260	20,556	ND	827	1,488	9,539
2002	0	13,366	17,174	3,541	2,204	3,794	18,450
2003	6	10,651	23,870	4,488	3,017	3,906	14,311
2004	1,098	9,421	22,023	2,086	1,379	3,620	17,549
2005	0	8,239	15,468	2,028	1,540	2,851	17,575
2006	6	7,577	17,734	4,586	1,577	2,642	19,875
2007	30	11,151	16,502	1,676	1,509	3,143	17,124
2008	0	2,664	5,900	833	1,160	1,560	15,180
2009	0	NA[f]	7,757	992	NA	NA	NA
Average	114	8,960	15,822	2,529	1,695	2,806	16,254

[a] Source: ADF&G, Division of Commercial Fisheries (CF), fish ticket database system. Includes all sockeye salmon harvested annually at the mouth of Buskin River in Women's Bay, statistical area 259-22.

[b] Source: Subsistence harvest records maintained by CF Westward Region; includes all reported harvest in Buskin River.

[c] Sources: Caldentey 2007, Caldentey 2009.

[d] Sources: Jennings et al. 2007, 2009a, 2009b, 2010a, 2010b; Jennings et al. 2004, 2006a; Jennings et al. 2006b; Walker et al. 2003.

[e] Units are angler-days. Includes effort directed toward other species.

[f] NA = not available.

Table 2.-Age and sex composition estimates and mean METF length (mm) at age of the sockeye salmon escapement, Buskin River weir, 2007.

	Age											
Run Component[a,b]	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total[c]
Buskin Lake Escapement												
Females												
Number sampled	0	0	0	5	0	111	3	2	21	0	0	156
Percent	0.0	0.0	0.0	1.5	0.0	34.4	0.9	0.6	6.5	0.0	0.0	43.6
SE Percent	0.0	0.0	0.0	0.7	0.0	2.6	0.5	0.4	1.4	0.0	0.0	2.6
Total Escapement[d]	0	0	0	263	0	5,846	158	105	1,106	0	0	7,413
SE Return	0	0	0	116	0	446	90	74	232	0	0	442
Mean Length	0	0	0	449	0	534	515	502	532	0	0	529
SE Mean Length	0	0	0	22	0	2	33	8	4	0	0	2
Minimum Length	0	0	0	397	0	468	464	494	496	0	0	397
Maximum Length	0	0	0	515	0	587	577	509	574	0	0	587
Males												
Number sampled	0	0	0	9	0	145	1	3	23	0	0	202
Percent	0.0	0.0	0.0	2.8	0.0	44.9	0.3	0.9	7.1	0.0	0.0	56.4
SE Percent	0.0	0.0	0.0	0.9	0.0	2.7	0.3	0.5	1.4	0.0	0.0	2.6
Total Escapement[d]	0	0	0	474	0	7,637	53	158	1,211	0	0	9,599
SE Return	0	0	0	155	0	467	52	90	241	0	0	442
Mean Length	0	0	0	519	0	568	364	577	566	0	0	564
SE Mean Length	0	0	0	19	0	2		17	4	0	0	2
Minimum Length	0	0	0	396	0	490	364	543	517	0	0	364
Maximum Length	0	0	0	573	0	612	364	596	612	0	0	621
All												
Number sampled	0	0	0	14	0	256	4	5	45	0	0	359
Percent	0.0	0.0	0.0	4.3	0.0	79.0	1.2	1.5	13.9	0.0	0.0	
SE Percent	0.0	0.0	0.0	1.1	0.0	2.2	0.6	0.7	1.9	0.0	0.0	
Total Escapement[d]	0	0	0	735	0	13,442	210	263	2,363	0	0	17,012
SE Return	0	0	0	191	0	382	104	116	324	0	0	
Mean Length	0	0	0	494	0	533	477	547	550	0	0	549
SE Mean Length	0	0	0	17	0	2	44	21	4	0	0	2
Minimum Length	0	0	0	396	0	468	364	494	496	0	0	364
Maximum Length	0	0	0	573	0	612	577	596	612	0	0	621

[a] All estimates are from unweighted analysis.

[b] Total female mean METF length includes 14 fish for which age was not estimated; total male mean METF length includes 21 fish for which age was not estimated; total sockeye mean METF length includes 35 fish for which age was not estimated.

[c] Sex/age components do not necessarily sum to sex pooled-over-age or age pooled-over-sex because of missing sex-for-age data and missing age-for-sex data.

[d] Assumed 3% loss due to uncounted fish before, after, and during weir operation.

Table 3.-Age and sex composition estimates and mean METF length (mm) at age of the sockeye salmon escapement at Lake Louise weir, 2007.

	Age											
Run Component[a,b]	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total[c]
Lake Louise Escapement												
Females												
Number sampled	0	0	0	15	0	73	10	0	13	0	0	121
Percent	0.0	0.0	0.0	8.6	0.0	34.7	6.3	0.0	4.7	0.0	0.0	52.1
SE Percent	0.0	0.0	0.0	2.3	0.0	3.9	2.1	0.0	1.7	0.0	0.0	3.7
Inriver Return	0	0	0	145	0	582	105	0	79	0	0	874
SE Return	0	0	0	39	0	66	36	0	28	0	0	62
Mean Length	0	0	0	466	0	517	454	0	499	0	0	503
SE Mean Length	0	0	0	7	0	4	12	0	10	0	0	4
Minimum Length	0	0	0	421	0	430	385	0	428	0	0	385
Maximum Length	0	0	0	517	0	580	540	0	555	0	0	590
Males												
Number sampled	0	7	0	22	7	68	10	3	1	0	0	130
Percent	0.0	3.1	0.0	9.1	3.7	24.5	4.4	0.5	0.3	0.0	0.0	47.9
SE Percent	0.0	1.3	0.0	2.3	1.6	3.4	1.7	0.3	0.3	0.0	0.0	3.7
Inriver Return	0	51	0	153	62	411	74	8	5	0	0	802
SE Return	0	22	0	38	27	57	28	5	5	0	0	62
Mean Length	0	346	0	469	348	545	459	551	516	0	0	505
SE Mean Length	0	11	0	17	11	4	16	13		0	0	7
Minimum Length	0	304	0	324	300	436	368	527	516	0	0	300
Maximum Length	0	377	0	562	387	628	506	572	516	0	0	647
All												
Number sampled	0	7	0	37	7	141	20	3	14	0	0	251
Percent	0.0	3.1	0.0	16.2	3.1	61.6	8.7	1.3	6.1	0.0	0.0	
SE Percent	0.0	1.1	0.0	2.3	1.1	3.0	1.7	0.7	1.5	0.0	0.0	
Inriver Return	0	51	0	271	51	1,032	146	22	102	0	0	1,676
SE Return	0	18	0	38	18	50	29	12	25	0	0	
Mean Length	0	346	0	468	348	531	456	551	500	0	0	504
SE Mean Length	0	11	0	11	11	3	10	13	10	0	0	4
Minimum Length	0	304	0	324	300	430	368	527	428	0	0	300
Maximum Length	0	377	0	562	387	628	540	572	555	0	0	647

[a] Estimates for age and age by sex are from weighted analysis with sex from unweighted analysis.

[b] Total female mean METF length includes 10 fish for which age was not estimated; total male mean METF length includes 12 fish for which age was not estimated; total sockeye mean METF length includes 22 fish for which age was not estimated.

[c] Sex/age components do not necessarily sum to sex pooled-over-age or age pooled-over-sex because of missing sex-for-age data and missing age-for-sex data.

Table 4.-Age and sex composition estimates and mean METF length (mm) at age of the reported sockeye salmon subsistence harvest, Buskin River drainage, 2007.

	Age											
Run Component[a,b]	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total[c]
Subsistence												
Females												
Number sampled	0	0	0	0	0	95	2	0	12	0	2	123
Percent	0.0	0.0	0.0	0.0	0.0	41.9	0.9	0.0	5.3	0.0	0.9	49.4
SE Percent	0.0	0.0	0.0	0.0	0.0	3.2	0.6	0.0	1.5	0.0	0.6	3.1
Total Harvest[d]	0	0	0	0	0	4,923	104	0	622	0	104	5,810
SE Return	0	0	0	0	0	382	72	0	173	0	72	369
Mean Length	0	0	0	0	0	544	503	0	538	0	538	542
SE Mean Length	0	0	0	0	0	2	3	0	6	0	17	2
Minimum Length	0	0	0	0	0	478	500	0	506	0	521	478
Maximum Length	0	0	0	0	0	595	505	0	578	0	555	595
Males												
Number sampled	0	0	0	0	0	101	0	2	13	0	0	126
Percent	0.0	0.0	0.0	0.0	0.0	44.5	0.0	0.9	5.7	0.0	0.0	50.6
SE Percent	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.6	1.5	0.0	0.0	3.1
Total Harvest[d]	0	0	0	0	0	5,233	0	104	674	0	0	5,952
SE Return	0	0	0	0	0	385	0	72	180	0	0	369
Mean Length	0	0	0	0	0	572	0	578	590	0	0	572
SE Mean Length	0	0	0	0	0	2	0	4	8	0	0	2
Minimum Length	0	0	0	0	0	513	0	574	550	0	0	490
Maximum Length	0	0	0	0	0	615	0	582	645	0	0	645
All												
Number sampled	0	0	0	0	0	196	2	2	25	0	2	249
Percent	0.0	0.0	0.0	0.0	0.0	86.3	0.9	0.9	11.0	0.0	0.9	
SE Percent	0.0	0.0	0.0	0.0	0.0	2.3	0.6	0.6	2.1	0.0	0.6	
Total Harvest[d]	0	0	0	0	0	10,156	104	104	1,295	0	104	11,762
SE Return	0	0	0	0	0	266	72	72	243	0	72	
Mean Length	0	0	0	0	0	559	503	578	565	0	538	558
SE Mean Length	0	0	0	0	0	2	3	4	7	0	17	2
Minimum Length	0	0	0	0	0	478	500	574	506	0	521	478
Maximum Length	0	0	0	0	0	615	505	582	645	0	555	645

[a] Estimates are from unweighted analysis.

[b] Total female mean METF length includes 12 fish for which age was not estimated; total male mean METF length includes 10 fish for which age was not estimated; total sockeye mean METF length includes 22 fish for which age was not estimated.

[c] Sex/age components do not necessarily sum to sex pooled-over-age or age pooled-over-sex because of missing sex-for-age data and missing age-for-sex data.

[d] Subsistence harvest estimates adjusted for unreturned permits.

Table 5.-Age and sex composition estimates and mean METF length (mm) at age of the sockeye salmon sport and commercial harvests combined, Buskin River drainage, 2007.

	Age											
Run Component[a]	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total[b]
Sport + Commerical Harvest												
Females												
Percent	0.0	0.0	0.0	1.5	0.0	34.4	0.9	0.6	6.5	0.0	0.0	43.6
SE Percent	0.0	0.0	0.0	0.7	0.0	2.6	0.5	0.4	1.4	0.0	0.0	2.6
Harvest	0	0	0	24	0	529	14	10	100	0	0	671
SE Return	0	0	0	13	0	197	9	7	42	0	0	249
Males												
Percent	0.0	0.0	0.0	2.8	0.0	44.9	0.3	0.9	7.1	0.0	0.0	56.4
SE Percent	0.0	0.0	0.0	0.9	0.0	2.7	0.3	0.5	1.4	0.0	0.0	2.6
Harvest	0	0	0	43	0	691	5	14	110	0	0	868
SE Return	0	0	0	20	0	256	5	9	45	0	0	320
All												
Percent	0.0	0.0	0.0	4.3	0.0	79.0	1.2	1.5	13.9	0.0	0.0	
SE Percent	0.0	0.0	0.0	1.1	0.0	2.2	0.6	0.7	1.9	0.0	0.0	
Harvest	0	0	0	67	0	1,216	19	24	214	0	0	1,539
SE Return	0	0	0	29	0	447	11	13	84	0	0	

[a] Estimates from age/sex proportions of Buskin River escapement.

[b] Sex/age components do not necessarily sum to sex pooled-over-age or age pooled-over-sex because of missing sex for-age-data and missing age-for-sex data.

Table 6.-Age and sex composition estimates and mean METF length (mm) at age of the sockeye salmon escapement, Buskin River weir, 2008.

