Salmon Lake Subsistence Sockeye Salmon Project: 2004 Annual Report

By

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September 2008

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ABSTRACT

In 2004, an estimated 980 sockeye salmon escaped ocean fisheries and entered Salmon Lake to spawn. This escapement level fell within the range of the previous three escapement estimates, the only three escapement estimates available for this system. Approximately 22% of this escapement was made up of age-1.1 males (e.g. jacks), a percentage also falling within the range observed in the three previous years. In all four years, the escapement was estimated with a weir-based mark-recapture study. This approach works well for this system, as some fish have passed through the weir undetected in all years, making the unadjusted weir counts an unreliable indicator of escapement magnitude. However, as crews need to handle a large number of fish to collect age, length, and sex information, an additional mark-recapture study to validate or adjust the weir count is cost-effective and easily accomplished in Salmon Lake.

INTRODUCTION

Sockeye salmon (*Oncorhynchus nerka)* returning to Redoubt and Salmon Lakes are important to local subsistence fishers, as these sockeye populations are easily accessed from the city of Sitka, Alaska. Although subsistence harvests at Salmon Lake are relatively small in number, these harvests may remove a large percentage of the total return to this system. In March 2000, the Southeast Alaska Regional Advisory Council identified Salmon Lake sockeye and coho salmon assessment as a priority for subsistence fisheries monitoring. In response, in 2001 the Alaska Department of Fish and Game and the Sitka Tribe of Alaska established a weir at the outlet of Salmon Lake to count the incoming sockeye and coho salmon (Tydingco et al. 2006). This successful project provided the first estimates of sockeye escapement for this lake, and this project built upon a limited escapement history and information base for coho salmon (Schmitd 1996).

Before this weir was installed, beginning in 1998, ADF&G and the Northern Southeast Regional Aquaculture Association conducted foot and snorkel surveys of Salmon Lake inlet streams to provide a low-cost indication of sockeye abundance in that system. However, observer counts from foot surveys or airplanes generally have failed to capture the magnitude of the total escapement across a season, and these aerial and foot counts have tended to under-represent the actual escapement on any given day. Furthermore, the detectability of spawning salmon depends on many factors such as water clarity; stream morphology; and the ecology, behavior, size, and color of salmon (e.g., Bevan 1961 or Bue et al. 1998). After several years of comparisons between snorkel surveys and total estimates of escapement, Tydingco et al. (2006) concluded that snorkel survey counts over time did not adequately reflect trends in escapements. Subsequently, these surveys were discontinued.

In 2004, the assessment of sockeye escapement in Salmon Lake was taken over by the Sitka Tribe of Alaska, and the project was focused on an accurate estimate of size of the sockeye escapement and a corresponding picture of demographic features of the spawning stock, such as the age-class distribution. We did not have funding to continue monitoring coho salmon, nor did we continue the sonar studies or the water quality measurements, as was done in 2001 through 2003 (Tydingco et al. 2006). We did continue to use the weir as our main tool. A key point is that the statistical population under study is the collection of fish that moved past the weir, and population size, age-class distribution, and other statistics will all relate to this collection of sockeye salmon, before any in-lake mortality. Although weir counts are often assumed to be an accurate assessment of sockeye escapement, many studies in Southeast Alaska have shown that weirs occasionally leak, leading to an underestimate of the fish that escape the fishery and enter the lake environment (e.g. Geiger et al. 2006, see p. 70). For that reason, we chose to follow the example set by Tydingco et al. (2006) and validate the weir count with a mark-recapture study, as has been the custom for most weir studies in Southeast Alaska since the 1990s. Our larger purpose was to contribute to a record of escapement sizes (and associated demographic statistics) for the purpose of assessing the capacity of the Salmon Lake stock to meet subsistence needs in the Sitka area.

OBJECTIVES

1. Estimate the escapement magnitude of sockeye salmon into Salmon Lake.
2. Estimate the age, length, and sex composition of the sockeye salmon in the Salmon Lake escapement.

STUDY AREA

Salmon Lake is located 14.4 km. southeast of Sitka at the head of Silver Bay (Figure 1). The lake lies at 15.2 m. elevation and is fed primarily by two main inlet streams and several smaller tributaries opposite the 1.1 km. outlet stream. The U.S. Forest Service maintains a recreational use cabin on the lake. A foot trail provides access to Salmon Lake and to Redoubt Lake (the latter being another sockeye stock important for subsistence use in the Sitka area). Tydingco et al. (2006) reported that the lake supports populations of sockeye, pink (*O. gorbuscha*), chum (*O. keta*), and coho salmon; Dolly Varden (*Salvelinus malma*); cutthroat (*O. clarki*) and steelhead (*O. mykiss*) trout; stickleback (*Gasterosteus aculeatus*); and sculpin (*Cottus sp.*).

