U.S. Fish and Wildlife Service

Estimation of Sockeye Salmon Escapement into McLees Lake, Unalaska Island, Alaska, 2006

Alaska Fisheries Data Series Number 2006-12

King Salmon Fish and Wildlife Field Office
King Salmon, Alaska

October 2006

The Alaska Region Fisheries Program of the U.S. Fish and Wildlife Service conducts fisheries monitoring and population assessment studies throughout many areas of Alaska. Dedicated professional staff located in Anchorage, Juneau, Fairbanks, Kenai, and King Salmon Fish and Wildlife Offices and the Anchorage Conservation Genetics Laboratory serve as the core of the Program's fisheries management study efforts. Administrative and technical support is provided by staff in the Anchorage Regional Office. Our program works closely with the Alaska Department of Fish and Game and other partners to conserve and restore Alaska's fish populations and aquatic habitats. Additional information about the Fisheries Program and work conducted by our field offices can be obtained at:

http://alaska.fws.gov/fisheries/index.htm

The Alaska Region Fisheries Program reports its study findings through two regional publication series. The **Alaska Fisheries Data Series** was established to provide timely dissemination of data to local managers and for inclusion in agency databases. The **Alaska Fisheries Technical Reports** publishes scientific findings from single and multi-year studies that have undergone more extensive peer review and statistical testing. Additionally, some study results are published in a variety of professional fisheries journals.

Alaska Fisheries Data Series Number 2006-12, October 2006
U.S. Fish and Wildlife Service

Estimation of Sockeye Salmon Escapement into McLees Lake, Unalaska Island, Alaska, 2006

Michael R. Edwards

Abstract

The King Salmon Fish and Wildlife Field Office operated a fixed picket weir at the outlet of McLees Lake on Unalaska Island from 30 May to 28 July 2006. A total of 12, 936 sockeye *Oncorhynchus nerka*, and 269 Pink *O. gorbuscha* salmon were counted through the weir. Peak daily passage occurred on 20 June when 1,524 sockeye salmon were counted through the weir. Seven hundred and nine sockeye salmon were sampled for age, sex, and length analysis. Of this sample 135 (19%) scales were unreadable. Seven age classes were identified from the 574 readable scales. Age class 1.3 (58%) and 1.2 (38%) accounted for 96 % of the sample. Females comprised an estimated 45 % of sockeye salmon sampled in 2006.

Introduction

McLees Lake empties into Reese Bay on the north side of Unalaska Island approximately 12 miles NW of the city of Unalaska (Figure 1). This watershed provides important spawning and rearing habitat for sockeye salmon *Oncorhynchus nerka*. Subsistence users from Unalaska harvest adult sockeye salmon returning to McLees Lake in Reese Bay. The Reese Bay subsistence fishery accounts for approximately 79% of the annual salmon harvest for this community (Tschersich 2006). Prior to 2001, management of the fishery was limited to aerial surveys and harvest data to assess escapement.

The spawning escapement of sockeye salmon to McLees Lake has been monitored using aerial survey counts since 1974 (Arnie Shaul, Alaska Department of Fish and Game, personal communication). Aerial surveys have generally been limited to one survey each year, and counts have ranged from 300 - 34,000 fish (Appendix A). Aerial counts potentially serve as an index of abundance, but can be influenced by several factors including time of survey, poor weather, lack of availability of suitable aircraft and variation among observers. No aerial surveys were conducted during some years because of weather or aircraft availability; and no surveys have been conducted over the last three years.

Subsistence harvest of sockeye salmon returning to McLees Lake has been monitored since 1985, and harvests have ranged from 897 to 5,267 sockeye salmon (Tschersich 2006). Since 1985, the number of subsistence permits issued for this fishery has steadily increased; the average number of permits issued from 2000-2004 was 216 (Tschersich 2006). Annual fluctuations in harvest have generally corresponded to the number of permits issued for the fishery. Since 1995, the average annual harvest has nearly doubled and the number of permits issued has nearly tripled from that observed from 1985-1994. These numbers suggest that sockeye salmon returning to McLees Lake have become increasingly important to the local subsistence fishery. Local residents and the Alaska Department of Fish and Game (ADFG) have expressed concerns that the lack of an escapement estimate for sockeye salmon into McLees Lake may jeopardize the health of the run, as well as future opportunities for subsistence fishing.

Author: Mike Edwards is a fisheries biologist with the U.S. Fish and Wildlife Service. The author can be contacted at King Salmon Fish and Wildlife Field Office, P.O. Box 277, King Salmon, Alaska 99613 or Mike_Edwards@fws.gov.