	Age											
Run Component[a, b]	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total[c]
Buskin Lake Escapement												
Females												
Number sampled	0	0	2	31	1	54	21	5	53	0	5	189
Percent	0.0	0.0	0.6	9.9	0.4	14.4	6.3	1.2	14.4	0.0	1.2	50.7
SE Percent	0.0	0.0	0.4	1.7	0.4	1.9	1.3	0.6	1.9	0.0	0.6	2.5
Total Escapement[d]	0	0	37	600	24	878	385	71	879	0	71	3,082
SE Return	0	0	25	101	22	114	81	34	116	0	34	153
Mean Length	0	0	507	447	458	522	459	536	514	0	525	499
SE Mean Length	0	0	53	5		3	7	14	4	0	8	3
Minimum Length	0	0	454	376	458	478	409	497	445	0	505	376
Maximum Length	0	0	560	488	458	598	528	582	462	0	551	598
Males												
Number sampled	2	1	0	61	1	38	15	8	41	0	5	184
Percent	0.8	0.3	0.0	15.5	0.3	11.3	3.9	2.8	12.2	0.0	1.4	49.3
SE Percent	0.5	0.3	0.0	1.9	0.3	1.7	1.1	1.0	1.8	0.0	0.7	2.5
Total Escapement[d]	47	18	0	945	18	690	239	168	744	0	87	3,000
SE Return	31	18	0	113	18	105	64	58	110	0	41	153
Mean Length	409	269	0	447	290	555	473	561	549	0	568	506
SE Mean Length	11		0	6		7	14	7	4	0	11	5
Minimum Length	398	269	0	380	290	401	379	523	497	0	541	269
Maximum Length	419	269	0	595	290	601	548	588	590	0	598	611
All												
Number sampled	2	1	2	92	2	92	36	13	94	0	10	373
Percent	0.8	0.3	0.6	25.4	0.7	25.8	10.3	3.9	26.7	0.0	2.6	
SE Percent	0.5	0.3	0.4	2.3	0.5	2.3	1.7	1.1	2.5	0.0	0.9	
Total Escapement[d]	47	18	37	1,545	42	1,568	624	239	1,623	0	157	6,082
SE Return	32	18	25	142	29	140	103	68	151	0	54	
Mean Length	409	269	507	447	374	536	465	551	529	0	547	502
SE Mean Length	11		53	4	84	4	7	8	3	0	10	3
Minimum Length	398	269	454	376	290	401	379	497	445	0	505	269
Maximum Length	419	269	560	595	458	611	548	588	590	0	598	611

[a] Age/age by sex estimates are from unweighted analysis with sex from weighted analysis.

[b] Total female mean METF length includes 17 fish for which age was not estimated; total male mean METF length includes 12 fish for which age was not estimated; total sockeye salmon mean METF length includes 29 fish for which age was not estimated.

[c] Sex/age components do not necessarily sum to sex pooled-over-age or age pooled-over-sex because of missing sex-for-age data and missing age-for-sex data.

[d] Assumed 3% loss due to uncounted fish before, after, and during weir operation.

Table 7.-Age sex composition estimates and mean METF length (mm) at age of the sockeye salmon escapement at Lake Louise weir, 2008.

Run Component[a, b]	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total[c]
	Age											
Lake Louise Escapement												
Females												
Number sampled	0	0	0	15	0	8	6	0	2	0	0	73
Percent	0.0	0.0	0.0	37.1	0.0	22.9	9.7	0.0	0.4	0.0	0.0	49.5
SE Percent	0.0	0.0	0.0	9.9	0.0	8.7	6.1	0.0	0.2	0.0	0.0	4.0
Inriver Return	0	0	0	309	0	191	81	0	3	0	0	413
SE Return	0	0	0	82	0	73	50	0	1	0	0	33
Mean Length	0	0	0	464	0	501	440	0	550	0	0	485
SE Mean Length	0	0	0	6	0	8	29	0	15	0	0	5
Minimum Length	0	0	0	426	0	472	305	0	535	0	0	305
Maximum Length	0	0	0	526	0	532	502	0	564	0	0	565
Males												
Number sampled	0	0	0	17	3	8	14	0	2	0	0	96
Percent	0.0	0.0	0.0	11.9	9.1	5.8	2.8	0.0	0.4	0.0	0.0	50.5
SE Percent	0.0	0.0	0.0	6.1	6.1	4.4	0.4	0.0	0.2	0.0	0.0	4.0
Inriver Return	0	0	0	99	76	49	23	0	3	0	0	420
SE Return	0	0	0	51	50	37	3	0	1	0	0	33
Mean Length	0	0	0	471	343	547	511	0	514	0	0	492
SE Mean Length	0	0	0	16	10	8	8	0	12	0	0	6
Minimum Length	0	0	0	323	323	524	468	0	529	0	0	287
Maximum Length	0	0	0	588	356	583	550	0	553	0	0	607
All												
Number sampled	0	0	0	32	3	16	20	0	4	0	0	169
Percent	0.0	0.0	0.0	42.7	4.0	21.3	26.7	0.0	5.3	0.0	0.0	
SE Percent	0.0	0.0	0.0	5.5	2.2	4.5	4.9	0.0	2.5	0.0	0.0	
Inriver Return	0	0	0	355	33	178	222	0	44	0	0	833
SE Return	0	0	0	46	18	38	41	0	21	0	0	
Mean Length	0	0	0	468	343	524	490	0	545	0	0	489
SE Mean Length	0	0	0	9	10	8	12	0	8	0	0	4
Minimum Length	0	0	0	323	323	472	305	0	529	0	0	287
Maximum Length	0	0	0	588	356	583	550	0	564	0	0	607

[a] Age/age by sex estimates are from unweighted analysis with sex from weighted analysis.

[b] Total female mean METF length includes 42 fish for which age was not estimated; total male mean METF length includes 51 fish for which age was not estimated; total sockeye salmon mean METF length includes 93 fish for which age was not estimated.

[c] Sex/age components do not necessarily sum to sex pooled-over-age or age pooled-over-sex because of missing sex-for-age data and missing age-for-sex data.

Table 8.-Age and sex composition estimates and mean METF length (mm) at age of the reported sockeye salmon subsistence harvest, Buskin River drainage, 2008.

	Age											
Run Component[a, b]	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total[c]
Subsistence												
Females												
Number sampled	0	0	0	2	0	25	1	2	17	0	1	56
Percent	0.0	0.0	0.0	1.7	0.0	20.7	0.8	1.7	14.0	0.0	0.8	42.1
SE Percent	0.0	0.0	0.0	1.1	0.0	3.6	0.8	1.1	3.1	0.0	0.8	4.2
Total Harvest[d]	0	0	0	49	0	610	24	49	415	0	24	1,244
SE Return	0	0	0	34	0	107	24	34	92	0	24	124
Mean Length	0	0	0	512	0	532	479	577	538	0	534	534
SE Mean Length	0	0	0	16	0	5		35	5	0		3
Minimum Length	0	0	0	496	0	495	479	542	510	0	534	479
Maximum Length	0	0	0	528	0	578	479	612	580	0	534	612
Males												
Number sampled	0	0	0	10	0	31	3	4	24	0	1	77
Percent	0.0	0.0	0.0	8.3	0.0	25.6	2.5	3.3	19.8	0.0	0.8	57.9
SE Percent	0.0	0.0	0.0	2.5	0.0	3.9	1.4	1.6	3.6	0.0	0.8	4.2
Total Harvest[d]	0	0	0	244	0	757	73	98	586	0	24	1,710
SE Return	0	0	0	73	0	115	41	47	105	0	24	124
Mean Length	0	0	0	494	0	561	475	576	560	0	583	549
SE Mean Length	0	0	0	10	0	5	17	14	6	0		5
Minimum Length	0	0	0	435	0	495	440	535	508	0	583	435
Maximum Length	0	0	0	537	0	667	496	598	620	0	583	667
All												
Number sampled	0	0	0	12	0	56	4	6	41	0	2	133
Percent	0.0	0.0	0.0	9.9	0.0	46.3	3.3	5.0	33.9	0.0	1.7	
SE Percent	0.0	0.0	0.0	2.7	0.0	4.5	1.6	1.9	4.2	0.0	1.1	
Total Harvest[d]	0	0	0	293	0	1,367	98	146	1,001	0	49	2,954
SE Return	0	0	0	79	0	132	47	57	125	0	34	
Mean Length	0	0	0	497	0	548	476	576	551	0	559	543
SE Mean Length	0	0	0	8	0	4	12	13	4	0	25	3
Minimum Length	0	0	0	435	0	495	440	535	508	0	534	435
Maximum Length	0	0	0	537	0	667	496	612	620	0	583	667

a Estimates are from unweighted analysis.

b Total female mean METF length includes 8 fish for which age was not estimated; total male mean METF length includes four fish for which age was not estimated; total sockeye salmon mean METF length includes 12 fish for which age was not estimated.

c Sex/age components do not necessarily sum to sex pooled-over-age or age pooled-over-sex because of missing sex-for-age data and missing age-for-sex data.

d Subsistence harvest estimates are adjusted for unreturned permits.

Table 9.-Age and sex composition estimates and mean METF length (mm) at age of the sockeye salmon sport and commercial harvests combined, Buskin River drainage, 2008.

	Age											
Run Component[a]	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total[b]
Sport and Commerical Harvest												
Females												
Percent	0.0	0.0	0.6	9.9	0.4	14.4	6.3	1.2	14.4	0.0	1.2	50.7
SE Percent	0.0	0.0	0.4	1.7	0.4	1.9	1.3	0.6	1.9	0.0	0.6	2.5
Harvest	0	0	7	114	4	167	73	13	168	0	13	588
SE Return	0	0	5	52	4	75	35	8	75	0	8	255
Males												
Percent	0.8	0.3	0.0	15.5	0.3	11.3	3.9	2.8	12.2	0.0	1.4	49.3
SE Percent	0.5	0.3	0.0	1.9	0.3	1.7	1.1	1.0	1.8	0.0	0.7	2.5
Harvest	9	4	0	180	4	132	46	32	142	0	17	572
SE Return	7	3	0	80	3	59	22	17	64	0	10	248
All												
Percent	0.8	0.3	0.6	25.4	0.7	25.8	10.3	3.9	26.7	0.0	2.6	
SE Percent	0.5	0.3	0.4	2.3	0.5	2.3	1.7	1.1	2.5	0.0	0.9	
Harvest	9	4	7	295	8	299	119	46	309	0	30	1,160
SE Return	7	3	5	109	6	111	47	20	115	0	14	

[a] Estimates from age/sex proportions of Buskin River escapement.

[b] Sex/age components do not necessarily sum to sex pooled-over-age or age pooled-over-sex because of missing sex-for-age data and missing age-for-sex data.

Table 10.-Age and sex composition estimates and mean METF length (mm) at age of the sockeye salmon escapement, Buskin River weir, 2009.

	Age											
Run Component[a, b]	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total[c]
Buskin Lake Escapement												
Females												
Number sampled	0	0	0	7	5	68	23	0	39	0	0	154
Percent	0.0	0.0	0.0	2.3	2.3	20.2	7.7	0.0	13.2	0.0	0.0	46.1
SE Percent	0.0	0.0	0.0	1.0	1.1	2.5	1.7	0.0	2.2	0.0	0.0	2.7
Total Escapement[d]	0	0	0	185	188	1,612	614	0	1,055	0	128	3,687
SE Return	0	0	0	78	86	199	138	0	175	0	63	214
Mean Length	0	0	0	482	324	529	485	0	516	0	0	511
SE Mean Length	0	0	0	18	8	3	9	0	5	0	0	4
inimum Length	0	0	0	412	296	455	394	0	426	0	0	296
Maximum Length	0	0	0	563	341	562	563	0	561	0	0	563
Males												
Number sampled	0	1	1	14	4	71	25	1	47	0	1	180
Percent	0.0	0.5	0.2	3.9	2.2	20.0	8.8	0.2	14.9	0.0	0.5	53.9
SE Percent	0.0	0.5	0.2	1.2	1.1	2.4	1.9	0.2	2.3	0.0	0.5	2.7
Total Escapement[d]	0	43	15	315	174	1,600	704	13	1,195	0	43	4,310
SE Return	0	42	14	93	85	191	149	13	181	0	42	214
Mean Length	0	322	568	465	335	571	486	593	562	0	599	540
SE Mean Length	0			15	13	3	13		4	0		5
Minimum Length	0	322	568	399	308	425	331	593	488	0	599	308
Maximum Length	0	322	568	592	361	614	587	593	614	0	599	630
All												
Number sampled	0	1	1	21	139	1	9	48	86	0	1	334
Percent	0.0	0.3	0.3	6.8	2.9	45.3	15.6	0.3	28.0	0.0	0.3	
SE Percent	0.0	0.3	0.3	1.4	0.9	2.8	2.0	0.3	2.5	0.0	0.3	
Total Escapement[d]	0	26	26	547	234	3,621	1,250	26	2,240	0	26	7,997
SE Return	0	26	26	113	76	223	163	26	201	0	26	
Mean Length	0	322	568	471	329	550	485	593	543	0	599	527
SE Mean Length	0			12	7	3	8		4	0		3
Minimum Length	0	322	568	399	296	425	331	593	426	0	599	296
Maximum Length	0	322	568	592	361	614	587	593	614	0	599	630

[a] Age by sex and sex estimates are from unweighted analysis with age from weighted analysis.

[b] Total female mean METF length includes 12 fish for which age was not estimated; total male mean METF length includes 15 fish for which age was not estimated; total sockeye salmon mean METF length includes 27 fish for which age was not estimated.

[c] Sex/age components do not necessarily sum to sex pooled-over-age or age pooled-over-sex because of missing sex-for-age data and missing age-for-sex data.

[d] Assumed 3% loss due to uncounted fish before, after, and during weir operation.