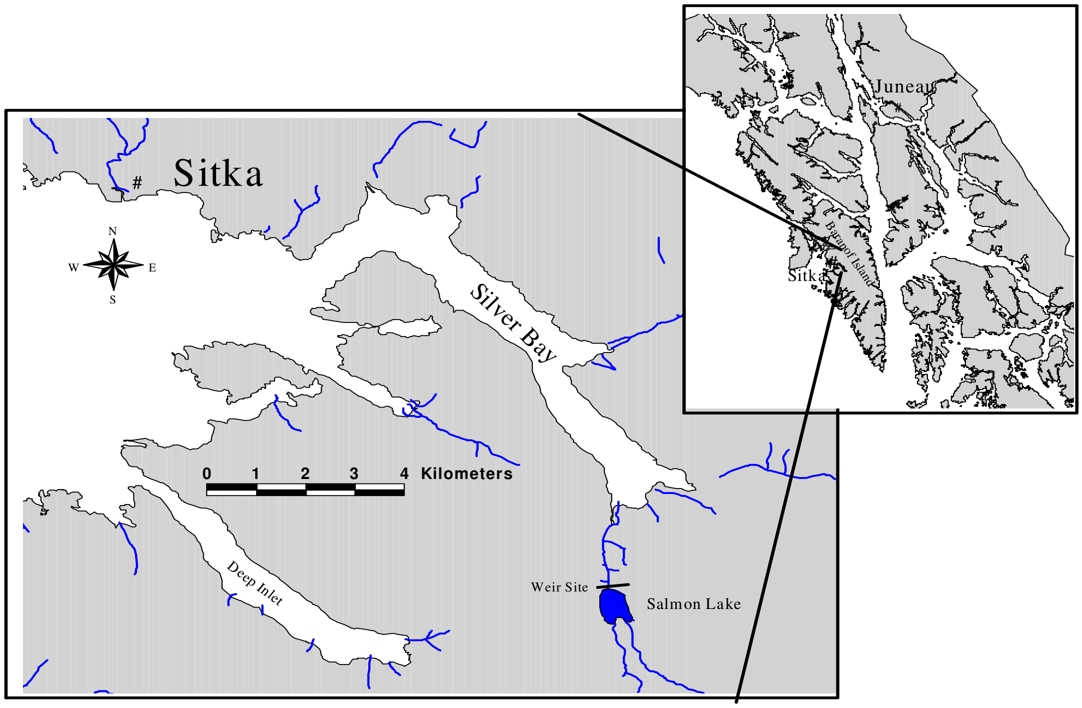

Figure 1.- Study area showing Salmon Lake, weir site and major tributaries.

METHODS

WEIR OPERATIONS AND FISH COUNTING

The floating weir, located at the outlet of Salmon Lake, was installed in June 1, 2004 and operated until October 8, 2004. This was the same weir described by Tydingco et al. (2006). It consisted of hollow PVC panels attached to an anchored cable laid across the stream channel, with a fixed live box attached on the upstream side. One-inch diameter schedule 30 PVC was used as the weir pickets. In 2004, the picket spacing was 19 pickets per 4-ft by 20-ft panels on the floating portion of the weir. A rigid weir was on either side of the 40-foot long floating weir. The rigid weir was supported by bipods and consisted of 3-in aluminum channel with a hole spacing of 49 per 8 ft. The pickets used for the rigid weir were 3/4-in galvanized conduit. Fish were allowed to move upstream though the weir by entering a holding trap. When passage rates were low, the trap was cleared of fish two or three times per day. At high passage rates the trap was cleared approximately every two hours.

FISH MARKING

Both adult and jack sockeye salmon were captured and sampled at the weir. All sockeye salmon that were > 445 mm in length (measured mid-eye to the fork of the tail) were assumed to be adult salmon that had spent more than one year in saltwater (based on the recommendation of Tydingco et al. 2006). All sockeye salmon < 445 mm (measured mid-eye to the fork of the tail) were assumed to be 1-ocean fish (fish that spent one year in saltwater), or what are generally called jacks. Each sockeye salmon that was passed through the weir, both adults and jacks, received an individually numbered Floy™ tag used to identify fish during the recapture portion of the study.

All sockeye salmon that entered the weir and were captured in the live box were counted and were anesthetized with a mixture of clove oil and Everclear™ alcohol (12 ml clove oil to 108 ml alcohol) in 15 gal of water prior to being tagged with a uniquely numbered t-bar anchor Floy™ tag. Tags were inserted immediately below the middle of the dorsal fin on the left side. Sockeye salmon were tagged with sequentially numbered tags. All tagged fish received an operculum punch as a secondary mark. Each fish was allowed to safely recover in a holding box before release on the upstream side of the weir.

