Fishery Data Series No. 16-47

Situk River Chinook and Sockeye Salmon Sport Harvest Estimates, 2008 -2011

by

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and

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December 2016

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

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ABSTRACT

For the years 2008-2011, sport angling effort, catch, and harvest was estimated on the Situk River using creel sampling interviews. This sampling was targeted at anglers fishing for Chinook salmon *Oncorhynchus tshawytscha* and sockeye salmon *Oncorhynchus nerka* on the Situk River from June 9 through July 31 each year. The methodology used in this report, and in past reports, utilized one sampler at a primary angler exit point on a lower portion of the river, and analysis with a mathematical expansion factor to expand that estimation and calculate fishery statistics for the entire drainage. In the last two years of this project period (2010 and 2011) a new method was also used that sampled all the exit points on the river with a second sampler in an attempt to improve precision. Chinook salmon fisheries were curtailed or closed on the Situk River by management actions all years of this report due to low abundance; during the same time, sockeye salmon abundance was high, and regulations were liberalized all years, except in 2008. Angler effort, measured in the number of hours fished, ranged from 8,782 to 10,701 hours per year. Foot traffic was the most common technique used by anglers, and jet boat travel was the least. Non-resident angler hours outnumbered resident angler hours. Non-guided angling effort was far more common than guided angling. The total number of Chinook salmon of all sizes caught ranged from 10 to 149, and the number harvested from zero to 64. Sockeye salmon catch ranged from 5,348 to 6,964 fish, and sockeye harvest ranged from 3,376 to 4,411 fish. In 2010 and 2011 the new sampling methodology estimated fishery performances with similar trends, but with lower estimates than the method used previously.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, sockeye salmon *Oncorhynchus nerka*, harvest, escapement, biological escapement goal, creel survey, Situk River, Yakutat, Southeast Alaska

INTRODUCTION

The Situk River is located in Southeast Alaska (SEAK) along the north coast of the Gulf of Alaska near The Village of Yakutat (Figure 1). The sport fishery for Situk River Chinook *Oncorhynchus tshawytscha* and sockeye salmon *Oncorhynchus nerka* provides a significant economic benefit for the local economy, and is utilized by both resident and nonresident anglers. The sport fisheries in the Situk River provide some of the only opportunity for angler harvest of Chinook salmon in fresh waters for the SEAK region, and the Situk River sockeye salmon fishery is one of the largest in the region. Chinook and sockeye salmon are also important subsistence and commercially sought species in the Yakutat area. In conjunction with biological escapement goals calculated by the Alaska Department of Fish and Game (ADF&G; Clark et al. 2002; McPherson et al. 2005), the Situk-Ahrnklin Inlet and Lost River Chinook Salmon Fisheries Management Plan (SCMP; 5 AAC 30.365) delineates specific multi-fishery management steps based on in-season Chinook salmon abundance, and both species are managed under this plan to achieve sustainability of all fisheries. The Situk Chinook and sockeye salmon creel project described in this report is used to estimate in season estimates of Chinook and sockeye salmon sport harvests so that managers can achieve the goals of the SCMP.

Figure 1.–The Situk River watershed in Southeast Alaska, and the three sampling locations for the Situk River Creel surveys.

Management goals are set for all utilized fish escapements on the Situk River. Biological escapement goals (BEGs) have been calculated for both Chinook and sockeye salmon in the Situk River. The Chinook salmon BEG is 450 to 1,050 large Chinook salmon (McPherson et al. 2005), and the sockeye salmon BEG is 30,000 to 70,000 fish (Clark et al. 2002). Fishery managers assess Chinook and sockeye salmon abundance on the Situk River with a weir located just above tidal influence (Figure 1). Commercial gillnet fisheries are prosecuted below the weir in the Situk-Ahrnklin Lagoon. Although subsistence gillnet fisheries can legally occur in-river, for fish quality reasons, most subsistence salmon are also taken within the lagoon (below the weir). Significant above-weir and inriver harvest of salmon is limited to the recreational fishery. The creel survey project described in this report is conducted by the Alaska Department of Fish and Game (ADF&G), Division of Sport Fish (DSF), to assess and predict inriver recreational harvest of salmon. Inseason escapement is calculated by subtracting the above-weir harvest of the recreational fishery from the weir count data. Data on abundance and run timing from previous years is used to predict expected escapement for any given week. If expected escapement differs markedly from current escapement, management measures such as daily limits can be altered to restrict or liberalize harvest potential in order to help achieve the escapement goals. Commercial fishing openers are also altered with similar rationale with this information.

This report describes results of the Situk River sport fishery creel survey for the years 2008–2011, similar to past reports for this project that include the years 2001–2003 (Johnson 2005) and 2004–2007 (Johnson 2008). These past reports, and the first two years covered under this report, utilized a single creel sampler at the primary angler exit point at the Lower Landing (Figure 1) of the Situk River. The fishery performance data that was gathered from this single-point sampler was then expanded mathematically to calculate estimates of year-end fishery performance for the entire drainage using information from previous years of this creel State Wide Harvest Survey (ADF&G 2016). Beginning in 2010 and continuing in 2011, the project also utilized a new second sampler methodology, and all angler exit points were covered in order to estimate fishery performance more directly. The two methods (as if with one sampler only and cumulatively with two samplers) are compared for 2010 and 2011 to help determine the necessity of the second sampler, which required additional expense. These inseason methodologies allow mangers to respond to inseason fish abundance and help achieve the SCMP.

METHODS

SINGLE SAMPLER METHODOLOGY

Chinook and sockeye salmon angling on the Situk River originates and terminates via 3 access points. These points are the Lower Landing, Maggie John Trail, and the bridge at Nine Mile of the Forest Highway 10 (Figure 1). Anglers do float trips from the Nine Mile Bridge downstream to the Lower Landing, boat upstream from the Lower Landing then return, or hike in from all three access points. As in past reports, a stratified two-stage “direct expansion” survey of anglers exiting the Situk River was used to estimate angler effort, as well as Chinook and sockeye salmon catch and harvest. A single sampler observed anglers at the Lower Landing boat ramp–trailhead, which is the primary exit point for anglers on the Situk River.

The daily sampling schedule timing, used since 2006, was identical for both strategies (1000–1630 and 1630–2300 hours). This two-stage survey design had “days” within each location/time

of day (TOD) stratum as primary sampling units and "anglers within days" as secondary sampling units. Once a "day" was selected for sampling within each location/TOD stratum, the entire sampling period was covered. On each sampled "day" all anglers seen exiting the Situk River fishery between the start and stop hours defining each period were interviewed if possible or were counted if they avoided the interview.