Table 11.-Age and sex composition estimates and mean METF length (mm) at age of the sockeye salmon escapement at Lake Louise weir, 2009.

	Age											
Run Component[a, b]	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total[c]
Lake Louise Escapement												
Females												
Number sampled	0	0	0	8	0	12	27	0	2	0	0	80
Percent	0.0	0.0	0.0	8.3	0.0	12.5	28.1	0.0	2.1	0.0	0.0	44.0
SE Percent	0.0	0.0	0.0	2.7	0.0	3.2	4.4	0.0	1.4	0.0	0.0	3.3
Inriver Return	0	0	0	83	0	124	279	0	21	0	0	436
SE Return	0	0	0	27	0	32	43	0	14	0	0	33
Mean Length	0	0	0	490	0	537	477	0	558	0	0	502
SE Mean Length	0	0	0	15	0	6	7	0	2	0	0	5
Minimum Length	0	0	0	442	0	512	410	0	556	0	0	410
Maximum Length	0	0	0	547	0	567	556	0	560	0	0	584
Males												
Number sampled	0	0	0	7	0	14	18	0	8	0	0	102
Percent	0.0	0.0	0.0	7.3	0.0	14.6	18.8	0.0	8.3	0.0	0.0	56.0
SE Percent	0.0	0.0	0.0	2.5	0.0	3.4	3.8	0.0	2.7	0.0	0.0	3.3
Inriver Return	0	0	0	72	0	145	186	0	83	0	0	556
SE Return	0	0	0	25	0	34	38	0	27	0	0	33
Mean Length	0	0	0	497	0	545	508	0	557	0	0	538
SE Mean Length	0	0	0	18	0	9	8	0	9	0	0	4
Minimum Length	0	0	0	448	0	504	442	0	508	0	0	416
Maximum Length	0	0	0	569	0	610	576	0	587	0	0	620
All												
Number sampled	0	0	0	15	0	26	45	0	10	0	0	182
Percent	0.0	0.0	0.0	15.6	0.0	27.1	46.9	0.0	10.4	0.0	0.0	
SE Percent	0.0	0.0	0.0	3.5	0.0	4.3	4.9	0.0	3.0	0.0	0.0	
Inriver Return	0	0	0	155	0	269	465	0	103	0	0	992
SE Return	0	0	0	35	0	43	48	0	30	0	0	
Mean Length	0	0	0	493	0	541	487	0	557	0	0	522
SE Mean Length	0	0	0	11	0	5	5	0	7	0	0	3
Minimum Length	0	0	0	442	0	504	410	0	508	0	0	410
Maximum Length	0	0	0	569	0	610	576	0	587	0	0	620

[a] Age/age by sex are from weighted analysis with sex from unweighted analysis.

[b] Total female mean METF length includes 31 fish for which age was not estimated; total male mean METF length includes 55 fish for which age was not estimated; total sockeye salmon mean METF length includes 86 fish for which age was not estimated.

[c] Sex/age components do not necessarily sum to sex pooled-over-age or age pooled-over-sex because of missing sex-for-age data and missing age-for-sex data.

Table 12.-Age and sex composition estimates and mean METF length (mm) at age of the reported sockeye salmon subsistence harvest, Buskin River drainage, 2009.

	Age											
Run Component[a, b]	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total[c]
Subsistence												
Females												
Number sampled	0	0	1	1	0	39	8	1	13	0	0	69
Percent	0.0	0.0	1.0	1.0	0.0	38.2	7.8	1.0	12.7	0.0	0.0	61.6
SE Percent	0.0	0.0	1.0	1.0	0.0	4.8	2.6	1.0	3.3	0.0	0.0	4.5
Total Harvest[d]	0	0	29	29	0	1,129	232	29	376	0	0	1,820
SE Return	0	0	28	28	0	140	78	28	96	0	0	134
Mean Length	0	0	541	550	0	548	516	559	539	0	0	541
SE Mean Length	0	0			0	3	8		5	0	0	3
Minimum Length	0	0	541	550	0	506	475	559	507	0	0	475
Maximum Length	0	0	541	550	0	600	542	559	568	0	0	600
Males												
Number sampled	0	0	0	2	0	26	5	0	6	0	0	43
Percent	0.0	0.0	0.0	2.0	0.0	25.5	4.9	0.0	5.9	0.0	0.0	38.4
SE Percent	0.0	0.0	0.0	1.4	0.0	4.3	2.1	0.0	2.3	0.0	0.0	4.5
Total Harvest[d]	0	0	0	58	0	753	145	0	174	0	0	1,134
SE Return	0	0	0	40	0	126	62	0	68	0	0	134
Mean Length	0	0	0	510	0	580	504	0	572	0	0	564
SE Mean Length	0	0	0	34	0	5	16	0	17	0	0	6
Minimum Length	0	0	0	476	0	532	470	0	516	0	0	470
Maximum Length	0	0	0	544	0	628	560	0	630	0	0	630
All												
Number sampled	0	0	1	3	0	65	13	1	19	0	0	112
Percent	0.0	0.0	1.0	2.9	0.0	63.7	12.7	1.0	18.6	0.0	0.0	
SE Percent	0.0	0.0	1.0	1.7	0.0	4.7	3.3	1.0	3.8	0.0	0.0	
Total Harvest[d]	0	0	29	87	0	1,882	376	29	550	0	0	2,954
SE Return	0	0	28	49	0	139	96	28	112	0	0	
Mean Length	0	0	541	523	0	561	511	559	549	0	0	550
SE Mean Length	0	0		24	0	3	8		7	0	0	3
Minimum Length	0	0	541	476	0	506	470	559	507	0	0	470
Maximum Length	0	0	541	550	0	628	560	559	630	0	0	630

[a] Estimates are from unweighted analysis.

[b] Total female mean METF length includes 6 fish for which age was not estimated; total male mean METF length includes 4 fish for which age was not estimated; total sockeye salmon mean METF length includes 10 fish for which age was not estimated.

[c] Sex/age components do not necessarily sum to sex pooled-over-age or age pooled-over-sex because of missing sex-for-age data and missing age-for-sex data.

[d] Subsistence harvest estimates anticipated from 2008 data.

Table 13.-Estimated total run of sockeye salmon to Buskin Lake by age class, 2007-2009.

Year		Age Class											Total
		0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	
2007	Number	0	0	0	802	0	24,814	333	390	3,872	0	104	30,314
	SE	0	0	0	193	0	645	127	137	413	0	72	
2008	Number	56	22	44	2,133	50	3,234	840	431	2,933	0	236	9,979
	SE	0	0	0	0	0	0	0	0	0	0	0	
2009[a]	Number	0	50	46	662	416	5,575	1,892	44	3,136	0	50	11,871
	SE	0	43	32	134	121	330	229	31	285	0	43	

[a] Includes anticipated 2009 subsistence and sport harvest estimates from 2008 data.

Table 14.-Estimated exploitation rates (%) of sockeye salmon migrating to Buskin Lake by fishery, 2007-2009.

Year	Subsistence Fishery	Sport /CF Fishery	Total
2007	38.8	5.0	43.8
SE	0.72	1.9	2.0
2008	29.6	11.6	41.2
SE	1.5	5.0	5.3
2009	24.9	9.8	34.7
SE	1.05	4.23	4.36

Note: Anticipated 2009 subsistence and sport harvest estimates from 2008 data.

Table 15.-Brood table for sockeye salmon migrating to Buskin Lake, 1990–2006 brood years.

		Age / Return Yr / Proportion					
Brood Year	Esc	Age 3 (0.2, 1.1)	Age 4 (0.3, 1.2, 2.1)	Age 5 (1.3, 2.2)	Age 6 (1.4, 2.3, 3.2)	Age 7 (2.4, 3.3)	Total Return
		1992	1993	1994	1995	1996	
1990	10,854	12	2,532	11,657	8,585	203	22,990
		0.00	0.11	0.51	0.37	0.01	1.00
		1993	1994	1995	1996	1997	
1991	10,092	181	2,460	8,484	11,961	467	23,553
		0.01	0.10	0.36	0.51	0.02	1.00
		1994	1995	1996	1997	1998	
1992	10,085	20	609	3,588	5,719	157	10,092
		0.00	0.06	0.36	0.57	0.02	1.00
		1995	1996	1997	1998	1999[a]	
1993	9,821	12	2,812	17,219	10,752	50	30,844
		0.00	0.09	0.56	0.35	0.00	1.00
		1996	1997	1998	1999[a]	2000	
1994	13,553	0	1,583	9,558	7,147	207	18,496
		0.00	0.09	0.52	0.39	0.01	1.00
		1997	1998	1999[a]	2000	2001	
1995	16,000	91	2,318	11,292	6,830	0	20,531
		0.00	0.11	0.55	0.33	0.00	1.00
		1998	1999[a]	2000	2001	2002	
1996	10,595	66	2,531	23,937	12,279	267	39,080
		0.00	0.06	0.61	0.31	0.01	1.00
		1999[a]	2000	2001	2002	2003	
1997	10,144	0	1,849	17,693	9,735	334	29,611
		0.00	0.06	0.60	0.33	0.01	1.00
		2000	2001	2002	2003	2004	
1998	15,224	20	3,473	20,124	12,908	78	36,602
		0.00	0.09	0.55	0.35	0.00	1.00
		2001	2002	2003	2004	2005	
1999	11,146	116	7,817	18,817	11,163	161	38,073
		0.00	0.21	0.49	0.29	0.00	1.00
		2002	2003	2004	2005	2006	
2000	11,580	239	3,074	12,886	10,922	104	27,225
		0.01	0.11	0.47	0.40	0.00	1.00
		2003	2004	2005	2006	2007	
2001	21,192	0	2,172	8,496	4,262	236	15,167
		0.00	0.14	0.56	0.28	0.02	1.00
		2004	2005	2006	2007	2008	
2002	17,705	351	8,713	25,146	3,364	50	37,624
		0.01	0.23	0.67	0.09	0.00	1.00
		2005	2006	2007	2008	2009[b]	
2003	24,608	0	802	4,074	3,181	74	8,130
		0.00	0.10	0.50	0.39	0.01	1.00
		2006	2007	2008	2009[b]	2010	
2004	22,704	0	2,227	7,467			9,693
		0.00	0.23	0.77	0.00	0.00	1.00
		2007	2008	2009[b]	2010	2011	
2005	15,946	78	1,124				1,202
		0.06	0.94	0	0	0	1.00
		2008	2009[b]	2010	2011	2012	
2006	18,282	50					50
		1	0	0	0	0	1.00
		2009[b]	2010	2011	2012	2013	

Note: All highlighted entries in this table are substituted (imputed) values. Escapement using 3% weir count adjustments and subsistence harvest from unreturned permit adjustments are incorporated.

[a] Imputed values for 1999 run year are based on sibling relationships.

[b] Imputed values for 2009 age 6 and 7 component are based partly on anticipated 2009 subsistence harvest.

Table 16.-Results of Buskin River sockeye salmon subsistence user interviews, 2007-2009.

Year	2007	2008	2009
Interview date range	7-23 June	2-18 June	7-Jun
Number of interveiws	103	51	3
	Number of responses		
Residency			
Kodiak	103	49	3
Unknown	0	2	0
Location of traditional effort[a]			
Buskin	100	48	3
Pasagshak	5	1	0
Southend	1	0	0
Litnik	2	0	0
Port Lions	1	0	0
Subsistence fish in other areas			
Yes	57	27	3
No	46	23	0
Location of additional traditional effort			
Pasagshak	39	20	2
Litnik	24	10	1
Port Lions-Ouzinkie	4	2	0
Buskin	2	1	0
Southend	2	0	0
Westside	2	0	0
Bristol Bay	1	0	0
Chignik	1	0	0
Settlers Cove	1	0	0
Number of years subsistence fishing at Buskin			
Mean	18.1	17.2	9.7
SE	1.5	2	4.2
Median	15	15	6
Minimum	1	1	5
Maximum	69	50	18

[a] Some anglers responded with more than one traditional fishing location.

Table 17.-Posterior percentiles for important nodes of the Bayesian analysis.