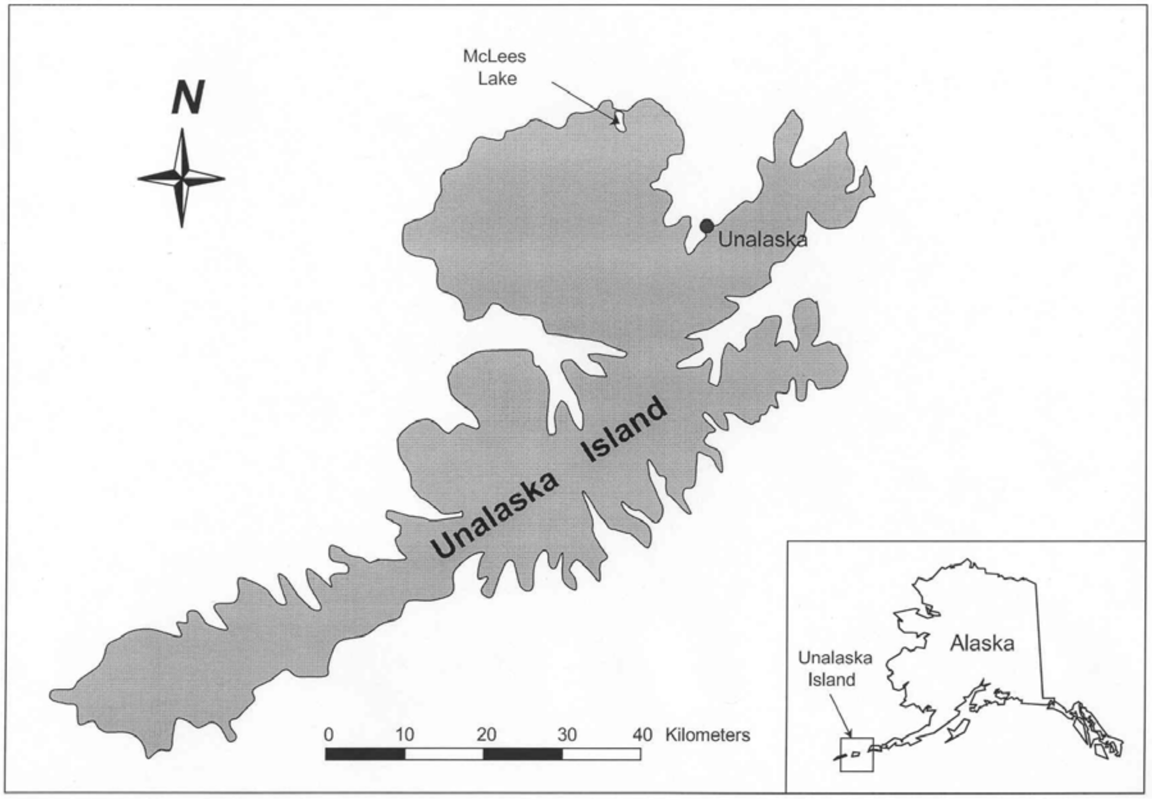


Figure 1. Map of Unalaska Island showing the location of McLees Lake.

These concerns prompted the Kodiak/Aleutians Federal Subsistence Regional Advisory Council to identify an escapement monitoring project on McLees Lake as a high priority. To address these concerns, the Kenai Fish and Wildlife Field Office and the Qawalangin Tribe of Unalaska entered into a partnership agreement to monitor the sockeye salmon return to McLees Lake beginning in 2001

In 2002, the Alaska Region Fisheries Program realigned areas of responsibility of the Kenai and King Salmon field offices; this resulted in the King Salmon Fish and Wildlife Field Office (KSFO) assuming responsibility for projects in the Aleutian Islands Area. Since the Kenai Office had received funding for the McLees Lake project through 2003, it was agreed that the Kenai Office would complete the 2003 field season. In 2004, KSFO received funding to operate the McLees Lake project through 2006.

Specific objectives of the project were to:

1. Enumerate the daily passage of sockeye salmon through the weir,
2. Describe the run-timing or proportional daily passage, of sockeye salmon through the weir,
3. Estimate the sex and age composition of sockeye salmon such that simultaneous 90% confidence intervals have a maximum width of 0.20, and
4. Estimate the mean length of sockeye salmon by sex and age.

Gates and Palmer (2004), Edwards (2005), and Edwards and Hildreth (2005) have summarized past project results. This report summarizes findings for the 2006 season. Edwards (in prep.) provides a synthesis of the findings from 6 years of weir operations.

Methods

Escapement Monitoring

A flexible picket weir spanning 21 m was installed at the outlet of McLees Lake and operated from 30 May to 28 July 2006. Weir pickets were composed of metal, electrical conduit with a 1.3 cm inside diameter. Picket spacing ranged from 3.5 cm for panels in shallow water near each stream bank to 2.2 cm on panels near the middle of the McLees Lake outlet channel. All pickets are 1.5 m long and strung together with 3 mm aircraft cable to make panels 3 m long. A spanning cable (6 mm aircraft) was strung bank-to-bank and pulled tight about 0.3 m above the surface of the water. The weir panels were leaned against the cable, which was supported with two wooden tripods evenly spaced across the channel and fence posts approximately every 3 m. To prevent fish from squeezing between the weir pickets, plastic snow fencing (3 m by 1 m with 2.2 cm square mesh) was attached to bottom third of each weir panel on the downstream side. A trap box was constructed on the upstream side of the weir to facilitate sampling fish and passing adult salmon through the weir. The weir and trap box were inspected daily and maintained as needed to ensure integrity. Stage height was measured in the morning and evening from a staff gauge located in the outlet channel, and water temperatures were recorded with a Hobo® temperature logger (Appendix B).

Fish were passed and counted intermittently between 0700 and 2400 hours each day. The duration of each counting session varied depending on the number of fish arriving at the weir. Daily escapement counts were relayed to KSFO via satellite phone, and the KSFO reported escapement information to the ADFG in Cold Bay (via E-mail) to support in-season management of the Reese Bay subsistence fishery.

Age, Sex, and Length Data

Data on sockeye salmon age, sex, and length (ASL) were collected using a temporally stratified sampling design (Cochran 1977), with statistical weeks generally defining strata (Table 1). In 2006, weeks 3, 4 and 5 were combined into two strata (strata 3 and 4). Age, sex, and length data were not collected during week 4 since the weir only had one technician on duty. Weekly sample size goals were determined from the work of Bromaghin (1993) who estimated that with 4 groups (2 dominate ages and 2 sexes) in the population, a sample size of 121 is needed to obtain the level of precision and accuracy stated in objective 3. Weekly sampling goals were set at 135 to account for 10% of the scale samples being unreadable. When the weekly sampling goal was unattainable because of low numbers, the crew attempted to sample 20% of the weekly escapement. Samples were dispersed throughout the week and taken periodically during the day. To avoid potential bias caused by the selection or capture of individual fish, all sockeye salmon within the trap were sampled, even if the sampling goal was exceeded.

