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Abundance and Run Timing of Adult Salmon in Long Lake in the Wrangell-St. Elias National Park and Preserve, 2010

2010 Annual Report 10-505

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ABSTRACT

Long Lake flows into Lakina River, a tributary of the Chitina River in the Copper River drainage. It provides important spawning habitat for sockeye salmon, which contribute to intensive down-river commercial and subsistence fisheries. The monitoring and evaluation of this run is essential to ensure that Wrangell - St. Elias National Park and Preserve (WRST) maintains natural and healthy populations of fish as required by the Alaska National Interest Lands Conservation Act (ANILCA). The Long Lake weir is one of several projects providing accurate assessment of yearly run strength and migratory timing in tributaries to the Copper River. In 2010 an underwater camera, DVR recording system and solar panel array were installed and used to enumerate salmon at this weir. The weir and recording system were installed August 1and removed October 20. A total of 10,876 sockeye salmon migrated through the weir between August 12 and October 20. This was approximately 70% of the 37 year average weir count of 15,593 sockeye salmon, and represented about 1.2% of the total inriver run estimated by the Miles Lake sonar project. Run timing in 2010 started earlier and ended earlier than what was observed in the last eight years and was more in line with the average run timing from1974-2007. Age, sex and length samples were collect from 9% of the escapement. Females comprised about 52% of the total sample. Age-1.2 sockeye salmon comprised 55% of the returning adults sampled; age-1.3 class comprised 39%. Average mid-eye-to-tail fork length of age-1.3 sockeye salmon was 565 mm for males and 545 mm for females, smaller than average sizes for the past four years.

INTRODUCTION

The upper Copper River drainage provides spawning habitat for sockeye *Oncorhynchus nerka*, coho *O. kisutch*, and Chinook *O. tshawytscha* salmon. Significant numbers of adult salmon are harvested in commercial drift gillnet operations near the mouth of the Copper River from mid-May to September. Salmon escapement into the upper Copper River system contributes to federal and state subsistence fishing through September each year. The monitoring and evaluation of these runs is essential to ensure that Wrangell - St. Elias National Park and Preserve (WRST) maintains natural and healthy populations of fish as required by the Alaska National Interest Lands Conservation Act (ANILCA).

Accurate assessment of yearly run strength and migratory timing in tributaries to the Copper River is essential to the development of a management strategy that meets the mandates of ANILCA. The upper Copper River sockeye salmon populations are of particular importance to both federally qualified and state subsistence users. The primary assessment of inriver abundance for Copper River sockeye salmon occurs at the Miles Lake sonar site. However, migratory timing of sockeye salmon into the Copper River is prolonged (May-September) and subsequent assessment of escapement into some tributaries is needed to determine spawning distribution. The sonar equipment at the Miles Lake site is typically shut down around August 1st each year, after the majority of the sockeye salmon have migrated through. A portion of the Long Lake sockeye salmon run enters the Copper River after the sonar has been pulled from the Miles Lake site.

Thirty-seven years of weir data show annual variations in abundance of Long Lake runs ranging from 636 to over 50,000 sockeye salmon (Table 1). This is the longest running data set of salmon weir counts in the Copper River drainage. The sockeye salmon stock that spawns within Long Lake is the largest salmon stock within the Chitina River drainage. The magnitude of escapement, and its contribution to the total inriver return of the Copper River, is widely variable (Table 1). The largest measured escapement (50,000) into Long Lake occurred in 2002, and comprised 6% of the estimated total inriver return. During the period 1978-1980, inriver returns to the Copper River were very low, and Long Lake escapements comprised 14-19% of the total. Since 1981, escapements into Long Lake have comprised no more than 6% of the total inriver return. There does not appear to be a relationship between the magnitude of inriver return and escapement into Long Lake during this 31-year period, which demonstrates the need for stock specific monitoring sites in addition to broad scale sonar sites estimating mixed stock returns.

Background

The Long Lake population has the longest known annual spawning duration (August through April) of any sockeye salmon population in North America. (Roberson, K, retired ADF&G Commercial Fisheries Division fisheries biologist, personal communication, November 2002). Throughout the winter, sockeye salmon spawn in the northwest corner of the lake since this portion of the lake rarely freezes (Figure 1).

Table 1 Long Lake weir and Miles Lake sonar sockeye salmon counts, 1974-2010. Miles Lake sonar counts obtained from Lewis et al. (2008) and ADF&G (2010). Data for Miles Lake not available (N/A) 1974-1977.

	Number of Sockeye Salmon		
Year	Miles Lake Sonar	Long Lake Weir	Long Lake as % of Sonar Estimates
1974	N/A	4,684	-
1975	N/A	6,768	-
1976	N/A	24,689	-
1977	N/A	8,624	-
1978	107,011	15,458	14.5
1979	237,173	46,110	19.4
1980	276,538	39,038	14.1
1981	535,263	12,659	2.4
1982	467,306	28,047	6.0
1983	545,724	28,133	5.2
1984	536,806	10,637	2.0
1985	436,313	21,131	4.8
1986	509,275	16,997	3.3
1987	483,478	13,633	2.8
1988	488,398	7,543	1.5
1989	607,797	14,981	2.5
1990	581,895	21,664	3.7
1991	579,435	11,511	2.0
1992	601,952	10,091	1.7
1993	797,902	16,101	2.0
1994	715,181	18,289	2.6
1995	599,265	17,923	3.0
1996	906,867	6,309	0.7
1997	1,148,079	4,443	0.4
1998	866,957	8,441	1.0
1999	848,921	12,922	1.5
2000	587,592	8,645	1.5
2001	833,569	26,999	3.2
2002	819,000	49,747	6.1
2003	695,233	4,604	0.7
2004	669,646	19,215	2.9
2005	854,268	7,770	0.9
2006	959,731	9,239	1.0
2007	926,438	7,846	0.9
2008	614,999	631	0.1
2009	709,330	4,555	0.6
2010	924,010	10,876	1.2

The Alaska Department of Fish and Game (ADF&G) initially operated the Long Lake weir in 1974 and 1975. Cliff Collins, a local private citizen who owned the land where the weir is located, voluntarily took over operation of the weir in 1976 when ADF&G was no longer able to fund its operation (Figure 2). He operated the weir continuously from 1976 through 2003. In

Figure 1 Salmon spawning in Long Lake, April 2004.