FISH MEASUREMENTS FOR AGE AND LENGTH CHARACTERISTICS AND SEX RATIOS

All of the adult sockeye salmon that passed through the live box, and were then subsequently tagged, were also sampled for length, sex, and scales (for age determination) at the Salmon Lake weir. The length of each fish was measured from mid eye to tail fork, to the nearest millimeter. Sex of the fish was decided by length and shape of the kype or jaw. Three scales were taken from the preferred area of each fish (INPFC 1963), and prepared for analysis as described by Clutter and Whitesel (1956). Scale samples were analyzed by the University of Alaska at the Advanced Instrumentation Laboratory in Fairbanks, Alaska. Age classes were designated by the European aging system where freshwater and saltwater years are separated by a period (e.g. 1.3 denotes a five-year-old fish with one freshwater and three ocean years; Koo 1962).

We assumed that if any fish passed through the weir undetected, the actual sample we obtained at the weir could be treated as a random sample from a finite population. Therefore, the approximate standard errors of were estimated using standard statistical techniques for finite population sampling (e.g. Cochran 1977). The finite population correction factor was calculated based on the mark-recapture estimate of population size taken as a fixed (non-random) quantity, ignoring the negligible error this introduced.

MARK RECAPTURES

The recapture sampling was primarily organized within the lake, near the eastern inlet stream, which is where a large aggregation of lake spawning salmon had previously been observed. The recapture events occurred when there was sufficient personnel. Fish were recaptured with a seine, approximately 300 by 25 feet, deployed from a skiff. Each fish was examined for primarily and secondary marks and then released.

ESCAPEMENT ESTIMATION WITH MARK-RECAPTURE METHODS

Because each fish was tagged with a uniquely numbered tag, there was a range of statistical options, beginning with the simple two-sample Petersen-type estimator (specifically, Chapman's modified estimator, Seber 1982). Alternatively, a more complicated time-stratified Darroch (1961) estimator could also be considered. The more complicated model would involve grouping sequentially numbered tags into multiple release strata and allowing multiple recovery events (again, Seber 1982). Stratified mark-recapture models, such as the Darroch estimator, extend the two-sample Petersen method over two or more sampling events in both the marking (first) and mark-recovery (second) samples. Stratified models are widely used for estimating escapement of salmonids as they migrate into their spawning streams (Arnason et al. 1996).

Before considering the assumptions that underlie the Petersen estimator, it is important to understand that our statistical population was made up of only that group of fish that actually moved through or past the weir—irrespective of the timing of that movement within the study period. Briefly stated, the most important assumptions underlying the Petersen approach are that 1) all fish have an equal probability of capture in the first sample (marking), 2) all fish have an equal probability of capture in the second sample (mark-recovery), and 3) all fish mix completely between the first and second sample. Note that these assumptions allow for death before the recapture sample, say by bear predation, but we require that both tagged and untagged fish have the same probability of death between marking and recapture sampling. Arnason et al. (1996) advises that if one or more of these assumptions is met, the marking and recovery strata can be pooled, resulting in a simple Petersen model, thereby providing the most precise estimate. However, if none of the assumptions are met, the pooled estimate will be more precise, but it will be inaccurate. Following the recommendation of Arnason et al., we assumed that a simple pooled Petersen-type estimate was appropriate if one of the diagnostic chi-squared tests (for complete mixing of animals across recovery strata independent of their initial marking stratum or for an equal proportion of marks in the marking or recovery strata) produced a P-value > 0.05. In either case, the Petersen-type or the more complicated approach, our mark-recapture estimate was rounded to two significant digits.

Confidence intervals for the pooled Petersen estimator were generated with a parametric bootstrap technique. A total of 2,000 simulated recaptures were generated from a binomial distribution with parameters n=62 (the actual number of recapture samples), and p=0.855 (the actual observed mark rate in the pooled second sample) (Table 1). These simulated recaptures were used to generate a bootstrap distribution of Petersen estimates, and the approximate 95% confidence interval was generated with the 0.025 and 0.975 quantiles.

RESULTS

WEIR OPERATIONS AND FISH COUNTING

The floating weir was operational on June 1, 2004. The first sockeye salmon was captured in the upstream trap on June 7 with the sockeye migration into Salmon Lake continuing through October 8, by which time 838 sockeye salmon were counted through the Salmon Lake weir (Table 1, Appendix Table 1). In addition, 10,941 pink salmon, 283 chum salmon (Appendix Table 1), and 245 Dolly Varden were counted through the weir during the same period. Peak counts occurred on July 28 and August 28 and coincided with peaks in water level (Figure 2).