	Percentile median				
Parameter	**5**	**10**	**50**	**90**	**95**
$\ln(\alpha)$	1.53	1.69	2.21	2.84	3.08
β	7.59E-05	8.54E-05	1.20E-04	1.60E-04	1.74E-04
σ_{RS}	0.32	0.34	0.44	0.60	0.65
S_{MSY}	4,973	5,335	6,544	8,061	8,711
π_1	0.09	0.09	0.11	0.13	0.14
π_2	0.45	0.46	0.49	0.52	0.53
π_3	0.36	0.37	0.40	0.43	0.44
φ	-0.41	-0.29	0.13	0.59	0.72

FIGURES

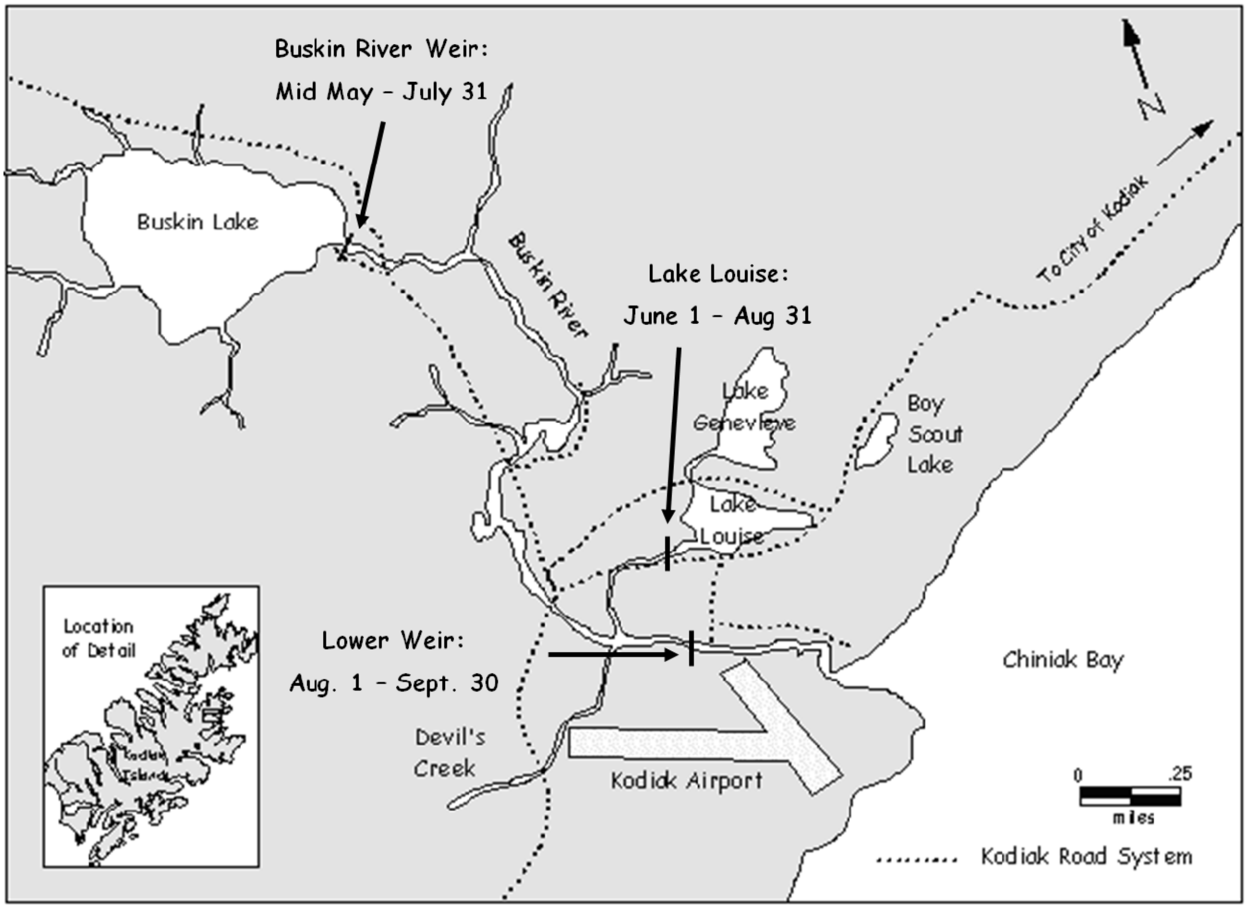
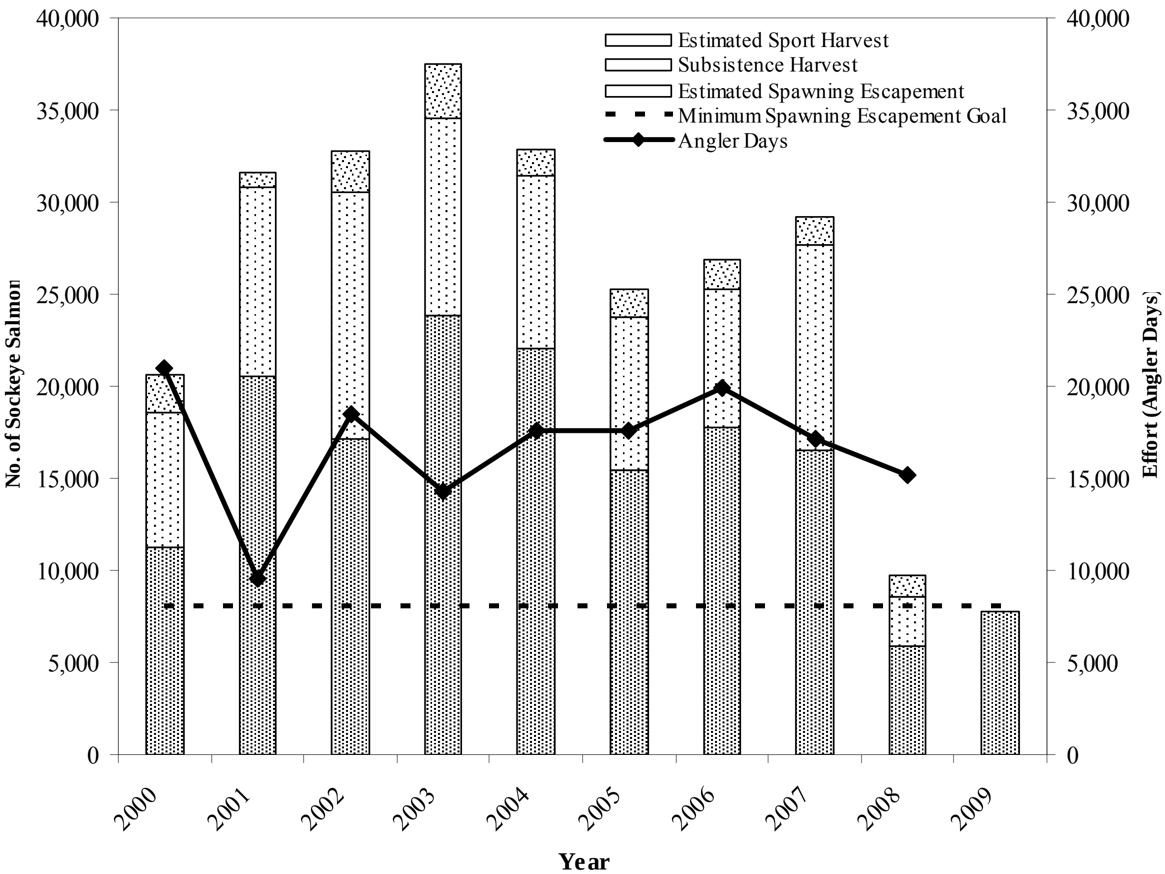


Figure 1.–Buskin River system weir locations, 2007–2009.



Note: Subsistence and sport harvests are unavailable for 2009.

Figure 2.–Buskin Lake sockeye salmon spawning escapement, estimated sport and subsistence harvest of sockeye salmon, and sport fishing effort (angler-days) directed towards all fish species in the Buskin River drainage, 2000-2009.

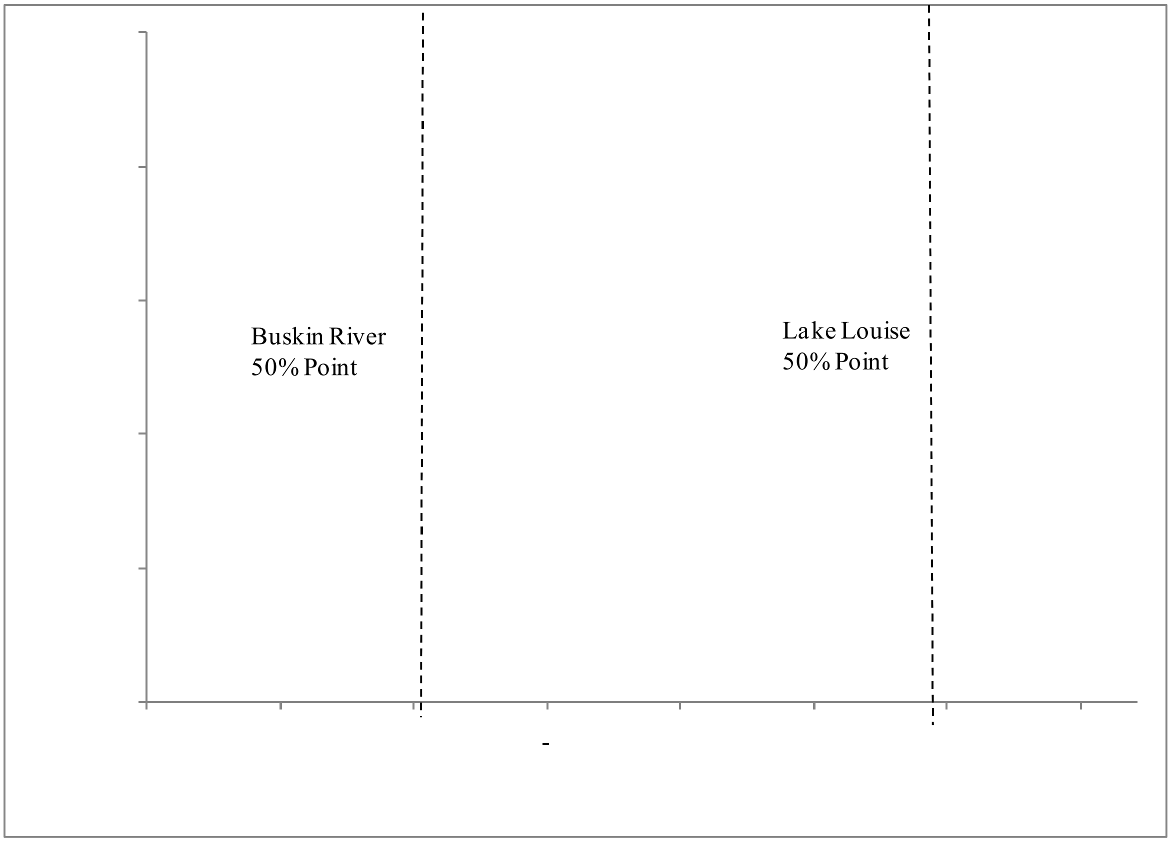
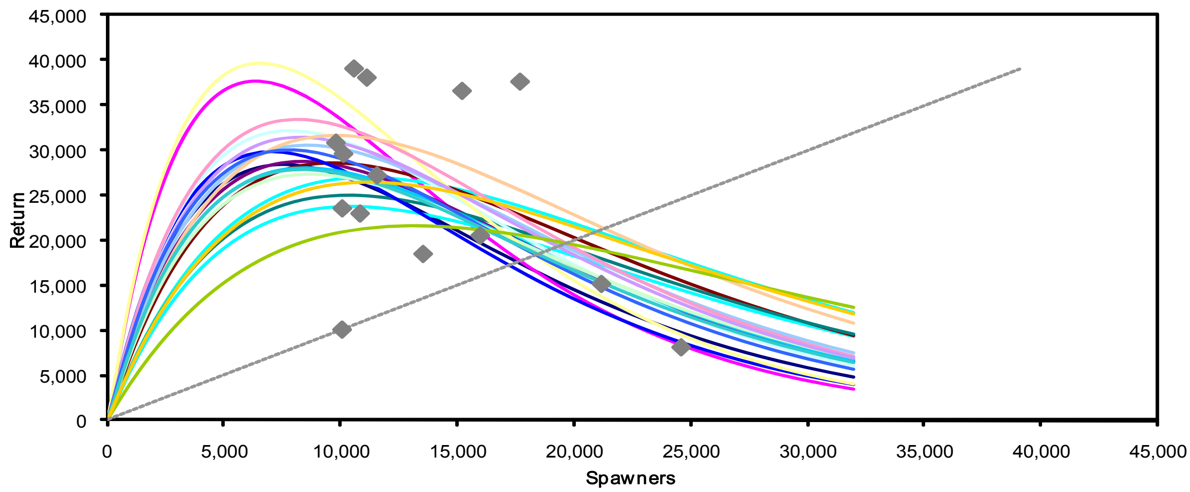


Figure 3.–Average run timing of sockeye salmon returning to Buskin River and Lake Louise, 2002–2009.



Note: the dotted line is S=R, diamonds are data (traditional analysis).

Figure 4.–Horsetail plot of the first twenty bootstrap Ricker model fits.

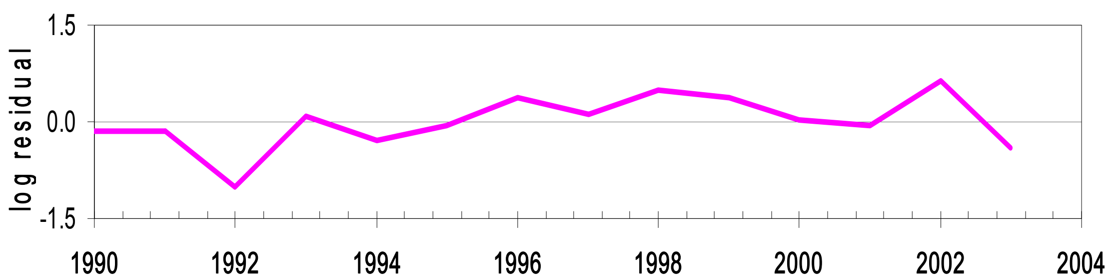


Figure 5.–Plot of residuals from the regression of ln(R/S) on S (traditional analysis).