Plots of angler effort, catch, and harvest of Chinook salmon from 1999 showed clear differences in effort and catch/harvest per unit effort between time of day strata for both guided and unguided anglers at the Lower Landing access point (Johnson 2001). There was little evidence of a significant type-of-day (i.e., weekday/weekend) effect for guided anglers and mild evidence for type-of-day effects for unguided anglers around the 4th of July (near the peak of the Chinook salmon fishery). Thus, a TOD stratified design (Bernard et al. 1998) has been used since 2000.

The logistics of this type of survey necessitate a tradeoff between unbiased estimates and precision (Bernard et al. 1998). Since 2000, we have allocated equal sampling effort between mid- and late-day strata. Because the mid-day stratum has had slightly greater harvest on average, it was sampled systematically, every third day, with a random starting day. Sampling of the late-day stratum was constrained to preserve back-to-back days off for the technicians, which led to sampling 2 consecutive days with 4 days in between ("quasi-systematic" sampling).

Table 1.–Summary of Typical stratification structure and sampling characteristics for the Situk River Chinook salmon creel survey at the Lower Landing, June 1-July 31.

Stratum	Time of day	Number of days	Days sampled	Sampling method[a]
Mid-day	1000 - 1630	61	21	SYS
Late-day	1630 - 2300	61	20	q-SYS

[a] SYS = systematic sampling; q-SYS = quasi-systematic sampling.

This method produces data to calculate fishery statistic estimates (# of hours, # of fish by species, etc.) per each stratum from the Lower Landing access site observations, and these estimates are then used to calculate a total yearly estimate with a mathematical expansion factor (see derivation below in Data Analysis section) to account for anglers at other sites and outside of the sampling schedule. The creel survey utilizing one sampler at the Lower Landing captures a large fraction, but not 100%, of the Chinook and sockeye salmon angling. Additional anglers fish before the 9 June project start date, as well as by accessing from Nine Mile Bridge and Maggie John Trail, and also before and after the hours of the survey. As such, an expansion factor (Appendix A) is needed to multiply the calculated stratum estimates into total year end estimates per stratum ($\widehat{N}_{ht}$). We used the relationship between the ADF&G Statewide Harvest Survey (SWHS) (see Appendix A) and the creel observations to derive an expansion factor (E_1) to expand the creel observations per stratum up to year-end estimates. The calculation of fishery statistics and analysis of this methods data is found below in the Data Analysis section.

TWO-SAMPLER METHODOLOGY

In order to test potential improvements to the sampling methodology, a second sampler was also used beginning in 2010 utilizing the same sampling schedule and interview method previously identified for the Lower Landing, while adding a second sampler to observe at the Nine Mile Bridge and Maggie John Trailhead. The rotation schedule for these two new sites was to systematically sample each location every other day (except the scheduled days off) after

randomly selecting which area was sampled on the first day. This method then produced stratum estimates analogous to the above method, but for each of the three access sites on the Situk River.

A summary of the stratification structure for the second sampler at Nine Mile Bridge and Maggie John Trailhead access points is presented in Table 2. The second sampler samples daily as in the one sampler method (Table 1).

Table 2.–Summary of stratification structure and sampling characteristics for the second sampler of the Situk River Chinook salmon creel survey at Nine Mile Bridge and Maggie John Trailhead, June 1-July 31.

Location[a]	TOD stratum	Time of day	Number of days	Sampling method for days[b]	Days sampled
MJT	Mid-day	1000 - 1630	61	SYS	11
	Late-day	1630 - 2300	61	SYS	10
NMB	Mid-day	1000 - 1630	61	SYS	10
	Late-day	1630 - 2300	61	SYS	10

[a] MJT = Maggie John Trailhead; NMB = Nine Mile Bridge.
[b] SYS = systematic sampling.

DATA ANALYSIS

EFFORT, CATCH, AND HARVEST

Angler effort (in hours), catch, and harvest of Chinook and sockeye salmon in each stratum were estimated using procedures for a stratified two-stage sample survey (Cochran 1977) where "days" (mid- or late-day periods) are first stage sampling units and "anglers" are second stage sampling units. Location and time of day were considered their own strata. First, the mean harvest (or catch or effort) is obtained over all anglers interviewed within each sampled day and location:

$$\bar{n}_{hi} = \frac{\sum_{j=1}^{m_{hi}} n_{hij}}{m_{hi}} \quad (1)$$

Where n_{hij} is the number of Chinook salmon harvested (or caught, etc.) by interviewed person j during sampled day i for location/TOD stratum h, and m_{hi} is the number of people interviewed during each day. This estimate is then expanded by the number of people (counted) who exit the site during the day (M_{hi}) to estimate a total for each sampled day:

$$\hat{N}_{hi} = M_{hi}\bar{n}_{hi} \quad (2)$$

The mean harvest over all days sampled within each stratum is then estimated:

$$\bar{\hat{N}}_h = \frac{\sum_{i=1}^{d_h} \hat{N}_{hi}}{d_h} \quad (3)$$

where d_h is the number of days sampled in each stratum. This estimate is multiplied by the number of days in the stratum (D_h) to estimate a total for each stratum:

$$\hat{N}_h = D_h \bar{\hat{N}}_h \quad (4)$$

For the single sampler method the two strata correspond to the early and late period of sampling at the lower landing.

For the two-sampler method the strata correspond to the early and late period of sampling at the lower landing, as well as at Nine Mile Bridge and the Maggie John Trailhead.

For either the single sampler or the two-sampler method, there is harvest that occurs outside of the sampling schedule either extending beyond the season of sampling, or extending beyond the hours of sampling within the season. For the two-sampler method this harvest is considered to be small because all of the main fishery exits are sampled. However, for the single sampler method the harvest that occurs via the other main exit locations is more substantial. As such, for the single sampler method, an expansion factor (Appendix A) is needed to multiply the calculated stratum estimates into expanded year-end estimates per stratum ($\hat{N}_{eh}$). We used the relationship between the ADF&G, SWHS estimate of Chinook salmon harvest, and this creel estimate of Chinook salmon harvest to derive an expansion factor (E_1) equal to 1.19 (SE = 0.159) to expand the creel estimates per stratum. Those estimates $(\hat{N}_{eh})$ were then added to give the expanded year-end estimates for the single sampler method $(\hat{N}_1)$.

$$\hat{N}_1 = \sum_h \hat{N}_{eh} = \sum_h \hat{N}_h * E_1 \quad (5)$$

For the two-sampler method, final total drainage year-end statistics ($\hat{N}_2$) are calculated by summing strata estimates, and no expansion factor is used:

$$\hat{N}_2 = \sum_h \hat{N}_h \quad (6)$$

Estimates of catch and angler effort are obtained similarly by substituting the appropriate statistics (catch or effort) into equations (1) through (3), above. Similar substitutions are obtained to estimate resident versus nonresident trips, guided versus non-guided trips, and type of access used by the angler.