Figure 2. Cliff Collins at the weir at age 93 with Karelian bear dog, 2003.

2003 when Mr. Collins, at age 93, was no longer able to operate the weir, a cooperative agreement was formed between the Collins' Family Trust, Wrangell-St. Elias National Park/Preserve and the Copper River Watershed Project to keep the weir operating. Since 2004, funding has been provided under the Subsistence Fisheries Resource Monitoring Program[1]. Starting in 2003, the weir operators began sampling sockeye salmon for age, sex, and length composition according to a sampling protocol established by ADF&G.

The physical structure of the weir has changed little since 1974. A small sampling box was constructed on the upstream side of the middle of the weir in 2003. In 2004 a larger sampling box was constructed against the west bank of the creek on the upstream side of the weir which has been in use since then. In 2010 an underwater camera and DVR recording system were installed at the weir and a video viewing and monitoring station was set up on the west bank.

OBJECTIVES

1) To enumerate adult sockeye salmon migrating past a weir from late July until mid-October by using video equipment to count all individuals entering Long Lake.

2) To use hierarchical models and model selection criteria (e.g. AIC, DIC) to determine whether there are detectable trends in run timing and to identify relationships between run timing and climate conditions. Trends and relationships to climate variables would be considered to be identifiable if supported by the model selection criteria and if the 95% credible intervals did not include 0.

3) To estimate the age, sex, length composition of the sockeye salmon escapement from scale and otolith interpretation, such that the estimates are within 5% of the true proportion 90% of the time.

METHODS

Site Description

Long Lake is 480 m above sea level, at latitude 61º 23' 1.68" N and longitude 143º 17' 15.89" W (Figure 3). Long Lake is located adjacent to the McCarthy Road and is 0.5 km wide and 8.5 km long. The outlet stream (called Salmon Creek by the Collins family) runs 2.1 kilometers through nearly level terrain to the Lakina River, a tributary of the Chitina River that flows into the Copper River. Willows, alders, mosses and sedges dominate the vegetation. Forested areas consist mainly of white spruce interspersed with stands of paper birch and quaking aspen. The soils are poorly drained. Average annual precipitation is 40.11 cm, and average annual temperature is 22° C with extremes of 13.39° C and -27.06° C (USDA 1979).

[1] Administered by U.S. Fish and Wildlife Service, Office of Subsistence Management.

Weir Operation

The project uses a rigid picket weir to enumerate the number of salmon migrating into Long Lake and to estimate the age, sex and length composition of the run by sampling sockeye salmon migrating through the weir. The weir site is on Collins Family Trust land and is located within a few hundred meters of the Collins family residence, at mile 45 on the McCarthy Road. The weir is installed and operated at the outlet of the lake, Weir pickets are spaced 3.75 cm apart (Figure 3).

The site is extremely conducive to the operation of a rigid picket weir. Flows fluctuate only slightly, water velocity is always low, and the stream is shallow and easily waded. A walkway is placed across the stream immediately upstream of the weir where a weir operator stands and counts migrating salmon simply by removing one or two pickets from the weir. Counting is done daily, and all pickets are kept in place so that fish cannot pass through when it is not being monitored.

We incorporated a major change in the escapement estimation methodology in 2010 by installing an underwater video camera recording system. The system was designed from insight gained through the use of similar technology at the Tanada Creek weir (Sarafin 2010). The underwater camera was installed directly onto a fish passage chute which was connected to the upstream side of the weir (Figure 4). This allows fish passage throughout the day and night, except when the crew closes the weir gate to review recorded video footage or to obtain AWL data from fish captured in the sampling trap. The fish passage chute forces fish passing through the weir to swim within a few inches of the glass surface of the camera housing. Footage is then recorded on a digital video recorder (DVR).

A 12 volt, underwater LED light was installed in the fish passage chute to illuminate the view area. A photocell switch automatically turns the light on and off in response to changes in the level of ambient light. A 12 volt deep cycle battery bank (400 Amp-hours total capacity) provides power to the system. The charge is maintained in the battery bank from a photovoltaic solar panel array (360 Watts total rating) and a MPPT charge controller.

Daily weir checks are performed throughout the season. Upon arrival at the site, staff closes the gate to the fish passage chute, stops video recording, and then reviews digital video footage on a video monitor from the previous day's video start time to the present day video stop time (Figure 5). All observed salmon passage is recorded by hour on a daily count data form.

There is a large sampling box approximately 2.1 m x 3.1 m in size, with a funnel-shaped entry trap on the northwestern bank of the creek. The bank of the creek is used as one side of the box, and there is a table at the upstream end that is used to sample salmon (Figure 6). Fish are allowed to enter the sampling box by removing one or two pickets on the west side of the weir. When the box has 20-50 sockeye salmon in it, the pickets are replaced, trapping the salmon within the box. In 2010 the weir, video camera recording system, and sampling box were installed and running by August 1. Work at the weir ended on October 20, when the weir pickets were removed for the winter. Sampling was typically performed with a crew of two people.

Figure 3. Long Lake weir with video installed.

Figure 4. Camera box and fish passage chute.

Figure 5. Work station and photovoltaic array.

Figure 6. Sampling box, Long Lake weir, 2010.

In 2010 water level was monitored throughout the summer, from August 1 to October 20. A staff gauge installed on the weir was used to measure water level (by observation) each day (Figure 7). Water temperature was monitored sporadically in 2010 because of problems with the thermometer.

Bears are frequently a problem at the weir and further downstream in the creek. An electric fence was installed around the weir, viewing station and sampling box for the entire 2010 field season to prevent bears from damaging the weir, equipment, and eating salmon from the box.

Figure 7. Staff gauge, electric bear fence, water surface thermometer at Long Lake weir, 2006.

