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USFWS Office of Subsistence Management
Fishery Information Services Division

Stock Assessment of Sockeye Salmon from the Buskin River, Kodiak, Alaska, 2000

by

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and

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August 2003

Alaska Department of Fish and Game **Division of Sport Fish**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used in Division of Sport Fish Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications without definition. All others must be defined in the text at first mention, as well as in the titles or footnotes of tables and in figures or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

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

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

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

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
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
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

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	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
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.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
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
standard length	SL
total length	TL
variance	Var

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Annual Report Summary Page

Title: Stock assessment of sockeye salmon from the Buskin River, Kodiak, Alaska, 2000

Study Number: FIS 00-032

Investigator(s)/Affiliation(s): Donn Tracy, and Julia S. Schmidt, Alaska Department of Fish and Game, Division of Sport Fish, 211 Mission Road, Kodiak, AK 99615-6399, USA.

Management Regions: Kodiak Area, Bristol Bay/Alaska Peninsula/Kodiak Region

Information Type: Stock Status and Trends

Issue Addressed: Data collected from the project will be used for inseason management of subsistence, sport and commercial fisheries and to develop an escapement goal for this sockeye salmon stock.

Study Cost: $18,500

Study Duration: May 20, 2000 – August 15, 2000

Key Words: Age composition, Buskin River, Kodiak Island, sockeye salmon, *Oncorhynchus nerka*, subsistence harvest, weir.

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ABSTRACT

A weir was operated on the Buskin River on Kodiak Island, Alaska, from May 24 - July 31, 2000 to enumerate sockeye salmon *Oncorhynchus nerka*. During this period a total of 11,180 sockeye salmon were counted. The midpoint of the run occurred on June 12. Most sockeye salmon in the escapement were ages 1.3 or 2.3. The reported subsistence harvest was 7,281 sockeye salmon, most of which were also ages 1.3 or 2.3.

Key words: Buskin River, Kodiak Island, sockeye salmon, *Oncorhynchus nerka*, weir, subsistence harvest, age composition.

INTRODUCTION

The Buskin River (Figure 1), located approximately 2 miles from the city of Kodiak, is the most intensively fished river on Kodiak Island (Mills 1990-1994; Howe et al. 1995 and 1996, 2001a-d; Walker et al. 2003). A subsistence fishery in marine waters near the mouth of the Buskin River harvests large numbers of sockeye salmon *Oncorhynchus nerka*. Subsistence harvests averaged 4,837 sockeye salmon from 1990-1998 and increased to over 7,000 fish in 1999 and 2000 (Schwarz et al. 2002), making the Buskin River sockeye salmon return the largest contributor to subsistence harvests in federally managed waters within the Kodiak area.

Sockeye salmon from the Buskin River are also harvested by a recreational fishery which has been monitored by the Alaska Department of Fish and Game (ADF&G) since 1980. Sockeye salmon sport harvests averaged 1,725 fish from 1990-2000 and recreational fishing effort on the Buskin River has represented an average of 35% of the annual freshwater recreational fishing effort in the Kodiak Management Area (Schwarz et al. 2002). However, this effort has also been directed at other anadromous fish stocks including Dolly Varden *Salvelinus malma*, coho salmon *O. kisutch*, pink salmon *O. gorbuscha* and steelhead *O. mykiss*. Sockeye salmon from the Buskin River are harvested commercially, but to a lesser degree than by the subsistence and sport fisheries. Recent historic commercial harvests of sockeye salmon have been less than 100 fish annually.

Escapements of sockeye salmon returning to the Buskin River have been monitored since 1980. From 1980-1984, escapement was annually estimated using aerial survey counts. Beginning in 1985, a weir has been used to monitor escapement. From 1990-1999, annual sockeye salmon escapements into the Buskin River averaged 11,300 fish (Schwarz et al. 2002).

Although harvests and escapements have been historically monitored, age data from the subsistence harvest have been collected consistently since only 1993 (Schwarz and Clapsadl 2000). (In 1999 age data from the escapement and subsistence harvest were not collected due to budget constraints.) Consequently, at present there is insufficient information available to assess productivity of this salmon stock and to evaluate the biological escapement goal (BEG).

