Fishery Data Series No. 99-33

Southeast Alaska Steelhead Studies, 1998: Situk River Weir and Surveys of Regional Index Streams

by

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and

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November 1999

Alaska Department of Fish and Game Division of Sport Fish

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
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

FISHERY DATA SERIES NO. 99-33

SOUTHEAST ALASKA STEELHEAD STUDIES, 1998: SITUK RIVER WEIR AND SURVEYS OF REGIONAL INDEX STREAMS

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ABSTRACT

Regionwide monitoring of trends in steelhead *Oncorhynchus mykiss* spawning abundance in twelve index streams in Southeast Alaska was continued in 1998. Each of these index streams was surveyed weekly for steelhead abundance by a two- or three-person team using snorkel gear during April and May 1998. Peak steelhead abundance in these 12 systems declined 34% from 1997 to 1998.

The Situk River produces the largest run of steelhead in Southeast Alaska. Between 4 May and 12 July 1998, 5,786 steelhead were counted as they emigrated downstream through a weir located 1.2 miles upstream of the Lower Landing on the Situk River. This count indicated a decline of 21% in the steelhead escapement from 1997. Float surveys on the Situk River downstream of Nine Mile bridge counted a maximum of 3,282 steelhead, 57% of the total counted at the weir.

Situk River steelhead abundance survey counts and conditions were compared to weir counts during 1994 to 1998. Float survey counts averaged 78% (SD = 14%) of the steelhead counted upstream of the weir under the best survey conditions. Total river surveys (Situk Lake–Lower Landing) conducted under the best observation conditions, during 5 May through 21 May, averaged 73% (SD = 10%) of the annual weir count for these years. Lower Situk River float count surveys conducted under the best observation conditions, during 16 May through 27 May averaged 63% (SD = 10%) of the weir counts.

The average total lengths of female and male steelhead from the Situk River were 776 mm (SE = 2) and 745 mm (SE = 4), respectively. Of the 1,136 fish sampled, 38 or 3% were ≥36 inches (914 mm) in total length; 21 of these were female and 17 were male. Length composition of samples taken early in the evening was similar to those taken late in the evening, but there were differences in sex composition.

Key words: steelhead, *Oncorhynchus mykiss*, emigration, abundance, Situk River, Eagle Creek, Harris River, Humpback Creek, Ketchikan Creek, McDonald Lake, White River, Marten Creek, Petersburg Creek, Sitkoh Creek, Ford Arm Creek, Peterson Creek, Pleasant Bay Creek, weir, timing, sex, length, abundance indices, snorkel survey, index stream.

INTRODUCTION

Southeast Alaska has 331 identified steelhead *Oncorhynchus mykiss* populations, most of which are believed to contain 200 or fewer spawning adults. Major fisheries occur on larger systems such as the Naha, Karta, and Thorne rivers, which support up to 1,000 spawning steelhead, and on the Situk River, which supports annual returns of 3,000 to 8,000 or more steelhead. Steelhead harvests in Southeast Alaska generally increased from the late 1970s through 1989, but then began to decline (Mills 1993). As fishery managers and participants reported lower escapements, an emergency order prohibiting steelhead harvests in the Situk River was enacted in 1991. In 1992, harvests were prohibited by emergency order in 24 popular systems, and in 1993 the Situk and 47 other systems were closed to steelhead harvest. In 1994, the Alaska Board of Fisheries enacted conservative regulations for steelhead in Southeast Alaska, and since 1994, anglers have been limited regionwide to a harvest of two steelhead per year with a minimum size limit of 36 inches (914 mm).

Intensive research on steelhead stocks in Southeast Alaska has largely been limited to Petersburg Creek (Jones 1972–1976, 1983) and the Situk River (Johnson 1990, 1991; Didier and Marshall 1991; Johnson and Marshall 1991; Glynn 1992; Glynn and Elliott 1993). Estimates of migratory timing, abundance, and age composition have also been made in a few other systems (Harding and Jones 1990, 1991, 1992; Jones et al. 1991; Yanusz 1997). Creel surveys of steelhead fisheries have also been conducted (Freeman and Hoffman 1989, 1990, 1991; Hubartt 1989, 1990; Hoffman et al. 1990; Harding and Jones 1991, 1993, 1994; Johnson and Marshall 1991; Schmidt 1992; Begich 1997), and enhancement has been studied in one system (Freeman 1992, 1995).

Although a few counts of steelhead in selected systems had been made for many years, in 1994, systematic foot surveys were initiated to monitor

annual trends in peak escapement in 17 streams. Since then, survey methodology has steadily evolved, and the streams and reaches selected to survey have changed as observers gain experience with each system. The 12 steelhead streams picked for survey in 1998 were dispersed across Southeast Alaska (Figure 1).

Substantial changes in survey methods were instituted in 1997 to increase the proportion of steelhead observed in index streams and to better identify dates of peak instream abundance (Johnson and Jones 1998). In 1998, two streams were dropped: 108 Creek on Prince of Wales Island— because of difficulty surveying the entire stream length and because of the low numbers of steelhead observed; and Windfall Creek in the Juneau area—because comparison with weir data showed snorkel counts in the outlet stream were not representative of the total run. Shardlow et al. (1987) found that among the most common survey methods, snorkel surveys by experienced observers yield the highest counts. During late April through May 1998, the primary objective of the steelhead survey project was to count by weekly snorkel surveys the number of steelhead in standardized sections of these 12 index streams.

As noted above, the Situk River has the largest steelhead run in Southeast Alaska, and studies were intensified in 1994 to provide consistent long-term assessment of this stock. Located east of Yakutat, the Situk River is 35.2 km long and drains two lakes with a combined surface area of about 397 ha (Figure 2). Prior to 1994, counts of Situk River steelhead were recorded incidentally at a weir installed 1.2 miles upstream of Lower Landing for the purpose of counting sockeye *O. nerka* and chinook salmon *O. tshawytscha* (Figure 2). These counts of steelhead were

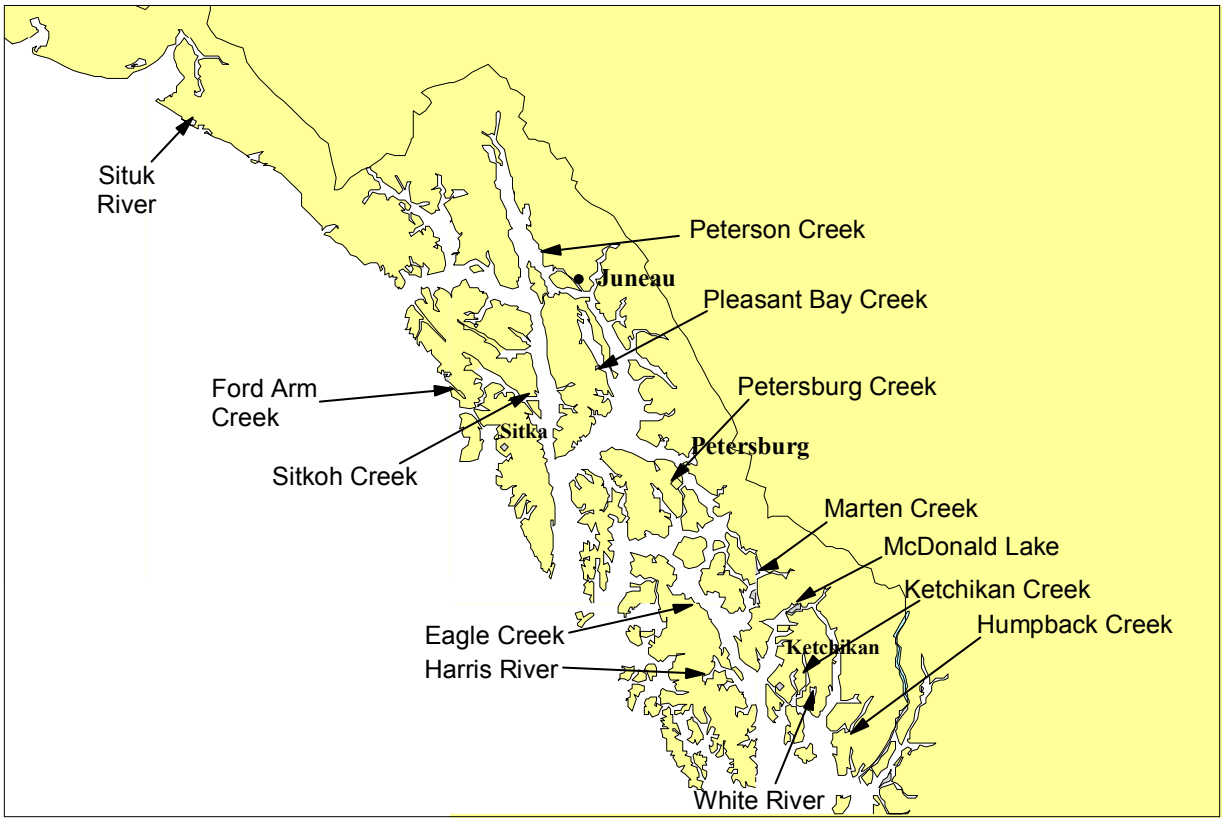

Figure 1.–Steelhead index systems in Southeast Alaska surveyed in 1998.