Sockeye salmon were measured from mid-eye to fork-of-caudal-fin to the nearest millimeter, and sex was determined from external characteristics. One scale was collected from the preferred area on the left side of each fish sampled (Jearld 1983). Salmon ages are reported according to the European method where the number of winters the fish spent in fresh water and in the ocean is separated by a decimal (Koo 1962).

Table 1. Strata used for analysis of McLees Lake weir sockeye salmon ASL data, 2006.

Stratum	Start Date	End Date
1	30 May	10 June
2	11 June	17 June
3	18 June	27 June
4	28 June	8 July
5	9 July	15 July
6	16 July	22 July
7	23 July	28 July

ASL sample data were recorded on all-weather field forms and transferred to mark-sense forms provided by ADFG. Salmon scales were cleaned and affixed to gummed scale cards. Mark-sense forms and scale cards were completed according to ADFG procedures (Murphy 2000). Scale samples were processed and aged by ADFG.

Age and sex characteristics of sockeye salmon passed through the weir were estimated using standard stratified random sampling estimators (Cochran 1977). Within a given stratum *m*, the proportion of fish passing the weir that are of sex *j* and age *k* ($\hat{p}_{jkm}$) was estimated by

$$\hat{p}_{jkm} = \frac{n_{jkm}}{n_{++m}},$$

where n_{jkm} denotes the number of fish sex *j* and age *k* sampled during stratum *m* and a subscript of "+" represents summation over all possible values of the corresponding variable, e.g., n_{++m} denotes the total number of fish sampled in stratum *m*, summing over sex and age. The variance of $\hat{p}_{jkm}$ was estimated by

$$\hat{v}\left(\hat{p}_{jkm}\right) = \left(1 - \frac{n_{++m}}{N_{++m}}\right)\frac{\hat{p}_{jkm}\left(1 - \hat{p}_{jkm}\right)}{n_{++m} - 1},$$

where N_{++m} denotes the total number of sockeye salmon passing the weir in stratum *m*. The number of sockeye salmon of sex *j* and age *k* passing the weir in stratum *m* (N_{jkm}) was estimated by

$$\hat{N}_{jkm} = N_{++m}\,\hat{p}_{jkm},$$

with estimated variance

$$\hat{v}\left(\hat{N}_{jkm}\right) = N_{++m}^{2}\,\hat{v}\left(\hat{p}_{jkm}\right).$$

Estimated proportions by sex and age (p_{ijk}) for the entire period of weir operation were computed as weighted sums of the stratum estimates

$$\hat{p}_{jk} = \sum_m \left(\frac{N_{++m}}{N_{+++}} \right) \hat{p}_{jkm},$$

with estimated variance

$$\hat{v}(\hat{p}_{jk}) = \sum_m \left(\frac{N_{++m}}{N_{+++}} \right)^2 \hat{v}(\hat{p}_{jkm}).$$

The total number of sockeye salmon in a sex and age category (N_{jk}) passed through the weir during the entire period of operation was estimated by

$$\hat{N}_{jk} = \sum_m \hat{N}_{jkm},$$

with estimated variance

$$\hat{v}(\hat{N}_{jk}) = \sum_m \hat{v}(\hat{N}_{jkm}).$$

If the length of the r^{th} fish of sex j and age k sampled in stratum m is denoted x_{jkmr}, the mean length of all such fish (μ_{jkm}) was estimated by

$$\hat{\mu}_{jkm} = \left(\frac{1}{n_{jkm}} \right) \sum_r x_{jkmr},$$

with estimated variance

$$\hat{v}(\hat{\mu}_{jkm}) = \left(1 - \frac{n_{jkm}}{\hat{N}_{jkm}} \right) \frac{\sum_r (x_{jkmr} - \hat{\mu}_{jkm})^2}{n_{jkm}(n_{jkm} - 1)}.$$

The mean length of all sockeye salmon of sex i and age j (μ_{jk}) was estimated as a weighted sum of the stratum estimates

$$\hat{\mu}_{jkm} = \sum_m \left(\frac{\hat{N}_{jkm}}{\hat{N}_{jk}} \right) \hat{\mu}_{jkm}.$$

An approximate estimator of the variance of $\hat{\mu}_{jk}$ was obtained using the delta method (Seber 1982) by

$$\hat{v}(\hat{\mu}_{jk}) = \sum_{m}\left\{\hat{v}(\hat{N}_{jkm})\left[\frac{\hat{\mu}_{jkm}}{\sum_{x}\hat{N}_{jkx}} - \sum_{y}\frac{\hat{N}_{jky}\,\hat{\mu}_{jky}}{\left(\sum_{x}\hat{N}_{jkx}\right)^{2}}\right]^{2} + \left(\frac{\hat{N}_{jkm}}{\sum_{x}\hat{N}_{jkx}}\right)^{2}\hat{v}(\hat{\mu}_{jkm})\right\}.$$

Results

Escapement Monitoring

Operation of the McLees Lake weir began 30 May and continued uninterrupted through 28 July 2006. During this time, 12,936 sockeye and 268 pink *O. gorbuscha* salmon were counted as they were passed through the weir. Sockeye salmon were passed through the weir during 54 (87.7%) of the 60 days of operation (Figure 2). Most (97%) pink salmon passage occurred during the last 11 days of weir operation. Sockeye salmon peak daily passage occurred on 20 June when 1,524 sockeye salmon were passed through the weir (Appendix C), and peak stratum passage occurred in stratum 3 (18-27 June) when 4,564 sockeye salmon were counted (Table 2).