Estimates of total return by age from sampling the escapement and subsistence harvest are needed in order reconstruct the run and develop brood tables. Cumulative weir counts are needed for comparison to historic time of entry data in order to ensure fisheries are managed to achieve the BEG. Results from this project will ensure that the Buskin River sockeye salmon stock is not negatively affected by subsistence, sport or commercial fisheries.

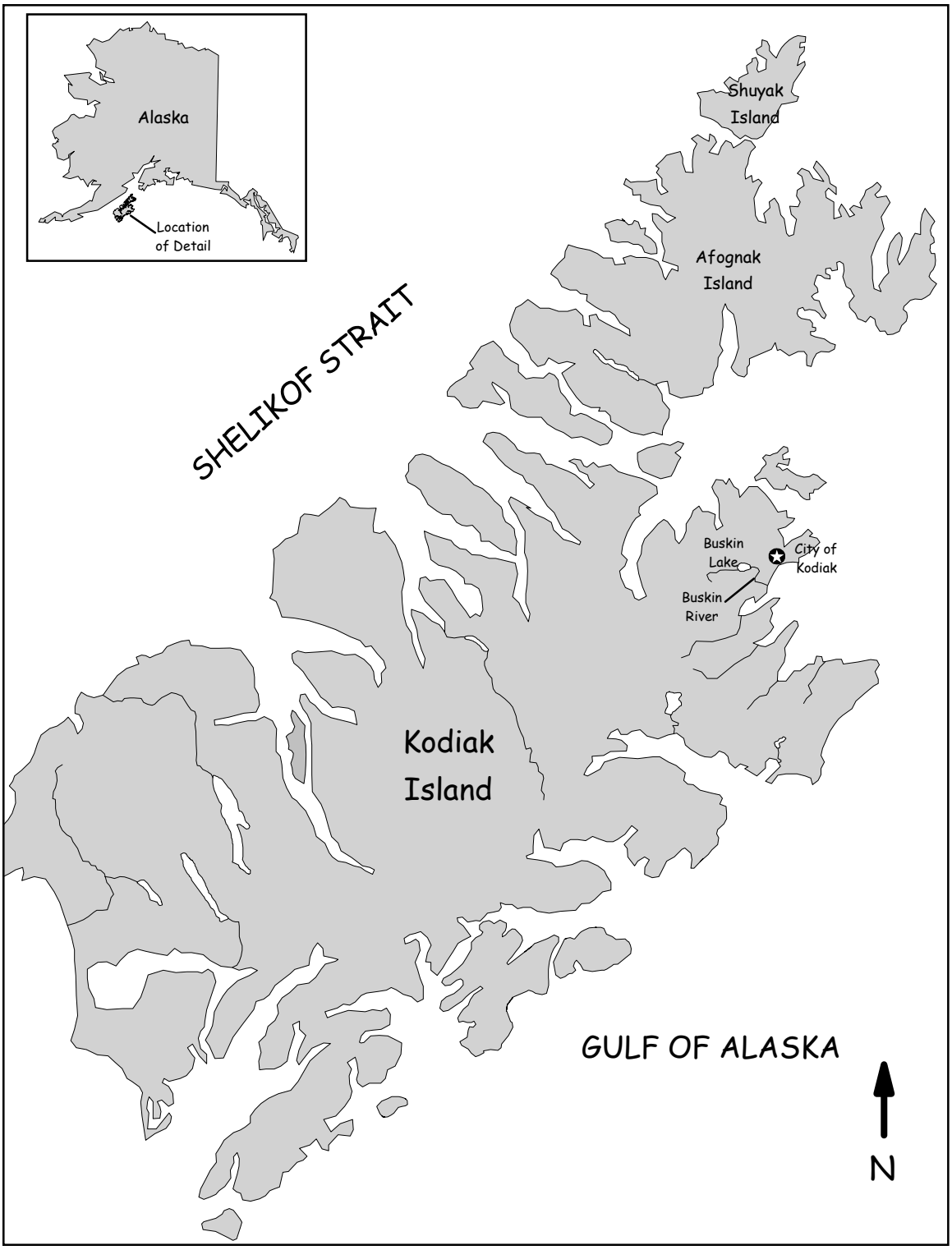

Figure 1.-Map of Kodiak Island.