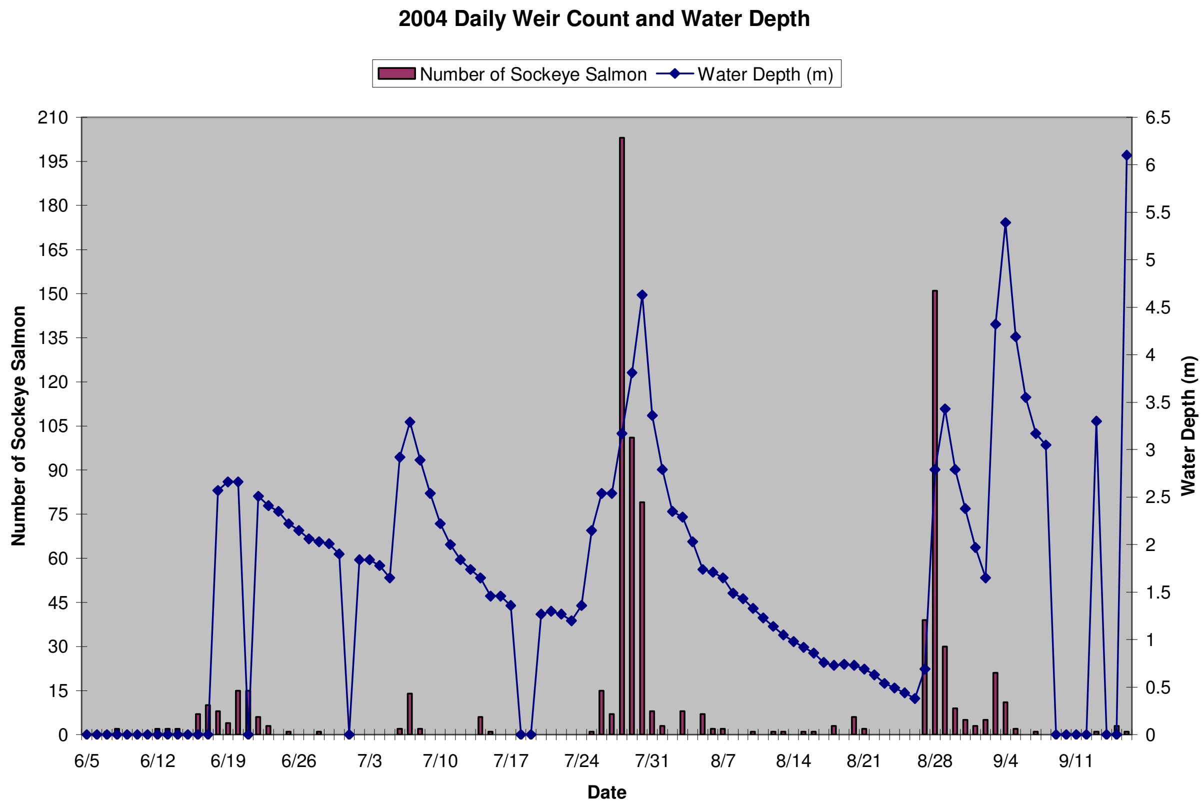

Figure 2.- Daily sockeye salmon weir counts (vertical bars, left axis) with to the water depth of Salmon Lake outlet stream (connected dots, right axis).

FISH MARKING

In all, 838 fish passed through the weir and were marked for use in the recovery phase. These fish were grouped into four release strata, the first of which contained all fish marked from June 1 to August 23 and included 66% of all marked fish. Because the recapture phase began before all tags were deployed, the assumption of equal mixing was obviously violated (Table 1).

Table 1.-Number of sockeye salmon marked at the weir for each marking period, and number of recoveries of marked fish by recapture event and marking stratum in Salmon Lake 2004. The number of fish passed through the weir during each marking period is included for comparison.

Marking at weir					Marks recaptured on spawning grounds					
Marking strata	**Marking dates**	**Tag number**	**Number through weir and marked**	**Percent sockeye salmon marked**	**Recapture Event 1: Aug. 23**	**Recapture Event 2: AUG. 23**	**Recapture Event 3: Sept. 7**	**Recapture Event 4: Sept. 23**	**Recapture Event 1-4 total**	**% sockeye marked and recovered**
1	thru 8/23	3038-3600	556	100%	7	4	8	10	29	5.2%
2	8/24-8/29	3601-3821	220	100%	0	8	2	10	20	9.0%
3	8/30-9/5	3822-3877	56	100%	0	0	3	1	4	7.1%
4	9/6-10/8	3878+	6	100%	0	0	0	0	0	0.0%
Total			838	100%	7	12	13	21	53	6.3%
Total sampled					8	14	15	25	62	
Percent marked fish in recapture sample					87.5%	85.7%	86.6%	84.0%	85.5%	

FISH MEASUREMENTS FOR AGE AND LENGTH CHARACTERISTICS AND SEX RATIOS

Of 836 usable sockeye scales, 746 provided age and gender measurements. The largest age class in the 2004 sockeye escapement was age 1.2, estimated to be about 42.6% of the total (Table 2). The second largest age class was age 1.1, representing about 25.1% of escapement, followed by age 1.3, representing about 16.9% of escapement. Examining the age composition by brood year shows a spawning population composed of about 25.1% 3-year olds, 49.4% 4-year olds, and 25.5% 5-year olds. About 84.6% of sockeye salmon in the 2004 escapement had one freshwater year.