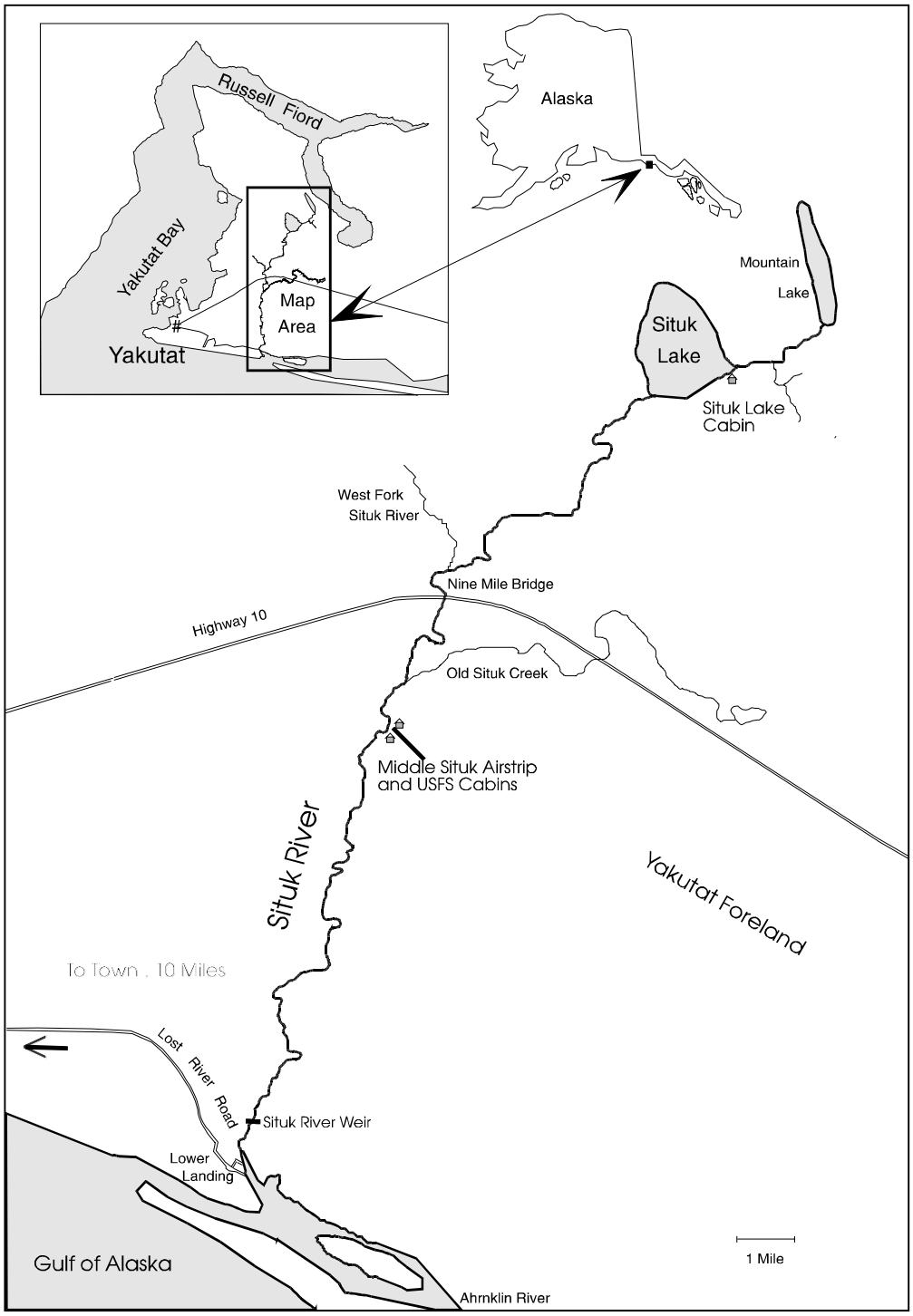

Figure 2.–Location of weir used to count emigrating steelhead from the Situk River drainage, Southeast Alaska, in 1998.

considered incomplete counts of total abundance, as the migratory timing of the target salmon species only partially overlapped that of the emigrating steelhead. Sonar was also used to count Situk River steelhead immigrants but was too labor-intensive to be readily implemented on an annual basis (Johnson 1990, 1991).

A weir was installed specifically to count emigrant steelhead in 1994, but spring floods washed out the weir and prevented a complete count. In 1995, a resistance board weir was installed, and annual counts have been complete to date.

Long-term data for Situk steelhead escapements include indices of abundance obtained from annual float survey counts; accuracy and precision of these float survey counts as measures of abundance have not been analyzed. However, float counts sometimes lack consistency because of variable factors such as number and experience of observers, weather and water conditions, and the timing of counts. Also, steelhead counts from the upper and lower Situk River made on different dates were sometimes added together, which may have resulted in some fish being counted twice.

In 1998, we continued standardized float counts for comparison with total counts of emigrant steelhead from a weir on the Situk River. These data, collected over a number of years, were used to estimate an expansion factor and associated variance for estimating steelhead abundance in years when weir counts of the total run are unavailable.

In 1997, we developed concerns that sampling practices at the weir could produce biased estimates of sex, length, and other population statistics, because "trap-shy" behavior appeared to occur in fish that refused to pass the weir while we were sampling for scales, size, and sex. We also noted that early in the evening there appeared to be a greater proportion of dark, feeble steelhead in the sample. We further noted that many of the brighter fish late in the evening tended to avoid the trap, and thus may not have been sampled at the same rate as more feeble fish. As a result, we redesigned the weir trap to make it easier to hold and segregate fish sampled over the course of an evening. To better quantify these trends, we tried to sample all fish emigrating past the weir during several nights of the peak emigration, as in 1997 (Johnson and Jones 1998). In 1998, we again sampled fish in the early evening and late evening to evaluate if there were differences related to the time of day when samples were collected at the weir. Results in 1998 and 1997 (Johnson and Jones 1998) are evaluated to assess impacts and recommend procedures for future sampling.

The Situk River portion of this study thus had four objectives: (1) count steelhead by standardized procedures in weekly float surveys; (2) count emigrant steelhead past a weir; (3) estimate the proportion of emigrant steelhead ≥36 inches in total length; and (4) estimate the sex composition and length of emigrant steelhead.

METHODS

SOUTHEAST ALASKA SNORKEL SURVEYS

Snorkel surveys were scheduled to provide indices of peak steelhead abundance for 12 streams in Southeast Alaska in 1998 (Figure 1), and the Situk River in Yakutat. These streams had all been surveyed for steelhead in 1997 (Johnson and Jones 1998). As in 1997, index streams were surveyed weekly, either three or four times (depending on the stream), from late April through May when instream abundance was expected to peak. If the peak count occurred during the last survey, an additional survey was scheduled. If a survey was missed because of unsuitable weather, the missed survey was performed as soon as conditions permitted, and the survey schedule was adjusted as possible so that a near-weekly counting interval was maintained. Snorkel surveys of the Karta River, Pt. Couverden Creek, Naha River and Ward Creek were also conducted to evaluate their potential use as index systems.

Surveys were conducted by at least two employees wearing dry suits and snorkel gear. One surveyor was always a senior, trained observer. Data from each survey in each stream were recorded by discrete sections (reaches) of the river. If a shoreside (third) party was available, counts were verbally conveyed to them and they tabulated and then recorded the counts by reach as

the survey progressed. When a shoreside party was not available, one or both snorkelers recorded the counts by reach with a waterproof (wax-based) marker on a small plastic diver's slate until it could be transcribed to conventional data forms.

Observers, as a team, counted all steelhead observed during the survey. The surveyors attempted to stay abreast of each other in the stream and coordinated their observations to obtain maximum coverage. When passing through high concentrations of steelhead, both observers counted the number of steelhead in their area of responsibility before consulting with each other on their counts. If either or both surveyors felt that a questionable count was made in a particular pool or stretch of river, the area was recounted. Since steelhead were often not too disturbed, recounts of a pool or run were usually possible.

The level of surface illumination, subsurface light transmission at a depth of 0.5 meters, surface water temperature in degrees Celsius (°C), and weather conditions (cloud cover, wind, and precipitation) were recorded at the beginning of the survey. Surface illumination and subsurface light transmission were recorded using a Sekonic L-188WH light meter protected by a waterproof underwater housing. The meter was set to an ASA value of 100, and the EV (exposure value) scale at the bottom of the light meter was recorded. On each index system, water levels were recorded at a permanent benchmark established in 1997. This benchmark was either a permanent mark on a bridge abutment, a USGS gauging station, or a mark carved in bedrock.

SITUK RIVER WEIR STUDIES

A bipod and picket weir with a center "resistance board" section about 40 ft wide was installed on the Situk River 1.2 miles upstream of the Lower Landing (Figure 2) and made "fish tight" on the evening of 5 May. Each day, steelhead were counted as they passed downstream through an opening in the resistance board section and then subsampled for biological information in a downstream weir trap.

In general, steelhead emigrated through the weir during the darkest hours (i.e., the highest rate of fish passage occurred between 2200 and 0200 hours). The low ambient light during these hours was supplemented by artificial light from three 300-watt electric lights hung from a cable spanning the river about 20 ft above normal water level. The lights illuminated the width of the trap opening in a band about 20 ft wide. Light intensity was kept at a low level, allowing observation of fish while minimizing behavioral changes in emigrating steelhead.

Emigrant kelts were funneled through a 7 ft wide weir opening into a three section trap downstream of the weir. The primary trap below the weir opening was 8 ft wide and 16 ft long. Two adjoining 8 ft × 8 ft holding pens interconnected via sliding "guillotine" type doors. Steelhead entered the trap from upstream through a "V" shaped chute equipped with a manually operated trap door. The three-section trap design allowed segregation of discrete groups of fish captured during a single night.

To satisfy precision levels established for the project, 612 steelhead were to be sampled for scales, length, and sex over the entire emigration (Cochran 1977). To reach that goal, an estimate of each evening's emigration was made from the estimated number of steelhead accumulating immediately upstream of the weir, the estimated average historical cumulative emigration to that date, and population size estimated from float and weir counts to date. A fixed percentage of the estimated daily emigration was then trapped and randomly sampled at least three times per week. Samples were usually collected during the early evening and the balance of the daily emigration was then counted downstream through the weir.

Past biological sampling of steelhead on the Situk River had raised the question of just how representative those samples were of the total population. From 1994 through 1996, about 10% of the run was sampled for scales, sex, size and other biological characteristics by collecting samples each day early in the daily emigration. Additional samples were collected to evaluate possible temporal effects in sampling. All or most outmigrating steelhead were sampled on three evenings (27 May, 3 June, and 10 June). These

samples were divided into early evening and late evening strata, and differences in size, sex, and coloration/condition between the early and late strata were compared.

The sex composition of emigrants was estimated:

$$\hat{p}_a = \frac{n_a}{n} \qquad (1)$$

$$\mathrm{var}(\hat{p}_a) = \left(1 - \frac{n}{N}\right) \frac{\hat{p}_a(1 - \hat{p}_a)}{n - 1} \qquad (2)$$

where p_a = proportion of the population with estimated sex a, n_a = number sampled fish with estimated sex a, n = number of fish sampled for sex, and N = number of fish counted at the weir. Because all (or most) emigrants were enumerated, an fpc (finite population correction) = (1-n/N) was included in the estimator. The standard error of p_a is $\mathrm{var}(\hat{p}_a)^{1/2}$.

The mean length (y) of emigrants was estimated:

$$\bar{y} = \frac{1}{n} \sum_i y_i \qquad (3)$$

$$\mathrm{var}(\bar{y}) = \left(1 - \frac{n}{N}\right) \frac{\sum_i (y_i - \bar{y})^2}{n(n-1)} \qquad (4)$$

where i denotes an individual fish. An fpc was again used since all fish were counted at the weir. The standard error $se(\bar{y})$ = $\mathrm{var}(\bar{y})^{1/2}$. Another statistic, the standard deviation $sd(y)$ was also calculated as a measure of the dispersion of the y values:

$$sd(y) \ \left(\sum (y_i - \bar{y})^2 / (n-1)\right)^{1/2} \qquad (5)$$

SITUK RIVER FLOAT COUNTS

High water conditions during the spring of 1998 allowed only one complete float survey (Situk Lake downstream to the Lower Landing), and three float surveys of the lower river (Nine Mile bridge to the Lower Landing) to count steelhead. Survey timing was based on peak steelhead counts obtained during years of multiple and fairly consistent float surveys since 1987. To further study steelhead distribution during float counts, the Situk River was divided into 22 sections: 9 in the upper river and 13 in the lower river (see Appendix A2 of Johnson and Jones 1998). The beginning and end of each section was based on prominent, easily distinguished features. The length in miles of each section was measured from aerial photographs. Float survey procedures are presented in Johnson and Jones (1998).