Biological Data

Fish migrating through the weir were counted and identified to species. Sockeye salmon were sampled according to the same procedures used by the ADF&G, Division of Commercial Fisheries in Cordova, Alaska. This required sampling 10 percent of the average total return of sockeye salmon to estimate the age, sex and length of the population. To do this, at least 10% of the fish were sampled each week. Age, sex, and length sampling at the weir occurred from August 27 through October 18, 2010 (Figure 8). Age, sex, and length data were also collected from 97 sockeye salmon carcasses sampled from the lake and shore in October. Otoliths were removed from these carcasses for future analysis by ADF&G (Figure 9). In addition otoliths were collected from approximately 250 sockeye salmon heads gathered from the open water spawning area of the lake in November and December. No sex or length measurements accompanied these otoliths.

Each sockeye salmon that was sampled was measured to the nearest millimeter from mid-eye to fork length (MEF). One scale was collected from the preferred area, located on the left side of the fish and two rows above the lateral line on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin, according to ADF&G sampling protocols. Scales were later analyzed by ADF&G Commercial Fisheries Division staff based in Cordova. Ages were adjusted for resorbed scale margins using an age-length relationship developed for Copper River sockeye salmon.

Figure 8. Scale collection at Long Lake weir, 2010.

To determine whether the 1978-2010 time series of sockeye salmon escapements into Long Lake showed linear trends over years, a linear regression line was fitted to the data, the coefficient of determination (R^2) was calculated to determine the amount of variation explained by the regression, and ANOVA was used to calculate an F-statistic to test the null hypothesis that the slope of the fitted line was equal to zero. Similar analyses were done for the 1978-2010 inriver estimates at the Miles Lake sonar site. Linear regression analysis was also used to determine whether sockeye salmon escapements into Long Lake (dependent variable, y) could be predicted from total inriver runs estimated at Miles Lake (independent variable, x). Regressions were considered to be statistically significant if the F-statistic had a P-value less than or equation to 0.05, which meant that, assuming the null hypothesis was true, there was no more than a 5% probability of obtaining a test statistic at least as extreme as the one that was actually observed solely due to chance.

Figure 9. Otolith sampling, Long Lake, 2009.

RESULTS

Weir Operation

In 2010, daily staff gauge readings between August 1 and October 20 varied between 1.65 feet and 2.20 feet, showing a maximum variation of 0.55 feet (Figure 10). In the early part of the summer the water level was slightly higher than normal compared to the previous four years (Figure 11).

In 2010, daily water temperature data ranged from a high of 62° F to a low of 42° F but was not recorded consistently (Figure 12).

Biological Data

In 2010, 10,876 sockeye salmon were enumerated through the Long Lake weir (Table 1, Figure 13, and Appendix A). The first sockeye salmon passed through the weir on August 12 when 20 were counted. The median run day occurred on August 30 when 6,168 sockeye salmon had been

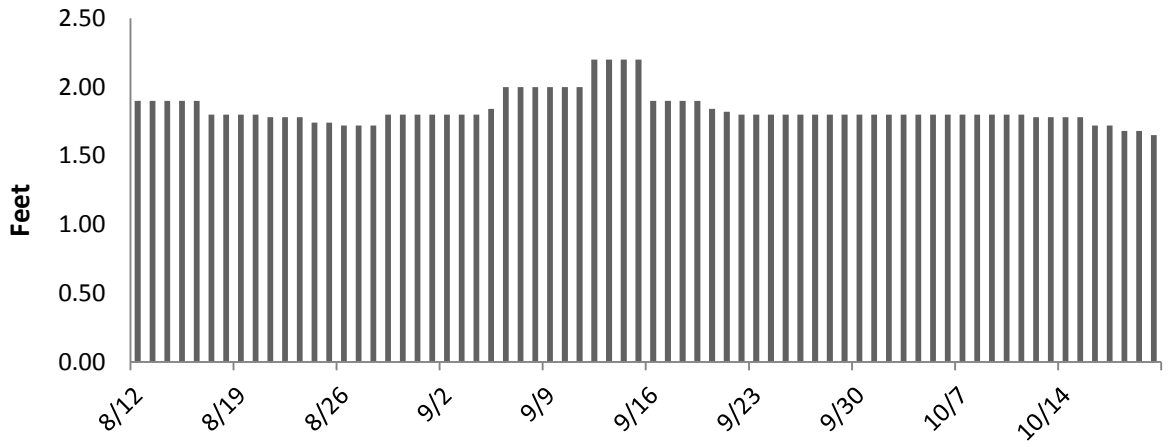

Figure 10. Daily staff gauge readings of water depth, Long Lake weir, 2010.

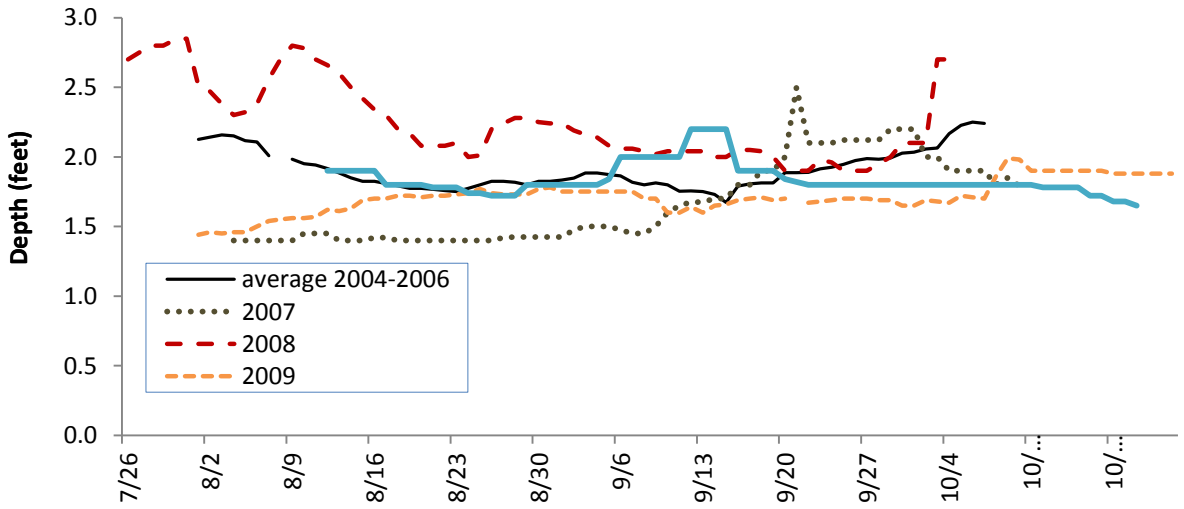

Figure 11. Staff gauge reading average 2004-2006, and staff gauge readings for 2007-2010.