Table 2.-Estimated age composition of sockeye salmon in Salmon Lake escapement by sex, brood year, and age class, sampled in 2004.

Brood Year	**2001**	**2000**	**1999**	**2000**	**1999**	**Total**
Age	**1.1**	**1.2**	**1.3**	**2.1**	**2.2**	
Male						
Age Classification	187	81	24	39	18	349
Percent	53.6%	23.2%	6.9%	11.2%	5.2%	100%
Standard Error	1.0%	<1%	<1%	<1%	<1%	
Female						
Age Classification		237	102	12	46	397
Percent		59.7%	25.7%	3.0%	11.6%	100%
Standard Error		<1%	<1%	<1%	<1%	
All Fish						
Age Classification	187	318	126	51	64	746
Percent	25.1%	42.6%	16.9%	6.8%	8.6%	100%
Standard Error	<1%	<1%	<1%	<1%	<1%	

The average fork length was 566.2 mm for age-1.3 fish and 540.5 mm for age-1.2 fish (Table 3). Sockeye salmon returning with three ocean years were about 29 mm longer, on average, than their counterparts with only two ocean years, across both freshwater age classes. Stratifying the sockeye escapement by week showed a consistently high percentage of sockeye salmon from age class 1.2 each week throughout the run (Table 4).

Table 3. - Mean fork length (mm) of 2004 sockeye salmon in Salmon Lake escapement, by brood year, sex, and age class.

Brood Year	**2001**	**2000**	**1999**	**2000**	**1999**	**Total**
Age	**1.1**	**1.2**	**1.3**	**2.1**	**2.2**	
Male						
Av. Length	472.3	535.3	587.2	471.8	532.6	
SE	0.38	0.66	0.78	1.92	3.26	
Sample Size	187	81	24	39	18	349
Female						
Av. Length		542.4	561.2	486.8	536.3	
SE		0.15	0.23	6.76	0.73	
Sample Size		235	102	12	46	395
All Fish						
Av. Length	472.3	540.5	566.2	471.9	534.4	
SE	0.38	0.12	0.19	1.41	0.63	
Sample Size	187	316	126	51	64	744

Table 4.-The percent of each age class, by week, from 6 July – 30 September, 2004 in Salmon Lake.

Week beginning	**1.1**	**1.2**	**1.3**	**2.1**	**2.2**	**Weekly sample totals**
6-Jun			100%			5
13-Jun		28%	69%		3%	32
20-Jun		35%	60%		5%	40
27-Jun		100%				1
4-Jul	6%	61%	28%		6%	18
11-Jul		57%	29%		14%	7
18-Jul						
25-Jul	26%	46%	13%	6%	8%	405
1-Aug	24%	43%		14%	19%	21
8-Aug	67%			33%		3
15-Aug	46%	23%	8%	23%		13
22-Aug	31%	42%	8%	9%	11%	127
29-Aug	32%	39%	7%	11%	11%	82
5-Sep	33%	33%		33%		3
12-Sep		75%			25%	4
19-Sep						
26-Sep	100%					1
Total						762

MARK RECAPTURES

Unmarked fish were detected above the weir, indicating that sockeye salmon had somehow passed through the weir undetected. Of the 838 sockeye salmon marked at the weir, 53 individual sockeye were recaptured at least once during subsequent recapture events; another 9 previously unmarked sockeye salmon were also captured. More importantly, the mark percentage was high and nearly constant (between 85.7% to 87.5%) in each recapture event (Table 1). Because the mark percentage was substantially less than 100% in each recapture event we proceeded to produce a mark-recapture estimate of escapement.