Age, Sex, and Length Data

Seven hundred and nine sockeye salmon were sampled for ASL analysis. Of this sample, 135 (19%) scales were unreadable. Seven age groups were identified from the scale samples; ages 1.3 (58%) and 1.2 (38%) accounted for 96% of the run (Table 3). Approximately 45% of the sockeye salmon escapement consisted of females (Table 2). Lengths of sockeye salmon sampled ranged from 540 to 551 mm for females and from 529 to 574 mm for males (Table 4, Figure 3). No ASL data were collected from pink salmon.

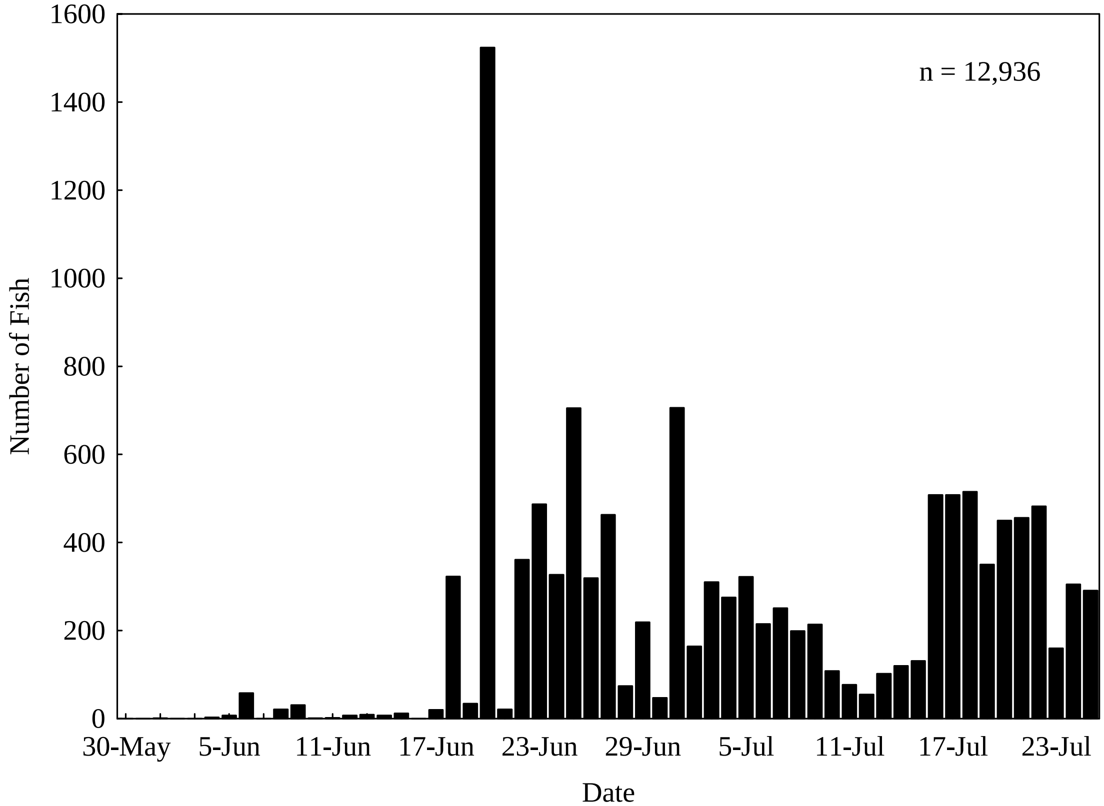


Figure 2. Daily passage of sockeye salmon into McLees Lake, 2006.

Table 2. Estimated sockeye salmon sex composition and escapement by stratum, McLees Lake weir, 2006.

Stratum	*n*	Female (%)	Male (%)	SE (%)	Escapement
1	28	32	68	7.9	122
2	9	44	56	16.1	57
3	135	41	59	4.2	4,564
4	136	51	49	4.2	2,782
5	110	45	55	4.4	807
6	153	46	54	3.9	3,269
7	138	48	52	4.0	1,335
Total	709	45	55	2.1	12,936

Table 3. Estimated sockeye salmon age composition by stratum, McLees Lake weir, 2006.

	Age Class						
	0.3	1.2	1.3	1.4	2.2	2.3	2.4
				Stratum 1			
%	--	24	71	0	--	--	5
SE	--	8.7	9.2	0.0	--	--	4.3
n	0	5	15	0	0	0	1
				Stratum 2			
%	--	13	88	--	--	--	--
SE	--	11.6	11.6	--	--	--	--
n	0	1	7	0	0	0	0
				Stratum 3			
%	--	20	74	--	2	5	--
SE	--	3.8	4.1	--	1.3	2.0	--
n	0	22	82	0	2	5	0
				Stratum 4			
%	4	32	62	1	2	--	--
SE	1.7	4.3	4.5	0.9	1.2	--	--
n	4	36	69	1	2	0	0
				Stratum 5			
%	--	43	53	1	4	--	--
SE	--	5.3	5.3	1.2	2.0	--	--
n	0	34	42	1	3	0	0
				Stratum 6			
%	1	57	40	1	2	--	--
SE	0.8	4.3	4.3	0.8	1.1	--	--
n	1	73	51	1	2	0	0
				Stratum 7			
%	--	62	38	--	--	--	--
SE	--	4	4	--	--	--	--
n	0	71	43	0	0	0	0
				Total[a]			
%	1	38	58	<1	2	2	<1
SE	0.4	2.0	2.1	0.3	0.6	0.7	<0.1
n	5	242	309	3	9	5	1

[a] Totals exceed 100% due to rounding errors.