RESULTS

SOUTHEAST ALASKA SNORKEL SURVEYS

Forty snorkel surveys were conducted on the twelve index streams during April and May, 1998 (Table 1 and Appendix A1). Peak steelhead counts ranged from 17 in Marten Creek to 156 in Harris River. The number of surveys made on index systems ranged from two in Sitkoh and Ford Arm creeks to six on Ketchikan Creek.

In addition, peak counts of 31 steelhead were recorded on 3 May in the Naha River, 31 steelhead in the Karta River on 14 April, 41 in Ward Creek on 19 May, and 3 on 15 May in the creek at Pt. Couverden (Appendix A1). Because of the low numbers of steelhead counted or the relatively small size of the system, none of these appeared to be good candidates for inclusion as index streams.

SITUK RIVER WEIR AND FLOAT COUNTS

Between 4 May and 12 July, 5,786 steelhead were counted at the weir as they emigrated from the Situk River (Figure 3; Appendix A2). The peak of emigration occurred 29 May, when 611 steelhead were counted downstream through the weir.

Float counts were conducted on five occasions between 23 April and 27 May (Table 2 and Appendix A3). Detailed environmental conditions measured during the float counts are listed in Appendix A4. The highest counts of 3,255 and 3,282 steelhead occurred in the lower

Table 1.–Index streams for steelhead surveyed along with dates of peak counts and peak numbers of steelhead counted, 1998.

STREAM NAME	NO. OF SURVEYS	PEAK COUNT DATE	PEAK COUNT OF STEELHEAD	GENERAL LOCATION
Eagle Creek	3	5 May	56	Prince of Wales I.
Harris River	3	6 May	156	Prince of Wales I.
Ketchikan Creek	6	29 May	47	Revillagigedo I.
White River	4	2 May	93	Revillagigedo I.
Humpback Creek	3	28 April	24	southern mainland
McDonald Lake	3	14 May	86	southern mainland
Marten Creek	3	6 May	17	southern mainland
Petersburg Creek	4	5 May	152	Kupreanof Island
Pleasant Bay Creek	4	5 May	81	Admiralty Island
Ford Arm Creek	2	11 May	103	Chichagof Island
Sitkoh Creek	2	12 May	154	Chichagof Island
Peterson Creek	3	4 May	29	northern mainland

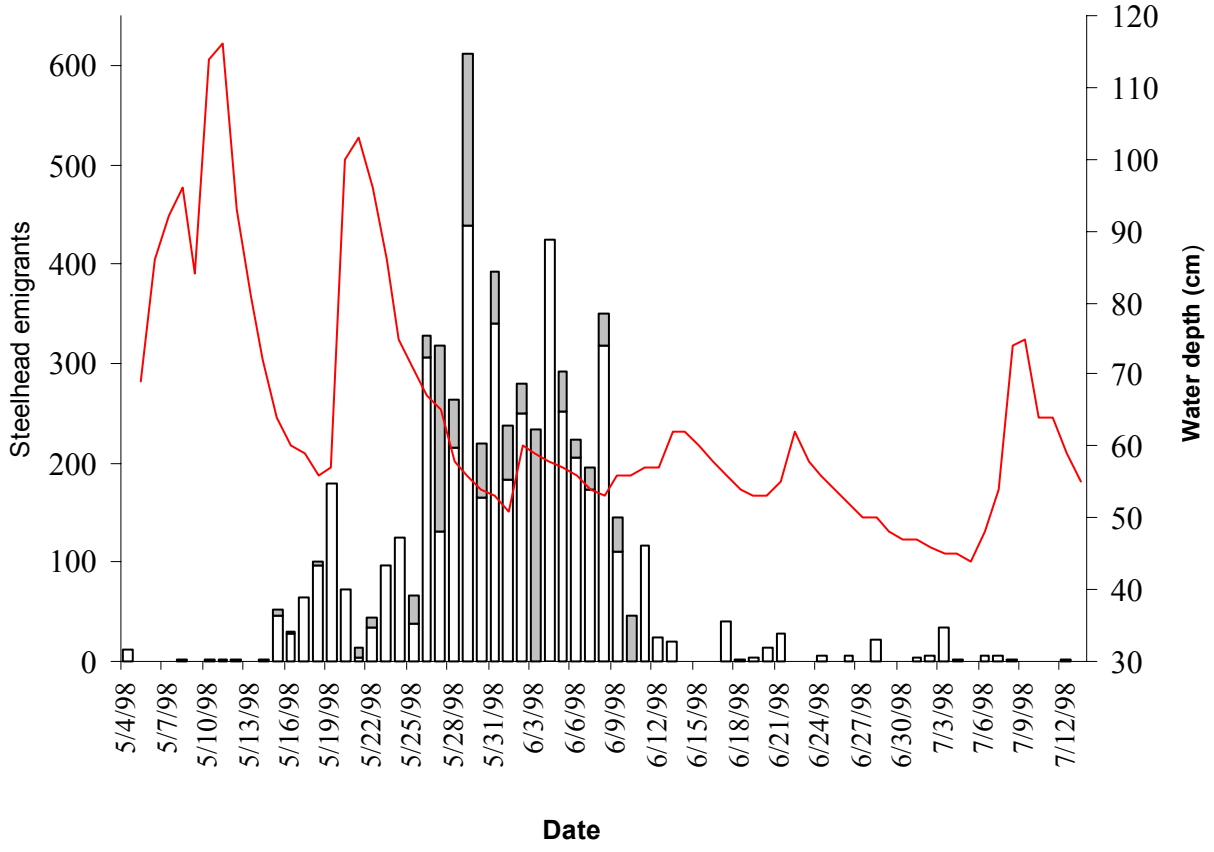

Figure 3.–Daily counts of emigrant steelhead (bars)**, daily sampled steelhead** (dark bars)**, and water level readings** (line)**, Situk River weir, 1998.**

Table 2.–Numbers of steelhead counted, by date, location, and observer, during Situk River float surveys in 1998.

SURVEY DATE	STEELHEAD COUNT	RIVER SECTION [a]	OBSERVERS	SUBJECTIVE VIEWING CONDITIONS
23 April	1,096	lower	Robert Johnson, Mike Tracy	fair/good
13 May	211	upper	Mike Tracy, Larry Derby	good
14 May	2,667	lower	Mike Tracy, Lee McKinley	fair
Total	2,878			
18 May	3,255	lower	Mike Tracy, Lee McKinley	good
27 May	3,282	lower	Robert Johnson, Larry Derby	excellent

[a] Lower = Situk Lake to Nine Mile bridge; upper = Nine Mile bridge to Lower Landing.

river on 18 and 27 May, respectively, when conditions were good and excellent, respectively. In general, fish were concentrated within the lower river from the weir (about river mile 1.2) to river mile 8.3 (Figure 4).

SITUK RIVER STEELHEAD BIOLOGICAL SAMPLING

We sampled a total of 1,136 steelhead for sex, scales, length and coloration in 1998. Scales have yet to be aged from this study, so no ages are available. A relatively fixed percentage of steelhead passing the weir were sampled three times each week (Figure 3), and yielded a sample of 671 fish. In addition, we sampled 185 of 317 steelhead on 27 May, 233 of 234 on 3 June, and 47 of 47 on 10 June for an additional sample of 465 steelhead.

There were few significant differences in lengths between the 671 steelhead sampled during "normal" sampling and the 465 fish sampled on the other three days (Table 3). Average length for males in the 3-day sample was 749 mm versus 742 mm for the normal sample. Average length for females in the 3-day sample was 780 mm versus 774 mm for the normal sample. Average length for both sexes combined in the 3-day sample was 767 mm versus 764 mm for the normal sample. Males constituted 56% (9 of 16) of the fish $\geq$36 inches in length in the 3-day sample and 36% (8 of 22) in the normal sample (not a significant difference, $p = 0.22$). Other small differences included that males were judged as 38% dark fish in the 3-day sample and 41% in the normal sample, whereas 94% of females were judged bright in the 3-day sample and 93% in the normal sample. More substantial differences included that males were judged as 30% with substantial fungus in the 3-day sample and 42% in the normal sample. Perhaps the biggest difference between the normal and 3-day sample was sex composition; males composed 42% of the three day sample while males composed 31% of the normal sample.

Given these generally small differences in the two sample statistics and the relatively good dispersion of samples collected across the emigration (Figure 3, Appendix A2), the pooled biological statistics were used to estimate parameters of the population (Table 3). Sixty-four percent (64%) of the fish sampled were females averaging 776 mm (SE = 2 mm) in length. Females ranged in length from 575 mm to 1,005 mm. The average total length of male steelhead was 745 mm (SE = 4 mm), from a range of 535 mm to 990 mm. Of the 1,136 steelhead sampled during the 1998 emigration, 174 (15%) were wounded or scarred. Ninety-seven (97) of the wounds were recent puncture, gash, slice, or bite types, 68 were fish-hook related, and one fish was gillnet scarred. Of the 1,136 steelhead sampled, 38 or 3.3% (SE = 0.5%) were at least 36 inches in total length. Based on this sample and the number of emigrants counted at the Situk River weir, an estimated 194 (SE = 31) fish were eligible for

