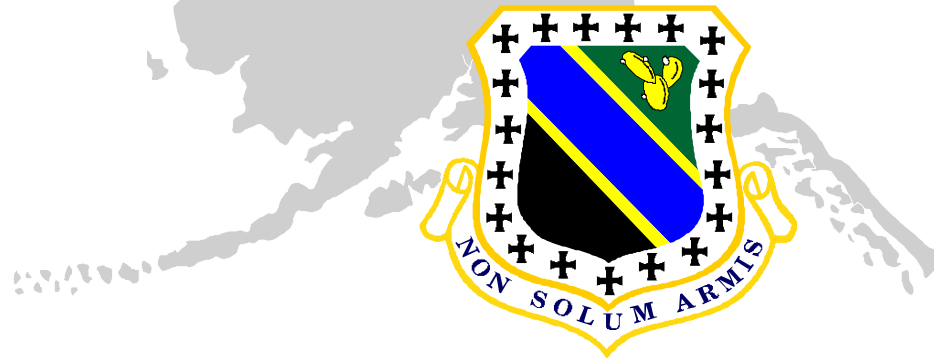


**FINAL**  
**ELMENDORF AIR FORCE BASE**  
**COOK INLET BELUGA WHALE HABITAT**  
**MONITORING 2009:**  
**SIXMILE CREEK SALMON SMOLT EMIGRATION**  
**AND ADULT SALMON ENUMERATION**



**Prepared for:**  
**3<sup>rd</sup> Civil Engineer Squadron**  
Cultural and Natural Resource Conservation  
3 CES/CEANC  
6326 Arctic Warrior Drive  
Elmendorf Air Force Base, AK  
99506-3204

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November 2009

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2009: Sixmile Creek Salmon Smolt Emigration and Adult Salmon  
Enumeration**

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# SF 298

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14. ABSTRACT Alaska Department of Fish and Game Sport Fish Division enumerated the adult salmon escapement and smolt emigration for Sixmile Drainage on Elmendorf AFB during summer 2009. Smolts were enumerated during May 15 through June 30 and adult were counted July 1 through August 31. The sockeye salmon ( <i>Oncorhynchus nerka</i> ) smolt emigration totaled 8,614. The dominant freshwater age class for sockeye smolt was age-1 smolt (95% , SE= 115.6) followed by age-2 (5%, SE= 115.6). The mean weight and length of sockeye age-1 smolts was 7.3 g (SE= 0.11) (range 2.2-15.3 g) and 88 mm (SE= 0.44) (range 62-113 mm) while age-2 smolts was 11.8 g (SE= 0.41) (range 10.1-15.1 g) and 102 mm (SE= 1.33) (range 90-110). Coho ( <i>O. kisutch</i> ) salmon smolts numbered only 52 and were not sampled for age and size. The total drainage adult salmon escapement was 3,342 sockeye, 197 coho, and 2,703 pink salmon. The 2009 sockeye escapement was greater than the historical average of 1,938 and the fourth largest escapement of record. Counts of adult coho and pink salmon were at record levels in 2009.					
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## EXECUTIVE SUMMARY

The Cook Inlet population of beluga whales *Delphinapterus leucas*, designated endangered by NOAA National Marine Fisheries Service, feeds on salmon in Upper Cook Inlet. Sixmile Drainage on Elmendorf Air Force Base (EAFB) produces salmon that are likely a food source for this population of whales and supports a sport fishery for salmon at the mouth of Sixmile Creek. Both uses warrant monitoring this small population of salmonids. Alaska Department of Fish and Game Sport Fish Division (ADF&G) was contracted by EAFB Natural Resources Conservation office to count and describe the smolt emigration and adult salmon escapement of the Sixmile Drainage during May-September 2009.

ADF&G used a fyke weir and an adult salmon weir at the outlet of Lower Sixmile Lake, the same methodology used since 2001 and 1996, respectively. Two counts of adult salmon in-stream below the weir added to the adult salmon escapement count.

The sockeye salmon *Oncorhynchus nerka* smolt emigration totaled 8,614. The dominant freshwater age class for sockeye salmon smolts was age-1 smolt (95%) followed by age-2 (5%). The mean weight and length of sockeye salmon age-1 smolts was 7.3 g (range 2.2-15.3 g) and 88 mm (range 62-113 mm) while for age-2 smolts the estimates were 11.8 g (range 10.1-15.1 g) and 102 mm (range 90-110). Coho *O. kisutch* salmon smolts numbered only 52 and were not sampled for age and size.