counted through the weir. A total of 950 sockeye salmon were sampled for sex, length, and age. Between September 15 and October 20, a total of 323 coho salmon were also enumerated.

Sockeye returns to Long Lake during the 37 year period of weir operations have been highly variable, ranging from a high of 50,000 in 2002 to a low of 631 in 2008 (Table 1, Figure 14). The 37 year average migration through the weir is 15,593 sockeye salmon: the 2010 count of 10,876 was 70% of the average. In 2010 the total inriver run estimated by the Miles Lake sonar project was 926,010 salmon and the Long Lake sockeye count represented about 1.2% of it (Table 1). During 1978-2010, Long Lake escapements counts represented an average of 3.8% of the total inriver run, but ranged from 0.4% to 19.4% of the total inriver run.

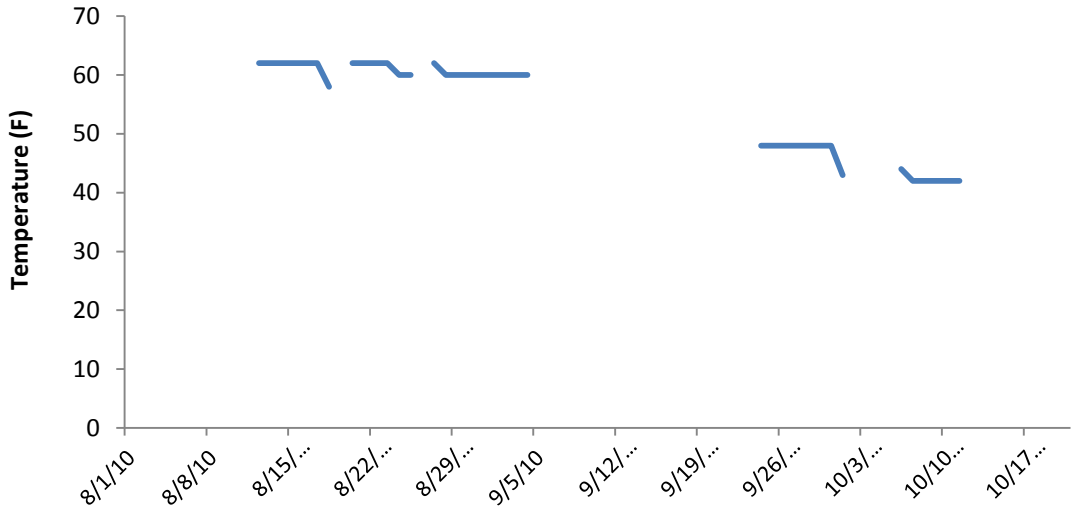

Figure 12. Water temperature (°F) for 2010.

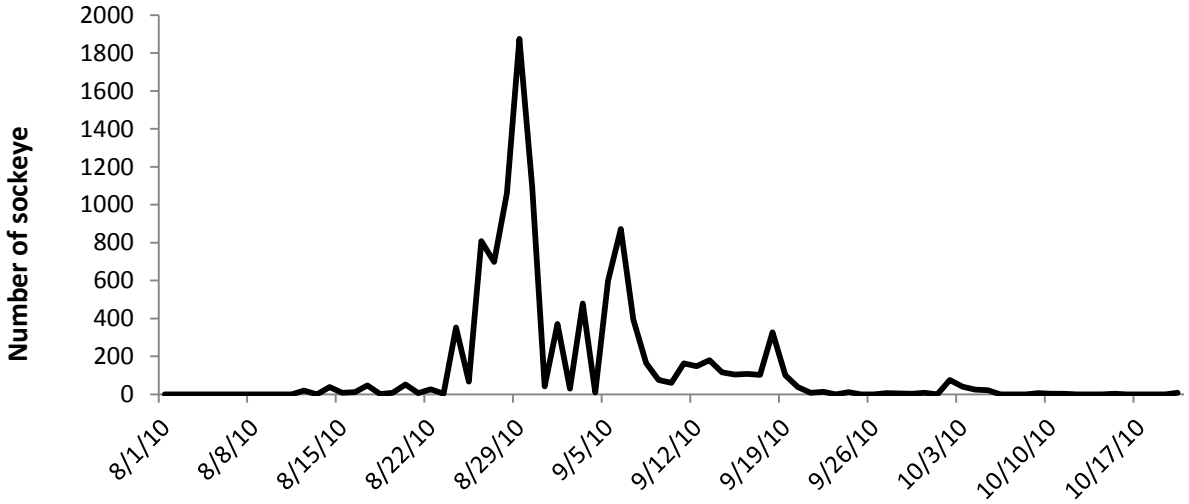

Figure 13. Daily sockeye salmon count, Long Lake weir, 2010.

Long Lake escapements showed a significant decreasing abundance trend ($P = 0.013$) for the 32 year time period 1978-2010, but only a small proportion of the total squared error (0.1841) was explained by the trend line (Figure 14). Conversely, Miles Lake estimates showed a significant increasing abundance trend ($P < 0.001$) for the same time period, and a much larger proportion of the total squared error (0.5852) was explained by the trend line (Figure 15).

While these opposite trends resulted in a significant linear relationship ($P = 0.023$) between annual Miles Lake sonar estimates and Long Lake weir sockeye salmon counts during this time period, only a small proportion of the total squared error (0.1558) was explained by the regression model (Figure 16).