Table 4. Sockeye salmon mean, minimum, and maximum length by sex and age class, McLees Lake weir, 2006

	Age Class						
Length	0.3	1.2	1.3	1.4	2.2	2.3	2.4
			Female				
Mean	546	498	542	--	483	566	--
SE	7.6	10.2	11.5	--	9.1	21.7	--
Min	540	439	448	--	460	550	--
Max	551	588	590	--	513	581	--
n	2	116	142	0	4	2	0
			Male				
Mean	555	509	569	584	512	558	--
SE	14.9	11.3	9.5	--	6.6	10.6	--
Min	529	455	504	569	470	546	--
Max	574	591	612	600	524	567	605
n	3	126	167	3	5	3	1
			All Fish				
Mean	551	503	557	584	500	561	--
SE	10.7	11.2	12.7	--	8.6	13.8	--
Min	529	439	448	569	460	546	--
Max	574	591	612	600	524	581	605
n	5	242	309	3	9	5	1

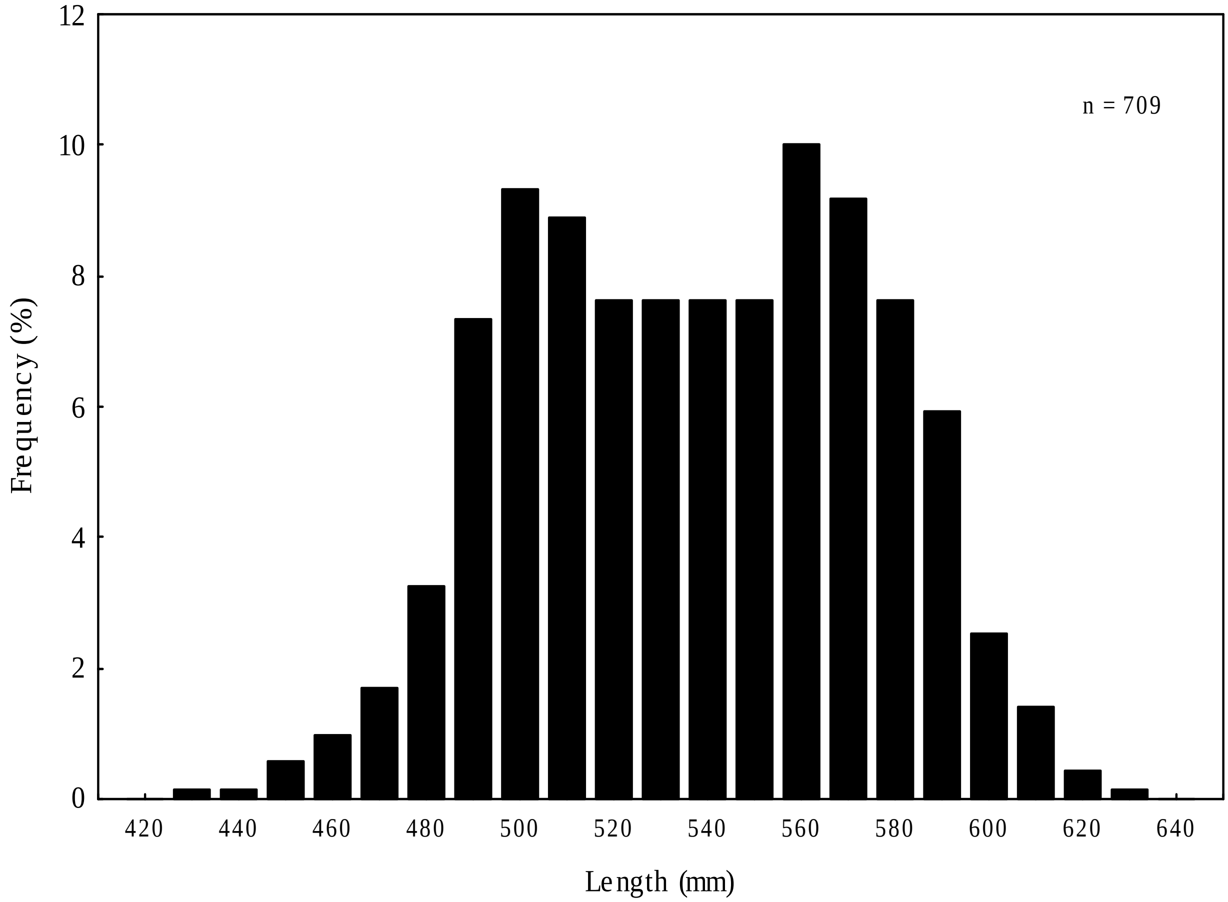


Figure 3**.** Length frequency distribution of sockeye salmon sampled at the McLees Lake weir, 2006.

Discussion

Sockeye salmon escapement in 2006 was the second lowest observed during the six years McLees Lake weir has been operated (Table 5). Although only three years are available for comparison, aerial survey counts (Appendix A; Arnie Shaul, ADFG personal communication) were always much less than corresponding weir counts. Timing of the 2006 run was approximately two weeks later than timing recorded in previous years. Most other sockeye salmon runs on the West side of the Alaska Peninsula also exhibited later than average timing in 2006 (Paul Salomone, ADFG personal communication). Although the 2006 escapement was one of the lowest recorded in the past 6 years, it appears that subsistence needs were met. Neither our office nor the local ADFG manager received any complaints from subsistence fishery participants. However, we do not know what escapement levels are needed to both sustain a healthy sockeye population and meet subsistence needs. We need to continue to collect escapement and harvest data so that a time series of production information is available for estimating sustainable harvest levels. Since most sockeye salmon return as 4 and 5 year old adults(over 90% of each run), it takes six years to obtain production data for every spawning escapement. We now have only one complete year of production information (for the 2001 escapement). However, with an additional three years of escapement and harvest information, we would have four years of production information (for the 2001-2004 escapements) on which to base sustainable production estimates.