The variance of the stratum estimates is estimated:

$$\hat{V}[\hat{N}_h] = (1 - f_{1h}) D_h^2 \frac{S_{1h}^2}{d_h} + \frac{D_h}{d'_h} \sum_{i=1}^{d'_h} \hat{V}[\hat{N}_{hi}] \quad (7)$$

where $f_{1h} = d_h / D_h$ is the sample fraction for "days", S_{1h}^2 is sample variance among "days", and $d_h^{'}$ is the number of days in which s_{2hi}^2 (see below) are estimable (i.e., when at least 2 people are interviewed or the number interviewed equals the number counted). The among-day sample variance for days selected systematically for sampling (the mid-day stratum for all locations and late-day stratum for Maggie John Trailhead and Nine Mile Bridge) is estimated using an approximation proposed by Wolter (1985):

$$S_{1h}^2 \approx \frac{\sum_{i=2}^{d_h}\left(\hat{N}_{hi} - \hat{N}_{h(i-1)}\right)^2}{2(d_h - 1)} \quad (8)$$

The among-angler variance component (usually 0 in this survey because all anglers exiting the fishery are interviewed) is estimated by:

$$\hat{V}\left[\hat{N}_{hi}\right] = \left(1 - \frac{m_{hi}}{M_{hi}}\right) M_{hi}^2 \frac{s_{2hi}^2}{m_{hi}} \quad (9)$$

where s_{2hi}^2 is the among-angler sample variance:

$$s_{2hi}^2 = \frac{\sum_{j=1}^{m_{hi}}\left(n_{hij} - \bar{n}_{hi}\right)^2}{m_{hi} - 1} \quad (10)$$

Sampling in the late-day stratum is "quasi"-systematic—i.e., it has non-regular sampling intervals between sampling days. However, if two consecutive days are considered as a single sampling unit (see sampling schedule in Table 1 and 2), then sampling becomes systematic with respect to the new 2-day sampling units. In this case, equations (1) - (11) can still be used for the late-day stratum at Lower Landing with the appropriate substitutions. For example, n_{hij} becomes the number of Chinook salmon harvested (or caught, etc.) by interviewed person j during sampled 2-day period i for late-day stratum; the number of days sampled, d_h, becomes the number of 2-day units sampled; the total for each sampled day, $\hat{N}_{hi}$, becomes the total for each 2-day sampling unit; the number of days in the stratum, D_h, becomes the number of 2-day units in the late-day stratum; etc.

For the single sampler method expanded estimates for stratum estimates are obtained by multiplying $\hat{N}_h$ in turn by the expansion factor ($\hat{E}_1$ = 1.19, SE = 0.15, Figure 3) to account for harvest outside the framework of the creel survey design, and therefore the variance for the expanded stratum is calculated by the application of Goodman's (1960) formula and those independent variances $\hat{V}\left[\hat{N}_{eh}\right]$ are summed to give the variance for the single sampler method $\hat{V}\left[\hat{N}_1\right]$:

$$\hat{V}\left[\hat{N}_1\right] = \sum_h \hat{V}\left[\hat{N}_{eh}\right] = \sum_h \hat{N}_h^2 \hat{V}\left[\hat{E}_1\right] + \hat{E}_1^2 \hat{V}\left[\hat{N}_{\mathrm{h}}\right] - \hat{V}\left[\hat{E}_1\right]\hat{V}\left[\hat{N}_{\mathrm{h}}\right] \quad (11)$$

For the single sampler method the two strata correspond to the early and late period of sampling at the lower landing.

For the two-sampler method, variances of strata are also summed. The strata of the two-sampler method corresponds to the early and late period of sampling at the lower landing and the sampling that occurs at the Nine Mile Bridge and the Maggie John Trailhead. The variance for the two-sampler method can be written as:

$$\hat{V}\left[\hat{N}_2\right] = \sum_h \hat{N}_{\mathrm{h}} \quad (12)$$

Variances of the stratum estimates of catch by species and angler effort were obtained similarly, by substituting the appropriate catch and effort statistics into equations (7) through (10).

RESULTS

In 2008, 10,701 (SE = 1,258) hours were expended angling (Table 4) for Chinook and sockeye on the Situk River, 8,199 (SE = 1,133) hours of which were not guided and 2,510 (SE = 478) which were guided[1]. The vast majority of angling effort was by foot, followed by drift boats (Table 3). Nonresident anglers dominated the effort with 10,337 (SE = 1,232) hours, while resident anglers expended only 373 (SE = 103) hours. All Anglers in total (representing both categories of residency or guided status) caught 270 (SE = 57) Chinook salmon releasing 270 (SE = 57), and caught 6,562 (SE = 623) sockeye salmon, releasing 2,986 (SE = 430) in 2008. The majority of the salmon were caught below the weir by nonresident anglers on foot, that were not guided (Tables 4-7), and the proportion of all salmon caught below the weir in 2008 was 92% (SE = 0.6%), which was the highest as compared to the other subsequent years of this study.

Table 3.–Angler-hours of effort expended by anglers per each travel method and total on the Situk River, 2008-2011.

	All Angler Hours and (SE) Per Method				
Year	Foot[a]	Jet[b]	Prop[c]	Drift[d]	All Total
2008	8,190 (1044)	225 (119)	1,263 (358)	1,425 (301)	10,710 (1,258)
2009	5,376 (744)	733 (280)	1,407 (353)	2,246 (453)	9,814 (1,234)
2010	4,267 (612)	329 (144)	2,605 (360)	3,076 (573)	10,253 (1,248)
2011	4,040 (474)	1,163 (300)	1,248 (250)	1,992 (416)	8,782 (906)

[a] mode of travel by foot

[b] mode of travel by jet boat

[c] mode of travel by propeller boat

[d] mode of travel by drifted boat with oars

Table 4.–Fish species caught above and below the Situk weir, 2008-2011.