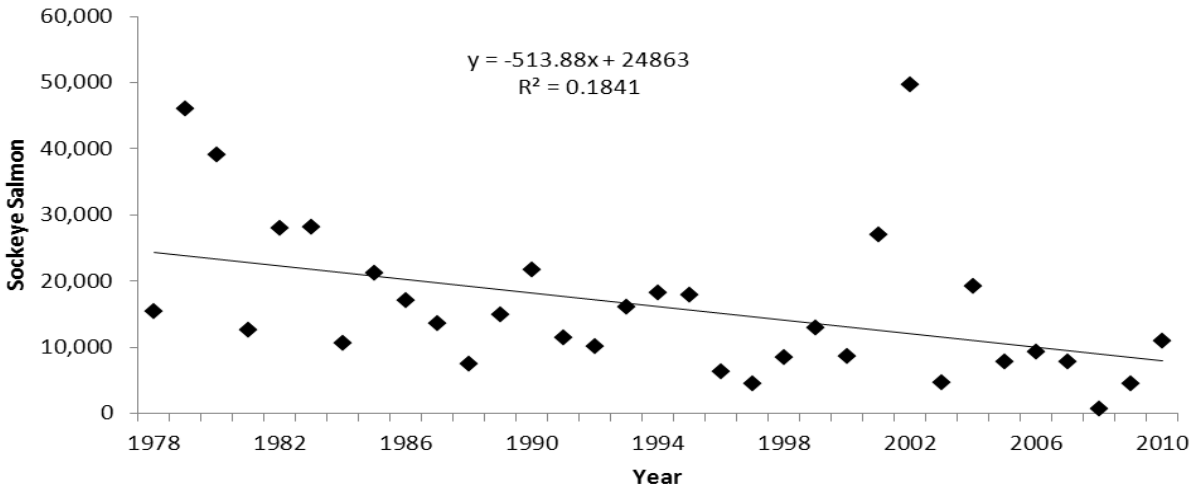

Figure 14. Sockeye salmon escapement estimates and trend line, Long Lake weir, 1978-2010.

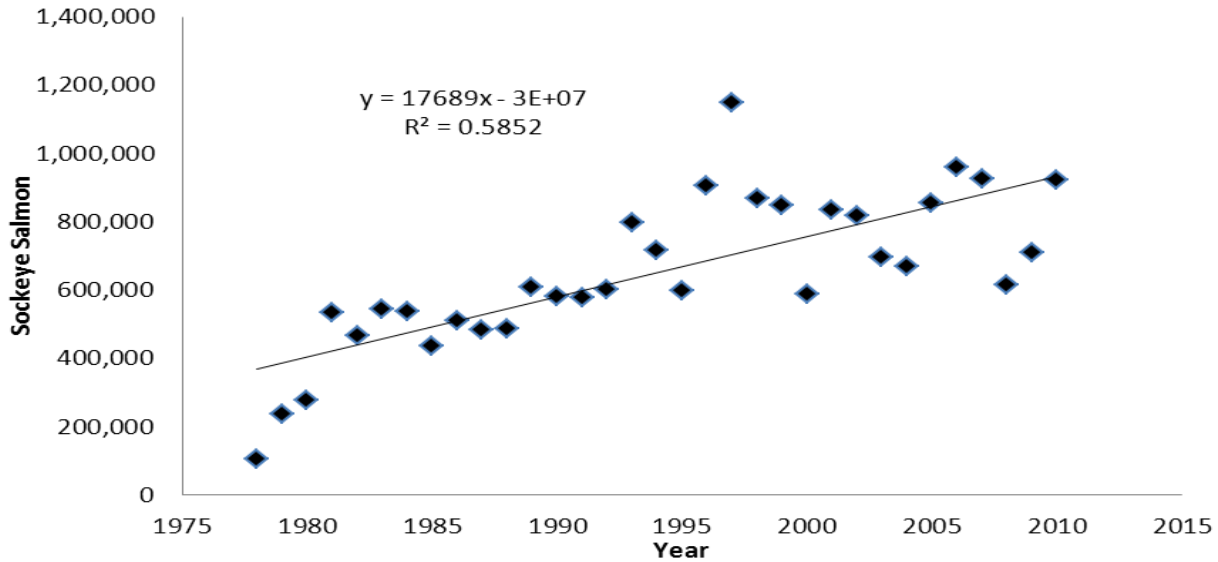

Figure 15. Sockeye salmon escapement estimates and trend line, Miles Lake sonar, 1978-2010.

In 2010, age-1.2 sockeye salmon comprised 55% and age-1.3 sockeye salmon comprised 38% of sockeye salmon sampled, Forty eight percent were males and 52% were females (Table 2). In the past nine years, this is the only year that the majority of sampled salmon have not been age-1.3 fish. Average MEF length of all sockeye salmon sampled was 492 mm, while the average of age-1.3 males was 565 mm and the average of age-1.3 females was 545 mm (Table 3).