Table 5. Annual weir counts of Pacific salmon into McLees Lake from 2001-2006.

	Species				
Year	Sockeye	Chinook	Chum	Coho	Pink
2001	45,866	1	--	1	--
2002	97,780	1	--	--	--
2003	101,793	--	--	--	19
2004	40,327	--	3	--	1
2005	12,097	--	1	--	3
2006	12,936	--	--	--	268

The length frequency distribution observed in 2006 was bi-modal. Several reasons could explain the distribution including sampling bias, the subsistence fishery was selective for sockeye salmon between 520-550 mm, or two dominant age classes influenced the length distribution. Length data from the subsistence harvest is unavailable; therefore, we can not dismiss the possibility of the fishery being size selective. The sampling protocol was the same in 2006 as in previous years so I do not believe that sampling influenced the observed length frequency distribution. The McLees Lake sockeye salmon runs are dominated by two age classes in some years. I believe that the bi-modal length distribution is reflective of these two dominate age classes in 2006 since the mean length of age classes 1.2 and 1.3 correspond to each peak of the length distribution (Table 4; Figure 3).

In 2006 several events occurred which could have influenced the precision our escapement and ASL estimates. A high water event breached the weir on 9 June (Appendix B.). The crew reported that water was flowing around the right-hand (facing downstream) end of the weir, so some sockeye salmon may have been able to enter the lake without being counted. The crew installed a temporary panel to extend the right hand side of the weir approximately 10 feet to prevent fish from swimming around the weir. High water conditions continued until 18 June when the river returned to its channel. The crew felt that although the weir had been breached, very few sockeye salmon entered the lake during this time period. Since the weir breach occurred during a period of low sockeye salmon passage, it is unlikely the total sockeye salmon count was greatly affected. No ASL samples were collected from 25 June – 1 July due to the resignation of the local hire technician. With only one crewman to operate the weir until a replacement arrived, he focused on maintaining an accurate escapement estimate. I re-stratified the three sampling weeks between June 18 and July 8 into two strata to account for the lack of samples during the 25 June – 1 July time frame. Also, during strata 5, the crew failed to meet sample size goal even though fish passage was adequate. And finally, the percentage of unreadable scale samples exceeded 10%.

The sampling design by Bromaghin (1993) is such that even though the sampling goal was not achieved in a strata and the percentage of un-readable scales exceeded 10% we still met the level of precision stated in objective 3 (Appendix D). Data presented in appendix D only represent the age composition analysis. The sample size requirement for the sex composition analysis has fewer categories than the age analysis; therefore, if the level of precision is obtained for the age analysis the same would be true for the sex composition analysis.

If this project is continued in 2007, the weekly sample size of 135 sockeye salmon should be maintained since it is adequate to meet the desired levels of accuracy and precision. Additionally, for future management of the McLees Lake subsistence fishery, I recommend that USFWS and ADFG work together to develop specific management objectives for sockeye salmon escapement into McLees Lake. In 2006, ADFG extended the July 1-9 closure around the stream outlet due to lower escapement levels than had been achieved in past years. However, without a clear escapement objective based on our best assessment of potential production from this system, there is no consistent measure of when to open or close waters to fishing. Once the waters open to fishing are reduced there is a substantial decrease in subsistence fishing effort (Matt Abrahamse, USFWS, personal communication). Development of an escapement goal or other management objectives would help ensure stock sustainability while not unduly restricting subsistence opportunities. It would also make management decisions easier to anticipate and could lessen the possibility of future restrictions.

Acknowledgements

I thank Matt Abrahamse and Jeff Massey for their efforts in operating the McLees Lake weir. Additionally I would like to thank Sharon Livingston, environmental coordinator for the Qawalangin Tribe, for her assistance in fulfilling tribal responsibilities for the project. I also appreciate ADFG local manager Forest Bowers and staff efforts in transporting supplies and personnel from Dutch Harbor to the weir site and for providing bunkhouse space for the crew while in Dutch Harbor.

The U. S. Fish and Wildlife Service Office of Subsistence Management provided funding for this work through Fisheries Resource Monitoring Program project number FIS 04-403.

References

Bromaghin, J.F. 1993. Sample size determination for interval estimation of multinomial probabilities. The American Statistician 47: 203-206.

Cochran, W.G. 1977. Sampling techniques, 3rd edition. John Wiley and Sons, New York.

Edwards, M.R. 2005. Estimation of sockeye salmon escapement into McLees Lake, Unalaska Island, Alaska, 2004. U.S. Fish and Wildlife Service, Alaska Fisheries Data Series Report Number 2005-4, King Salmon, Alaska.

Edwards, M.R. and D. R. Hildreth. 2005. Estimation of sockeye salmon escapement into McLees Lake, Unalaska Island, Alaska, 2005. U.S. Fish and Wildlife Service, Alaska Fisheries Data Series Report Number 2005-16, King Salmon, Alaska.

Edwards, M.R. In preparation. Abundance and Run Timing of Sockeye Salmon into McLees Lake, Alaska Maritime National Wildlife Refuge, Alaska, 2001-2006. Alaska Fisheries Technical Report. King Salmon, Alaska.

Gates, K.S. and D.E. Palmer. 2004. Estimation of sockeye salmon escapement into McLees Lake, Unalaska Island, Alaska, 2003. U.S. Fish and Wildlife Service, Alaska Fisheries Data Series Report Number 2004-1, Kenai, Alaska.

Jearld, A. 1983. Age determination. Pages 301-324 *in* L.A. Nielsen and D.L. Johnson, editors. Fisheries Techniques. American Fisheries Society, Bethesda, Maryland.