The total drainage adult salmon escapement was 3,342 sockeye, 197 coho, and 2,703 pink salmon. The 2009 sockeye salmon escapement was greater than the historical average of 1,938 and the fourth largest escapement of record. Peak run timing was five days earlier than the historic run timing (1988-2008). Counts of adult coho and pink salmon were at record levels in 2009.

ADF&G recommends continued monitoring of both smolts and adult salmon; replacing the aging fish ladder because it is a barrier to smolt movement; conduct a well designed creel census and increase enforcement of fishing regulations at the mouth of Sixmile Creek; and consider a study of rainbow trout predation affected by a smolt weir.

**Herman Griese, YD-02**  
**Wildlife Biologist**  
**3 CES/CEANC**

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## INTRODUCTION

The Cook Inlet beluga whale *Delphinapterus leucas*, a distinct stock, is an opportunistic feeder that feeds primarily on eulachon *Thaleichthys pacificus* during their seasonal abundance in upper Cook Inlet. Belugas' predatory focus switches to salmon as eulachon spawning runs decline (National Marine Fisheries Service. 2008). The Cook Inlet beluga whale was designated endangered 22 December 2008 by NOAA National Marine Fisheries Service. The salmon population of Sixmile Creek drainage on Elmendorf Air Force Base (EAFB) (Figure 1) may contribute to the prey base of the whale's critical habitat in Cook Inlet and Knik Arm.

Upper and Lower Sixmile Lakes were created in the early 1950's after Sixmile Creek was dammed. Sockeye salmon *Oncorhynchus nerka* were first reported colonizing the Sixmile Drainage in the mid 1970's and were pioneers from the Big Lake/Fish Creek Drainage. Sixmile Creek Drainage sockeye salmon are genetically similar to Big Lake/Fish Creek populations and are clustered below well supported nodes (Habicht et. al. 2007). Historical age composition estimates from the Big Lake drainage show that the return is primarily composed of age-1 freshwater fish which is similar to the overall freshwater composition of Sixmile Creek drainage return. Gotthardt (2006) found that age-1 smolts were 88% and age-2 were 12 % of the sockeye smolt run in 2003.

The purpose of this study was to count the outmigration of sockeye and coho *O. kisutch* salmon smolts and the escapement of all adult salmon at Sixmile Creek Drainage in EAFB, Alaska (Figure 1) in 2009.