Fish species caught	2008	SE	2009	SE	2010	SE	2011	SE
Sockeye kept above	360	85	768	133	669	134	526	149
Sockeye released above	118	41	905	217	628	175	353	107
Sockeye kept below	3,216	442	2,607	349	3,292	485	3,885	442
Sockeye released below	2,867	428	1,067	207	2,144	380	2,199	323
Jack Chinook kept above	0	0	0	0	11	7	53	18
Jack Chinook released above	18	11	4	3	0	0	0	0
Jack Chinook kept below	0	0	0	0	0	0	11	9
Jack Chinook released below	11	5	11	7	4	3	51	27
Small Chinook kept above	0	0	0	0	0	0	0	0
Small Chinook released above	0	0	0	0	0	0	0	0
Small Chinook kept below	0	0	0	0	25	13	0	0
Small Chinook released below	93	38	15	10	14	6	4	3
Large Chinook kept above	0	0	0	0	0	0	0	0
Large Chinook released above	40	22	7	4	0	0	3	3
Large Chinook kept below	0	0	4	3	0	0	0	0
Large Chinook released below	109	34	25	13	22	8	7	4

[1] Unless otherwise noted, all results are considered preliminary estimates.

Table 5.–Salmon caught by anglers along the Situk River per each method of travel, 2008-2011.

Species caught above or below weir in 2008 per each travel method	Foot	SE	Drift Boat	SE	Prop Boat	SE	Jet Boat	SE
Sockeye kept above	135	42	251	92	42	17	0	0
Sockeye released above	14	10	101	38	0	0	0	0
Sockeye kept below	2,840	409	207	63	581	178	19	16
Sockeye released below	2,510	393	121	63	615	209	0	0
Jack Chinook kept above	0	0	0	0	0	0	0	0
Jack Chinook released above	0	0	15	10	4	3	0	0
Jack Chinook kept below	0	0	0	0	0	0	0	0
Jack Chinook released below	11	5	0	0	0	0	0	0
Small Chinook kept above	0	0	0	0	0	0	0	0
Small Chinook released above	0	0	0	0	0	0	0	0
Small Chinook kept below	0	0	0	0	0	0	0	0
Small Chinook released below	93	38	0	0	0	0	0	0
Large Chinook kept above	0	0	0	0	0	0	0	0
Large Chinook released above	0	0	36	22	4	3	0	0
Large Chinook kept below	0	0	0	0	0	0	0	0
Large Chinook released below	81	23	4	3	25	18	0	0
Species caught above or below weir in 2009 per each travel method	Foot	SE	Drift Boat	SE	Prop Boat	SE	Jet Boat	SE
Sockeye kept above	89	39	550	108	96	44	11	10
Sockeye released above	82	47	739	197	84	50	0	0
Sockeye kept below	1,599	243	298	116	437	115	273	106
Sockeye released below	592	150	269	126	103	55	103	61
Jack Chinook kept above	0	0	0	0	0	0	0	0
Jack Chinook released above	0	0	0	0	4	3	0	0
Jack Chinook kept below	0	0	0	0	0	0	0	0
Jack Chinook released below	11	7	0	0	0	0	0	0
Small Chinook kept above	0	0	0	0	0	0	0	0
Small Chinook released above	0	0	0	0	0	0	0	0
Small Chinook kept below	0	0	0	0	0	0	0	0
Small Chinook released below	11	10	4	3	0	0	0	0
Large Chinook kept above	0	0	0	0	0	0	0	0
Large Chinook released above	0	0	4	3	4	3	0	0
Large Chinook kept below	4	3	0	0	0	0	0	0
Large Chinook released below	14	10	7	6	4	3	0	0

-continued-

Table 5.–Page 2 of 2.

Species caught above or below weir in 2010 per each travel method	Foot	SE	Drift Boat	SE	Prop Boat	SE	Jet Boat	SE
Sockeye kept above	39	23	370	100	232	60	0	0
Sockeye released above	25	19	427	166	150	54	0	0
Sockeye kept below	1,552	265	558	117	971	154	253	96
Sockeye released below	950	243	647	256	455	105	138	50
Jack Chinook kept above	0	0	7	6	4	3	0	0
Jack Chinook released above	0	0	0	0	0	0	0	0
Jack Chinook kept below	0	0	0	0	0	0	0	0
Jack Chinook released below	0	0	0	0	4	3	0	0
Small Chinook kept above	0	0	0	0	0	0	0	0
Small Chinook released above	0	0	0	0	0	0	0	0
Small Chinook kept below	0	0	14	9	11	9	0	0
Small Chinook released below	7	4	8	5	0	0	0	0
Large Chinook kept above	0	0	0	0	0	0	0	0
Large Chinook released above	0	0	0	0	0	0	0	0
Large Chinook kept below	0	0	0	0	0	0	0	0
Large Chinook released below	15	8	0	0	7	5	0	0
Species caught above or below weir in 2011 per each travel method	Foot	SE	Drift Boat	SE	Prop Boat	SE	Jet Boat	SE
Sockeye kept above	0	0	493	130	33	28	0	0
Sockeye released above	0	0	267	84	86	45	0	0
Sockeye kept below	2,714	329	207	70	664	130	644	187
Sockeye released below	957	149	20	9	636	203	415	137
Jack Chinook kept above	0	0	53	18	0	0	0	0
Jack Chinook released above	0	0	0	0	0	0	0	0
Jack Chinook kept below	21	12	0	0	0	0	0	0
Jack Chinook released below	27	13	0	0	0	0	10	7
Small Chinook kept above	0	0	0	0	0	0	0	0
Small Chinook released above	0	0	0	0	0	0	0	0
Small Chinook kept below	0	0	0	0	0	0	0	0
Small Chinook released below	7	4	0	0	0	0	0	0
Large Chinook kept above	0	0	0	0	0	0	0	0
Large Chinook released above	0	0	3	3	0	0	0	0
Large Chinook kept below	0	0	0	0	0	0	0	0
Large Chinook released below	7	4	0	0	4	3	0	0

Table 6.–Salmon caught by anglers along the Situk River with and without guides.