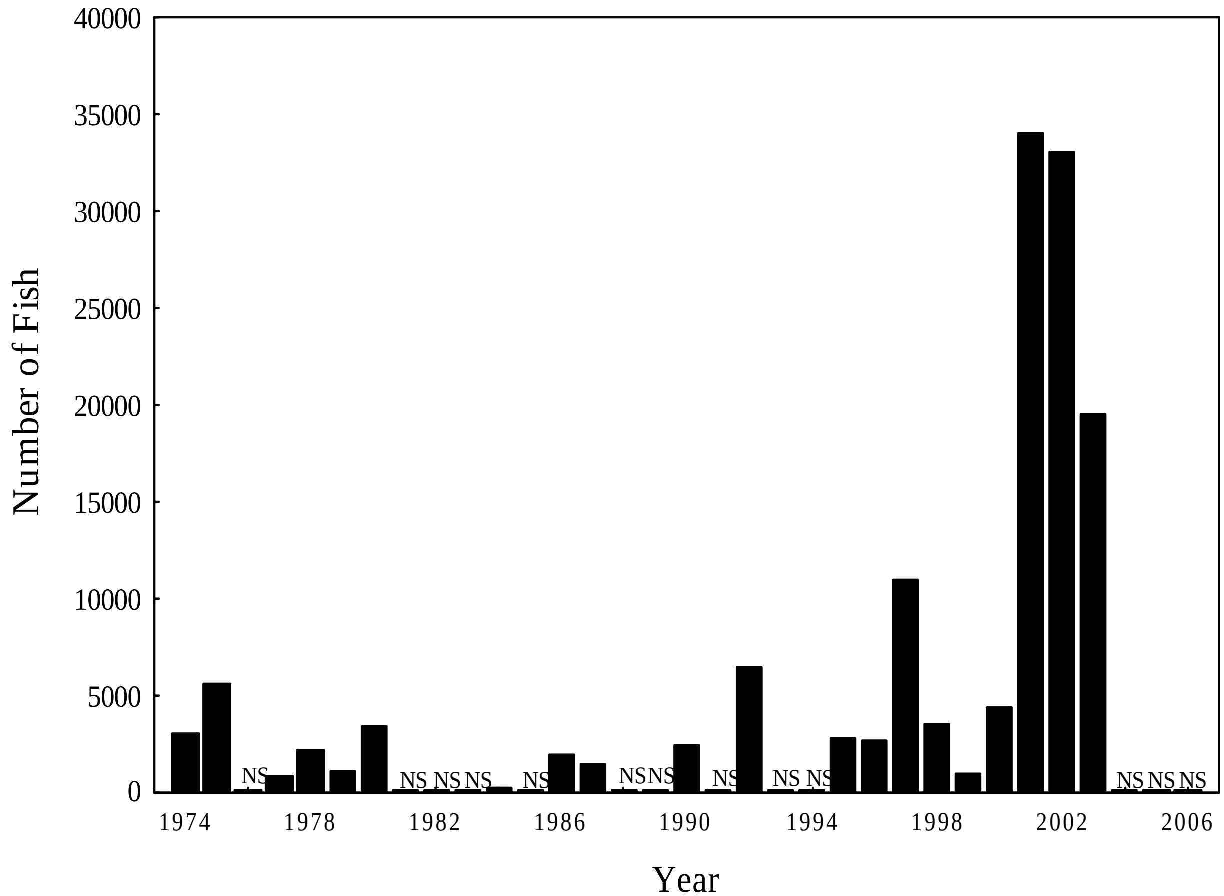
Koo, T.S.Y. 1962. Age determination in salmon. Pages 37-48 *in* T.S.Y. Koo, editor. Studies of Alaskan red salmon. University of Washington Press, Seattle, Washington.

Murphy, R.L. 2000. Alaska Peninsula salmon evaluation and escapement sampling operating procedures, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak, Alaska.