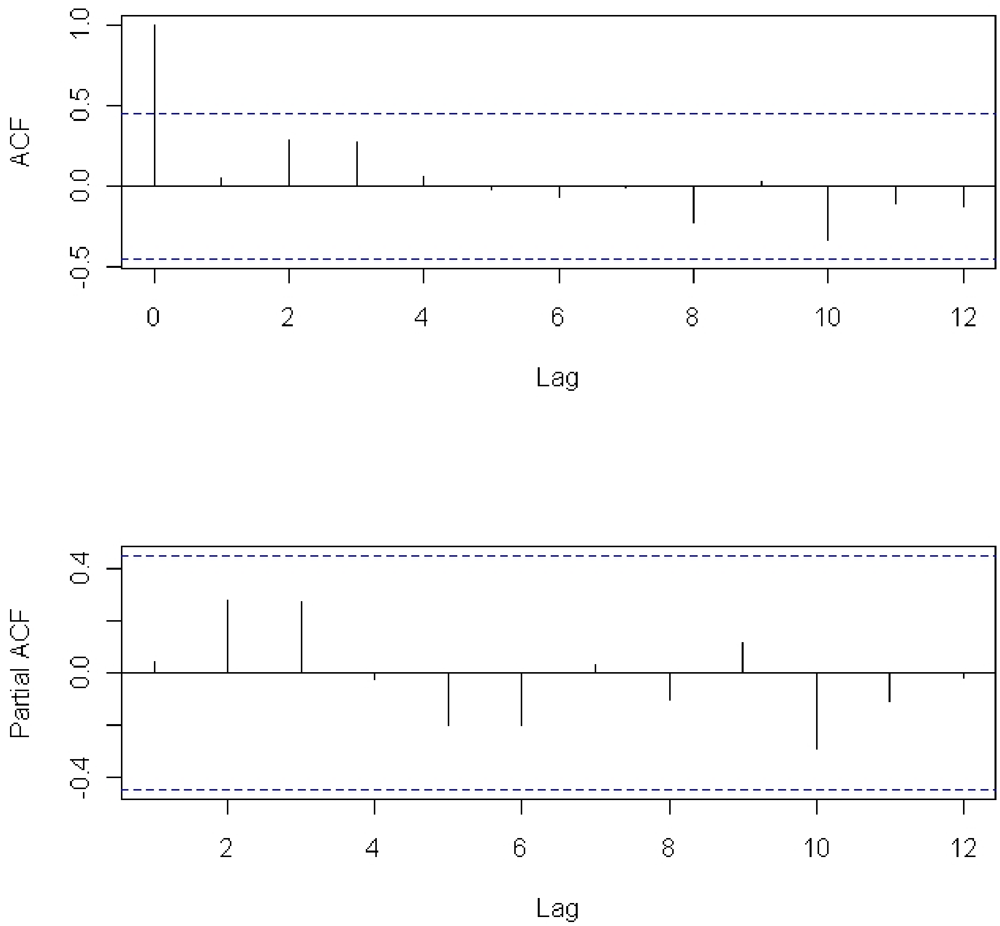
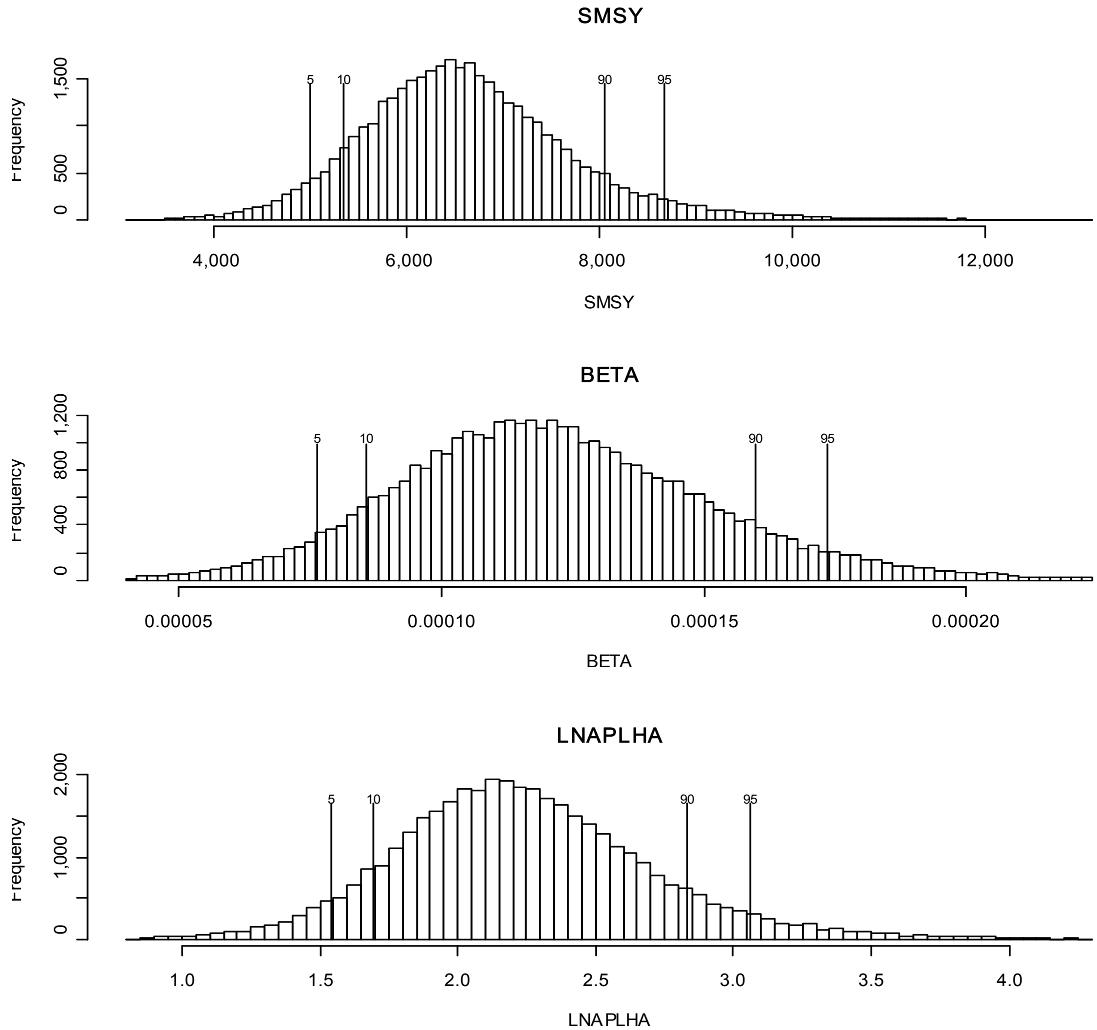
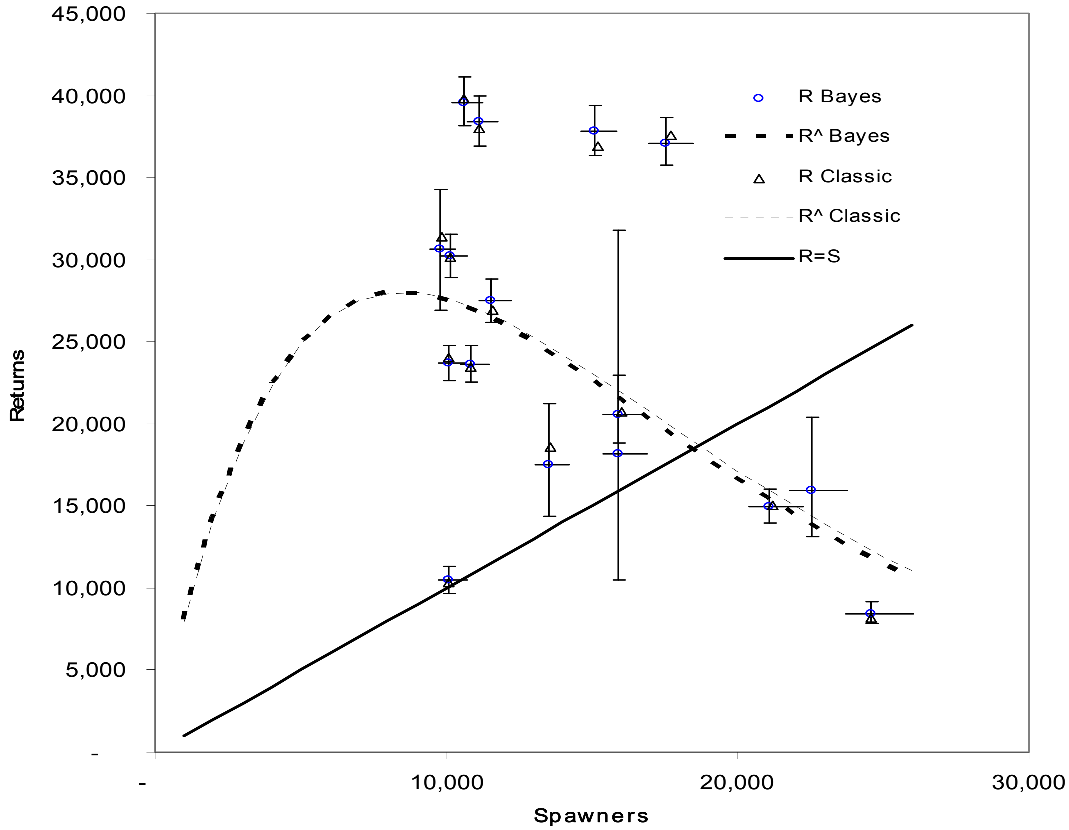


Figure 6.–Autocorrelation and partial autocorrelation function plots for residuals from the regression of ln(R/S) on S (traditional analysis).



Note: Vertical lines depict 5, 10, 90, and 95th percentiles of the distributions (Bayesian analysis).

Figure 7.–Posterior distributions of S_{MSY}, β, and $\ln(\alpha)$.



Note: Posterior medians are plotted as open symbols, 10th and 90th posterior percentiles are bracketed by error bars. Original data-based estimates of S and R are plotted as triangles. Ricker relationships are Bayesian posterior median (heavy dashed line) and classical estimate (light dashed line). Replacement line (solid line).

Figure 8.–Scatter plot of recruitment versus escapement estimates for Buskin River sockeye salmon.

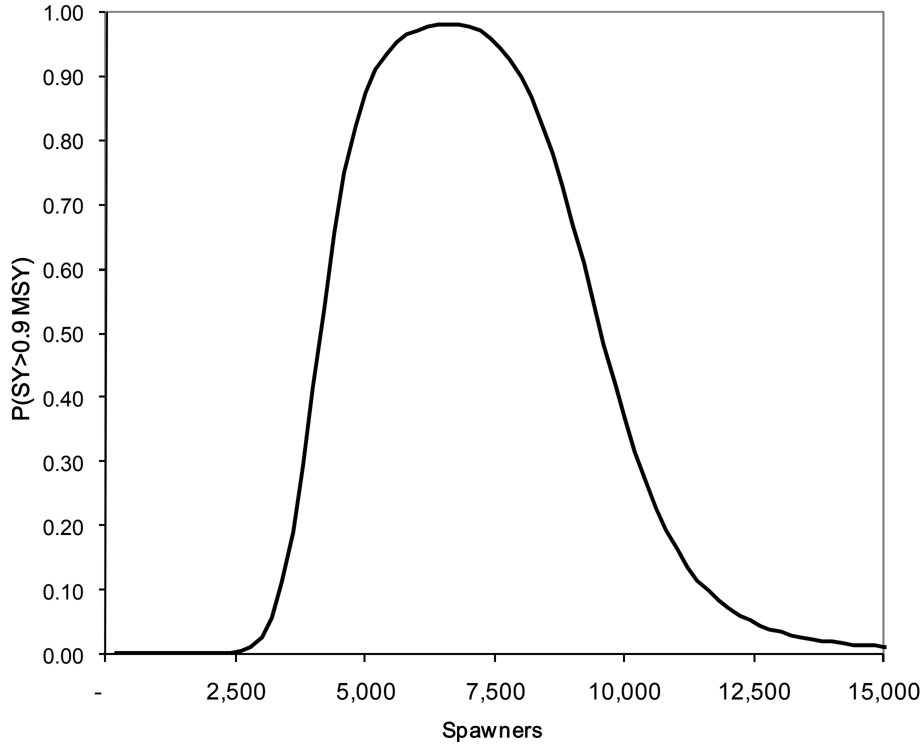


Figure 9.–Probability that sustained yield (SY) is greater than 90% of maximum sustained yield (MSY) (Bayesian analysis).

APPENDIX A. SOCKEYE SALMON COUNTS AT THE BUSKIN RIVER AND LAKE LOUISE WEIRS, 2000-2009

Appendix A1.–Daily cumulative counts (*N*) of sockeye salmon passage through Buskin River weir, 20 May through 31 August, 2000-2009.