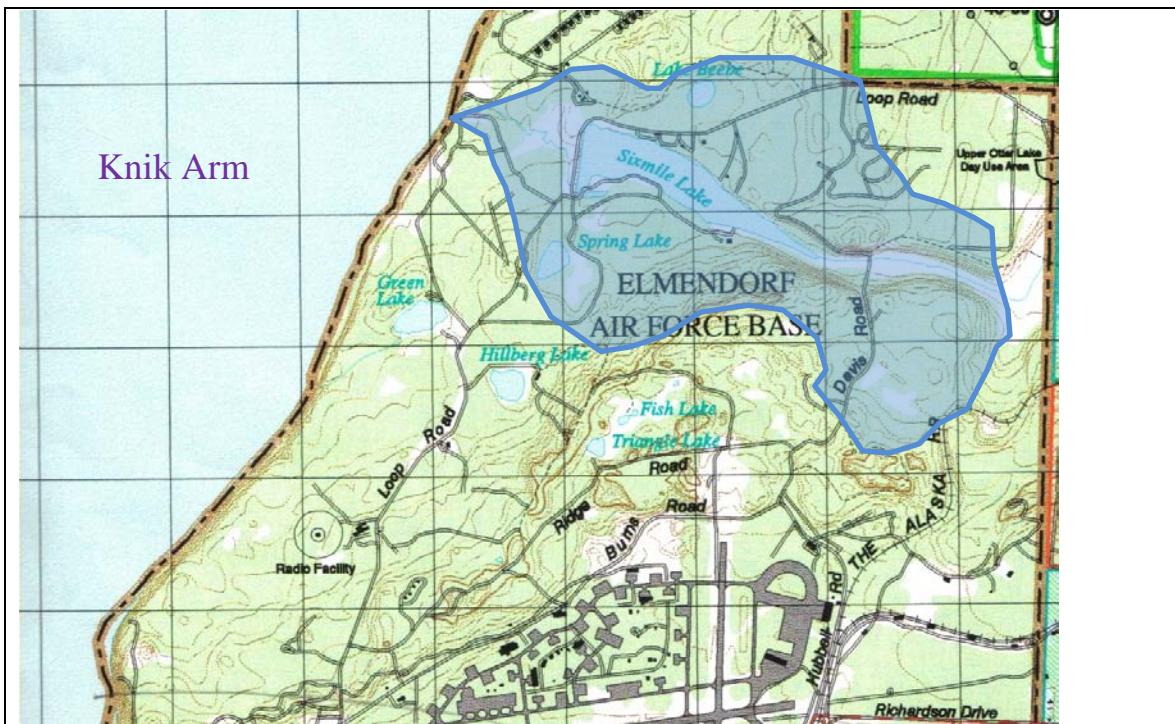


Figure 1.- Sixmile Drainage on Elmendorf Air Force Base near Anchorage, Alaska.

The Sixmile salmon monitoring activity was previously conducted or coordinated by biological staff from 3 CES/CEANC from 1988 to 2008. In 2009, this project was awarded to the Alaska Department of Fish and Game with U.S. Air Force funding through U. S. Army Medical Research and Acquisition Activity, Ft. Detrick, Maryland.

An adult fish weir was first operated approximately 0.5 km downstream of the current fish ladder beginning in 1988. In 1996 the weir was moved to the current site under the bridge across the outlet of Lower Sixmile Lake (Figure 2). Smolt out-migration during 2003-2006 was also measured under the bridge. In addition to documenting fish entering

or departing Lower Sixmile Lake, stream walks were conducted during late August to early September to provide an estimate of salmon that spawned below the lake.

Adult salmon enter the Sixmile system for spawning from July through September. Both sockeye and coho salmon spawn in or above Sixmile Lake, while pink salmon *O. gorbuscha* spawn downstream of the fish ladder at the outlet of Lower Sixmile Lake. Annual returns of sockeye salmon adults since 1988 averaged 1,938 (range 663 – 4,282) fish. The adult pink salmon annual return has been estimated to range 1,000 – 2,500 fish since 2001, while 23 – 102 coho salmon have returned during the same period. Chum salmon *O. keta* are relatively rare in the stream.

Salmon smolts have been counted emigrating from Lower Sixmile Lake from mid-May through June. Sixmile smolt out-migration includes sockeye and coho salmon. Sockeye salmon smolts are the most abundant species ranging from 6,004 – 20,113, while coho salmon smolts have ranged from 23 – 393 fish.

## **OBJECTIVES**

The objectives for the Sixmile Creek weir project were:

1. Count the number of sockeye and coho salmon smolts emigrating from Sixmile Lake from 15 May through 30 June.
2. Estimate the fresh-water age composition of the smolt emigration of sockeye salmon such that the estimates are within 10 percentage points of the true value 95% of the time.
3. Count the number of adult salmon (all species) migrating into Sixmile Creek from 1 July through 15 September.
4. Estimate the age and sex composition of the adult escapement of sockeye such that the estimates are within 10 percentage points of the true value 95% of the time.
5. Census the sex composition of the adult coho salmon escapement.
6. Count adult salmon spawning below the weir (stream surveys).

## **Tasks**

1. Estimate mean length-at-age for the Sixmile Creek sockeye salmon smolt outmigration.
2. Estimate mean length-at-age for the Sixmile Creek adult sockeye salmon escapement.
3. Collect environmental data (air temperature, water temperature, water clarity) on a daily basis at the weir site
4. Interview anglers encountered during stream survey for harvest information (effort and harvest).



# METHODS

## Study Site

The Sixmile Creek Drainage is located in Southcentral Alaska on EAFB (Figure 1) and flows approximately 1.5 kilometers into the Knik Arm of Cook Inlet (Figure 2).