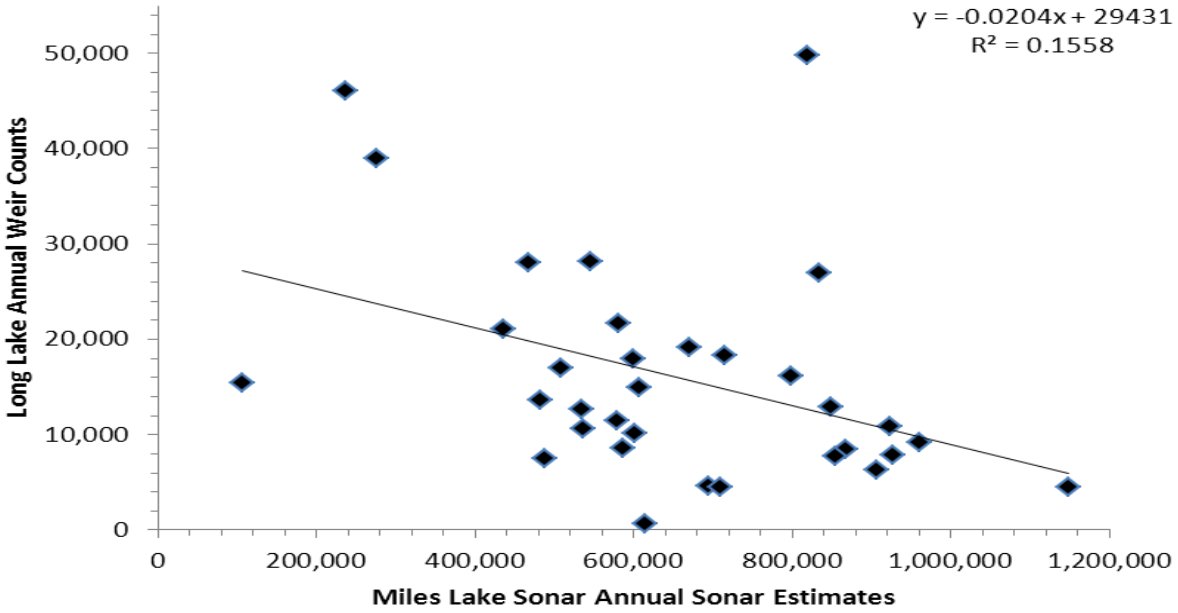

Figure 16. Relationship between Long Lake weir sockeye salmon and Miles Lake sonar counts, 1978-2010.

Table 2. Numbers by sex and age class of sockeye salmon sampled at the Long Lake weir, August 23 - October 27, 2010.

Brood Year and Age Class[1]								
Sex		2007	2006	2005		2004	Total Fish Counted	Number of fish sampled
		1.1	1.2	1.3	2.2	2.3		
F	Percent	0.0	27.1	22.2	1.7	0.9	5,649	389
	Number	0	2,948	2,410	189	102		
M	Percent	0.8	27.9	16.6	1.6	1.2	5,227	360
	Number	87	3.035	1,801	174	131		
Total	Percent	0.8	55.0	38.7	3.3	2.1	10,876	749
	Number	87	5,983	4,211	363	232		
	SE	35	198	194	71	57		

[1]Ages determined using length frequency and otolith data.

Table 3. Average Length (mid-eye to tail fork), standard error (SE), and sample size by sex and age of sockeye salmon sampled at the Long Lake weir, August 23 - October 22, 2010.

Sex		Brood Year and Age Class[1]				
		2007	2006	2005		2004
		1.1	1.2	1.3	2.2	2.3
F	Average Length (mm)		489	545	487	531
	SE		2.2	1.6	9.0	4.0
	Sample Size		199	162	13	7
M	Average Length (mm)	357	510	565	515	561
	SE	5.6	1.3	2.2	3.6	3.5
	Sample Size	6	207	123	12	9
Total	Average Length (mm)	357	498	554	501	548
	SE	5.6	1.4	1.4	5.6	4.6
	Sample Size	6	406	285	25	16

[1]Ages determined using length frequency and otolith data.

Run Timing

The median date of the 2010 run (August 29) occurred earlier than that observed for five of the previous six years. The last sockeye salmon were counted through the weir on October 20 (Table 4 and Figure 17). Migratory timing started later and ended earlier than every year since 2004 excepting for 2008.

Table 4. Run timing information for the sockeye salmon migration through the Long Lake weir, 2004-2010.

Year	First Sockeye Salmon	Median Date	Cumulative Count on Median Date
2004	August 8	September 12	9,608
2005	August 11	September 12	3,885
2006	August 7	September 4	4,620
2007	August 15	September 8	4,868
2008	August 6	August 20	329
2009	August 23	August 31	2,352
2010	August 11	August 29	6,168

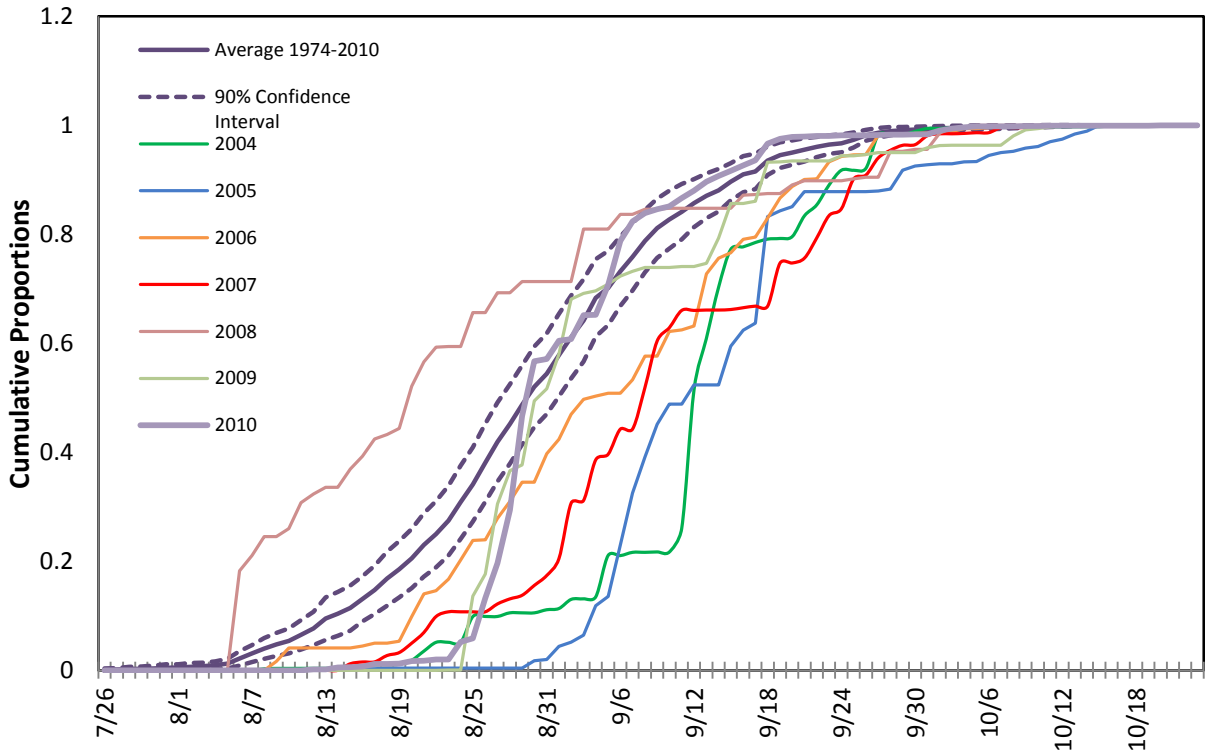

Figure 17. Average sockeye salmon migratory run timing for 1974-2010 and annual migratory run timing for 2004-2010, Long Lake weir.