Species caught above and below weir	Year 2008				Year 2009			
	Guide	SE	No guide	SE	Guide	SE	No guide	SE
Sockeye kept above	325	90	35	30	520	100	248	69
Sockeye released above	89	31	30	26	632	182	273	95
Sockeye kept below	767	164	2,648	388	402	122	2,205	282
Sockeye released below	265	71	2,603	406	170	83	898	158
Jack Chinook kept above	0	0	0	0	0	0	0	0
Jack Chinook released above	4	3	15	10	4	3	0	0
Jack Chinook kept below	0	0	0	0	0	0	0	0
Jack Chinook released below	0	0	11	5	0	0	11	7
Small Chinook kept above	0	0	0	0	0	0	0	0
Small Chinook released above	0	0	0	0	0	0	0	0
Small Chinook kept below	0	0	0	0	0	0	0	0
Small Chinook released below	0	0	93	38	0	0	15	10
Large Chinook kept above	0	0	0	0	0	0	0	0
Large Chinook released above	7	4	33	20	7	4	0	0
Large Chinook kept below	0	0	0	0	0	0	4	3
Large Chinook released below	21	18	88	25	0	0	25	13

Species caught above and below weir	Year 2010				Year 2011			
	Guide	SE	No guide	SE	Guide	SE	No guide	SE
Sockeye kept above	532	112	137	63	393	124	133	65
Sockeye released above	447	156	182	87	264	93	90	44
Sockeye kept below	1,028	176	2,263	348	1,017	172	2,868	370
Sockeye released below	871	271	1,273	264	772	186	1,426	237
Jack Chinook kept above	4	3	7	6	53	18	0	0
Jack Chinook released above	0	0	0	0	0	0	0	0
Jack Chinook kept below	0	0	0	0	0	0	11	9
Jack Chinook released below	4	3	0	0	10	7	41	24
Small Chinook kept above	0	0	0	0	0	0	0	0
Small Chinook released above	0	0	0	0	0	0	0	0
Small Chinook kept below	11	9	14	9	0	0	0	0
Small Chinook released below	0	0	14	6	0	0	4	3
Large Chinook kept above	0	0	0	0	0	0	0	0
Large Chinook released above	0	0	0	0	3	3	0	0
Large Chinook kept below	0	0	0	0	0	0	0	0
Large Chinook released below	7	4	15	8	4	3	4	3

Table 7.–Salmon caught and kept by Alaskan resident and other nonresident anglers along the Situk River, 2008-2011.

Species caught above and below weir	2008 State Residency				2009 State Residency			
	AK	SE	Other	SE	AK	SE	Other	SE
Sockeye kept above	0	0	360	85	14	10	754	136
Sockeye released above	0	0	119	41	105	76	800	200
Sockeye kept below	59	20	3,356	467	192	83	2,414	307
Sockeye released below	123	71	2,745	425	83	46	984	194
Jack Chinook kept above	0	0	0	0	0	0	0	0
Jack Chinook released above	0	0	18	11	0	0	4	3
Jack Chinook kept below	0	0	0	0	0	0	0	0
Jack Chinook released below	0	0	11	5	0	0	11	7
Small Chinook kept above	0	0	0	0	0	0	0	0
Small Chinook released above	0	0	0	0	0	0	0	0
Small Chinook kept below	0	0	0	0	0	0	0	0
Small Chinook released below	0	0	93	38	0	0	15	10
Large Chinook kept above	0	0	0	0	0	0	0	0
Large Chinook released above	0	0	40	22	0	0	7	4
Large Chinook kept below	0	0	0	0	0	0	4	3
Large Chinook released below	0	0	109	34	4	3	21	11

Species caught above and below weir	2010 State Residency				2011 State Residency			
	AK	SE	Other	SE	AK	SE	Other	SE
Sockeye kept above	11	10	658	135	37	19	490	141
Sockeye released above	89	77	539	154	34	15	320	100
Sockeye kept below	229	56	3,063	458	188	42	3,697	417
Sockeye released below	141	44	2,002	368	179	51	2,019	293
Jack Chinook kept above	0	0	11	7	0	0	53	18
Jack Chinook released above	0	0	0	0	0	0	0	0
Jack Chinook kept below	0	0	0	0	0	0	11	9
Jack Chinook released below	0	0	4	3	0	0	51	27
Small Chinook kept above	0	0	0	0	0	0	0	0
Small Chinook released above	0	0	0	0	0	0	0	0
Small Chinook kept below	0	0	25	13	0	0	0	0
Small Chinook released below	4	3	11	5	0	0	4	3
Large Chinook kept above	0	0	0	0	0	0	0	0
Large Chinook released above	0	0	0	0	0	0	3	3
Large Chinook kept below	0	0	0	0	0	0	0	0
Large Chinook released below	0	0	22	8	0	0	7	4

In 2009, 9,814 (SE = 1,234) hours were expended angling (Tables 3–7) for Chinook and sockeye on the Situk River, 7,620 (SE = 1,050) hours of which were not guided and 2,193 (SE = 394) which were guided. The vast majority of angling effort was by foot followed by drift boats (Table 3). Nonresident anglers dominated the effort with 9,212 (SE = 1,143) hours and resident anglers expended 601 (SE = 162) hours. All anglers in total (representing both categories of residency or guided status) caught 64 (SE = 19) Chinook salmon, releasing 61 (SE = 19), and anglers caught 5,348 (SE = 479) sockeye salmon releasing 1,972 (SE = 300). The majority of the salmon were caught below the weir by nonresident anglers on foot who were not guided (Tables 4–7) and the proportion of all salmon caught below the weir in 2009 was 69 % (SE = 1.0), which was the lowest compared to the other years of this study.

In 2010, 10,253 hours (SE = 1,248) were expended angling (Tables 3–7) for Chinook and sockeye on the Situk River, 6,517 (SE = 921) hours of which were not guided and 3,735 (SE = 560) which were guided. The vast majority of angling effort was by foot followed by drift boats (Table 3). Nonresident anglers dominated the effort with 9,610 (SE = 1,175) hours and resident anglers expended 642 (SE = 142) hours. All Anglers in total (representing both categories of residency or guided status) caught 75 (SE = 18) Chinook salmon, releasing 40 (SE = 10), and anglers caught 6,734 (SE = 654) sockeye salmon releasing 2,772 (SE = 419). The majority of the salmon were caught below the weir by nonresident anglers on foot who were not guided (table 4–7) and the proportion of all salmon caught below the weir in 2010 was 81% (SE = 0.8). In 2010 the second sampler method estimated the overall angler hours at 8,598 (SE = 709) and the sockeye catch at 5,647 (SE = 452), and both of these statistics are lower than that of the calculations with the single sampler method for that year.