	2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2000-2009	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	Avg %
20-May	0	0	0	0					2	0	0	0	1	0	0	0	0	0	0	0	0	0
21-May	0	0	0	0					2	0	0	0	10	0	0	0	0	0	0	0	2	0
22-May	0	0	0	0					2	0	0	0	20	0	0	0	0	0	2	0	3	0
23-May	0	0	0	0	44	0	66	0	48	0	0	0	20	0	10	0	0	0	2	0	19	0
24-May	0	0	0	0	47	0	69	0	396	2	181	1	20	0	48	0	0	0	2	0	76	0
25-May	0	0	12	0	146	1	69	0	604	3	218	1	20	0	57	0	0	0	2	0	113	1
26-May	0	0	56	0	268	2	70	0	976	4	424	3	20	0	61	0	0	0	2	0	188	1
27-May	2	0	133	1	280	2	80	0	979	4	491	3	20	0	61	0	0	0	2	0	205	1
28-May	2	0	311	2	674	4	132	1	1,040	5	661	4	20	0	61	0	0	0	2	0	290	2
29-May	2	0	467	2	1,658	10	591	2	1,252	6	676	4	20	0	61	0	0	0	102	1	483	3
30-May	5	0	939	5	1,738	10	822	3	1,498	7	851	6	20	0	61	0	0	0	116	1	605	3
31-May	186	2	1,657	8	2,048	12	1,036	4	1,580	7	1,114	7	20	0	63	0	0	0	116	1	782	4
1-Jun	202	2	1,955	10	2,051	12	1,169	5	2,250	10	1,136	7	20	0	64	0	4	0	116	1	897	5
2-Jun	202	2	2,452	12	2,191	13	1,497	6	2,562	12	1,136	7	20	0	112	1	4	0	116	1	1,029	5
3-Jun	408	4	2,723	13	2,303	13	1,546	6	3,790	17	2,003	13	148	1	380	2	4	0	183	2	1,349	7
4-Jun	862	8	3,323	16	2,513	15	3,150	13	4,405	20	2,774	18	406	2	487	3	13	0	183	2	1,812	10
5-Jun	1,296	12	4,824	23	3,688	21	4,372	18	4,922	22	2,779	18	431	2	927	6	13	0	428	6	2,368	13
6-Jun	1,296	12	5,440	26	4,319	25	5,123	21	5,209	24	2,930	19	434	2	1,319	8	79	1	431	6	2,659	14
7-Jun	2,555	23	5,940	29	5,870	34	6,445	27	6,171	28	4,795	31	723	4	2,072	13	81	1	444	6	3,510	20
8-Jun	3,294	29	7,308	36	6,584	38	6,903	29	8,296	38	5,380	35	3,004	17	2,403	15	106	2	448	6	4,374	24
9-Jun	3,910	35	7,827	38	7,315	43	7,223	30	8,627	39	6,240	40	4,104	23	2,707	16	231	4	458	6	4,944	27
10-Jun	4,046	36	10,065	49	7,490	44	8,395	35	8,893	40	6,652	43	4,607	26	3,002	18	289	5	1,258	16	5,471	31
11-Jun	4,657	41	11,173	54	7,637	44	9,019	38	10,419	47	6,748	44	5,188	29	5,250	32	467	8	1,268	16	6,183	35
12-Jun	5,897	52	11,815	57	8,162	48	9,342	39	11,646	53	7,268	47	5,976	34	6,351	38	680	12	1,268	16	6,846	40
13-Jun	6,309	56	13,023	63	8,295	48	9,942	42	12,263	56	7,406	48	6,268	35	6,679	40	764	13	1,324	17	7,275	42
14-Jun	6,318	56	14,037	68	8,839	51	11,300	47	12,790	58	7,691	50	7,091	40	6,792	41	805	14	1,805	23	7,750	45
15-Jun	6,779	60	14,316	70	8,941	52	11,926	50	13,257	60	8,089	52	7,512	42	7,399	45	964	16	1,835	24	8,104	47
16-Jun	6,784	60	15,008	73	9,342	54	12,196	51	13,939	63	8,334	54	7,812	44	8,423	51	1,020	17	1,860	24	8,580	49
17-Jun	7,034	63	15,483	75	10,175	59	12,743	53	14,151	64	8,838	57	8,665	49	8,868	54	1,036	18	2,937	38	9,010	53
18-Jun	7,103	63	15,629	76	10,459	61	12,879	54	14,539	66	8,974	58	9,116	51	9,221	56	1,242	21	3,107	40	9,231	55
19-Jun	7,743	69	15,946	78	10,839	63	13,601	57	14,713	67	9,767	63	9,337	53	9,328	57	1,385	23	3,143	41	9,622	57
20-Jun	8,471	75	16,502	80	10,990	64	13,929	58	14,758	67	9,921	64	9,635	54	9,657	59	1,430	24	3,556	46	9,911	59
21-Jun	8,631	77	16,608	81	11,392	66	14,186	59	15,101	69	9,933	64	11,091	63	10,015	61	1,517	26	3,821	49	10,230	61
22-Jun	8,773	78	16,721	81	11,456	67	14,645	61	15,236	69	10,336	67	11,148	63	10,346	63	1,783	30	4,129	53	10,457	63
23-Jun	8,772	78	17,346	84	12,030	70	17,339	73	15,562	71	10,419	67	11,154	63	10,507	64	1,859	32	4,237	55	10,923	66
24-Jun	9,877	88	17,994	88	12,481	73	17,497	73	15,729	71	10,505	68	11,388	64	10,595	64	1,945	33	4,352	56	11,236	68
25-Jun	10,014	89	18,078	88	12,832	75	17,544	73	15,905	72	10,509	68	11,626	66	10,904	66	2,583	44	4,476	58	11,447	70

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	2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2000-2009	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	Avg %
26-Jun	10,300	92	18,602	90	12,916	75	17,586	74	15,964	72	10,825	70	11,779	66	11,100	67	2,608	44	4,640	60	11,632	71
27-Jun	10,334	92	18,897	92	12,948	75	18,421	77	16,013	73	10,974	71	11,939	67	11,914	72	2,830	48	4,979	64	11,925	73
28-Jun	10,440	93	18,914	92	13,257	77	18,498	77	16,238	74	11,210	72	12,225	69	11,914	72	3,008	51	5,242	68	12,095	75
29-Jun	10,458	93	18,976	92	13,279	77	18,575	78	16,261	74	11,211	72	12,375	70	12,039	73	3,069	52	5,370	69	12,161	75
30-Jun	10,484	93	18,995	92	13,518	79	18,633	78	18,167	82	11,274	73	12,405	70	12,145	74	3,648	62	5,642	73	12,491	78
1-Jul	10,484	93	19,015	93	13,616	79	18,814	79	18,194	83	11,362	73	12,442	70	12,243	74	3,745	63	5,666	73	12,558	78
2-Jul	10,582	94	19,065	93	13,740	80	18,865	79	18,223	83	11,416	74	12,467	70	12,319	75	3,802	64	5,746	74	12,623	79
3-Jul	10,680	95	19,470	95	14,062	82	18,943	79	18,336	83	11,667	75	12,671	71	12,720	77	4,150	70	5,753	74	12,845	80
4-Jul	10,836	96	19,534	95	14,233	83	18,966	79	18,362	83	11,693	76	13,108	74	12,951	78	4,235	72	5,756	74	12,967	81
5-Jul	10,876	97	19,865	97	14,305	83	19,067	80	18,422	84	12,087	78	13,123	74	13,069	79	4,235	72	5,807	75	13,086	82
6-Jul	10,885	97	19,885	97	14,383	84	19,268	81	18,438	84	12,190	79	13,136	74	13,620	83	4,244	72	5,825	75	13,187	82
7-Jul	10,885	97	19,891	97	14,402	84	20,017	84	18,526	84	12,437	80	13,142	74	13,659	83	4,281	73	5,903	76	13,314	83
8-Jul	10,887	97	19,928	97	14,421	84	20,399	85	18,721	85	12,470	81	13,239	75	13,669	83	4,302	73	6,255	81	13,429	84
9-Jul	10,887	97	19,977	97	15,126	88	20,419	86	18,974	86	12,512	81	14,201	80	13,887	84	4,401	75	6,297	81	13,668	85
10-Jul	10,889	97	19,978	97	15,168	88	20,486	86	19,085	87	12,550	81	14,368	81	14,150	86	4,402	75	6,313	81	13,739	86
11-Jul	11,066	99	19,994	97	15,208	89	21,978	92	19,242	87	12,685	82	14,938	84	14,213	86	4,403	75	6,375	82	14,010	87
12-Jul	11,085	99	20,033	97	15,329	89	22,043	92	19,278	88	13,420	87	15,019	85	14,258	86	4,587	78	6,376	82	14,143	88
13-Jul	11,087	99	20,055	98	15,338	89	22,124	93	19,357	88	13,444	87	15,032	85	14,462	88	4,658	79	6,385	82	14,194	89
14-Jul	11,089	99	20,104	98	15,718	92	22,183	93	19,360	88	13,457	87	15,059	85	14,465	88	4,658	79	6,435	83	14,253	89
15-Jul	11,090	99	20,119	98	15,727	92	22,257	93	20,002	91	13,498	87	15,061	85	14,466	88	4,664	79	6,527	84	14,341	90
16-Jul	11,090	99	20,179	98	15,737	92	22,262	93	20,223	92	13,500	87	15,218	86	14,578	88	4,680	79	6,887	89	14,435	90
17-Jul	11,092	99	20,179	98	15,741	92	22,265	93	20,231	92	14,109	91	15,221	86	14,579	88	4,770	81	6,889	89	14,508	91
18-Jul	11,092	99	20,198	98	15,803	92	22,327	94	20,233	92	14,125	91	15,224	86	14,641	89	4,777	81	6,910	89	14,533	91
19-Jul	11,092	99	20,465	100	15,821	92	22,406	94	20,234	92	14,125	91	15,489	87	14,662	89	4,777	81	6,911	89	14,598	91
20-Jul	11,092	99	20,472	100	15,932	93	22,448	94	20,557	93	14,126	91	15,531	88	14,698	89	4,777	81	6,921	89	14,655	92
21-Jul	11,175	99	20,491	100	16,012	93	22,523	94	20,564	93	14,199	92	15,631	88	14,776	90	4,785	81	7,007	90	14,716	92
22-Jul	11,177	100	20,493	100	16,332	95	22,656	95	20,913	95	14,203	92	15,637	88	14,829	90	4,787	81	7,060	91	14,809	93
23-Jul	11,177	100	20,521	100	16,377	95	22,681	95	20,942	95	14,204	92	15,637	88	14,872	90	4,787	81	7,067	91	14,827	93
24-Jul	11,177	100	20,523	100	16,389	95	22,705	95	20,946	95	14,204	92	15,637	88	15,135	92	4,990	85	7,068	91	14,877	93
25-Jul	11,177	100	20,544	100	16,395	95	22,760	95	20,964	95	14,361	93	15,940	90	15,335	93	5,043	85	7,289	94	14,981	94
26-Jul	11,179	100	20,544	100	16,433	96	22,797	96	21,071	96	14,457	93	15,951	90	15,335	93	5,044	85	7,395	95	15,021	94
27-Jul	11,180	100	20,544	100	16,437	96	22,818	96	21,076	96	14,885	96	15,972	90	15,335	93	5,045	86	7,399	95	15,069	95
28-Jul	11,180	100	20,544	100	16,477	96	22,824	96	21,185	96	14,910	96	16,031	90	15,685	95	5,050	86	7,421	96	15,131	95
29-Jul	11,180	100	20,544	100	16,480	96	22,865	96	21,218	96	14,935	97	16,078	91	15,774	96	5,412	92	7,461	96	15,195	96
30-Jul	11,180	100	20,544	100	16,494	96	22,914	96	21,247	96	14,976	97	16,079	91	15,811	96	5,441	92	7,480	97	15,217	96
31-Jul	11,180	100	20,544	100	16,503	96	22,930	96	21,273	97	15,031	97	16,081	91	15,822	96	5,466	93	7,502	97	15,233	96
1-Aug	11,180	100	20,544	100	16,558	96	22,946	96	21,286	97	15,033	97	16,094	91	15,827	96	5,486	93	7,516	97	15,247	96
2-Aug	11,180	100	20,544	100	16,580	97	22,959	96	21,320	97	15,035	97	16,146	91	15,879	96	5,503	93	7,516	97	15,266	96