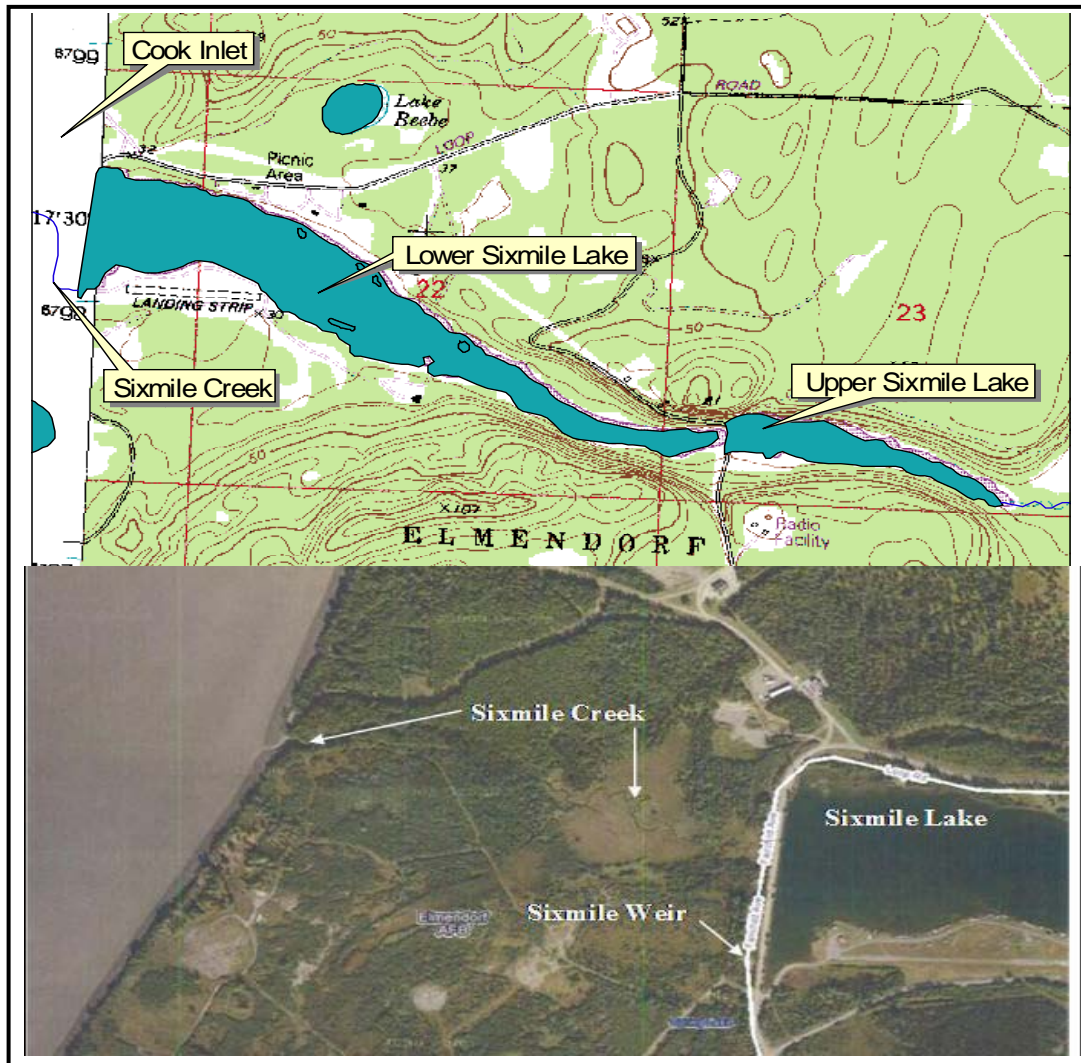


Figure 2.- Sixmile Creek, Lower and Upper Sixmile Lakes, and weir location, Elmendorf Air Force Base, Anchorage, Alaska.

The Sixmile Creek Drainage includes Sixmile Creek, Lower Sixmile Lake, and Upper Sixmile Lake, and occupies a valley created by an old channel of Eagle River. The system is charged primarily by springs entering the south side of Upper Sixmile Lake. The creek is now flooded for most of its length by the waters of Upper and Lower Sixmile Lakes, which were created by damming Sixmile Creek in 1951. Improvements to Talley Avenue crossing the upper portion of the system in 1996 included the addition

of a fish ladder-culvert easing fish access into Upper Sixmile Lake. Much of the old creek channel is still visible in the lakes.