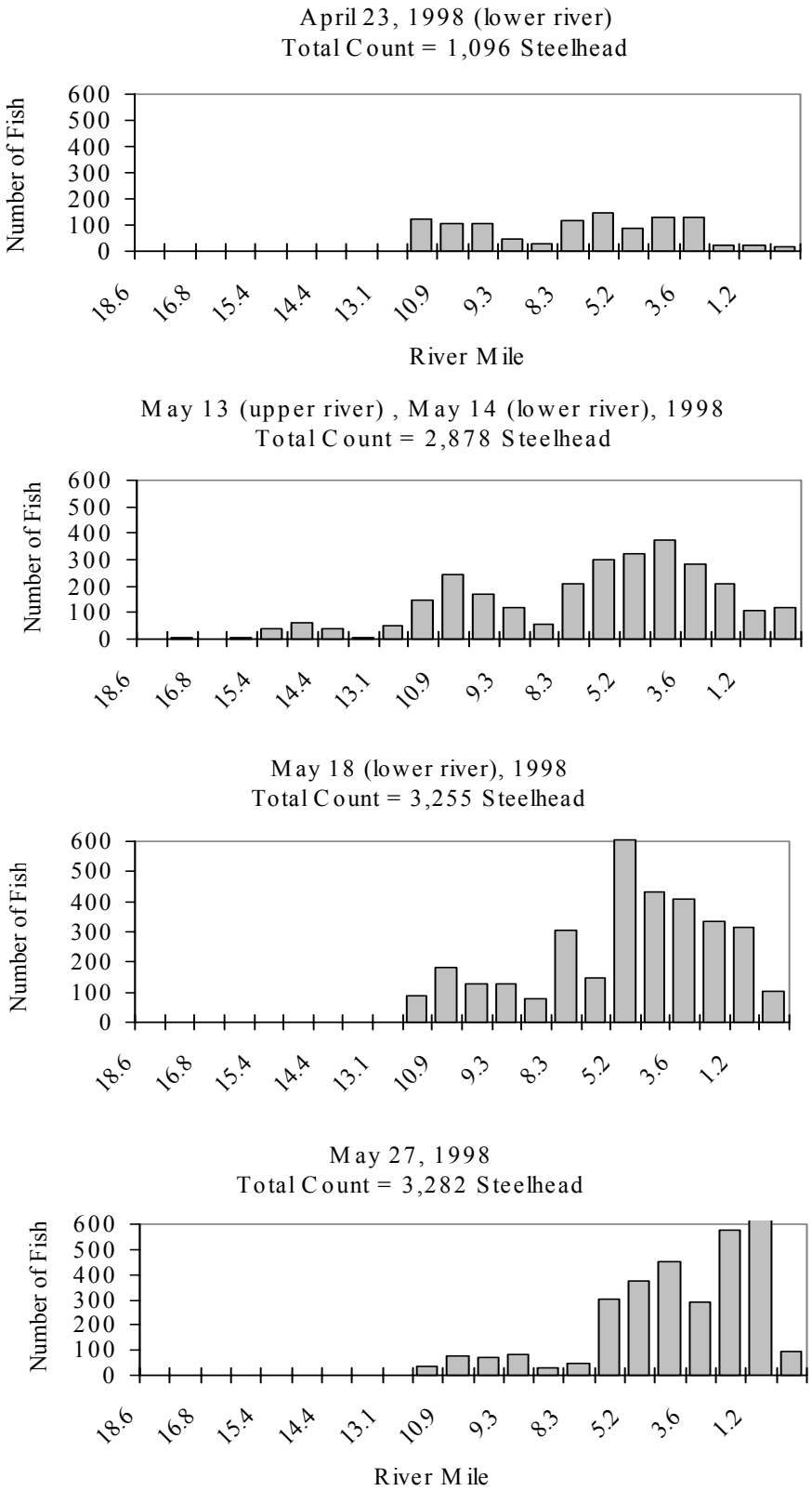

Figure 4.–Steelhead density per mile, Situk River float surveys, 1998.

Table 3.–Biological statistics by sex for all fish sampled randomly during normal sampling procedures (excluding 27 May, 3 June, and 10 June), for those fish sampled on 27 May, 3 June, and 10 June, and for all samples combined, 1998.

	Normal Sampling			May 27, June 3, June 10			Combined		
	M	F	All	M	F	All	M	F	All
Sample size	208	463	671	197	268	465	405	731	1,136
% by sex	31	69		42	58		36	64	
SE % by sex	2	2		1	1		1	1	
Mean length (mm)	742	774	764	749	780	767	745	776	765
SD (length)	90	70	78	90	74	83	90	71	80
SE (mean length)	6	3	3	4	3	1	4	2	2
Number of fish ≥36"	8	14	22	9	7	16	17	21	38
Bright	32	429	461	38	253	291	70	684	754
Medium	91	29	120	84	14	98	175	43	218
Dark	85	3	88	75	1	76	160	4	164
With fungus	88	11	99	60	6	66	148	17	165
Without fungus	120	452	572	137	262	399	257	714	971

harvest. There were significant differences in the average size of male steelhead by color classification (Table 4). In general, the darker males were larger.

The samples taken on the evenings of 27 May, 3 June, and 10 June were split into two groups (early evening and late evening) to test for differences. Fairly consistent differences in sex composition appeared between samples collected in early evening versus late evening, with a smaller proportion of male fish emigrating during the late evening period (Table 5). On 27 May, 49% of the early evening sample were males, versus 36% of the late evening sample (Table 5 and Table 6). On 3 June, the percentage of males declined from 45% in the early evening to 39% in the late evening sampling period. On 10 June, sample sizes were low but males composed 45% and 41%, respectively, of early and late periods.

Comparisons of mean length between early evening and late evening periods show that marginal statistical differences exist amongst the three periods sampled. For example, early evening males were slightly larger on 27 May, and late evening females were slightly larger on 3 June and slightly smaller on 10 June (Table 6).

Table 4.–Average total length (mm) for male and female steelhead by color classification, Situk River, 1998.

Sex	Statistic	Bright	Medium	Dark
Male	Sample size	70	175	160
	Mean length	716	709	797
	SD	102	67	81
	SE	12	5	6
Female	Sample size	684	43	4
	Mean length	776	769	789
	SD	72	67	80
	SE	3	10	40

A distinct difference was observed in coloration of males between early and late evening periods on 27 May (Table 7). Bright males constituted a greater proportion (22%) of the early evening sample than of the late sample (10%). The proportion of bright males in early evening was consistent through the three sample days, whereas the proportion of bright males in the late evening

Table 5.–Summary statistics for emigrating steelhead sampled in the Situk River on 27 May, 3 June, and 10 June 1998, combined, by sex and time period (early evening and late evening) [a].

	EARLY			LATE			COMBINED		
	M	F	All	M	F	All	M	F	All
Sample size	102	116	218	95	152	247	197	268	465
% by sex	47	53		38	62		42	58	
SE % by sex	0	0		0	0		0	0	
Mean length (mm)	758	777	768	738	782	765	749	780	767
SD (length)	97	76	87	81	73	79	90	74	83
SE (mean length)	0	0	0	0	0	0	0	0	0
Number of fish ≥36"	5	6	11	4	1	5	9	7	16
Bright	22	109	131	16	144	160	38	253	291
Medium	39	6	45	45	8	53	84	14	98
Dark	41	1	46	34	0	34	75	1	76
With fungus	38	2	40	22	4	26	60	6	66
Without fungus	64	114	178	73	148	221	137	262	399

[a] Another 132 steelhead counted downstream without being sampled between "early" and "late" periods on 27 May are not included in these statistics.

increased steadily (10% to 27%) over the 3 dates. Coloration differed between sexes, as 94% of all females sampled (3 dates combined) were judged to be bright fish, compared to 19% of all males (Table 7). In males, 38% of the samples over the 3 days were judged to be dark fish.

On 3 and 10 June, the percentage of males sampled in the early evening with external fungus was much higher than in late evening (Table 8). On 27 May, the incidence of fungus was about equal for males sampled in early and late evening. The overall percentage of males with fungus varied from 18% to 45% during the 3 days. The incidence of external fungus in females was 4% or less during all late and early evenings sampled.

A total of 18 steelhead mortalities washed up on the weir during 1998; 5 were female and 13 were male. All were dark in coloration, with the exception of two bright females. All of the males and one of the females exhibited external fungal growth. The average total length of these steelhead mortalities was 869 mm, which was considerably larger than the average size of the other sampled kelts (765mm).

DISCUSSION

In 1998, for only the second time, all steelhead surveys were snorkel surveys (other than the Situk River). Snorkel surveys record a much higher percentage of the fish in streams than do foot surveys (Shardlow et al. 1987). Consequently, the 1998 surveys were directly comparable only to surveys from 1997 (Table 9). Summing the peak surveys for the 12 index streams monitored both years results in a total count in 1997 of 1,505 steelhead and a 34% drop in 1998 to 998. The peak counts in most areas were mixed but both streams on Chichagof Island (Ford Arm and Sitkoh) showed large declines in abundance. Since only 2 counts were made for each of these two systems, however, it is possible that peak numbers were missed. Both counts in streams near Petersburg (Petersburg and Marten creeks) increased somewhat from 1997 levels.

Table 6.–Sample sizes, length, and condition by sex, during early and late sample periods for Situk River steelhead sampled on three evenings of emigration, 1998.

	MAY 27, 1998 [a]						JUNE 3, 1998						JUNE 10, 1998					
	Early 2200–0135			Late 0300–0430			Early 2315–0156			Late 0200–0515			Early 0036–0100			Late 0214–0400		
	M	F	All	M	F	All	M	F	All	M	F	All	M	F	All	M	F	All
Sample size	51	54	105	29	51	80	42	51	93	55	85	140	9	11	20	11	16	27
% by sex	49	51		36	64		45	55		39	61		45	55		41	59	
SE % by sex	0	0		0	0		0	0		0	0		0	0		0	0	
Mean length (mm)	800	784	792	772	787	782	715	765	742	723	778	756	722	802	766	727	784	761
SD (length)	93	86	89	90	82	85	82	70	79	72	71	76	87	42	76	81	51	70
SE (mean length)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of fish ≥36"	5	4	9	3	1	4	0	2	2	1	0	1	0	0	0	0	0	0
Bright	11	50	61	3	49	52	9	48	57	10	79	89	2	11	13	3	16	19
Medium	14	4	18	8	2	10	21	2	23	33	6	39	4	0	4	4	0	4
Dark	26	0	26	18	0	18	12	1	13	12	0	12	3	0	3	4	0	4
With fungus	22	1	23	14	2	16	12	1	13	5	2	7	4	0	4	3	0	3
Without fungus	29	53	82	15	49	64	30	50	80	50	83	133	5	11	16	8	16	24

[a] Statistics do not include another 132 steelhead counted downstream without being sampled between “early” and “late” periods.

Table 7.–Percentages of bright, medium, and dark colored steelhead by sex and combined, emigrating during early and late evening sample periods, 27 May, 3 June, and 10 June 1998.

		EARLY			LATE			COMBINED		
Date	Color	M	F	All	M	F	All	M	F	All
27 May 98	bright	22	93	58	10	96	65	18	94	61
3 June 98	bright	21	94	61	18	93	64	20	93	63
10 June 98	bright	22	100	65	27	100	70	25	100	68
27 May 98	medium	27	7	17	28	4	13	28	6	15
3 June 98	medium	50	4	25	60	7	28	56	6	27
10 June 98	medium	29	2	14	22	0	9	40	0	17
27 May 98	dark	51	0	25	62	0	23	55	0	24
3 June 98	dark	29	2	14	22	0	9	25	1	11
10 June 98	dark	33	0	15	36	0	15	35	0	15

Table 8.–Percentages of steelhead with external fungus, by sex and by early and late evening sampling periods, 27 May, 3 June, and 10 June 1998.

DATE	SEX	% IN EARLY SAMPLE	% IN LATE SAMPLE	% IN ALL SAMPLES
27 May 98	male	43	48	45
3 June 98	male	29	9	18
10 June 98	male	44	27	35
27 May 98	female	2	4	3
3 June 98	female	2	2	2
10 June 98	female	0	0	0
27 May 98	all	22	20	21
3 June 98	all	14	5	9
10 June 98	all	20	11	15

Table 9.–Peak steelhead survey counts for index systems monitored in both 1997 and 1998 and the percent difference between years.

STREAM	1997	1998	% (+/-) DIFFERENCE
Peterson Creek	26	29	+12
Pleasant Bay	155	81	-48
Humpback Creek	91	24	-74
Ketchikan Creek	48	47	-2
McDonald Lake	145	86	-41
White River	84 [a]	93	+11
Marten Creek	14	17	+21
Petersburg Creek	123	152	+24
Eagle Creek	90	56	-38
Harris River	104	156	+50
Ford Arm Creek	296	103	-65
Sitkoh Creek	329	154	-53
Totals	1,505	998	-34

[a] Updated from Johnson and Jones (1998) with corrected data.

In two streams, Peterson Creek and Pleasant Bay, we have three years of snorkel data. Steelhead counts in Peterson Creek were 36, 26, and 29, respectively, in 1996, 1997, and 1998. At Pleasant Bay, counts were 168, 155, and 81 for the same 3-year period.