In 2011, 8,782 (SE = 906) hours were expended angling (Tables 3–7) for Chinook and sockeye on the Situk River, 5,597 (SE = 633) hours of which were not guided and 3,184 (SE = 422) which were guided. As observed in all other seasons, the vast majority of angling effort occurred by foot, followed by drift boats (Table 3). Nonresident anglers dominated the effort with 8,335 (SE = 859) hours and resident anglers expended 447 (SE = 108) hours. All Anglers in total (representing both categories of residency or guided status) caught 128 (SE = 34) Chinook salmon, releasing 65 (SE = 28), and anglers caught 6,964 (SE = 578) sockeye salmon releasing 2,552 (SE = 340). Again, similar to all other years, the majority of the salmon were caught below the weir by nonresident anglers on foot that were not guided(Tables 4–7) and the proportion of all salmon caught below the weir in 2011 was 87% (SE = 0.6). In 2011 the second sampler method estimated the overall angler hours at 7,364 (SE = 368) and the sockeye catch at 5,840 (SE = 337). Both of these statistics are lower than the calculations with the single sampler method for that year.

DISCUSSION

TRENDS IN FISHERY STATISTICS

Historically, creel sampling studies of Chinook or sockeye salmon recreational fisheries on the Situk River have occurred with different methodologies between 1989–1997 (Glynn 1992; Johnson 2001, 2005, 2008), and continuous studies have used similar methods since 1998. Studies with similar methodology have shown that Chinook salmon catch ranged from 73 to 1,815 fish and sockeye salmon catch ranged from 4,407 to 11,225 fish. The results of the current reporting period are similar but at the low end of those reported ranges for sockeye and Chinook salmon catch, but Chinook salmon harvest was markedly lower during 2008–2011. Chinook

salmon fishery harvest statistics began to decline in 2005 (Johnson 2008), and have continued to decline into the current reporting period (2008-2011).

In addition to fish abundance, the productivity of Chinook and sockeye salmon angling on the Situk River could also be influenced by regulation changes, specific to freshwaters. Regulations are set and or changed by the Alaska Board of Fisheries (BOF) process. These regulations are permanent and remain in effect until changed by subsequent BOF decisions. The BOF process reviews and potentially changes regulations at regional meetings held every 3 years in response changes in fish abundance, allocation issues among fisheries, or public request. The BOF changed the Situk River sockeye salmon fishery regulations in 2009, lowering the sockeye daily bag limit from 6 to 3 per day. These regulatory changes may have altered angler effort and salmon catch during this reporting period.

Angling statistics can also be altered by temporary in-season regulation changes. Emergency Orders (EO) are temporary in-season adaptations of regulations enacted by local fishery managers in response to seasonal fish abundance changes. When inseason weir counts of fish show escapement to be in excess of established goals, an EO can be issued to liberalize bag limits and harvest opportunity. Conversely, inseason escapement counts that project numbers lower than established goals can result in emergency order restrictions that lower harvest opportunity. Emergency Orders were used in every year of this report to restrict the Chinook salmon fishery due to low escapements. Emergency Orders were also used in 2008 to restrict the sockeye salmon fishery due to low escapement, and EOs were used in 2009 and 2011 to increase bag limits in the sockeye salmon fishery due to high escapements. These inseason changes to angling regulation likely altered angler use and success on the Situk River.

Evidence for the effect of permanent regulatory changes on harvest is shown with sockeye salmon management as it occurred in this reporting period. Harvest of sockeye salmon has decreased for this reporting period as compared to previous years, even though most years had observed high escapements after 2008. This likely resulted from the BOF change of the sockeye salmon daily bag limit from 6 to 3 per day in 2009, which cut daily harvest potential in half. High escapements and increases of the daily bag limits through EOs mitigated that effect to some degree, but escapement counts did not always show that escapement was high until late in the run. For example, in 2009 the high weir counts and the resulting EO that raised sockeye bag limits back to six could not be issued until late July. By late July 2009 angler effort had waned, which typically peaks in mid-July (Figure 2), so that the changes had only a small effect on overall effort and harvest (Figure 2B; Tables 4-7). In 2011, however, high escapement counts occurred early in the run, and the resultant EO was issued earlier. An earlier and sustained increase (June 27 peak) in overall effort (Figure 2D) and sockeye harvest (Tables 4–7) occurred in 2011, resulting in that year experiencing the highest sockeye harvest in this reporting period. These observations suggest that EOs have changed both angling preferences and sockeye salmon harvests on the Situk River.