### **Smolt Emigration**

Sockeye and coho salmon smolts emigrating from Sixmile Lake are typically counted from mid-May through the end of June and the actual dates vary annually. In 2009 smolts were counted emigrating from Lower Sixmile Lake from 19 May through 1 July. All smolts were counted by hand and identified by species (Objective 1). Smolts were captured with a fyke trap at the lake outlet, located under the bridge and positioned just above the fish ladder. The fyke trap was fished continuously during the project operation.

Age and length data was collected from sockeye salmon smolts emigrating from Lower Sixmile Lake (Objective 2). Smolts were anesthetized with Alka-Seltzer® prior to sampling. To meet objective criteria, a sample size of 160 sockeye salmon smolts (Thompson, 1987) was needed, assuming an unreadable scale rate of 20%, and a migration of 7,790 sockeye salmon smolts (average from 2003-2006 and used in the finite population correction factor). To ensure a representative sample of smolts was taken, the crew sampled the emigration daily for age and length data.

### **Adult Escapement**

All adult salmon escaping into Sixmile Lake were enumerated from 14 July through 31 August, 2009 (Objective 3).

Age, Sex, and Length (ASL) data was collected from sampled adult sockeye salmon passing through the weir (Objective 4). To meet objective criteria, a sample size of 160 sockeye salmon was needed (Thompson, 1987), assuming unreadable scale rate of 20% and an escapement of 1,300 sockeye salmon (5-year average and used in the finite population correction factor). To ensure a representative sample of adults was taken, the crew sampled the escapement daily for ASL data.

Sex composition, male and female, data was collected from all adult coho salmon passing through the weir (Objective 5).

Foot and Angler surveys were conducted downstream of the weir to count salmon spawning below the weir during the third week of August, peak of the pink salmon return, and the day after the weir was pulled (Objective 6). The number of anglers observed during the stream surveys was recorded, and anglers were asked how long they had fished and how many salmon of each species they harvested (Task 4).

### **Environmental Observations**

Water clarity and water temperature were documented daily at the weir site (Task 3).

## DATA COLLECTION

### Smolt Emigration

#### *Counts*

The following information was collected:

1. The number of sockeye and coho salmon smolts counted and released from the fyke trap alive (daily);
2. The number of sockeye smolts sampled for age, weight, and length (daily);
3. Environmental observations (daily);
4. Any comments regarding the ability to accurately count salmon through the live trap (daily).

Sockeye and coho smolts emigrating from Lower Sixmile Lake were captured daily in a fyke trap, identified by species, and counted by hand and released below the weir. The fyke trap is a 1.5-m<sup>2</sup> tunnel that narrows to a cylindrical entrance into a rectangular aluminum box with 1.0 m x 0.85 m x 0.80 m (L x W x H) dimensions. Meshed wings were attached to the fyke trap and extended from each side of the tunnel entrance to the bridge abutment and, so that it effectively fished the entire stream width. The trap was contained entirely under the bridge and protected from vandalism by locked gates on both ends.

The sampling crew monitored the fyke net closely to pass fish in a timely fashion and minimize impeding the downstream migration. The fyke trap was also inspected daily by the sampling crew for gaps that would allow smolts to pass through undetected.

The information detailed above was recorded daily in a Rite-In-the-Rain® notebook and entered in a Microsoft Excel<sup>TM</sup> file daily.

#### *Age, Weight, and Length-Sockeye Salmon Only*

Scale samples were taken from the preferred area (Clutter and Whitesel 1956), mounted on microscope slides and labeled. Smolts were anesthetized with Alka-Seltzer® prior to collecting size information and scale samples. Scale-age was determined was done using a microfiche reader and a dissecting microscope. Weight (g) information was collected with an electronic balance and recorded. Fork length was measured from the tip of the snout to the fork of the tail to the nearest 1mm and recorded.

The information detailed above was recorded in a Rite-In-the-Rain® notebook and entered in a Microsoft Excel<sup>TM</sup> file.