The objectives of this study were to census the sockeye salmon escapement into the Buskin River during 2000, and to estimate the age composition of escapement and subsistence harvest of sockeye salmon returning to the Buskin River. This information will be used in conjunction with historic data and sport and commercial harvest estimates to begin development of a brood table to evaluate the sockeye salmon escapement goal for this system.

METHODS

BUSKIN RIVER WEIR

The spawning escapement of sockeye salmon was censused through a weir at the outlet of Buskin Lake (Figure 2) from May 24 - July 31, 2000. Fish present behind the weir were enumerated as they were allowed to migrate upstream. Daily counts of sockeye salmon were entered on salmon weir count forms. After July 31, the weir was moved to a downstream location to enumerate coho salmon.

AGE, SEX, AND LENGTH SAMPLING

We sampled sockeye salmon from the Buskin River weir sampling box during each of three temporal strata: May 20 – June 15, June 16-30, and July 1-31. Sampling was conducted on two days, one week apart, during each stratum. All fish entering the trap on selected days were sampled, even if the daily sample goal was exceeded. When large numbers (>100) of sockeye salmon were present behind the weir, fish were sampled during the early, middle and late portions of the time interval required for their passage upstream.

The subsistence harvest was sampled for age, sex, and length on the same schedule as escapement. Harvested fish were sampled from permit holders opportunistically within each time stratum. Sampling was conducted on the fishing grounds from a boat during good weather, or dockside at the local boat harbor.

Fish were measured from mid-eye to fork-of-tail and sex determined. Two scales were taken from each fish and mounted on a gum card. Scales were taken 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 (Clutter and Whitesel 1956). Scales were taken proximal to the preferred region when necessary, although only within the area bounded dorsally by the fourth row of scales above the lateral line, ventrally by the lateral line, and between lines drawn vertically from the posterior insertion of the dorsal fin and the anterior insertion of the anal fin. If scales were not available in the preferred region on the left side of the fish, scales were collected from the preferred region on the right side. Age was interpreted from scales using the criteria of Clutter and Whitesel (1956).

DATA ANALYSIS

Chi-squared statistics were used to test for differences in age and sex composition among temporal strata within each source (i.e. escapement or subsistence harvests) and also between each source. If differences were detected, estimates were stratified to minimize bias. If differences were not detected, age data were pooled to improve precision. The proportion of sockeye salmon from source h (escapement or subsistence harvest) during stratum i (i = 1,2,3) in age/sex class j was estimated as a binomial proportion by:

$$\hat{p}_{hij} = \frac{n_{hij}}{n_{hi}}, \tag{1}$$

and its variance by:

$$\hat{V}(\hat{p}_{hij}) = \left[\frac{N_{hi} - n_{hi}}{N_{hi}}\right]\frac{\hat{p}_{hij}\left(1 - \hat{p}_{hij}\right)}{n_{hi} - 1}, \tag{2}$$

where:

n_{hij} = the number of sockeye salmon from source h during stratum i that were in age/sex class j,

n_{hi} = the number of sockeye salmon sampled from source h during stratum i, and

N_{hi} = the total number of sockeye salmon in source h during stratum i.

Weir counts and permit returns of subsistence harvests were treated as censuses with no variance. In the event that temporal stratification was required for the subsistence harvest, N_{Si} was calculated by multiplying the total subsistence harvest by the proportion of the sockeye salmon run passing through the weir in temporal stratum i.