DISCUSSION

Weir Operation

Escapement monitoring typically relies on video, sonar, or direct visual observation. Video technology provides a means of monitoring without having staff continually on site throughout the field season. Prior to 2010, Long Lake weir operations were based on direct visual observations at the weir made one or more times each day. The gate in the weir was only open to allow fish passage when counting was being done. Despite efforts to make counts and pass fish at various times of the day, salmon would not always pass through the weir while someone was on site and opened the gate. Inevitably, salmon would be observed backed up below the weir and congregated in pools, apparently delayed in their migration due to weir operations. This increases their vulnerability to predation, can cause self-inflicted injuries when salmon repeatedly attempt to pass the weir when the gate is closed, and may also deplete their energy stores. When salmon concentrate behind the weir, the likelihood of human-bear habituation is also increased, particularly as bears begin to associate the weir site with food availability.

An alternative to regulating fish passage by closing and opening a gate within the weir is to keep the gate open at all times. However, this makes it necessary to either, continuously observe and

record salmon passage or to extrapolate data to cover periods when visual observations are lacking. Since salmon passage rates vary within and among days, direct visual observations would need to be made several times each day to reduce the magnitude of extrapolation errors. We have been able to avoid these problems by using an underwater video recording system in conjunction with a passage chute built into the weir to ensure that all fish passing through the weir travel close to the camera lens. This allows us to keep the weir gate open when staff is not present, and allows salmon to pass the site in a less obstructed manner that should allow them to migrate in a more natural pattern with fewer detrimental effects.

There were no other major changes in weir operations in 2010. The basic construction of the weir has changed very little since it was built in 1974 because the rigid picket design works well in this location. The pickets are removed from the weir and stored at the end of each field season and then replaced each summer, while the weir's framework is left in place in the creek throughout the winter. Erecting the electric fence earlier in the season to deter bears seems to have provided a safer work place at the weir site. Being able to staff the sampling crew with people living near the weir site (the 2009 sampling crew consisted of two individuals living in the Collins' household and one other local resident) has made it possible to operate this project efficiently and cost effectively.

The 2004 sampling box design has continued to work well This sampling box replaced a smaller one that was built in 2003 (shown in Figure 2), which was the first year sampling was done at the weir and the first year that WRST was involved in the project. The redesigned box is larger than the 2003 box, and was built adjacent to the northwestern bank of Salmon Creek.

Biological Data

Otolith collecting was started in 2007 to supplement the age data collected from scale samples. Scales taken from the sockeye salmon that return to Long Lake are usually difficult to read because they are worn at the edges and have started to be resorbed. Because of this, the ages in these reports are based on length frequency data derived from mixed stock samples collected in the lower Copper River. Otoliths provide a more accurate way to age these salmon, but it is more problematic to collect otoliths. This is because otoliths are collected from carcasses of spawned-out sockeye salmon sampled from spawning areas in the lake and upstream of the weir site. Such sampling depends upon availability of carcasses to the sampling crew. This is a late run and spawning occurs over an extended time period: it has been documented as late as April in some areas of the lake. The crew is generally not available for sampling after the end of October and weather conditions make sampling difficult during the winter months

Sockeye salmon returns to Long Lake have been highly variable, ranging from 631 in 2008 to 50,000 in 2002 (Table 1). While the total run of sockeye salmon to the Copper River, estimated at the Miles Lake sonar site, has shown an increasing trend in abundance since 1978, the escapement into Long Lake has generally shown a decreasing, although not statistically significant ($P > 0.05$), trend since 1974. This negative relationship between Miles Lake and Long Lake counts is statistically significant ($P < 0.05$), although we do know whether this is just a spurious relationship or due to factors associated with the total abundance of sockeye salmon returning to the Copper River drainage. For example, Long Lake sockeye salmon smolt survival

may decrease as they compete with increasing numbers of smolt from other Copper River spawning populations, or Long Lake sockeye salmon adults may be harvested at a greater rate than other Copper River run components with changes in fishing patterns due to increasing total runs. However, our findings do indicate that not all spawning components of the total Copper River run experience similar trends over time, and that a large total return does not ensure, and may actually be detrimental to, achieving spawning escapements into all portions of this large drainage. Additionally, even though a statistically significant ($P = 0.023$) relationship was found between Mile Lake estimates and Long Lake escapements, this relationship does not have much predictive power since only a small proportion of the total squared error (0.1558) was explained by the regression model. Therefore, we feel it is important to continue to monitor spawning components of the total run in addition to the total inriver return since it is vitally important to conserve all segments of the population to ensure the continued health and sustainability of this important fishery resource,

CONCLUSIONS

Weir Operation

The underwater camera and video recording system functioned well and provided an excellent means of enumerating salmon passage through the weir. Likewise, the photovoltaic system demonstrated its capability of providing necessary power for the electronics. There were no other major changes at the weir in 2010. The sampling box design continued to work well and erecting the electric fence earlier insured a safer work place for the entire sampling season. The sampling crew which was composed of two local residents also functioned well. The incorporation of the underwater video system allowed us to reduce the number of crew members and work hours required for the project.