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	2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2000-2009	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	Avg %
3-Aug	11,180	100	20,544	100	16,584	97	22,962	96	21,404	97	15,035	97	16,207	91	15,948	97	5,521	94	7,519	97	15,290	97
4-Aug	11,180	100	20,544	100	16,588	97	22,975	96	21,432	97	15,035	97	16,264	92	15,979	97	5,538	94	7,572	98	15,311	97
5-Aug	11,180	100	20,544	100	16,604	97	23,042	97	21,462	97	15,035	97	16,380	92	16,013	97	5,562	94	7,579	98	15,340	97
6-Aug	11,180	100	20,544	100	16,625	97	23,090	97	21,498	98	15,035	97	16,479	93	16,047	97	5,570	94	7,580	98	15,365	97
7-Aug	11,180	100	20,544	100	16,630	97	23,251	97	21,523	98	15,045	97	16,606	94	16,073	97	5,578	95	7,581	98	15,401	97
8-Aug	11,180	100	20,544	100	16,630	97	23,283	98	21,589	98	15,055	97	16,663	94	16,085	97	5,589	95	7,581	98	15,420	97
9-Aug	11,180	100	20,544	100	16,630	97	23,304	98	21,630	98	15,067	97	16,776	95	16,104	98	5,592	95	7,586	98	15,441	97
10-Aug	11,180	100	20,544	100	16,630	97	23,315	98	21,685	98	15,086	98	16,818	95	16,132	98	5,608	95	7,589	98	15,459	98
11-Aug	11,180	100	20,544	100	16,630	97	23,323	98	21,692	98	15,114	98	16,876	95	16,146	98	5,639	96	7,592	98	15,474	98
12-Aug	11,180	100	20,544	100	16,639	97	23,327	98	21,705	99	15,136	98	16,918	95	16,162	98	5,660	96	7,594	98	15,487	98
13-Aug	11,180	100	20,544	100	16,667	97	23,352	98	21,751	99	15,164	98	16,963	96	16,175	98	5,661	96	7,601	98	15,506	98
14-Aug	11,180	100	20,544	100	16,693	97	23,409	98	21,774	99	15,185	98	17,017	96	16,197	98	5,858	99	7,603	98	15,546	98
15-Aug	11,180	100	20,544	100	16,696	97	23,515	99	21,803	99	15,214	98	17,059	96	16,217	98	5,862	99	7,604	98	15,569	98
16-Aug	11,180	100	20,544	100	16,721	97	23,569	99	21,824	99	15,238	99	17,077	96	16,219	98	5,875	100	7,605	98	15,585	99
17-Aug	11,180	100	20,544	100	16,734	97	23,600	99	21,841	99	15,269	99	17,109	96	16,226	98	5,878	100	7,612	98	15,599	99
18-Aug	11,180	100	20,546	100	16,757	98	23,614	99	21,890	99	15,285	99	17,150	97	16,269	99	5,882	100	7,613	98	15,619	99
19-Aug	11,180	100	20,546	100	16,778	98	23,645	99	21,923	100	15,303	99	17,186	97	16,285	99	5,882	100	7,615	98	15,634	99
20-Aug	11,181	100	20,547	100	16,786	98	23,679	99	21,939	100	15,323	99	17,238	97	16,286	99	5,882	100	7,620	98	15,648	99
21-Aug	11,182	100	20,547	100	16,792	98	23,691	99	21,954	100	15,338	99	17,281	97	16,295	99	5,883	100	7,620	98	15,658	99
22-Aug	11,182	100	20,549	100	16,801	98	23,697	99	21,961	100	15,354	99	17,304	98	16,303	99	5,883	100	7,620	98	15,665	99
23-Aug	11,185	100	20,550	100	16,814	98	23,721	99	21,968	100	15,366	99	17,332	98	16,314	99	5,886	100	7,622	98	15,676	99
24-Aug	11,187	100	20,550	100	16,825	98	23,757	100	21,977	100	15,379	99	17,457	98	16,329	99	5,887	100	7,622	98	15,697	99
25-Aug	11,189	100	20,550	100	16,827	98	23,779	100	21,978	100	15,390	99	17,495	99	16,340	99	5,889	100	7,623	98	15,706	99
26-Aug	11,190	100	20,551	100	16,828	98	23,790	100	21,993	100	15,393	100	17,522	99	16,348	99	5,889	100	7,623	98	15,713	99
27-Aug	11,192	100	20,551	100	16,831	98	23,814	100	21,997	100	15,397	100	17,571	99	16,381	99	5,890	100	7,625	98	15,725	99
28-Aug	11,192	100	20,552	100	16,836	98	23,818	100	22,003	100	15,403	100	17,586	99	16,381	99	5,890	100	7,698	99	15,736	99
29-Aug	11,193	100	20,552	100	16,847	98	23,829	100	22,005	100	15,404	100	17,607	99	16,381	99	5,890	100	7,728	100	15,744	100
30-Aug	11,193	100	20,552	100	16,854	98	23,835	100	22,006	100	15,404	100	17,656	100	16,394	99	5,890	100	7,731	100	15,752	100
31-Aug	11,194	100	20,553	100	17,174	100	23,837	100	22,008	100	15,408	100	17,668	100	16,400	99	5,892	100	7,731	100	15,787	100
Yearly Total [a]	11,233		20,556		17,174		23,870		22,023		15,468		17,734		16,502		5,900		7,757		15,822	

Note: From mid-May through July, the weir was operated continuously at the outlet of Buskin Lake. From early August through September, the weir was operated about 0.6 miles downstream from Buskin Lake outlet, except in 2009.

[a] The yearly total includes counts from 1-30 September. However, because these totals are so low, the daily counts for September are not shown.

Appendix A2.–Daily cumulative count (*N*) of sockeye salmon passage through the Lake Louise weir, 1 June through 31 August, 2002-2009.

	2002		2003		2004		2005		2006		2007		2008		2009		2000-2009	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	Avg %
1-Jun	0	0	0	0													0	0
2-Jun	0	0	0	0	0	0									0	0	0	0
3-Jun	0	0	0	0	0	0			0	0	0	0			0	0	0	0
4-Jun	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
5-Jun	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
6-Jun	0	0	0	0	1	0	0	0	0	0	0	0		0	0	0	0	0
7-Jun	2	0	0	0	1	0	0	0	0	0	0	0		0	0	0	0	0
8-Jun	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
9-Jun	2	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0
10-Jun	2	0	2	0	2	0	2	0	0	0	0	0	0	0	0	0	1	0
11-Jun	2	0	4	0	4	0	3	0	0	0	0	0	0	0	0	0	2	0
12-Jun	2	0	5	0	5	0	3	0	2	0	0	0	0	0	0	0	2	0
13-Jun	2	0	5	0	5	0	3	0	3	0	0	0	0	0	0	0	2	0
14-Jun	3	0	7	0	11	1	3	0	3	0	0	0	0	0	0	0	3	0
15-Jun	3	0	14	0	32	2	5	0	3	0	0	0	0	0	0	0	7	0
16-Jun	3	0	18	0	47	2	5	0	3	0	0	0	0	0	0	0	10	0
17-Jun	4	0	18	0	51	2	5	0	3	0	0	0	0	0	0	0	10	0
18-Jun	4	0	18	0	54	3	7	0	3	0	0	0	1	0	0	0	11	0
19-Jun	4	0	20	0	63	3	8	0	5	0	0	0	1	0	0	0	13	1
20-Jun	4	0	21	0	68	3	9	0	8	0	0	0	1	0	0	0	14	1
21-Jun	7	0	26	1	72	3	10	0	8	0	0	0	1	0	0	0	16	1
22-Jun	41	1	29	1	82	4	10	0	9	0	0	0	1	0	0	0	22	1
23-Jun	53	1	35	1	92	4	10	0	10	0	0	0	1	0	0	0	25	1
24-Jun	55	2	46	1	92	4	10	0	10	0	0	0	1	0	0	0	27	1
25-Jun	171	5	55	1	93	4	21	1	10	0	0	0	1	0	0	0	44	1
26-Jun	194	5	56	1	98	5	26	1	10	0	0	0	1	0	0	0	48	2
27-Jun	243	7	57	1	102	5	37	2	13	0	0	0	1	0	0	0	57	2
28-Jun	316	9	58	1	108	5	45	2	20	0	0	0	5	1	0	0	69	2
29-Jun	377	11	61	1	128	6	47	2	20	0	0	0	13	2	0	0	81	3
30-Jun	462	13	71	2	149	7	69	3	22	0	0	0	13	2	0	0	98	3
1-Jul	523	15	84	2	171	8	83	4	24	1	0	0	13	2	0	0	112	4

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	2002		2003		2004		2005		2006		2007		2008		2009		2000-2009	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	Avg %
2-Jul	553	15	86	2	184	9	96	5	24	1	0	0	13	2	0	0	120	4
3-Jul	603	17	109	2	210	10	98	5	26	1	0	0	32	4	0	0	135	5
4-Jul	628	18	166	4	234	11	107	5	28	1	0	0	51	6	0	0	152	6
5-Jul	661	18	207	5	247	12	113	6	28	1	0	0	51	6	0	0	163	6
6-Jul	705	20	237	5	260	12	126	6	28	1	0	0	51	6	0	0	176	6
7-Jul	732	20	258	6	290	14	138	7	28	1	0	0	52	6	0	0	187	7
8-Jul	741	21	307	7	301	14	142	7	28	1	0	0	56	7	0	0	197	7
9-Jul	768	21	360	8	352	17	142	7	29	1	0	0	56	7	0	0	213	8
10-Jul	778	22	374	8	418	20	143	7	32	1	0	0	56	7	0	0	225	8
11-Jul	785	22	408	9	461	22	146	7	154	3	0	0	56	7	0	0	251	9
12-Jul	791	22	621	14	483	23	146	7	155	3	41	2	56	7	0	0	287	10
13-Jul	819	23	639	14	509	24	151	7	155	3	65	4	56	7	0	0	299	10
14-Jul	820	23	657	15	590	28	157	8	171	4	65	4	56	7	0	0	315	11
15-Jul	1,064	30	689	15	654	31	160	8	175	4	66	4	56	7	0	0	358	12
16-Jul	1,067	30	709	16	660	32	167	8	177	4	66	4	56	7	0	0	363	12
17-Jul	1,073	30	737	16	671	32	207	10	177	4	206	12	56	7	0	0	391	14
18-Jul	1,090	30	758	17	740	35	212	10	179	4	206	12	56	7	0	0	405	15
19-Jul	1,110	31	760	17	752	36	212	10	196	4	206	12	56	7	0	0	412	15
20-Jul	1,134	32	835	19	774	37	216	11	453	10	206	12	56	7	9	1	460	16
21-Jul	1,238	35	837	19	784	38	219	11	794	17	206	12	56	7	188	19	540	20
22-Jul	1,536	43	858	19	910	44	226	11	828	18	206	12	56	7	190	19	601	22
23-Jul	2,048	57	898	20	944	45	226	11	953	21	206	12	56	7	190	19	690	24
24-Jul	2,253	63	917	20	958	46	226	11	1,024	22	206	12	56	7	190	19	729	25
25-Jul	2,387	67	926	21	985	47	251	12	1,085	24	284	17	90	11	314	32	790	29
26-Jul	2,487	69	928	21	1,012	49	274	14	1,135	25	284	17	90	11	337	34	818	30
27-Jul	2,535	71	929	21	1,012	49	279	14	1,223	27	287	17	90	11	350	35	838	30
28-Jul	2,594	72	930	21	1,012	49	283	14	1,287	28	287	17	90	11	350	35	854	31
29-Jul	2,635	74	930	21	1,039	50	298	15	1,315	29	319	19	90	11	368	37	874	32
30-Jul	2,661	74	930	21	1,072	51	312	15	1,339	29	340	20	90	11	401	40	893	33
31-Jul	2,689	75	932	21	1,074	51	314	15	1,351	29	350	21	90	11	404	41	901	33
1-Aug	2,728	76	932	21	1,075	52	323	16	1,353	30	386	23	90	11	404	41	911	34
2-Aug	2,758	77	932	21	1,082	52	399	20	1,355	30	399	24	90	11	404	41	927	34