The number of fish from source h during stratum i of age/sex class j was estimated by:

$$\hat{N}_{hij} = N_{hi}\hat{p}_{hij}, \tag{3}$$

where N_{hi} = the total number of sockeye salmon from source h during stratum i;

and its variance by:

$$\hat{V}(\hat{N}_{hij}) = N_{hi}^2 \hat{V}(\hat{p}_{hij}). \tag{4}$$

The total number of fish from source h of age/sex class j was estimated as:

$$\hat{N}_{hj} = \sum_{i=1}^{t} \hat{N}_{hij}, \tag{5}$$

where t = the number of strata; and the variance was estimated as the sum of the variances as:

$$V\left(\hat{N}_{hj}\right) = \sum V\left(\hat{N}_{hij}\right). \tag{6}$$

The proportion of sockeye salmon of age/sex class j for the total of source h was estimated as:

$$\hat{p}_{hj} = \frac{\hat{N}_{hj}}{N_h}, \tag{7}$$

where N_h = the total for source h.

The variance of the proportion was estimated by:

$$V\left(\hat{p}_{hj}\right) = \frac{V\left(\hat{N}_{hj}\right)}{N_h^2}. \tag{8}$$

RESULTS

Between May 24 and July 31, 2000, a total of 11,180 sockeye salmon were counted through the Buskin River weir (Table 1). The highest daily count of 1,259 fish occurred on June 10 (Figure 3), even though the midpoint of the run occurred on June 12 (Figure 4). Age and sex data were collected for 430 sockeye salmon, and sex and length data for 482 fish. Age compositions in the escapement were not significantly different by temporal strata (χ^2 = 5.11, df = 4, P=.28) and were thus not stratified. Most fish in the escapement were ages 1.3 or 2.3 (Table 2). Mean length of females in the escapement was 523mm (SE = 3.01); mean length of males was 542 mm (SE = 4.81).

The subsistence harvest was 7,281 sockeye salmon in 2000. Age compositions were significantly different by temporal strata (χ^2 = 9.08, df = 3, P = 0.03) and the sample results were consequently stratified. Most fish in the subsistence harvest were ages 1.3 or 2.3 (Table 3). Mean length of females in the subsistence harvest was 543 mm (SE = 3), and 559 mm (SE = 4) for males.

The age composition of the escapement was significantly different from the subsistence harvest (χ^2 = 8.45, df = 4, P = 0.08).