Emigration timing of steelhead in the Situk River was about a week later than in the previous three years (Figure 5). Only half as many fish exceeded the 36-inch minimum size limit during 1998 as survived the fishery in 1997. Similarly, the percentage of steelhead ≥36 inches fell from 6% in 1997 to 3% in 1998. The average length of male steelhead (745 mm) during 1998 was 52 mm shorter than during 1997 (797 mm).

Float count data from the Situk River indicated that returns of steelhead in 1998 were much better than in 1991 and 1992 (Table 10). Recent weir data indicated that the 1998 return was 21% lower than in 1997 and the lowest in 5 years (Table 11).

Because some emigrant steelhead are either not in the river during surveys, or are in the system but not within the survey area, counting efficiency differs somewhat from the statistic "proportion observed" each year. For example, 94% of the emigration was counted in 1995 (Table 11) while efficiency of surveys in 1995 varied from 73% to 93% (Table 12). Overall, float counts have represented about 70% of the kelt emigration, 1994–1998. Also, subjective survey conditions appear to reflect the "proportion observed" during total river surveys (Table 11). Float surveys where the highest percentage (70% –93%) of the total steelhead run is observed have occurred

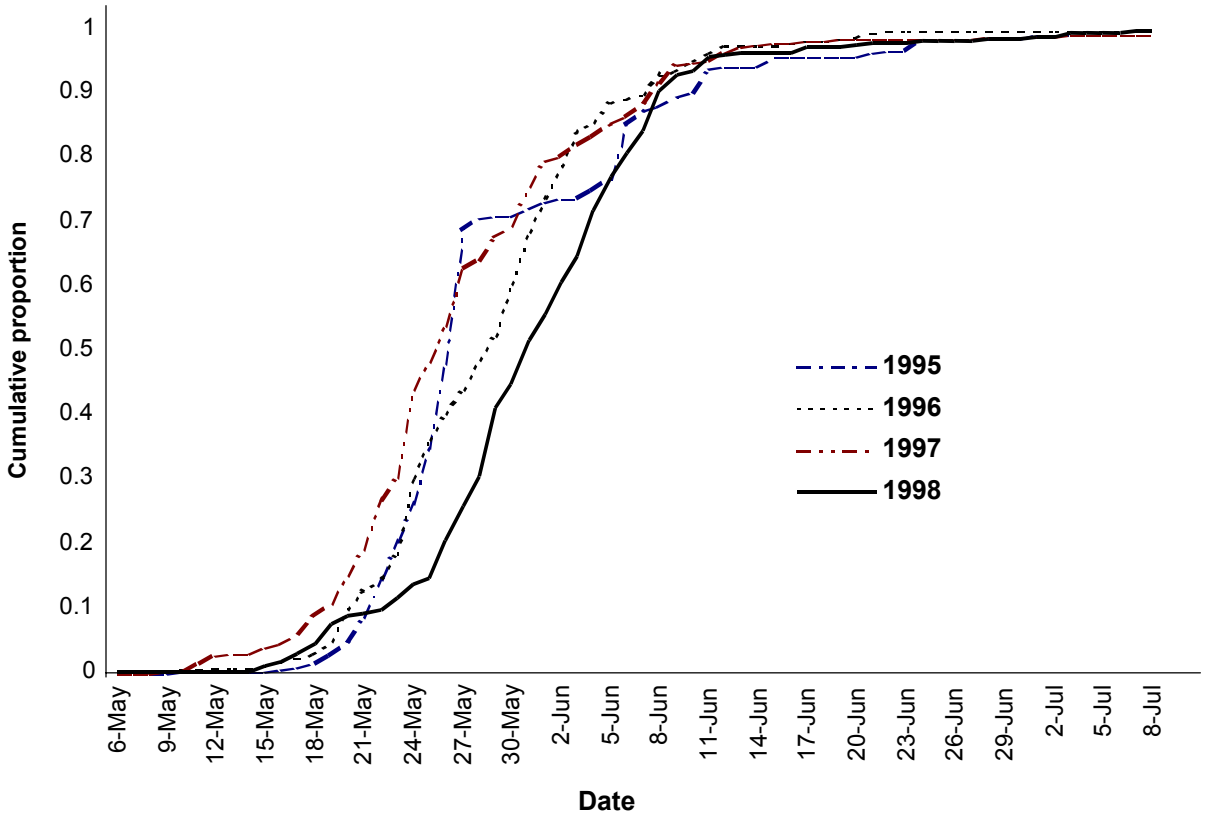

Figure 5.–Cumulative proportions of Situk River weir daily steelhead counts, 1995–1998.

Table 10.–Date, location, and peak counts of steelhead during Situk River float surveys, 1987–1998.

Year	Upper river	Date	Lower river	Date	Total
1987	1,123	5/11	2,083	5/12	3,206
1988	430	5/15	2,165	5/25	2,595
1989	1,016	5/20	1,235	5/21	2,251
1990	502	5/16	1,138	5/17	1,640
1991	386	5/14	593	5/12	979
1992	220	5/16	663	5/16	883
1993	369	5/19	3,130	5/18	3,499
1994	319	5/21	4,383	5/21	4,702
1995	1,406	5/8	4,829	5/9	6,235
1996	566	5/21	5,368	5/21	5,934
1997	848	5/4	4,095	5/5	4,943
1998	N/A	N/A	3,282	5/27	3,282

when the water height is between 44 and 46.5 inches, as measured from the concrete seam on the Nine Mile bridge support to water's surface (Table 12). Percentages of the total steelhead weir emigration observed during total river surveys (Situk Lake to Lower Landing) conducted under the best survey conditions during May 5 through May 21 range from 60% to 93% (average 73%, SD = 10%) (Table 12). Lower river float count surveys conducted under the best observation conditions during May 18 through May 27 observed proportions of the total annual weir emigration ranging from 56% to 78%, (average 63%, SD = 10%). Allowing for post-survey weir immigration and emigration prior to a given survey, float count surveys conducted during the best environmental conditions and timing windows over the past 4 years have counted from 63% to 109% (average 78%, SD = 14%) of the steelhead accounted for upstream of the weir. Note that this proportion is different from the total percentage of the annual population counted during a survey, which is the statistic most important for management purposes. Situk River float survey counts, proportion of the total weir emigration counted, and environmental conditions encountered during each survey are presented in Appendix A5.

Besides incomplete immigrations and some emigration at the time of a given float survey, other factors influence the proportion of the steelhead run available to be counted within a given survey area. For example, prior to 4 May during some years, a large proportion of stream-maturing (fall/winter run) steelhead can be located within Situk Lake. During the period from 8 May through 17 May, from 14% to 23% of the fish observed during a total river survey may be counted upstream from Nine Mile bridge. The proportion of steelhead in this area declines sharply following 15 May as those fish emigrate seaward after spawning (Figure 6).

Table 11.–Weir count, peak float count, percent of total steelhead observed, and subjective survey conditions during five years of both weir operation and standardized float surveys.

Year	Weir count	Peak float count	Proportion observed	Subjective survey conditions	
1994	7,854	4,702	0.60	very good	good
1995	6,608	6,235	0.94	excellent	excellent
1996	8,510	5,934	0.70	excellent	fair
1997	7,328	4,943	0.67	good	good/excellent
1998	5,786	3,282 [c]	0.57	not counted	excellent

[a] From Situk Lake to Nine Mile bridge.
[b] From Nine Mile bridge to Lower Landing.
[c] Upper section count not included in 1998 total.

Table 12.–Comparison of float count surveys observing the highest proportion of the annual steelhead (SH) weir emigration under the best, similar conditions, by date and area, Situk River, 1994–1998.

River section [a]	Date	Float count totals	Annual weir emigration	%Total run counted during survey	SH counted down past weir to date	SH counted up after count if weir was in place	% SH present above weir, counted during float considering emigration & immigration	Water height [b]
All	21 May 94	4,702	7,854	60	2 [c]	16 [c]	60 [c]	40.25
All	21 May 96	5,934	8,510	70	1,069	251	83	46.00
All	18 May 96	6,544	8,510	77	279	197	81	46.50
All	16 May 95	4,889	6,688	73	46	245	76	43.10
All	09 May 95	6,235	6,688	93	9	0	93	44.00
All	08 May 96	5,840	8,510	69	33	107	70	46.00
All	05 May 97	4,943	7,328	67	0	0	67	47.50
Lower	27 May 98	3,282	5,786	57	1,515	418	85	41.00
Lower	23 May 95	5,189	6,688	78	1,417	520	109	45.50
Lower	20 May 97	4,377	7,328	60	1,109	424	76	43.00
Lower	18 May 98	3,255	5,786	56	273	381	63	43.00

[a] All = entire river, from Situk Lake to Lower Landing; lower = lower river sections, Nine Mile bridge to Lower Landing.

[b] Distance (inches) from concrete seam on Nine Mile bridge support to water's surface (higher values indicate shallower water).

[c] Weir not installed during 1994 until 21 May.

Given appropriate conditions and timing, Situk River float surveys are capable of counting nearly every steelhead present within the Situk River survey area. Unfortunately, the total Situk steelhead population is rarely located within the bounds of the survey area because steelhead migrate through areas of the Situk River system other than that portion where steelhead counts are possible. Also, during peak abundance occasions, environmental conditions allowing high percentage counts during a float survey are infrequent during a given season, but have occurred at least once annually during this investigation. Total river counts performed under low, clear water conditions during the period from 8 May through 18 May generally result in the most accurate index of Situk River steelhead abundance, as fish are spread out over 20 miles of river instead of being concentrated downstream where counting accurately is difficult.

Several factors seem to affect subsurface visibility—i.e., the proportion of steelhead present in the survey area observed—during a float survey more than others. These include river water depth and the ability of observers to accurately count large groups of fish passing the boat, which is problematic during late season surveys when up to 7,000 steelhead can be concentrated in a small section of the lower river. Additionally, recent increases in angler densities during the peak of the steelhead season can lead to increased boat traffic and other in-water activity which decreases subsurface visibility in the river. Counts from Nine Mile bridge downstream from 20 to 27 May have observed from 57% to 78% of the total weir emigration; however, weir data have demonstrated that 15% to 25% of the annual emigration may occur earlier (Table 12). Any future index of steelhead abundance will need to consider this factor for counts occurring after 20 May.