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	2002		2003		2004		2005		2006		2007		2008		2009		2000-2009	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	Avg %
3-Aug	2,775	77	932	21	1,083	52	1,444	71	1,717	37	399	24	90	11	405	41	1,106	42
4-Aug	2,777	78	932	21	1,087	52	1,605	79	1,754	38	399	24	90	11	405	41	1,131	43
5-Aug	2,781	78	932	21	1,087	52	1,654	82	1,763	38	399	24	90	11	577	58	1,160	45
6-Aug	2,786	78	932	21	1,088	52	1,682	83	1,775	39	399	24	90	11	600	60	1,169	46
7-Aug	2,791	78	932	21	1,088	52	1,693	83	1,788	39	400	24	90	11	600	60	1,173	46
8-Aug	2,792	78	932	21	1,095	52	1,705	84	1,797	39	400	24	90	11	600	60	1,176	46
9-Aug	2,794	78	932	21	1,513	73	1,715	85	1,802	39	400	24	90	11	600	60	1,231	49
10-Aug	3,097	86	1,117	25	1,582	76	1,737	86	1,806	39	400	24	90	11	600	60	1,304	51
11-Aug	3,122	87	1,152	26	1,588	76	1,755	87	1,820	40	400	24	90	11	600	60	1,316	51
12-Aug	3,235	90	1,168	26	1,588	76	1,775	88	1,825	40	400	24	99	12	600	60	1,336	52
13-Aug	3,242	91	1,173	26	1,597	77	1,789	88	1,827	40	400	24	743	89	600	60	1,421	62
14-Aug	3,242	91	1,679	37	1,601	77	1,794	88	2,131	46	403	24	761	91	600	60	1,526	64
15-Aug	3,581	100	1,810	40	1,602	77	1,808	89	2,192	48	403	24	762	91	600	60	1,595	66
16-Aug	3,581	100	1,832	41	1,603	77	1,817	90	2,192	48	403	24	762	91	600	60	1,599	66
17-Aug	3,581	100	1,832	41	1,608	77	1,894	93	2,193	48	403	24	762	91	600	60	1,609	67
18-Aug	3,581	100	1,834	41	1,613	77	1,917	95	2,227	49	500	30	766	92	600	60	1,630	68
19-Aug	3,581	100	2,074	46	1,743	84	1,930	95	2,245	49	710	42	787	94	600	60	1,709	71
20-Aug	3,581	100	3,027	67	1,743	84	1,940	96	2,376	52	718	43	789	95	600	60	1,847	75
21-Aug	3,581	100	3,268	73	1,748	84	1,950	96	2,386	52	718	43	791	95	601	61	1,880	75
22-Aug	3,581	100	3,408	76	1,755	84	1,964	97	2,396	52	723	43	794	95	601	61	1,903	76
23-Aug	3,581	100	3,445	77	1,773	85	1,980	98	2,412	53	776	46	797	96	601	61	1,921	77
24-Aug	3,581	100	3,467	77	2,040	98	1,990	98	2,827	62	778	46	797	96	602	61	2,010	80
25-Aug	3,581	100	3,470	77	2,063	99	1,999	99	2,906	63	778	46	798	96	603	61	2,025	80
26-Aug	3,581	100	3,483	78	2,073	99	2,004	99	3,028	66	778	46	798	96	604	61	2,044	81
27-Aug	3,581	100	3,486	78	2,077	100	2,004	99	3,168	69	795	47	798	96	624	63	2,067	81
28-Aug	3,581	100	3,488	78	2,086	100	2,013	99	3,196	70	1,326	79	798	96	898	91	2,173	89
29-Aug	3,581	100	4,488	100	2,086	100	2,021	100	3,206	70	1,467	88	798	96	955	96	2,325	94
30-Aug	3,581	100	4,488	100	2,086	100	2,023	100	4,586	100	1,500	89	798	96	987	99	2,506	98
31-Aug	3,581	100	4,488	100	2,086	100	2,028	100	4,586	100	1,511	90	806	97	990	100	2,510	98
Yearly Total	3,581		4,488		2,086		2,028		4,586		1,676		833		992		2,534	

APPENDIX B. TEMPORALLY STRATIFIED AGE COMPOSITIONS OF THE BUSKIN RIVER SOCKEYE SALMON ESCAPEMENT, 2007–2009

Appendix B1.–Age composition estimates by temporal stratum of sockeye salmon escapement to the Buskin River, 2007.

Stratum		Age Classes											
Date	Statistics	None	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total
1-15 June	Sample Size	18	0	0	3	0	96	1	2	20	0	0	122
	Prop		0.00	0.00	0.02	0.00	0.79	0.01	0.02	0.16	0.00	0.00	1.00
	SE		0.000	0.000	0.014	0.000	0.037	0.008	0.011	0.033	0.000	0.000	
	Estimate		0	0	182	0	5,822	61	121	1,213	0	0	7,399
	SE		0	0	103	0	273	60	85	247	0	0	
16-30 June	Sample Size	9	0	0	4	0	87	2	3	6	0	0	102
	Prop		0.00	0.00	0.04	0.00	0.85	0.02	0.03	0.06	0.00	0.00	1.00
	SE		0.000	0.000	0.019	0.000	0.035	0.014	0.017	0.023	0.000	0.000	
	Estimate		0	0	186	0	4,048	93	140	279	0	0	4,746
	SE		0	0	91	0	165	65	79	110	0	0	
1-15 July	Sample Size	3	0	0	2	0	26	1	0	6	0	0	35
	Prop		0.00	0.00	0.06	0.00	0.74	0.03	0.00	0.17	0.00	0.00	1.00
	SE		0.000	0.000	0.040	0.000	0.074	0.028	0.000	0.064	0.000	0.000	
	Estimate		0	0	133	0	1,724	66	0	398	0	0	2,321
	SE		0	0	92		173	66	0	149	0	0	
>15 July	Sample Size	5	0	0	5	0	47	0	0	13	0	0	65
	Prop		0.00	0.00	0.08	0.00	0.72	0.00	0.00	0.20	0.00	0.00	1.00
	SE		0.000	0.000	0.341	0.000	1.042	0.000	0.000	0.549	0.000	0.000	
	Estimate		0	0	157	0	1,472	0	0	407	0	0	2,036
	SE		0	0	694	0	2,122		0	1,119	0	0	

Note: Prop = proportion.

Appendix B2.–Age composition estimates by temporal stratum of sockeye salmon escapement to the Buskin River, 2008.

Stratum		Age Classes												
Date	Statistics	None	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total
1-15 June	Sample Size	9	0	0	0	37	0	32	13	4	32	0	5	123
	Prop		0.00	0.00	0.00	0.30	0.00	0.26	0.11	0.03	0.26	0.00	0.04	1.00
	SE		0.000	0.000	0.000	0.039	0.000	0.037	0.026	0.015	0.037	0.000	0.017	
	Estimate		0	0	0	290	0	251	102	31	251	0	39	964
	SE		0	0	0	37	0	36		0	36	0	0	
16-30 June	Sample Size	13	2	0	0	43	1	15	17	4	29	0	3	114
	Prop		0.02	0.00	0.00	0.38	0.01	0.13	0.15	0.04	0.25	0.00	0.03	1.00
	SE		0.012	0.000	0.000	0.045	0.009	0.031	0.033	0.017	0.040	0.000	0.015	
	Estimate		47	0	0	1,012	24	353	400	94	683	0	71	2,684
	SE		0		0	120		84		0	108	0	40	
1-15 July	Sample Size	4	0	1	2	8	1	20	4	1	18	0	0	55
	Prop		0.00	0.02	0.04	0.15	0.02	0.36	0.07	0.02	0.33	0.00	0.00	1.00
	SE		0.000	0.018	0.025	0.047	0.018	0.064	0.034	0.018	0.062	0.000	0.000	
	Estimate		0	18	37	148	18	369	74	18	333	0	0	1,016
	SE		0	18	0	47		65		0	63	0	0	
> 15 July	Sample Size	3	0	0	0	4	0	25	2	4	15	0	2	52
	Prop		0.00	0.00	0.00	0.08	0.00	0.48	0.04	0.08	0.29	0.00	0.04	1.000
	SE		0.000	0.000	0.000	0.037	0.000	0.068	0.026	0.037	0.062	0.000	0.026	
	Estimate		0	0	0	95	0	594	48	95	357	0	48	1,236
	SE		0		0	45	0	85		0	77	0	0	

Note: Prop = proportion.

Appendix B3.–Age composition estimates by temporal stratum of sockeye salmon escapement to the Buskin River, 2009.

Stratum		Age Classes											
Date	Statistics	None	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total
1-15 June	Sample Size	9	0	1	7	0	70	11	0	36	0	0	125
	Prop		0.00	0.01	0.06	0.00	0.56	0.09	0.00	0.29	0.00	0.00	1.00
	SE		0.0	0.008	0.020	0.000	0.043	0.025	0.000	0.039	0.000	0.000	
	Estimate		0	15	103	0	1,028	161	0	528	0	0	1,835
	SE		0	0	37	0	79	45	0	72	0	0	
16-30 June	Sample Size	5	1	0	6	4	34	16	0	26	0	1	88
	Prop		0.01	0.00	0.07	0.05	0.39	0.18	0.00	0.30	0.00	0.01	1.00
	SE		0.0	0.000	0.027	0.022	0.052	0.041	0.000	0.048	0.000	0.011	
	Estimate		43	0	260	173	1,471	692	0	1,125	0	43	3,807
	SE		0	0	102	0	196	156	0	184	0	0	
1-15 July	Sample Size	4	0	0	7	1	27	15	1	15	0	0	66
	Prop		0.00	0.00	0.11	0.02	0.41	0.23	0.02	0.23	0.00	0.00	1.00
	SE		0.0	0.000	0.037	0.015	0.059	0.050	0.015	0.050	0.000	0.000	
	Estimate		0	0	94	13	362	201	13	201	0	0	885
	SE		0	0	33	0	52	44	0	44	0	0	
> 15 July	Sample Size	9	0	0	1	4	8	6	0	9	0	0	28
	Prop		0.00	0.00	0.04	0.14	0.29	0.21	0.00	0.32	0.00	0.00	1.00
	SE		0.0	0.000	0.035	0.067	0.086	0.078	0.000	0.089	0.000	0.000	
	Estimate		0	0	44	176	351	264	0	395	0	0	1,230
	SE		0	0	43	0	106	96	0	109	0	0	

Note: Prop = proportion.

APPENDIX C. TEMPORALLY STRATIFIED AGE COMPOSITIONS OF SOCKEYE SALMON ESCAPEMENT IN THE LAKE LOUISE TRIBUTARY, 2007–2009

Appendix C1.–Age composition estimates by temporal stratum of sockeye salmon escapement to Lake Louise, 2007.

Stratum Date	Statistics	None	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total
		Age Classes												
1 June - 15 July	Sample Size	3	0	0	0	4	1	35	5	2	3	0	0	50
	Prop		0.00	0.00	0.00	0.08	0.02	0.70	0.10	0.04	0.06	0.00	0.00	1.00
	SE		0.000	0.000	0.000	0.019	0.010	0.032	0.021	0.014	0.017	0.000	0.000	
	Estimate		0	0	0	5	1	46	7	3	4	0	0	66
	SE		0		0	1	0	2	1	1	1	0		
16 - 31 July	Sample Size	4	0	4	0	13	0	30	2	1	3	0	0	53
	Prop		0.00	0.08	0.00	0.25	0.00	0.57	0.04	0.02	0.06	0.00	0.00	1.00
	SE		0.000	0.033	0.000	0.054	0.000	0.062	0.024	0.017	0.029	0.000	0.000	
	Estimate		0	21	0	67	0	155	10	5	16	0	0	274
	SE		0	9	0	15		17	7	5	8	0	0	
1 - 15 Aug.	Sample Size	1	0	1	0	5	2	24	2	0	4	0	0	38
	Prop		0.00	0.03	0.00	0.13	0.05	0.63	0.05	0.00	0.11	0.00	0.00	1.00
	SE		0.000	0.017	0.000	0.035	0.023	0.050	0.023	0.000	0.032	0.000	0.000	
	Estimate		0	2	0	8	3	40	3	0	7	0	0	63
	SE		0	1		2	0	3	1		2	0		
16 - 31 Aug.	Sample Size	14	0	2	0	15	4	52	11	0	4	0	0	88
	Prop		0.00	0.02	0.00	0.17	0.05	0.59	0.13	0.00	0.05	0.00	0.00	1.00
	SE		0.000	0.015	0.000	0.039	0.022	0.051	0.034	0.000	0.022	0.000	0.000	
	Estimate		0	29	0	217	58	752	159	0	58	0	0	1,273
	SE		0	0	0	50	0	65	44		27	0	0	

Note: Prop = proportion.

Appendix C2.–Age composition estimates by temporal stratum of sockeye salmon escapement to Lake Louise, 2008.

Stratum		Age Classes												
Date	Statistics	None	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total
1 July -31 July	Sample Size	5	0	0	0	22	1	10	18	0	4	0	0	55
	Prop		0.00	0.00	0.00	0.40	0.02	0.18	0.33	0.00	0.07	0.00	0.00	1.00
	SE		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Estimate		0	0	0	36	2	16	29	0	7	0	0	90
	SE		0		0	4	1	3	4	0	2	0	0	
> 31 July	Sample Size	89	0	0	0	10	2	6	2	0	0	0	0	20
	Prop		0.00	0.00	0.00	0.50	0.10	0.30	0.10	0.00	0.00	0.00	0.00	1.00
	SE		0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	
	Estimate		0	0	0	372	74	223	74	0	0	0	0	743
	SE		0		0	84	50	77	50	0		0	0	

Note: Prop = proportion.

Appendix C3.-Age composition estimates by temporal stratum of sockeye salmon escapement to Lake Louise, 2009.

	Age Classes												
Statistics	None	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	Total
Sample Size	31	0	0	0	8	0	15	25	0	5	0	0	53
Prop		0.00	0.00	0.00	0.15	0.00	0.28	0.47	0.00	0.09	0.00	0.00	1.00
SE		0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	
Estimate		0	0	0	61	0	113	190	0	36	0	0	404
SE		0		0	0		40	40	0	0	0	0	
Sample Size	55	0	0	0	7	0	11	20	0	5	0	0	43
Prop		0.00	0.00	0.00	0.16	0.00	0.26	0.47	0.00	0.12	0.00	0.00	1.00
SE		0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	
Estimate		0	0	0	96	0	150	273	0	68	0	0	588
SE		0	0	0	32	0	38	44	0	28	0	0	

Note: Prop = proportion.