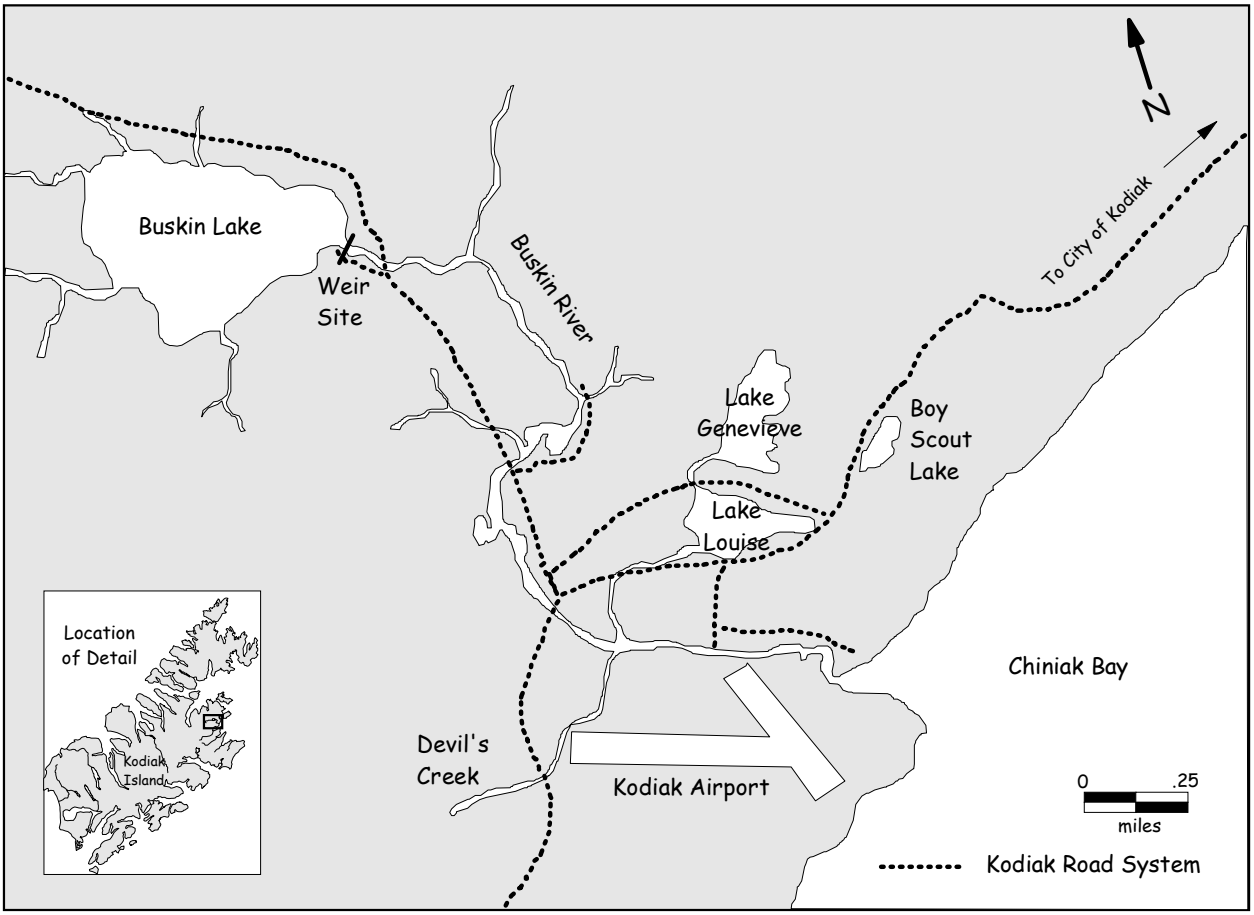

Figure 2.-Location of the Buskin River weir, 2000.

Table 1.-Immigration of sockeye salmon by date through the Buskin River weir, 2000.

Date	Number Counted	Cumulative %	Date	Number Counted	Cumulative %
24-May	0	0.0%	1-Jul	0	93.5%
25-May	0	0.0%	2-Jul	98	94.4%
26-May	0	0.0%	3-Jul	98	95.3%
27-May	2	0.0%	4-Jul	156	96.7%
28-May	0	0.0%	5-Jul	40	97.0%
29-May	0	0.0%	6-Jul	9	97.1%
30-May	3	0.0%	7-Jul	0	97.1%
31-May	181	1.7%	8-Jul	2	97.1%
1-Jun	16	1.8%	9-Jul	0	97.1%
2-Jun	0	1.8%	10-Jul	2	97.2%
3-Jun	206	3.6%	11-Jul	177	98.7%
4-Jun	454	7.7%	12-Jul	19	98.9%
5-Jun	434	11.6%	13-Jul	2	98.9%
6-Jun	0	11.6%	14-Jul	2	98.9%
7-Jun	1,259	22.8%	15-Jul	1	99.0%
8-Jun	739	29.4%	16-Jul	0	99.0%
9-Jun	616	34.9%	17-Jul	2	99.0%
10-Jun	136	36.1%	18-Jul	0	99.0%
11-Jun	611	41.6%	19-Jul	0	99.0%
12-Jun	1,240	52.6%	20-Jul	0	99.0%
13-Jun	412	56.3%	21-Jul	83	99.7%
14-Jun	9	56.4%	22-Jul	2	99.7%
15-Jun	461	60.5%	23-Jul	0	99.7%
16-Jun	5	60.5%	24-Jul	0	99.7%
17-Jun	250	62.8%	25-Jul	0	99.7%
18-Jun	69	63.4%	26-Jul	2	99.8%
19-Jun	640	69.1%	27-Jul	1	99.8%
20-Jun	728	75.6%	28-Jul	0	99.8%
21-Jun	160	77.0%	29-Jul	0	99.8%
22-Jun	142	78.3%	30-Jul	0	99.8%
23-Jun	0	78.3%	31-Jul	0	99.8%
24-Jun	1,104	88.1%			
25-Jun	137	89.4%	Total	11,180	
26-Jun	286	91.9%			
27-Jun	34	92.2%			
28-Jun	106	93.2%			
29-Jun	18	93.3%			
30-Jun	26	93.5%			