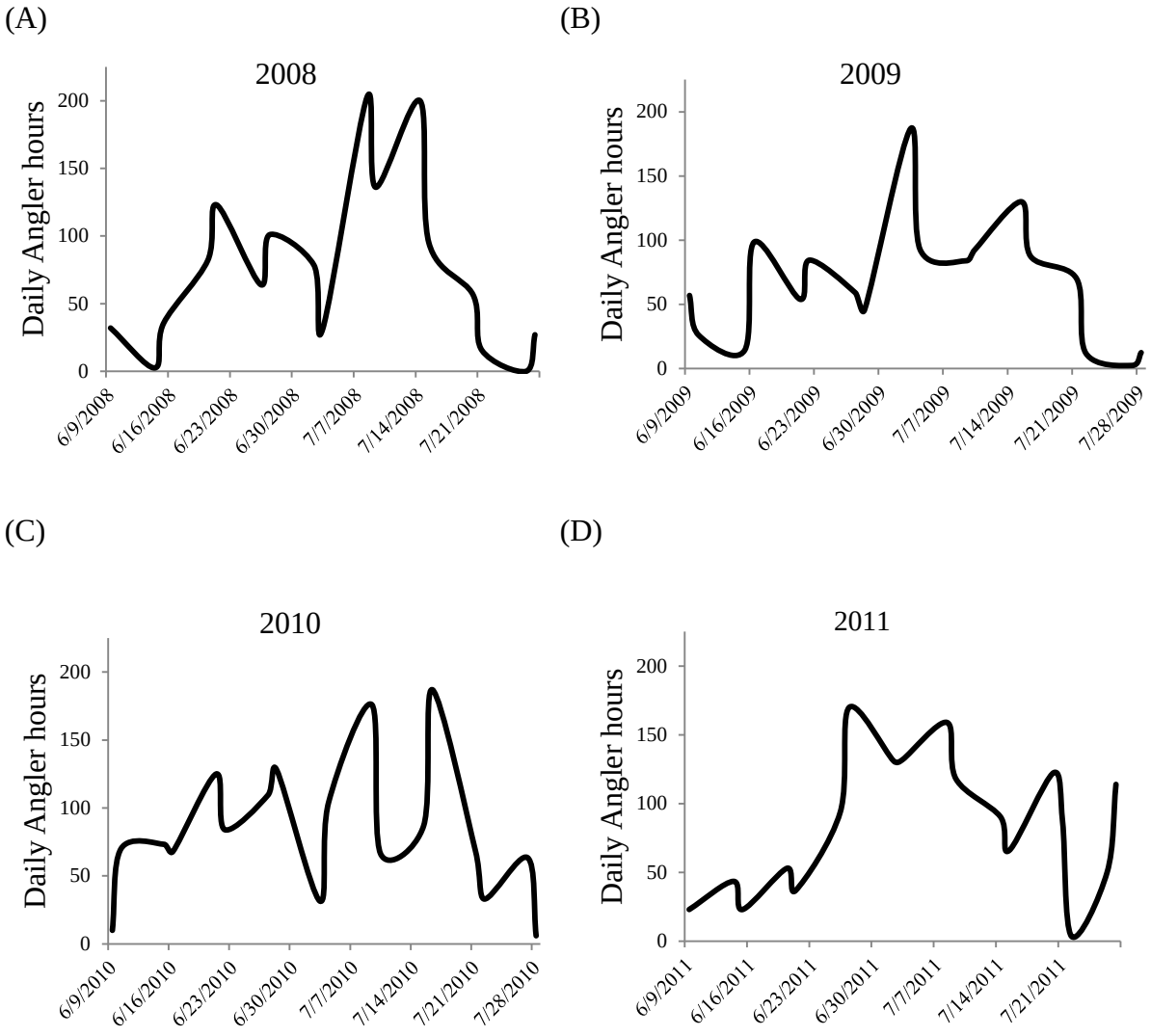

Figure 2.–Daily angler hours per each year (2008-2011, A–D) for the Situk River Chinook and sockeye salmon sport fisheries.

More extreme evidence of the combined effect of fish abundance and EO regulatory action on angler success is displayed with the statistics of Chinook angling for this reporting period. Chinook harvest success throughout the entirety of this reporting period (2008–2011) fell to the lowest ever recorded for this project, while catch numbers were also very low. Chinook angling was restricted by EO regulation in every year of this period due to low fish abundance in season, which both leads to lower catch rates and harvest. Catch rates of Chinook salmon were not as affected as harvest rates (Tables 4–7), recognizing that anglers still encountered Chinook salmon while angling for sockeye, and in some years Chinook angling was allowed but Chinook harvest was not. Catch was only severely curtailed when all angling for Chinook was closed entirely and no angling gear that would likely catch Chinook salmon was allowed (Table 4–7). Furthermore, some changes in angler statistics for either sockeye or Chinook salmon may have been due to regulation of the other species, as anglers that prefer to fish for both species may have altered fishing habits when angling regulations for the other species was restricted. As an example, the observation in 2009, the only year Chinook salmon harvest and angling was allowed above the

weir, that only 69% of sockeye salmon caught on the Situk were caught below the weir, suggests changes to Chinook angling may have changed angler statistics for sockeye as well. During all other years of this reporting period, when no Chinook angling was allowed above Situk Weir, a larger proportion of sockeye salmon were caught in the waters below the weir (87–91%).

COMPARISON OF METHODOLOGIES

Comparing harvest statistics derived from the two methodologies shows that the two-sampler method has lower estimates than the one-sampler method for both 2010 and 2011 (Figure 3), but the estimates are not significantly different based on their 95% confidence intervals. The single sampler methodology utilizes the past relationship between creel data and the SWHS (Appendix A) to expand the observations from the Lower Landing to a total drainage estimate. This relationship is likely quite variable, especially in years when angler use varies at the other access sites. This situation could lead to variation and inaccuracy in the relationship used to expand the single sampler observations. Additionally, in recent years the Nine Mile Bridge site has also received significant access improvements including a new boat ramp, and new camping spots that did not exist prior to 2010. This development has increased the use of this area in recent years. Also, in years when regulations were changed by EO in order to raise sockeye limits (2009 and 2011), more angling could have occurred upriver at the Nine Mile Bridge location relative to the Lower Landing because EOs are typically enacted later in the season when more fish are available upriver relative to downriver sites. As such, the relationship of the Lower Landing access site angler statistics to that of the entire drainage may now be lower, and/or be somewhat chaotic, limiting the accuracy of the method that uses only the one Lower Landing sampler.

More years of data are needed to fully assess whether the two-sampler or one-sampler method is more accurate and or cost-effective in assessing the sport use of Chinook and sockeye salmon on the Situk River. Generally, creel estimates that are not significantly different from the SWHS numbers are what we were trying to achieve when redesigning methodologies for this project. Future reports for this project will explore the differences between the two methods, and their comparison to the SWHS, after more data have been obtained. It is possible the expansion factor for the one sampler method could be improved, or an expansion factor could be added to the two-sampler methodology. It is anticipated that more years of data and differences in angler use among those years will provide for a more robust comparative analysis. Although the similarity in results of the two methods is promising, the comparisons here were preliminary and should be evaluated with caution because only two years were available for calculation with the newer two-sample methodology.