ESCAPEMENT ESTIMATION WITH MARK-RECAPTURE METHODS

We found no evidence of temporal variability in the probability of capture at the weir throughout the migration (*P*-value =.1694). In addition, we could not find evidence of temporal variability in the probability of recapture in the lake (*P*-value=.9974). We were able to demonstrate unequal mixing throughout the recapture events (*P*-value= .0035). This is not an unexpected result given the duration of the salmon run. Salmon marked early at the weir could die before the final recapture event, and recapture sampling was begun before all marks were out, making complete mixing impossible. Based on our earlier decision rule, because two of the three *P*-values were greater than 0.05, we concluded that a Petersen-type estimator was appropriate for estimation sockeye salmon abundance. The pooled Petersen estimate was 980 sockeye salmon; the 95% confidence interval for the escapement was 900–1100 fish. Note that the weir count of 838 sockeye salmon did not fall within the 95% confidence interval for the population size.

DISCUSSION

The 2004 sockeye salmon escapement into Salmon Lake fell neatly into the range of the three previous escapement measures (840 – 1,431) developed by Tydingco et al. (2006). As was the case in 2001 through 2003, sampling crews detected what should be considered a substantial number of unmarked fish in spawning aggregations, given that all fish that were passed through the weir were marked. We therefore recommend the mark-recapture estimate of 980 as the official record of sockeye escapement into Salmon Lake in 2004. The fact that some fish leaked through the weir should not be considered a failure on the part of the weir crew. This observation is common on weir projects throughout Southeast Alaska. As the Salmon Lake weir controlled approximately 85% of the escapement, this demonstrates that this weir can be a very useful tool for escapement monitoring, when combined with a mark-recapture validation study.

The age-class and length distribution measurements, described in the objectives, were obtained with negligible sampling error because such a large fraction of the population was sampled. However, whenever fish move through a weir undetected there is the strong possibility that the weir was acting as a size-selective barrier to passage. If that were the case, age-class proportions and length distributions would be statically biased, and the reported standard errors and confidence intervals would only represent one part of the statistical uncertainty. Unfortunately, the length distribution was not collected in the unmarked fish in the recapture samples, so that the size distribution of the tagged and untagged fish could not be compared. Even if these measurements were available, with only nine unmarked fish in the recovery sample, a comparison between the sizes of tagged and untagged fish would not be conclusive. However, Tydingco et al. (2006) performed this comparison for both sockeye and coho salmon during all three years of their studies. They concluded that they found evidence of size size-selective sampling in the first sample (that is, in the marking sample at the weir) for sockeye and coho salmon in 2001; however, they failed to find evidence of size-selective sampling for either species in 2002 and 2003. It seems reasonable to conclude that if this weir was strongly size selective, then these effect should be highly repeatable. Again, essentially 85% of the population was examined for sex, length, and age, and this should give further confidence that any bias that resulted from size selection at the weir can be considered negligible.

The age-class distribution in 2004 differed somewhat from the previous three years. In 2001 – 2003, 5-year-old fish dominated the escapement, with age-2.2 fish more common than 1.3-year old fish in 2002 and 2003. However, the abundance of fish with one freshwater year in the 2004 escapement (>80% of the 2004 escapement), and the dominance of age-1.2 fish (>40% of the 2004 escapement) would seem to indicate that the growing conditions within the lake must have been good for the 2000 and 2001 brood years, as obviously many sockeye salmon from these brood years were able to successfully reach a size that provided adequate marine survival after just one year in freshwater.

In the future, project managers may want to decrease the handling of fish at the weir. The number of fish examined for age and length measurement could be substantially reduced, with very little loss in precision or information. Because greater than 80% of the population was used for age and length determination in 2004, the standard errors on all age class proportion estimates were negligible. This decision to reduce handling and measurement at the weir does involve tradeoffs. All handling of sockeye salmon surely involves stress, and some level of mortality. Therefore, reducing handling associated with scale collection and length measurements would seem to have an obvious benefit, although it cannot be quantified. However, if this sampling level is reduced (at the weir), then it will be more important to sample fish for lengths in the second sample (the mark recovery phase), so as to detect and correct for size selection at the weir, if it exists. In years when 100% of the fish are tagged at the weir, only the unmarked fish need to be measured in the recovery sample; at least a sample of length measurement will be available for a tagged fish, based on their length measurements at the weir. However, only untagged fish need to be measured as long as the tag number is recorded for each tagged fish in the recovery sample. It is harder to recommend reducing the number of fish to tag at the weir. Even with an effort that produced 100% of the available fish tagged, the length of the 95% confidence interval was still approximately 20% of the estimate. Reducing the tagging rate appreciably would result in a mark-recapture program that would be unable to detect and correct a 15% bias in the escapement estimate cause by weir leakage. By tagging 100% of the fish passing through the weir, when untagged fish show up in the recovery sample this is an unambiguous sign that fish passed though the weir undetected and that the weir count is unreliable. In summary, the sampling goals should be reviewed and possibly lowered, especially the sampling goals of 100% of fish though the weir for length and scale collection. However, the decision to mark 100% of the fish passing through the weir is probably a good one, given the history of fish passing though this weir undetected and the small recovery sample sizes, reflecting the small population size in this system.