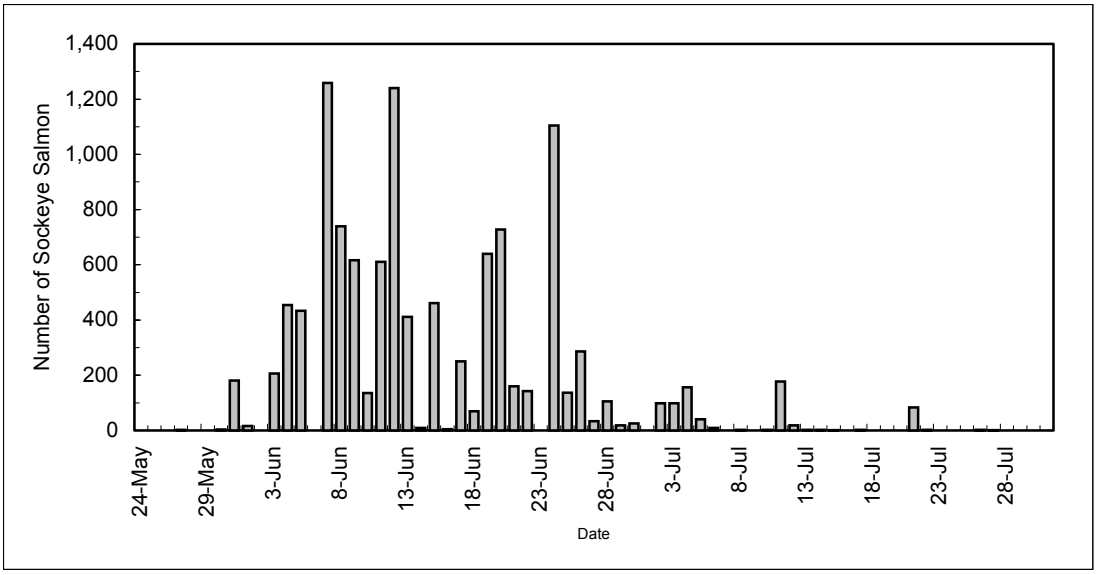

Figure 3.-Daily counts of sockeye salmon passing the Buskin River weir, 2000

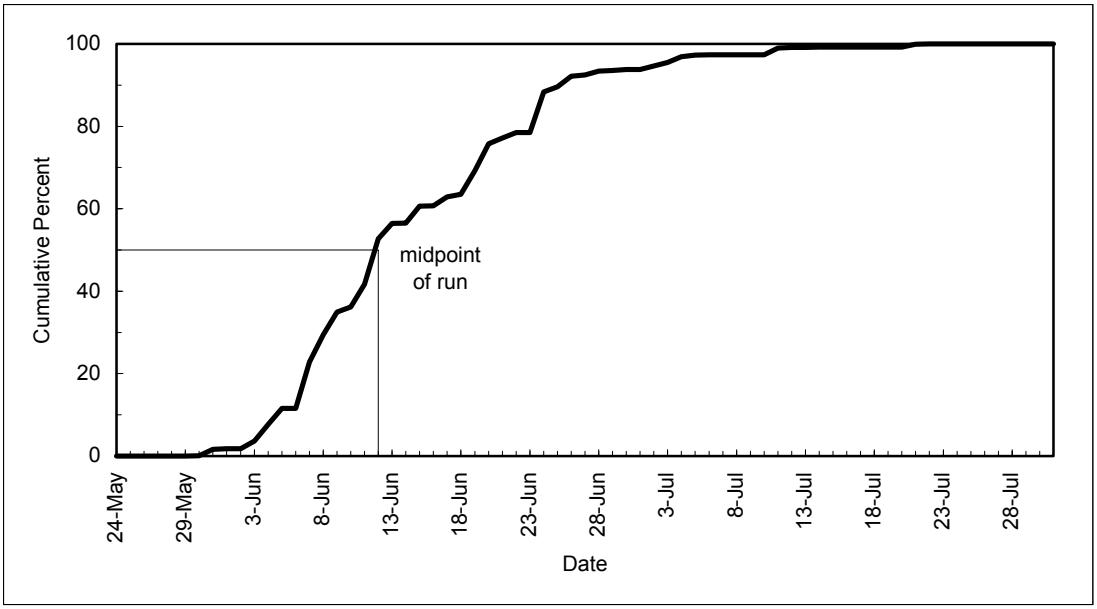

Figure 4.-Cumulative percent of sockeye salmon passing the Buskin River weir, 2000.

Table 2.-Estimates by age of Buskin River sockeye salmon escapement, 2000.

	Age					
Estimate	1.2	2.1	1.3	2.2	2.3	Total
Males						
Estimated Run	0	0	0	0	0	0
SE Run	0	0	0	0	0	0
Proportion	0.65	1.00	0.48	0.51	0.52	0.53
SE Proportion	0.10	0.00	0.07	0.12	0.08	0.04
Females						
Estimated Run	0	0	0	0	0	0
SE Run	0	0	0	0	0	0
Proportion	0.35	0.00	0.52	0.49	0.48	0.47
SE Proportion	0.13	0.00	0.07	0.12	0.08	0.04
Total						
Estimated Run	0	0	0	0	0	11,180
SE Run	0	0	0	0	0	
Proportion	0.14	0.01	0.41	0.13	0.31	1.00
SE Proportion	0.06	0.07	0.05	0.06	0.05	

Table 3.-Estimates by age and temporal stratum of the subsistence harvest of Buskin River sockeye salmon, 2000.

	Age							
Stratum	1.2	2.1	1.3	2.2	1.4	2.3	2.4	Total
20 May - 15 June	293	0	2,688	342	49	2,199	0	5,571
16 June - 30 June	98	0	733	98	49	538	49	1,564
01 July - 31 July	5	0	5	0	0	5	0	147
Total	396	0	3,425	440	98	2,741	49	7,281

Table 4.-Escapement of sockeye salmon into the Buskin River, 1985-2000.

Year	Escapement
1985	18,010
1986	8,939
1987	12,690
1988	12,144
1989	17,853
1990	10,528
1991	9,789
1992	9,782
1993	9,526
1994	11,783
1995	15,520
1996	9,661
1997	9,840
1998	14,767
1999	10,812
2000	11,233