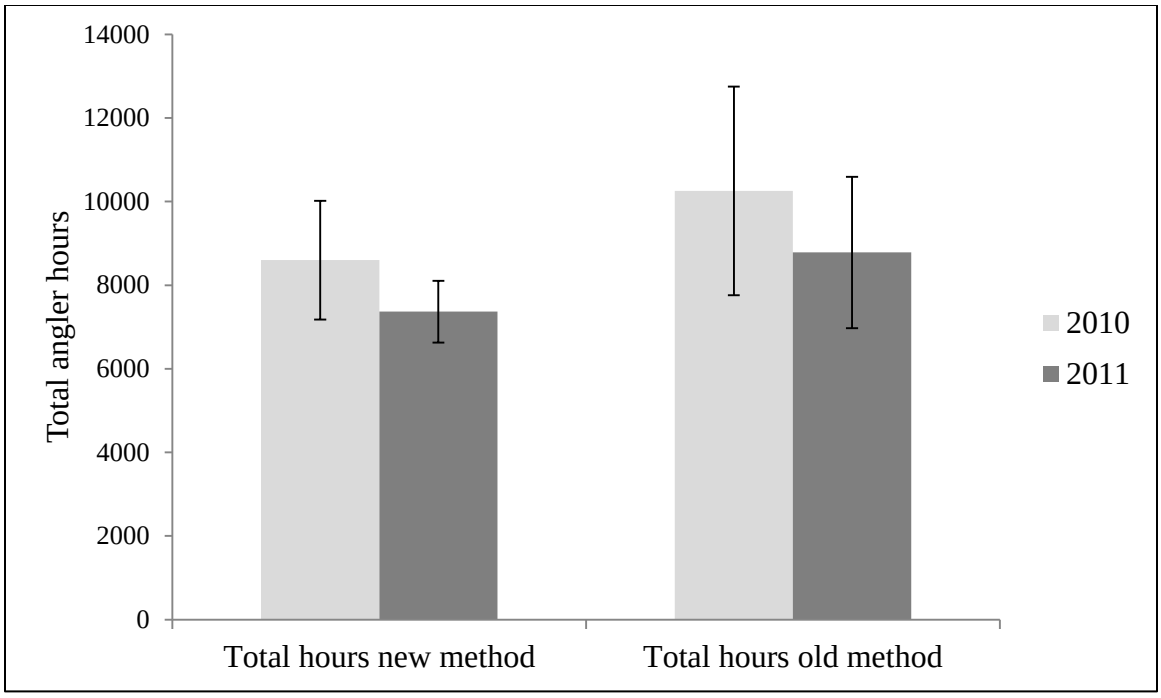

Figure 3.–Comparison of the two methods for calculating total yearly angler hours in years 2010 and 2011, for the Situk River creel project (error bars are ±2 SE ≈ 95% confidence interval).

The largest freshwater Chinook and sockeye salmon sport fishery in the Southeast Alaska region exists on the Situk River. Along with budgetary and accuracy considerations, the second sampling employee also creates an additional enforcement presence on the river; the departmental presence at all access sites potentially decreases regulatory infractions by anglers and/or the public's perception of the extent of infractions. Additionally, All Yakutat area fisheries are relatively remote, and anglers may choose not to expend the funds needed to travel to the Yakutat area when angling is restricted on the Situk River, which is the most often utilized freshwater system in the area. Because these anglers would likely also have fished in saltwater areas, the lack of consistent fishery management and opportunity on the Situk River can influence all angling efforts in all Yakutat area waters. These compounding affects that could affect all angler use in the area should also be considered when determining the importance of a second creel sampler on the Situk River. Lastly, both subsistence and commercial fisheries for Chinook and sockeye salmon are also conducted on the Situk River. The data generated in this project is utilized for inseason management for all of these fisheries, as well as for Chinook salmon sibling relationship models used for preseason stock estimations and management. The impact of the increased budgetary requirements for more staff to improve methodologies of this project should be weighed along with all of its varied benefits to fisheries sustainability and management across all user groups.

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APPENDIX A

Appendix A.–Relationship between the ADF&G SWHS and the Situk Creel estimates as used to calculate the expansion factor E_1 for the single sampler analysis method.

The ADF&G Statewide Harvest Survey (SWHS) is a total yearly estimate of salmon harvest obtained by mail in surveys. Comparison of SWHS and creel survey harvest estimates indicate that the SWHS encompasses approximately 1.19 times the unexpanded Chinook salmon harvest from the creel (Figure A). The fitted linear regression relationship (Figure 2) was obtained using a model that considered the measurement error in both variables. In order to calculate total drainage fishery statistics from our single sampler creel observations, the creel survey estimates ($\widehat{N}$) were multiplied by this expansion factor (E_1 = 1.19). The standard error of the estimated expansion factor, considering the measurement error in each variable, is 0.159.

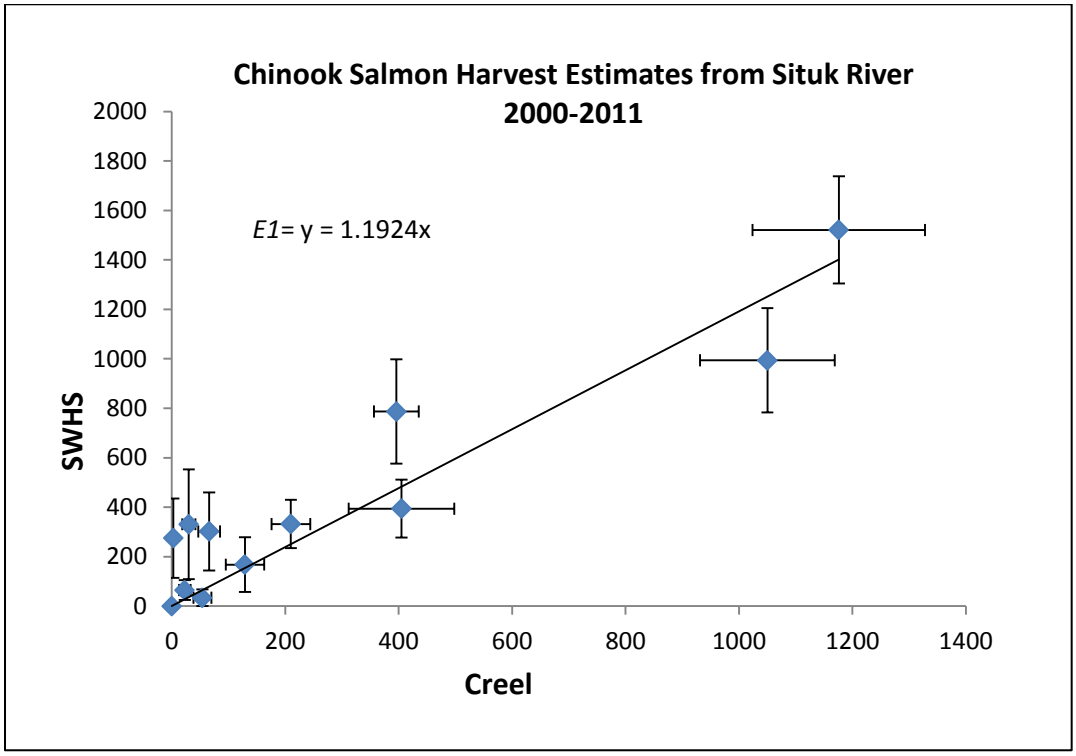

Figure A.–Unexpanded creel survey Chinook salmon harvest estimates using the single sampler method versus Statewide Harvest Survey estimates, all sizes, above and below the weir, 2000-2011.

Note: Bars are ± 1 SE.

APPENDIX B

Appendix B.–Computer files used to generate estimates of on the Situk River, 2008-2011.

File Name	Description
Creelanalysis2008.xlsx	Excel 2010 spreadsheet with all creel harvest and effort information necessary to generate estimates for 2008.
Creelanalysis2009.xls	Excel 2010 spreadsheet with all creel harvest and effort information necessary to generate estimates for 2009.
Creelanalysis2010.xlsx	Excel 2010 spreadsheet with all creel harvest and effort information necessary to generate estimates for 2010.
Creelanalysis2011.xlsx	Excel 2010 spreadsheet with all creel harvest and effort information necessary to generate estimates for 2011.