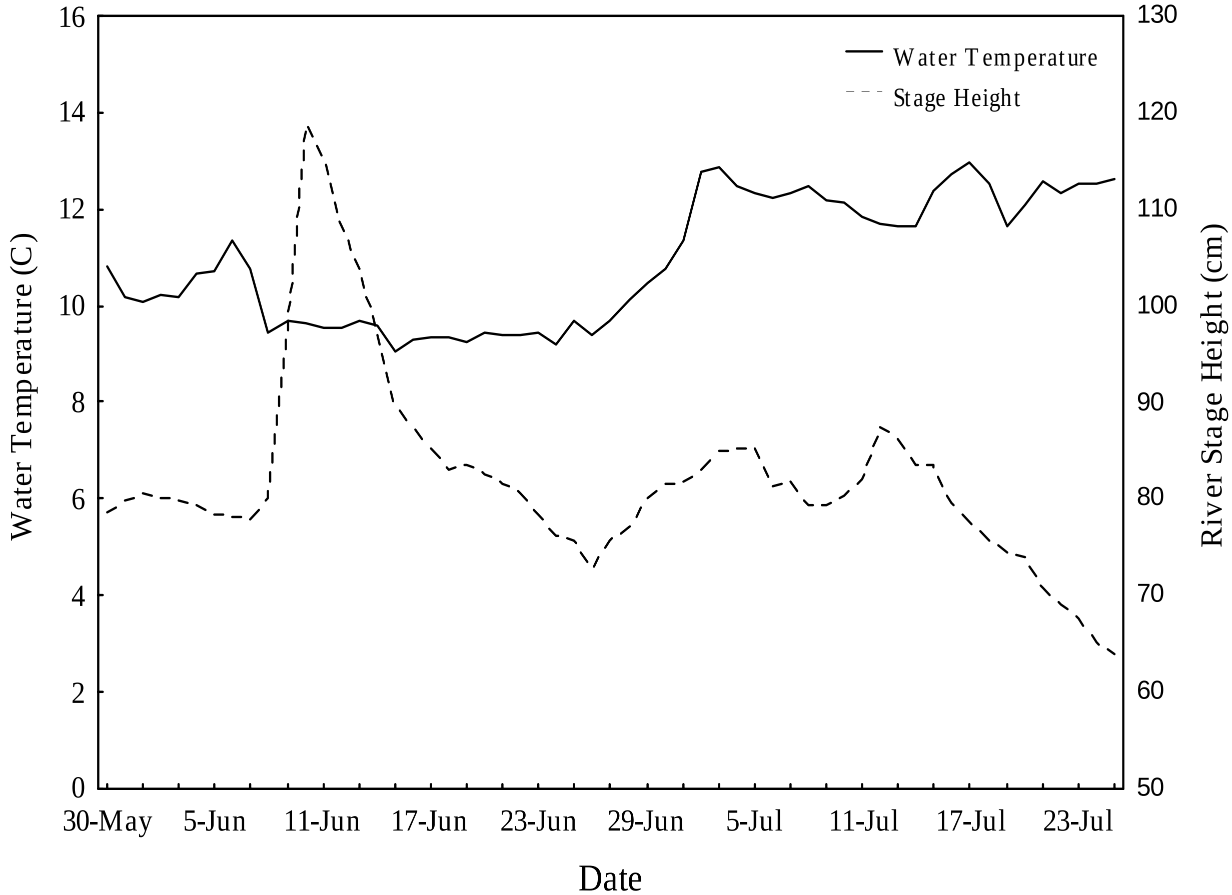
Seber, G.A.F. 1982. The Estimation of Animal Abundance and Related Parameters, 2nd edition. Maxmillan, New York.

Tschersich, P. 2006. Aleutian Islands, and Atka-Amlia Islands management areas salmon management report, 2005. Alaska Department of Fish and Game, Division of Commercial Fisheries, Fishery Management Report 06-04, Kodiak, Alaska.

Appendix A. Counts of sockeye salmon in McLees Lake from aerial surveys, 1974 – 2006. NS denotes no survey conducted. (Arnie Shaul, ADFG unpublished data).



Appendix B. Staff height and temperature, McLees Lake, 2006.



Appendix C. Daily weir passage, number sampled and cumulative count of sockeye salmon entering McLees Lake 2006.

Date	Passage	Sampled	Daily Total	Cumulative Count
30-May	0	0	0	0
31-May	0	0	0	0
1-Jun	1	0	1	1
2-Jun	0	0	0	1
3-Jun	0	0	0	1
4-Jun	3	0	3	4
5-Jun	0	7	7	11
6-Jun	58	0	58	69
7-Jun	0	0	0	69
8-Jun	0	21	21	90
9-Jun	31	0	31	121
10-Jun	1	0	1	122
11-Jun	2	0	2	124
12-Jun	7	0	7	131
13-Jun	9	0	9	140
14-Jun	0	7	7	147
15-Jun	12	0	12	159
16-Jun	0	0	0	159
17-Jun	18	2	20	179
18-Jun	303	20	323	502
19-Jun	10	24	34	536
20-Jun	1,450	74	1,524	2,060
21-Jun	21	0	21	2,081
22-Jun	361	0	361	2,442
23-Jun	470	17	487	2,929
24-Jun	327	0	327	3,256
25-Jun	705	0	705	3,961
26-Jun	319	0	319	4,280
27-Jun	463	0	463	4,743
28-Jun	74	0	74	4,817
29-Jun	219	0	219	5,036
30-Jun	47	0	47	5,083
1-Jul	706	0	706	5,789
2-Jul	137	27	164	5,953
3-Jul	276	34	310	6,263

Appendix C continued.

Date	Passage	Sampled	Daily Total	Cumulative Count
4-Jul	252	23	275	6,538
5-Jul	322	0	322	6,860
6-Jul	189	26	215	7,075
7-Jul	251	0	251	7,326
8-Jul	173	26	199	7,525
9-Jul	214	0	214	7,739
10-Jul	82	26	108	7,847
11-Jul	50	27	77	7,924
12-Jul	35	20	55	7,979
13-Jul	92	10	102	8,081
14-Jul	116	4	120	8,201
15-Jul	108	23	131	8,332
16-Jul	467	41	508	8,840
17-Jul	489	19	508	9,348
18-Jul	475	40	515	9,863
19-Jul	350	0	350	10,213
20-Jul	424	26	450	10,663
21-Jul	429	27	456	11,119
22-Jul	482	0	482	11,601
23-Jul	121	39	160	11,761
24-Jul	280	25	305	12,066
25-Jul	273	18	291	12,357
26-Jul	129	41	170	12,527
27-Jul	132	15	147	12,674
28-Jul	262	0	262	12,936

Appendix D. Critical values of the t Distribution, 90% confidence interval, SE, upper and lower bounds and overall width of 90% confidence intervals of the estimated age composition of sockeye salmon sampled at the McLees Lake 2006.

	Age Class[a]				
	0.3	1.2	1.3	2.2	2.3
Critical value	1.533	1.285	1.284	6.314	6.314
SE	0.4	2.0	2.1	0.6	0.7
CI	0.642	2.612	2.741	3.766	4.351
Upper bound	0.016	0.403	0.603	0.0541	0.0594
Lower bound	0.003	0.351	0.549	-0.0317	-0.0366
Width of Interval	0.013	0.052	0.055	0.0858	0.0960

[a]Age classes 1.4 and 2.4 are not represented as they accounted for less than 1% of the estimate.