We recommend that float surveys continue. Additional data will improve estimates of the proportion of the total Situk River steelhead population observed during float surveys. These data will be valuable if the weir is removed in the future. We had indications that past sampling practices at the weir may have led to biases in estimating length, sex, and other population

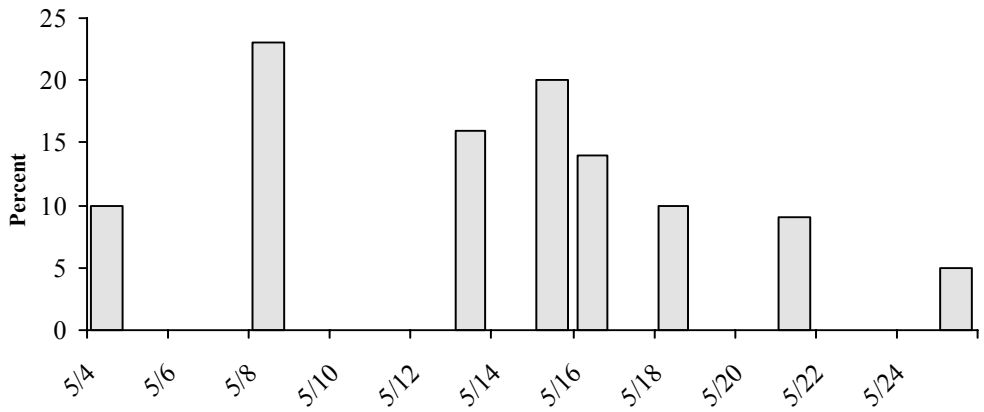

Figure 6.–Proportion of steelhead observed from Situk Lake to Nine Mile bridge only, by date, during total Situk River surveys, 1994–1998.

parameters; hence, we conducted the early-evening versus late-evening sampling to evaluate this potential problem. Some difference was noted between the composite early and late evening samples and the "normal" sampling technique that has been used for the past 4 years: (1) the percentage of males in the combined late evening samples (42%) was greater than in the "normal" daily samples (31%); and (2) the percentage of males with fungal growth was slightly higher in the normal samples (42% versus 30%). Because of these differences, attempts should be made to routinely sample from both early and late evening periods during daily emigrations.

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APPENDIX A

Appendix A1.–Counts of steelhead from 1998 snorkel surveys by stream, date, and reach of stream along with measured habitat variables. (Abbreviations: S = snorkel; F = foot; S/F = snorkel and foot combined; O = overcast; R = rain; RW = rain/wind.)

Stream name	Date	Reach	Distance surveyed	Survey type	# Live	Redds	Weather codes	Observers[a]	Surface light	Light trans	Surface temp.	Comments
Peterson Creek	4-May	1	0.7mi	S	29		O	BG, MS	10.8		8.5	Water level -46.5
Peterson Creek	4-May	2		S	ns							Not surveyed
Peterson Creek	11-May	1	0.7mi	S	14	10	O	MS, BG			8	Water Level -42.5
Peterson Creek	11-May	2		S	ns							Not surveyed
Peterson Creek	18-May	1		S	11		O	MS, BG				-55.5 cm
Pleasant Bay Creek	23-Apr	1	Length	S	43	2	O	DJ,KK,BG	nd			Water Level -39
Pleasant Bay Creek	23-Apr	2	Length	S	24		O	DJ,KK,BG	nd			Water Level -39
Pleasant Bay Creek	23-Apr	3	Length	S	2		O	DJ,KK,BG	nd			Water Level -39
Pleasant Bay Creek	28-Apr	1	Length	S	31	4	O	MS,BG,KK	10.5		4.5	Water level -36.5
Pleasant Bay Creek	28-Apr	2	Length	S	24		O	MS,BG,KK	10.5		4.5	Water level -36.5
Pleasant Bay Creek	28-Apr	3	Length	S	5		O	MS,BG,KK	10.5		4.5	Water level -36.5
Pleasant Bay Creek	5-May	1	Length	S	50	8	O	BG,DJ,MS	nd		6	Water level -37
Pleasant Bay Creek	5-May	2	Length	S	27	0	O	BG,DJ,MS	nd		6	Water level -37
Pleasant Bay Creek	5-May	3	Length	S	4	0	O	BG,DJ,MS	nd		6	Water level -37
Pleasant Bay Creek	12-May	1	Length	S	42		O	MS,BG,PS	11.0	10.0	7	Water level -38
Pleasant Bay Creek	12-May	2	Length	S	24		O	MS,BG,PS	11.0	10.0	7	Water level -38
Pleasant Bay Creek	12-May	3	Length	S	7		O	MS,BG,PS	11.0	10.0	7	Water level -38
Pt. Couverden Creek	15-May	1	3	S	3	0	O	DJ,KK,BG				Exploratory, no fish
Humpback Creek	28-Apr	1	Length	S	22	0	R	GF,SH,AH	7.0	8.0	4	Visibility fair
Humpback Creek	28-Apr	2	Length	S	2	1	R	GF,SH,AH	7.0	8.0	4	+ 1 dead
Humpback Creek	28-Apr	3	Length	S	0	13	R	GF,SH,AH	7.0	8.0	4	
Humpback Creek	28-Apr	4	Length	S/F	0	10	R	GF,SH,AH	7.0	8.0	4	
Humpback Creek	8-May	1	Length	S	12	0	O	GF,NZ,MW	13.0	12.0	7	
Humpback Creek	8-May	2	Length	S	3	2	O	GF,NZ,MW	13.0	12.0	7	
Humpback Creek	8-May	3	Length	S	2	15	O	GF,NZ,MW	13.0	12.0	7	
Humpback Creek	8-May	4	Length	S/F	0	13	O	GF,NZ,MW	13.0	12.0	7	
Humpback Creek	21-May	1	Length	S	0	4	O	GF,NZ,JP	11.0	10.0	9	
Humpback Creek	21-May	2	Length	S	1	10	O	GF,NZ,JP	11.0	10.0	9	
Humpback Creek	21-May	3	Length	S	0	9	O	GF,NZ,JP	11.0	10.0	9	
Humpback Creek	21-May	4	Length	S/F	0	12	O	GF,NZ,JP	11.0	10.0	9	
Karta River	14-Apr	1	Length	S	26	0	C	GF,SH,MW			5.6	Falls to small Trib
Karta River	14-Apr	2	Length	S	5	0	C	GF,SH,MW			5.6	Trib to USFS cabin
Ketchikan Creek	10-Apr	1	Length	S	4		C	MW,SH			33F	400+RB
Ketchikan Creek	10-Apr	2	Length	S	6		C	MW,SH			33F	20DV

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Stream name	Date	Reach	Distance surveyed	Survey type	# Live	Redds	Weather codes	Observers[a]	Surface light	Light trans	Surface temp.	Comments
Ketchikan Creek	10-Apr	3	Length	S	3		C	MW,SH			33F	2 anglers
Ketchikan Creek	23-Apr	1	Length	S	2		O	GF,SH	8.0	7.0	4	
Ketchikan Creek	23-Apr	2	Length	S	3	1	O	GF,SH	8.0	7.0	4	
Ketchikan Creek	23-Apr	3	Length	S	1		O	GF,SH	8.0	7.0	4	
Ketchikan Creek	30-Apr	1	Length	S	8		O	GF,SH	14.0	13.0	7	Water Level 3.3
Ketchikan Creek	30-Apr	2	Length	S	8	1	O	GF,SH	14.0	13.0	7	
Ketchikan Creek	30-Apr	3	Length	S	1		O	GF,SH	14.0	13.0	7	
Ketchikan Creek	7-May	1	Length	S	7	0	O	GF,NZ	14.0	13.0	10	Water very low
Ketchikan Creek	7-May	2	Length	S	15	3	O	GF,NZ	14.0	13.0	10	
Ketchikan Creek	7-May	3	Length	S	9	0	O	GF,NZ	14.0	13.0	10	
Ketchikan Creek	21-May	1	Length	S	18	3	C	GF,NZ				Level 3.4 @ bridge
Ketchikan Creek	21-May	2	Length	S	14	10	C	GF,NZ				Turbid water (run-off)
Ketchikan Creek	21-May	3	Length	S	0	0	C	GF,NZ				
Ketchikan Creek	29-May	1	Length	S	14	3	C	GF,NZ	12.0	11.0	13	Water Level 3.0 @ Harris bridge
Ketchikan Creek	29-May	2	Length	S	27	18	C	GF,NZ	12.0	11.0	13	
Ketchikan Creek	29-May	3	Length	S	6	0	C	GF,NZ	12.0	11.0	13	
Ketchikan Creek	5-Jun	1	Length	S	4	4	C	GF,MW	16.0	16.0	14	
Ketchikan Creek	5-Jun	2	Length	S	12	24	C	GF,MW	16.0	16.0	14	
Ketchikan Creek	5-Jun	3	Length	S	4	0	C	GF,MW	16.0	16.0	14	
McDonald Lake	1-May	1	Length	S	17		C	MW,SH,GF	12.0	11.0	4	
McDonald Lake	1-May	2	Length	S	24	7	C	MW,SH,GF	12.0	11.0	4	
McDonald Lake	1-May	3	Length	S	8		C	MW,SH,GF	12.0	11.0	4	
McDonald Lake	1-May	4	Length	S	6		C	MW,SH,GF	12.0	11.0	4	
McDonald Lake	14-May	1	Length	S	27	3	O	NZ,SH,GF				
McDonald Lake	14-May	2	Length	S	40	19	O	NZ,SH,GF				
McDonald Lake	14-May	3	Length	S	14	0	O	NZ,SH,GF				
McDonald Lake	14-May	4	Length	S	5	8	O	NZ,SH,GF				
McDonald Lake	27-May	1	Length	S	29	5	C	NZ,AP,GF	11.0	11.0	13	19 of total off inlet in lake
McDonald Lake	27-May	2	Length	S	26	11	C	NZ,AP,GF	11.0	11.0	13	Water just above top of rock
McDonald Lake	27-May	3	Length	S	9	2	C	NZ,AP,GF	11.0	11.0	13	
McDonald Lake	27-May	4	Length	S	4	4	C	NZ,AP,GF	11.0	11.0	13	
Naha River	9-Apr	1		S	3		O	AP,NZ			6	
Naha River	9-Apr	2		S	5		O	AP,NZ			6	
Naha River	9-Apr	3		S	9	6	O	AP,NZ			6	
Naha River	3-May	1		S	8	3	C	GF,MW,NZ	12.0	11.0	10	