ACKNOWLEDGEMENTS

We wish to acknowledge the many people in all three cooperating agencies, the Sitka Tribe of Alaska (STA), the Alaska Department of Fish and Game (ADF&G), and the U.S.D.A. Forest Service (USFS), who played a vital role in the completion of this project. Jack Lorrigan of STA supervised the fieldwork and data collection during the third year of the project. Karen Hyer from the US Fish & Wildlife Service and Terry Suminski of the USFS, Sitka Ranger District, reviewed this report and provided input into field data collection procedures. Cameron Lingle of ADF&G provided on-site training in data collection for the field crew and assisted in the field at critical times during each season. Zachary Penny served as the crew leader at Salmon Lake and was responsible for collecting the weir and creel survey. We thank Dr. Hal Geiger at the St. Hubert Research Group in Juneau for editorial assistance. The US Forest Service provided approximately $91,500 in funding support for this project through the Fisheries Resource Monitoring Program under agreement number 04-608.

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APPENDIX

Appendix Table 1. Daily weir counts, by species, for the Salmon Lake weir in 2004.

	Sockeye		Chum		Pink		Physical data		
Date	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Water depth (mm)	Water temp (°C)	Air temp (°C)
5-Jun	0	0	0	0	0	0	N.A.	N.A	N.A.
6-Jun	0	0	0	0	0	0	N.A.	N.A.	N.A.
7-Jun	1	1	0	0	0	0	N.A.	N.A	N.A.
8-Jun	2	3	0	0	0	0	N.A.	N.A	N.A.
9-Jun	0	3	0	0	0	0	N.A.	N.A	N.A.
10-Jun	0	3	0	0	0	0	N.A.	N.A	N.A.
11-Jun	0	3	0	0	0	0	N.A.	N.A	N.A.
12-Jun	2	5	0	0	0	0	N.A.	N.A	N.A.
13-Jun	2	7	0	0	0	0	N.A.	N.A.	N.A.
14-Jun	2	9	0	0	0	0	N.A.	N.A.	N.A.
15-Jun	0	9	0	0	0	0	N.A.	N.A.	N.A.
16-Jun	7	16	0	0	0	0	N.A.	N.A.	N.A.
17-Jun	10	26	0	0	0	0	N.A.	N.A.	N.A.
18-Jun	8	34	0	0	0	0	257	11.0	N.A.
19-Jun	4	38	0	0	0	0	266	8.0	N.A.
20-Jun	15	53	0	0	0	0	266	N.A.	N.A.
21-Jun	15	68	0	0	0	0	N.A.	N.A .	N.A.
22-Jun	6	74	0	0	0	0	251	N.A.	26
23-Jun	3	77	0	0	0	0	241	10.0	13
24-Jun	0	77	0	0	0	0	235	10.0	16
25-Jun	1	78	0	0	0	0	222	12.0	16
26-Jun	0	78	0	0	0	0	215	11.0	16
27-Jun	0	78	0	0	0	0	206	12.0	15
28-Jun	1	79	0	0	0	0	203	12.0	13
29-Jun	0	79	0	0	0	0	201	12.0	14
30-Jun	0	79	0	0	0	0	190	12.0	16
1-Jul	0	79	0	0	0	0	N.A.	12.0	17
2-Jul	0	79	0	0	0	0	184	13.5	16
3-Jul	0	79	0	0	0	0	184	14.5	16
4-Jul	0	79	0	0	0	0	178	15.0	17
5-Jul	0	79	0	0	0	0	165	14.0	16
6-Jul	2	81	0	0	0	0	292	9.5	13
7-Jul	14	95	1	1	3	3	329	13.5	16
8-Jul	2	97	0	1	0	3	289	14.0	15
9-Jul	0	97	0	1	0	3	254	14.5	15
10-Jul	0	97	0	1	0	3	222	11.0	16
11-Jul	0	97	0	1	0	3	200	12.0	18
12-Jul	0	97	0	1	0	3	184	13.5	16
13-Jul	0	97	0	1	0	3	174	13.5	14
14-Jul	6	103	0	1	0	3	165	16.0	15
15-Jul	1	104	0	1	0	3	146	12.0	16
16-Jul	0	104	0	1	0	3	146	15.5	17
17-Jul	0	104	0	1	0	3	136	16.5	16
18-Jul	0	104	0	1	0	3	N.A.	N.A.	N.A.

Append. Table 1. Daily weir counts, by species, for the Salmon Lake weir in 2004 (cont.)