Biological Data

sockeye salmon returns to Long Lake appear to be highly variable, from a high of 50,000 in 2002 to a low of 631 in 2008 (Table 1). The number of fish counted through the weir in 2010 is approximately 70 percent of the 37 year average of 15,593 sockeye. Different from past years, the fish migrating into Long Lake are not predominantly age-1.3. The majority this year was age-1.2.

RECOMMENDATIONS

The Office of Subsistence Management has provided funding for the Long Lake weir for four more years, 2010-2013, and this will allow us to:

1. Continue monitoring the sockeye salmon escapement into Long Lake so that an appropriate natural and healthy escapement range can be determined.

2. Continue sampling sockeye salmon for age, length, and sex information to monitor the health of the spawning population.
3. Continue collecting otolith as a means to determine accurate age information for the sockeye salmon spawning population and extend the collection timing into the winter months. We now know that it is feasible to collect otoliths from salmon carcasses during the winter months. Since it is difficult to use scale samples from fish that have been in the silty freshwater systems for a long period for accurate age analysis, we would like to depend more on the collection of otoliths for the aging process.
4. Continue to operate the underwater video recording system to estimate escapement.

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In 2010 the Collins family provided some of the labor used for operating the weir. Stefanie Tschappat assumed the majority of the responsibility for operating the weir and she and Lucas Stumpf were instrumental in assuring that age, sex, and length and otolith collection were conducted properly. Steve Moffit and crew at the ADF&G, Commercial Fisheries Division in Cordova, Alaska proposed the sampling regime for the weir, read scale samples, and provide age, sex, and length summaries. The U.S. Fish and Wildlife Service, Office of Subsistence Management, provided $20,121 in funding support for 2009 through the Fisheries Resource Monitoring Program, under contract number FIS07-505. Stephen Fried, FWS, OSM, provided statistical advice.

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Appendix A. Daily and cumulative sockeye and coho salmon counts, and number of sockeye salmon sampled for age, sex, and length information, Long Lake weir, 2007.

	Sockeye Salmon (Number)				Coho Salmon (Number)	
Date	Daily Count	Cumulative Count	Daily Sample	Cumulative Sample	Daily Count	Cumulative Count
8/1/10	0				0	
8/2/10	0	0			0	0
8/3/10	0	0			0	0
8/4/10	0	0			0	0
8/5/10	0	0			0	0
8/6/10	0	0			0	0
8/7/10	0	0			0	0
8/8/10	0	0			0	0
8/9/10	0	0			0	0
8/10/10	0	0			0	0
8/11/10	0	0			0	0
8/12/10	20	20			0	0
8/13/10	0	20			0	0
8/14/10	38	58			0	0
8/15/10	8	66			0	0
8/16/10	11	77			0	0
8/17/10	47	124			0	0
8/18/10	1	125			0	0
8/19/10	7	132			0	0
8/20/10	51	183			0	0
8/21/10	6	189			0	0
8/22/10	26	215			0	0
8/23/10	2	217			0	0
8/24/10	352	569			0	0
8/25/10	66	635			0	0
8/26/10	807	1,442			0	0
8/27/10	698	2,140	0	0	0	0
8/28/10	1060	3,200	62	62	0	0
8/29/10	1875	5,075	15	77	0	0
8/30/10	1093	6,168	23	100	0	0
8/31/10	42	6,210	32	132	0	0
9/1/10	370	6,580	0	132	0	0
9/2/10	29	6,609	29	161	0	0
9/3/10	478	7,087	60	221	0	0
9/4/10	9	7,096	9	230	0	0
9/5/10	599	7,695	77	307	0	0
9/6/10	872	8,567	11	318	0	0
9/7/10	395	8,962	0	318	0	0
9/8/10	165	9,127	0	318	0	0
9/9/10	75	9,202	0	318	0	0
9/10/10	60	9,262	0	318	0	0
9/11/10	163	9,425	11	329	0	0
9/12/10	147	9,572	84	413	0	0

-continued-

Appendix A. Continued.

	Sockeye Salmon (Number)				Coho Salmon (Number)	
Date	Daily Count	Cumulative Count	Daily Sample	Cumulative Sample	Daily Count	Cumulative Count
9/13/10	180	9,752	95	508	43	43
9/14/10	115	9,867	100	608	5	48
9/15/10	104	9,971	72	680	13	61
9/16/10	108	10,079	88	768	18	79
9/17/10	102	10,181	113	881	11	90
9/18/10	327	10,508	0	881	45	135
9/19/10	100	10,608	0	881	30	165
9/20/10	38	10,646	38	919	0	165
9/21/10	8	10,654	0	919	21	186
9/22/10	12	10,666	0	919	8	194
9/23/10	0	10,666	0	919	0	194
9/24/10	11	10,677	0	919	5	199
9/25/10	0	10,677	0	919	4	203
9/26/10	0	10,677	0	919	0	203
9/27/10	6	10,683	0	919	4	207
9/28/10	4	10,687	0	919	16	223
9/29/10	2	10,689	0	919	4	227
9/30/10	8	10,697	0	919	4	231
10/1/10	0	10,697	0	919	0	231
10/2/10	75	10,772	0	919	12	243
10/3/10	39	10,811	0	919	16	259
10/4/10	25	10,836	0	919	15	274
10/5/10	21	10,857	0	919	13	287
10/6/10	0	10,857	0	919	11	298
10/7/10	0	10,857	20	939	11	309
10/8/10	0	10,857	0	939	8	317
10/9/10	6	10,863	0	939	2	319
10/10/10	2	10,865	0	939	2	321
10/11/10	2	10,867	0	939	2	323
10/12/10	0	10,867	0	939	0	323
10/13/10	0	10,867	0	939	0	323
10/14/10	0	10,867	0	939	0	323
10/15/10	2	10,869	0	939	0	323
10/16/10	0	10,869	0	939	0	323
10/17/10	0	10,869	0	939	0	323
10/18/10	0	10,869	11	950	0	323
10/19/10	0	10,869	0	950	0	323
10/20/10	7	10,876	0	950	0	323

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