Notes: From 1985-1989 the weir was operated upstream of Bridge #1 from April through October. Beginning in 1990, the weir has been located at the outlet of Buskin Lake during the sockeye immigration (June and July) and then moved to upstream of Bridge #1 during the coho immigration (mid-July through September). From 1990-1992 the weir at the lake outlet was also operated during the spring Dolly Varden emigration. Sockeye entering the tributary lakes of Louise and Genevieve are not counted at the upriver location.

Sources: 1985-1998 data from Schwarz and Clapsadl 2000; 1999-2000 data from Schwarz et al. 2002.

Table 5.-Reported subsistence harvests of Buskin River sockeye salmon, 1980-2000.

Year	Harvest
1980	4,279
1981	4,742
1982	6,748
1983	5,690
1984	565
1985	5,326
1986	5,303
1987	3,375
1988	3,099
1989	3,312
1990	3,448
1991	4,301
1992	3,295
1993	4,745
1994	4,899
1995	5,547
1996	5,403
1997	5,890
1998	6,011
1999	7,985
2000	7,281

Source: data for 1980-2000 from Schwarz et al. 2002.

DISCUSSION

The 2000 escapement of 11,233 sockeye salmon into the Buskin River was a little below the 12,055 average since weir operations began in 1985, while the subsistence harvest was the second highest since 1980. Escapements, subsistence harvests, and age estimates obtained from this project will be used with sport and commercial harvest data to construct brood tables. This information will then be used to evaluate and refine escapement goals for Buskin River sockeye salmon.

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