	Sockeye		Chum		Pink		Physical data		
Date	**Daily**	**Cumulative**	**Daily**	**Cumulative**	**Daily**	**Cumulative**	**Water depth (mm)**	**Water temp (°C)**	**Air temp (°C)**
19-Jul	0	104	0	1	0	3	N.A.	N.A.	N.A.
20-Jul	0	104	0	1	0	3	127	16.5	17
21-Jul	0	104	0	1	0	3	130	16.0	16
22-Jul	0	104	0	1	0	3	127	16.5	16
23-Jul	0	104	0	1	0	3	120	16.0	17
24-Jul	0	104	0	1	0	3	136	16.0	16
25-Jul	1	105	0	1	0	3	215	15.5	15
26-Jul	15	120	2	3	4	7	254	16.0	14
27-Jul	7	127	6	1	2	9	254	15.5	15
28-Jul	203	330	2	11	18	27	317	13.0	14
29-Jul	101	431	0	11	3	30	381	12.0	14
30-Jul	79	510	17	28	15	45	463	14.0	16
31-Jul	8	518	5	33	3	48	336	13.0	14
1-Aug	3	521	0	33	0	48	279	13.5	14
2-Aug	0	521	0	33	0	48	235	16.5	16
3-Aug	8	529	3	36	2	50	229	16.5	16
4-Aug	0	529	0	36	0	50	203	16.5	17
5-Aug	7	536	3	39	3	53	174	14.0	15
6-Aug	2	538	0	39	2	55	171	14.0	15
7-Aug	2	540	1	40	11	66	165	14.0	16
8-Aug	0	540	0	40	0	66	149	14.5	16
9-Aug	0	540	0	40	0	66	143	14.0	16
10-Aug	1	541	0	40	0	66	133	15.0	16
11-Aug	0	541	2	42	2	68	123	15.0	16
12-Aug	1	542	0	42	2	70	114	15.0	15
13-Aug	1	543	0	42	3	73	105	16.0	16
14-Aug	0	543	0	42	0	73	98	15.0	15
15-Aug	1	544	0	42	1	74	92	16.0	16
16-Aug	1	545	0	42	0	74	86	16.0	17
17-Aug	0	545	0	42	1	75	76	20.0	28
18-Aug	3	548	0	42	0	75	73	19.0	23
19-Aug	0	548	0	42	0	75	74	18.5	0
20-Aug	6	554	0	42	11	86	73	17.0	16
21-Aug	2	556	0	42	22	108	69	17.0	15
22-Aug	0	556	0	42	2	110	63	17.0	14
23-Aug	0	556	0	42	0	110	54	16.5	13
24-Aug	0	556	0	42	0	110	49	16.0	14
25-Aug	0	556	0	42	0	110	44	15.0	12
26-Aug	0	556	0	42	0	110	38	16.0	16
27-Aug	39	595	0	42	655	765	69	16.0	N.A.
28-Aug	151	746	61	103	1985	2750	279	13.0	14

Append. Table 1. Daily weir counts, by species, for the Salmon Lake weir in 2004 (cont.)

	Sockeye		Chum		Pink		Physical data		
Date	**Daily**	**Cumulative**	**Daily**	**Cumulative**	**Daily**	**Cumulative**	**Water depth (mm)**	**Water temp (°C)**	**Air temp (°C)**
29-Aug	30	776	46	149	4211	6961	343	13.0	N.A.
30-Aug	9	785	16	165	956	7917	279	17.0	N.A.
31-Aug	5	790	3	168	1	7918	238	15.0	N.A.
1-Sep	3	793	4	172	220	8138	197	14.0	N.A.
2-Sep	5	798	0	172	0	8138	165	15.0	N.A.
3-Sep	21	819	36	208	523	8661	432	12.0	N.A.
4-Sep	11	830	23	231	1126	9787	539	10.5	N.A.
5-Sep	2	832	31	262	715	10502	419	11.5	N.A.
6-Sep	0	832	11	273	202	10704	355	13.0	N.A.
7-Sep	1	833	0	273	0	10704	317	11.5	N.A.
8-Sep	0	833	3	276	39	10743	305	11.0	5
9-Sep	0	833	0	276	0	10743	N.A.	N.A.	N.A.
10-Sep	0	833	0	276	0	10743	N.A.	N.A.	N.A.
11-Sep	0	833	0	276	0	10743	N.A.	N.A.	N.A.
12-Sep	0	833	0	276	0	10743	N.A.	N.A.	N.A.
13-Sep	1	834	0	276	0	10743	330	7.5	9
14-Sep	0	834	0	276	0	10743	N.A.	N.A.	N.A.
15-Sep	3	837	7	283	207	10950	N.A.	N.A.	N.A.
8-Oct	1	838	0	283	0	10950	610	8.0	9

All captured adult sockeye salmon were marked and counted as they entered Salmon Lake through the weir and live box.