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Stream name	Date	Reach	Distance surveyed	Survey type	# Live	Redds	Weather codes	Observers[a]	Surface light	Light trans	Surface temp.	Comments
Naha River	3-May	2		S	9	2	C	GF,MW,NZ	12.0	11.0	10	
Naha River	3-May	3		S	14	10	C	GF,MW,NZ	12.0	11.0	10	
Ward Creek	19-May	1	Length	S	14	6	C	GF, NZ			8	Vis obscured by plankton bloom
Ward Creek	19-May	2	Length	S	26	16	C	GF, NZ			8	
Ward Creek	19-May	3	Length	S	1	0	C	GF, NZ			8	
White River	24-Apr	1	3.7mi	S	29	7	O	GF,SH	16.0	15.0	5	
White River	24-Apr	2	3.7 mi	S	5	5	O	GF,SH	16.0	15.0	5	
White River	24-Apr	3	3.7 mi	S	52	4	O	GF,SH	16.0	15.0	5	
White River	2-May	1	3.7 mi	S	43	12	O	GF,MW	14.0	13.0	7	Water 4" below bridge
White River	2-May	2	3.7 mi	S	10	7	O	GF,MW	14.0	13.0	7	
White River	2-May	3	3.7 mi	S	40	3	O	GF,MW	14.0	13.0	7	
White River	9-May	1	3.7 mi	S	21	12	C	MW,NZ	14.0	13.0	11	Fish dark
White River	9-May	2	3.7 mi	S	7	10	C	MW,NZ	14.0	13.0	11	
White River	9-May	3	3.7 mi	S	55	8	C	MW,NZ	14.0	13.0	11	
White River	20-May	1	3.7 mi	S	8	17	O	GF,NZ	14.0	14.0	12	Water 4" below bridge
White River	20-May	2	3.7 mi	S	12	12	O	GF,NZ	14.0	14.0	12	Water 4" below bridge
White River	20-May	3	3.7 mi	S	12	8	O	GF,NZ	14.0	14.0	12	Water 4" below bridge
Marten Creek	2-May	1	Length	S	5	0	C	DB, VG				Depth 16"
Marten Creek	2-May	2	Length	S	0	0	C	DB, VG				Depth 16"
Marten Creek	6-May	1	Length	S	17	2	R	DB, VG				Depth 14"
Marten Creek	6-May	2	Length	S	0	0	R	DB, VG				Depth 14"
Marten Creek	14-May	1	Length	S	8	2	C	VG, EC			48F	Depth 16"
Marten Creek	14-May	2	Length	S	0	0	C	VG, EC			48F	Depth 16"
Petersburg Creek	1-May	1	Length	S	56		C	DB, VG	22.0			Depth 15"
Petersburg Creek	1-May	2	Length	S	52		C	DB, VG	22.0			
Petersburg Creek	1-May	3	Length	S	0			DB, VG				
Petersburg Creek	5-May	1	Length	S	92	10	O	DB,VG, RG				Depth 17"
Petersburg Creek	5-May	2	Length	S	60	5	O	DB,VG, RG				
Petersburg Creek	5-May	3	Length	S	0	0	O	DB,VG, RG			52F	Lower reach not done
Petersburg Creek	17-May	1	Length	S	22	5	C	VG, TG				Depth 22"
Petersburg Creek	17-May	2	Length	S	95	3	C	VG, TG				
Petersburg Creek	17-May	3	Length	S								Lower reach not done
Petersburg Creek	29-May	1	Length	S	11	5	C	DB, VG			57F	Depth 18.5"
Petersburg Creek	29-May	2	Length	S	18	6	C	DB, VG				
Petersburg Creek	29-May	3	Length	S								Lower reach not done
Harris River	28-Apr	1	7.3	S	0	0	O	BC, TQ	9.0	8.5	6	12 cm depth
Harris River	28-Apr	2	7.3	S	0	0	R	BC, TQ				
Harris River	28-Apr	3	7.3	S	0	0	OR	BC, TQ				

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Stream name	Date	Reach	Distance surveyed	Survey type	# Live	Redds	Weather codes	Observers[a]	Surface light	Light trans	Surface temp.	Comments
Harris River	28-Apr	4	7.3	S	23	3	OR	BC, TQ				
Harris River	28-Apr	5	7.3	S	33	0	CO	BC, TQ				
Harris River	6-May	1	7.3	S	0	0	CO	BC, TQ	11.0	10.0	6	0 cm depth
Harris River	6-May	2	7.3	S	13	0	CO	BC, TQ				
Harris River	6-May	3	7.3	S	76	15	CO	BC, TQ				
Harris River	6-May	4	7.3	S	66	21	CO	BC, TQ				
Harris River	6-May	5	7.3	S	1	0	CO	BC, TQ				
Harris River	15-May	1	7.3 mi	S	0	0	C	BC, MW	11.0	11.5	6	
Harris River	15-May	2	7.3 mi	S	0	0	C	BC, MW				
Harris River	15-May	3	7.3 mi	S	36	12	C	BC, MW				
Harris River	15-May	4	7.3 mi	S	66	17	C	BC, MW				
Harris River	15-May	5	7.3 mi	S	0	0	C	BC, MW				
Eagle Creek	24-Apr	1	5.4 mi	S	0	0	O	BC, AP	9.0	7.0	6	
Eagle Creek	24-Apr	2	5.4 mi	S	2	4	O	BC, AP				
Eagle Creek	24-Apr	3	5.4 mi	S	9	21	RW	BC, AP				
Eagle Creek	24-Apr	4	5.4 mi	S	4	2	RW	BC, AP			7	
Eagle Creek	5-May	1	5.4 mi	S	0	0	O	BC, TQ	10.0	10.5	6.5	
Eagle Creek	5-May	2	5.4 mi	S	4	3	O	BC, TQ				
Eagle Creek	5-May	3	5.4 mi	S	31	32	O	BC, TQ			7.5	
Eagle Creek	5-May	4	5.4 mi	S	21	7	O	BC, TQ				
Eagle Creek	14-May	1	5.4 mi	S	0	0	C	BC, MW	10.0	8.5	6.5	
Eagle Creek	14-May	2	5.4 mi	S	6	9	C	BC, MW				All on redds
Eagle Creek	14-May	3	5.4 mi	S	14	19	C	BC, MW				Fish old
Eagle Creek	14-May	4	5.4 mi	S	22	7	C	BC, MW			7.5	
Ford Arm Creek	11-May	1	Length	S	56		O	TB,KK,DJ				Very low water
Ford Arm Creek	11-May	2	Length	S	47		O	TB,KK,DJ				Very low water
Ford Arm Creek	18-May	1	Length	S	45		O	KK,TB,DJ				
Ford Arm Creek	18-May	2	Length	S	48		O	KK,TB,DJ				
Sitkoh Creek	12-May	1	Length	S	9	23	C	TB,KK,DJ				Six anglers
Sitkoh Creek	12-May	2	Length	S	55	9	C	TB,KK,DJ				
Sitkoh Creek	12-May	3	Length	S	90	22	C	TB,KK,DJ				
Sitkoh Creek	19-May	1	Length	S	3	28	C	AS,KK,DJ				One angler
Sitkoh Creek	19-May	2	Length	S	47	12	C	AS,KK,DJ				
Sitkoh Creek	19-May	3	Length	S	56	32	C	AS,KK,DJ				

[a] Observer initials: MS (Mark Schwan), BG (Brian Glynn), KK (Kurt Kondzela), RH (Roger Harding), DJ (Doug Jones), AS (Art Schmidt), MW (Mike Wood), BC (Bob Chadwick), GF (Glenn Freeman), TB (Tom Brookover), AP (Andy Piston), VG (Vera Goudima), DB (Dean Beers), TQ (Todd Qualls).

Appendix A2.–Daily steelhead emigration count, steelhead biological samples taken, and water level and temperature data, Situk River Weir, 1998.

Date	Steelhead down	Morts (incl.)	Cumulative proportion	Number sampled	Not sampled	Cumulative % sampled	Water level, cm	Water temp. (°C)
5/4/98	12	0	0.002	0	12	0	-	-
5/5/98	0	0	0.002	0	0	0	69	5
5/6/98	0	0	0.002	0	0	0	86	5
5/7/98	1	0	0.002	0	1	0	92	5
5/8/98	2	0	0.003	0	2	0	96	5
5/9/98	1	0	0.003	0	1	0	84	5
5/10/98	2	0	0.003	0	2	0	114	5
5/11/98	2	0	0.003	0	2	0	116	5
5/12/98	2	0	0.004	0	2	0	93	6
5/13/98	1	0	0.004	0	1	0	81	6
5/14/98	2	1	0.004	0	2	0	72	7
5/15/98	52	0	0.013	5	47	6	64	7
5/16/98	31	0	0.019	3	28	7	60	7
5/17/98	64	1	0.030	0	64	5	59	7.5
5/18/98	101	0	0.047	5	96	5	56	8.5
5/19/98	179	0	0.078	0	179	3	57	8
5/20/98	72	0	0.091	0	72	2	100	8
5/21/98	14	0	0.093	10	4	4	103	8
5/22/98	44	0	0.101	10	34	6	96	7.5
5/23/98	96	0	0.117	0	96	5	86	7
5/24/98	125	0	0.139	0	125	4	75	8.5
5/25/98	67	0	0.150	29	38	7	71	9.5
5/26/98	328	3	0.207	22	306	7	67	9.5
5/27/98	317	1	0.262	185	132	18	65	10
5/28/98	263	3	0.307	48	215	18	58	-
5/29/98	611	0	0.413	173	438	21	56	-
5/30/98	219	0	0.451	53	166	21	54	-
5/31/98	393	5	0.519	53	340	20	53	-
6/1/98	237	4	0.560	53	184	20	51	11
6/2/98	280	0	0.608	30	250	19	60	10.5
6/3/98	234	0	0.648	233	1	24	59	-
6/4/98	425	0	0.722	0	425	22	58	11.5
6/5/98	291	0	0.772	39	252	21	57	11
6/6/98	224	0	0.811	18	206	21	56	12
6/7/98	196	0	0.845	22	174	20	54	11
6/8/98	351	0	0.905	34	317	20	53	12.5
6/9/98	145	0	0.931	34	111	20	56	11
6/10/98	47	0	0.939	47	0	20	56	10.5
6/11/98	116	0	0.959	0	116	20	57	11
6/12/98	25	0	0.963	0	25	20	57	10.5
6/13/98	21	0	0.967	0	21	20	62	10
6/14/98	0	0	0.967	0	0	20	62	10
6/15/98	0	0	0.967	0	0	20	60	12
6/16/98	1	0	0.967	0	1	20	58	11.5
6/17/98	41	0	0.974	0	41	20	56	11
6/18/98	2	0	0.974	0	2	20	54	14

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Date	Steelhead down	Morts (incl.)	Cumulative proportion	Number sampled	Not sampled	Cumulative % sampled	Water level, cm	Water temp. (°C)
6/19/98	4	0	0.975	0	4	20	53	14
6/20/98	15	0	0.978	0	15	20	53	11
6/21/98	29	0	0.983	0	29	19	55	11
6/22/98	0	0	0.983	0	0	19	62	11
6/23/98	0	0	0.983	0	0	19	58	11
6/24/98	7	0	0.984	0	7	19	56	11
6/25/98	0	0	0.984	0	0	19	54	11.5
6/26/98	7	0	0.985	0	7	19	52	13.5
6/27/98	0	0	0.985	0	0	19	50	12
6/28/98	22	0	0.989	0	22	19	50	12
6/29/98	0	0	0.989	0	0	19	48	12
6/30/98	0	0	0.989	0	0	19	47	13
7/1/98	4	0	0.989	0	4	19	47	15
7/2/98	7	0	0.991	0	7	19	46	13.5
7/3/98	34	0	0.997	0	34	19	45	13
7/4/98	3	0	0.997	0	3	19	45	12.5
7/5/98	1	0	0.997	0	1	19	44	13
7/6/98	6	0	0.998	0	6	19	48	12
7/7/98	6	0	0.999	0	6	19	54	11
7/8/98	2	0	1.000	0	2	19	74	10.5
7/9/98	0	0	1.000	0	0	19	75	10.5
7/10/98	0	0	1.000	0	0	19	64	11.5
7/11/98	0	0	1.000	0	0	19	64	11
7/12/98	2	0	1.000	0	2	19	59	11
7/13/98	0	0	1.000	0	0	19	55	11

Appendix A3.–Situk River steelhead index float survey data, 1998.