## **Adult Escapement**

### *Counts*

The following information was collected:

1. The number of salmon by species counted through the live trap (daily);
2. The number of salmon by species sampled for age, sex, and length (daily);
3. The number of other fish, by species, that passed through the live trap (daily);
4. Environmental observations;
5. The number of salmon by species that were recorded harvested by anglers below the weir (twice weekly);
6. Any comments regarding the ability to accurately count salmon through the live trap.

The weir was cleaned and inspected for gaps daily that would allow salmon to pass through the weir undetected and more frequently if conditions warranted. The weir was monitored closely during daylight hours, to pass fish in a timely fashion in order to minimize impeding the upstream migration of salmon.

The information detailed above was recorded daily in a Rite-In-the-Rain® notebook and entered in a Microsoft Excel™ file daily.

### *Age, Sex, and Length*

Sampled fish were measured from the mid-eye to the fork-of-tail to the nearest 0.5 cm. Sex was determined by external physical characteristics, such as kype development or a protruding ovipositor. Length and sex was recorded in Rite-In-the Rain® notebooks while sampling, entered into a Microsoft Excel™ file, and transferred to standard age, weight, and length (AWL) version 1.2 mark-sense forms (Heineman unpublished; Appendix A1).

One scale was collected from sockeye salmon from the preferred location (Clutter and Whitesel 1956). If the preferred scales couldn't be obtained, another scale was taken from as close to the preferred scale as possible, and always from the first or second row above the lateral line, in order to capture the early life history portion of the age. If no scales were available in the preferred area on the left side of the fish, scales were collected from the preferred area on the right side of the fish. If scales were not obtainable from a given fish, that fish was not sampled at all and sampling continued with the next available fish. Scales were mounted on gum cards, which were covered with wax paper after drying, placed in a press to keep from curling, and impressions were made in cellulose acetate as described in Clutter and Whitesel (1956). The corresponding litho-code and line numbers from the mark-sense form were recorded on the gum card along with the date, collector name, and location. The impressions were magnified and viewed on a microfiche reader and the ages were determined from the growth patterns of the circuli. Ages were reported in European notation (Jearld Jr. 1983) and recorded on AWL forms and into a Microsoft Excel™ file.

## DATA ANALYSIS

### Smolt Emigration

#### *Counts*

Total sockeye and coho salmon smolt counts were added to the historic database. Cumulative and daily run timing plots were made for each species to allow comparison to previous years.

#### *Age and Length -Sockeye Salmon Only*

The proportion of sockeye salmon smolts of age category  $g$  migrating downstream was estimated as:

$$\hat{p}_g = \frac{n_g}{n}$$

where:

$n_g$  = the number of sockeye salmon sampled belonging to age category  $g$ , and  
 $n$  = the total number of sockeye salmon sampled for age.

The number of salmon smolts of age category  $g$  passing downstream was estimated by:

$$\hat{N}_g = N\hat{p}_g$$

where:

$N$  = the total number of sockeye salmon smolts enumerated during the migration.

The variance of  $\hat{N}_g$  was estimated as:

$$V[\hat{N}_g] = N^2 V[\hat{p}_g]$$

where

$$V[\hat{p}_g] = \frac{\hat{p}_g(1 - \hat{p}_g)}{n - 1}$$

Mean length at age was estimated using standard sample summary statistics.

### Adult Escapement

#### *Counts*

Total sockeye and coho salmon escapement counts were added to the historic database. Cumulative and daily timing plots will be made for each species to allow comparison to previous years.

Sockeye and coho salmon counted below the weir after it was removed (9/1/2009 survey) were added to the respective weir counts for these species. The vast majority of pink

salmon spawn below the weir and only the 8/21/2009 survey count was included in the count for this species..

#### *Age, Sex and Length*

The proportion, total number and its variance, of adult sockeye salmon of age or sex category  $g$  migrating upstream through the weir will be estimated identically to that for smolts above. Mean length at age will be estimated using standard sample summary statistics.

## **RESULTS**

### **Smolt Emigration**

From 18 May to 1 July 2009 a total of 8,614 sockeye and 52 coho salmon smolts were counted emigrating from Lower Sixmile Lake (Table 1).