Date & reach surveyed	Sections	River mile	Number of steelhead counted	LENGTH OF SECTION		DENSITY	
				km	mi	SH/km	SH/mi
APRIL 23	9 Mile bridge	13.1		Begin		-	-
LOWER		12.0	125	1.7	1.1	74	114
RIVER	Old Situk airstrip	10.9	103	1.9	1.2	54	86
		10.1	103	1.3	0.8	79	129
		9.3	50	1.3	0.8	38	63
		8.8	30	0.8	0.5	38	60
		8.3	117	0.8	0.5	146	234
		6.6	147	2.6	1.6	57	92
		5.2	91	2.3	1.4	40	65
		4.4	130	1.3	0.8	100	163
		3.6	132	1.3	0.8	102	165
		2.4	23	2.0	1.2	12	19
	Weir	1.2	25	1.8	1.1	14	23
	Lower Landing	0.0	20	2.0	1.2	10	17
	Reach total		1,096	21.1	13.1		
MAY 13	Situk Lake	19.4		Begin		-	-
UPPER		18.6	0	1.30	0.8	0	0
RIVER		17.6	7	1.60	1.0	4	7
		16.8	1	1.30	0.8	1	1
		15.9	8	1.40	0.9	6	9
		15.4	40	0.80	0.5	50	80
		14.8	64	1.80	1.1	64	107
		14.4	37	0.70	0.4	53	93
	West Fork	13.6	5	1.20	0.8	4	6
MAY 14	9 Mile bridge	13.1	49	0.8	0.5	61	98
LOWER		12.0	148	1.7	1.1	87	135
RIVER	Old Situk	10.9	246	1.9	1.2	129	205
	airstrip	10.1	172	1.3	0.8	132	215
		9.3	120	1.3	0.8	92	150
		8.8	56	0.8	0.5	70	112
		8.3	207	0.8	0.5	259	414
		6.6	300	2.6	1.6	115	188
		5.2	325	2.3	1.4	141	232
		4.4	373	1.3	0.8	287	466
		3.6	284	1.3	0.8	218	355
		2.4	212	2.0	1.2	106	177
	Weir	1.2	107	1.8	1.1	59	97
	Lower Landing	0.0	117	2.0	1.2	59	98
	River total		2,878	31.2	19.3		

-continued-

Appendix A3.–Page 2 of 2.

Date & reach surveyed	Sections	River mile	Number of steelhead counted	LENGTH OF SECTION		DENSITY	
				km	mi	SH/km	SH/mi
MAY 18	9 Mile bridge	13.1		Begin		-	-
LOWER		12.0	88	1.70	1.1	52	80
RIVER	Old Situk	10.9	180	1.90	1.2	95	150
	airstrip	10.1	130	1.30	0.8	100	163
		9.3	127	1.30	0.8	98	159
		8.8	78	0.80	0.5	98	156
		8.3	305	0.80	0.5	381	610
		6.6	147	2.60	1.6	57	92
		5.2	605	2.30	1.4	263	432
		4.4	433	1.30	0.8	333	541
		3.6	406	1.30	0.8	312	508
		2.4	336	2.00	1.2	168	280
	Weir	1.2	315	1.80	1.1	175	286
	Lower Landing	0.0	105	2.00	1.2	53	88
	River total		3,255	21.1	13.1		
MAY 27	9 Mile bridge	13.1		Begin		-	-
LOWER		12.0	35	1.70	1.1	21	32
RIVER	Old Situk	10.9	77	1.90	1.2	41	64
	Airstrip	10.1	74	1.30	0.8	57	93
		9.3	83	1.30	0.8	64	104
		8.8	32	0.80	0.5	40	64
		8.3	47	0.80	0.5	59	94
		6.6	305	2.60	1.6	117	191
		5.2	377	2.30	1.4	164	269
		4.4	453	1.30	0.8	348	566
		3.6	294	1.30	0.8	226	368
		2.4	575	2.00	1.2	288	479
	Weir	1.2	834	1.80	1.1	463	758
	Lower Landing	0.0	96	2.00	1.2	48	80
	Reach total		3,282	21.1	13.1		

Appendix A4.–Environmental conditions during Situk River steelhead float surveys, 1998.

					Luminosity [c]		Cloud Cover				Wind				Precipitation				Turbidity/Color				Overall Conditions Could not see well into -				
Date	Section [a]	Time	Water Height [b]	Water Temp. (°C)	Air	Water	Complete Overcast	Mostly Overcast	Partly Overcast	No Clouds	Constant	Frequent	Occaisional	None	Constant	Frequent	Occaisional	None	Very Heavy	Heavy	Slight	None	Average Pools	Deep Pools	Deepest Pools	No reduction in Vis.	Subjective Visibility
4/23/98	2	10:16	38.0	3.9	13.5	11.0				x				x				x			x			x			Good
4/23/98	3	12:32	-	5.0	13.8	10.5				x			x					x			x				x		Good
5/13/98	1	12:08	34.8	7.0	16.0	11.0	x						x					x			x				x		Fair
5/14/98	2	11:22	38.8	7.0	15.7	10.6			x				x					x			x			x			Fair
5/14/98	3	13:36	-	8.0	14.8	10.2			x				x					x			x			x			Fair
5/18/98	2	11:30	43.0	8.0	15.6	9.6	x							x			x				x			x			Fair
5/18/98	3	14:10	-	8.0	14.0	10.0	x						x				x				x			x			Fair
5/27/98	2	10:21	41.0	10.0	16.0	10.3				x			x					x			x					x	Excellent
5/27/98	3	12:42	-	10.5	14.3	11.0				x			x					x			x					x	Excellent

[a] Section 1 is the area from Situk Lake downstream to Nine Mile bridge; section 2 is the area from Nine Mile bridge downstream to river mile/km 5.2/8.4; section 3 is the area downstream from section 2 to the Lower Landing.

[b] Measured from the Nine Mile bridge support concrete seam, down to the water surface, in inches.

[c] ISO 100, see text.

Appendix A5.–Situk River steelhead float survey counts and proportion of total weir emigration counted, with environmental conditions observed, by date, 1994–1998.

							Luminosity [c]		Cloud Cover				Wind				Precipitation				Turbidity/Color				Overall Conditions Could not see well into -			
Date	Float Count Total	Annual Weir Emigration	Percent of annual weir count	Section [a]	Water Height [b]	Water Temp. (°C)	Air	Water	Complete Overcast	Mostly Overcast	Partly Overcast	No Clouds	Constant	Frequent	Occasional	None	Constant	Frequent	Occasional	None	Very Heavy	Heavy	Slight	None	Average Pools	Deep Pools	Deepest Pools	No reduction in Vis.
23-Apr-94	2,850	7,854	36%	CL	43.25	7.0	14.5	12.9				5			3	2				5			5				3	2
30-Apr-94	1,612	7,854	21%	CL	37.00	7.5	14.5	12.3		5				3	2				5				5		5			
04-May-94	2,437	7,854	31%	TR	40.00	7.0	14.5	12.0	3	2					5				3	2			5			5		
13-May-94	2,940	7,854	37%	TR	28.50	6.7	15.7	12.5			1	5			3	0				6		5			3	2	1	
17-May-94	4,561	7,854	58%	TR	37.75	10.7	15.7	13.2			5	1		5						6			5	1			5	1
21-May-94	4,702	7,854	60%	TR	40.25	9.3	15.0	11.7	6					5	1			3	2	1			5	1		2	0	
06-Apr-95	777	6,688	12%	CL	38.50	1.6	16.3	11.2				5				5				5			5			3	2	
20-Apr-95	2,463	6,688	37%	CL	43.00	3.7	14.0	10.5			5					2			3	2			5				5	
27-Apr-95	1,754	6,688	26%	CL	39.80	4.1	12.4	11.9				5			3	2				5			5				5	
09-May-95	6,235	6,688	93%	TR	44.00	7.1	13.6	11.8			4	2		3	0					6				6				6
16-May-95	4,889	6,688	73%	TR	43.10	8.8	13.25	10.0	3	0			3	2		1		1		5			5	1	3	2	1	
23-May-95	5,189	6,688	78%	CL	45.50	10	13.5	10.5	5						5					5				3			5	
29-Mar-96	758	8,510	9%	CL	48.00		16.3	11.9				5			3	2				5				5				5
17-Apr-96	1,409	8,510	17%	CL	45.50	4.1	14.8	11.0			3	2		3		2				5				5		3	2	
23-Apr-96	1,715	8,510	20%	CL	44.00	4.5	14.63	10.9			3	2				5				5			3	2			5	
08-May-96	5,840	8,510	69%	TR	46.00	6.7	15.3	10.1			6				5	1				6				6			6	
16-May-96	5,168	8,510	61%	CL	45.50	7.9	15.0	8.8	3	2					5			5						5		5		
18-May-96	6,544	8,510	77%	TR	46.50	8.6	14.0	11.5			1	5			6					6				6				6
21-May-96	5,934	8,510	70%	TR	46.00	9.6	12.33	11.3			5			3	0					6			1	0			5	1
25-May-96	4,393	8,510	52%	TR	46.00	8.3	15.3	9.8	6						6			6						6				
28-May-96	3,729	8,510	44%	CL	45.50	9.9	14.5	10.3			5				3	2				5				5			5	
24-Apr-97	1,605	7,328	22%	CL	43.75	4.9	16.0	10.5			5					5				5			5			5		
28-Apr-97	1,847	7,328	25%	CL	44.00	5	15.7	10.0		5					5				5				5			5		
05-May-97	4,943	7,328	67%	TR	47.50	7.3	13.9	10.3			1	5			5					6			3	0				0
16-May-97	2,597	7,328	35%	TR	39.00	7.9	15	9.3		2	4				4	2				6			6			5	1	
20-May-97	4,377	7,328	60%	CL	43.00	9.3	12	9.7				5			5					5			5				5	
23-Apr-98	1,096	5,786	19%	CL	38.00	4.5	13.65	10.8				5			3	2				5			5			2	3	
14-May-98	2,878	5,786	50%	TR	36.75	7.3	15.5	10.6	1		5				6					6			6			5	1	
18-May-98	3,255	5,786	56%	CL	43.00	8	14.8	9.8	5						3	2			5				5			5		
27-May-98	3,282	5,786	57%	CL	41.00	10.3	15.2	10.7				5			5					5			5					5

Numeric codes for environmental observations encountered: 0 = condition occurred in area 1 and 2 only; 1 = condition occurred in area 1 only; 2 = condition occurred in area 2 only; 3 = condition occurred in area 3 only; 4 = condition occurred in area 1 and 3 only; 5 = condition occurred in area 2 and 3 only; 6 = condition occurred in areas 1, 2, and 3.

[a] CL = combined lower river survey (Nine Mile downstream, sections 1 & 2); TR = total river, all sections combined (1, 2, & 3); section 1 is the area from Situk Lake downstream to Nine Mile bridge; section 2 is the area from Nine Mile bridge downstream to river mile/km 5.2/8.4; section 3 is the area from section 2 to the Lower Landing

[b] Measured from the Nine Mile bridge support seam, down to the water's surface, in inches.

[c] ISO 100 – see Johnson and Jones (1998) for measurement details.