#### *Age, Weight, and Length Estimates*

Sockeye salmon smolt age, weight (g), and length (mm) composition was estimated based on 272 readable scales from 273 fish sampled during the smolt emigration (Table 2). The dominant freshwater age class for sockeye salmon smolts was age-1 smolt (95%) followed by age-2 (5%). The mean weight and length of sockeye smolts age-1 smolt were 7.3 g (range 2.2-15.3 g) and 88 mm (range 62-113 mm) while age-2 smolt were 11.8 g (range 10.1-15.1 g) and 102 mm (range 90-110) respectfully (Table 2).

#### *Run Timing*

Peak smolt emigration occurred from 5 June through 9 June when 4,256 fish or 50% of the total was counted emigrating from the lake (Table 3). Two major peaks in daily emigration occurred with the first on 5 June ( $n = 1,071$ ) followed by a slightly larger peak on 8 June ( $n = 1,103$ ) (Figures 3).

Table1.- Daily and cumulative smolt emigration counts by salmon species, Sixmile Creek Drainage, 2009

DATE	Sockeye		Coho		Rainbow		Water Temp°C
	Daily	Cum	Daily	Cum	Daily	Cum	
5/18							
5/19	26	26	0	0	2	2	11.5
5/20	114	140	0	0	8	10	12.0
5/21	86	226	0	0	3	13	12.0
5/22	192	418	7	7	17	30	12.0
5/23	402	820	3	10	28	58	12.0
5/24	87	907	1	11	3	61	12.0
5/25	375	1,282	11	22	1	62	13.0
5/26	83	1,365	3	25	0	62	13.0
5/27	209	1,574	1	26	0	62	13.0
5/28	38	1,612	0	26	0	62	12.0
5/29	28	1,640	0	26	1	63	12.0
5/30	23	1,663	1	27	1	64	14.0
5/31	8	1,671	0	27	1	65	15.0
6/1	64	1,735	2	29	0	65	16.0
6/2	117	1,852	0	29	1	66	15.5
6/3	123	1,975	0	29	0	66	16.0
6/4	238	2,213	0	29	1	67	16.0
6/5	1,071	3,284	4	33	0	67	16.0
6/6	483	3,767	0	33	3	70	16.0
6/7	963	4,730	1	34	0	70	16.5
6/8	1,103	5,833	3	37	0	70	16.0
6/9	636	6,469	2	39	1	71	18.0
6/10	357	6,826	0	39	0	71	19.0
6/11	44	6,870	0	39	0	71	19.0
6/12	123	6,993	0	39	0	71	19.0
6/13	488	7,481	0	39	1	72	18.0
6/14	303	7,784	3	42	0	72	18.0
6/15	237	8,021	0	42	0	72	18.0
6/16	10	8,031	0	42	0	72	19.0
6/17	42	8,073	0	42	0	72	18.0
6/18	318	8,391	4	46	0	72	18.0
6/19	47	8,438	1	47	0	72	18.0
6/20	38	8,476	2	49	0	72	18.0
6/21	35	8,511	0	49	0	72	18.0
6/22		8,511		49		72	
6/23	29	8,540	0	49	0	72	17.0
6/24	12	8,552	0	49	0	72	17.0
6/25	0	8,552	1	50	0	72	17.0
6/26	18	8,570	0	50	0	72	17.0
6/27		8,570		50		72	

Table1.- (continuation)

DATE	Sockeye		Coho		Rainbow		Water Temp°C
	Daily	Cum	Daily	Cum	Daily	Cum	
6/28	3	8,573	0	50	0	72	18.0
6/29	1	8,574	0	50	0	72	18.0
6/30		8,574		50		72	
7/1	40	8,614	2	52	1	73	19.0
<b>Total</b>		8,614		52		73	15.9

Table 2.- Age, weight (g), and length (mm) composition of the sockeye salmon smolt emigration, Sixmile Creek Drainage, 2009

Sockeye Smolts	Freshwater Age Group		
	1	2	Total
Sample size	258	14	272
Percent	0.95	0.05	
SE	0.01	0.01	
Number of Fish	8,171	443	8,614
SE	115.6	115.6	
Weight (g)	7.3	11.8	7.6
SE	0.11	0.41	
Min Weight	2.2	10.1	2.2
Max Weight	15.3	15.1	15.3
Mean Length (mm)	88	102	88
SE	0.44	1.33	
Min Length	62	90	62.0
Max Length	113	110	113

Table 3.- Historical daily sockeye salmon smolt emigration counts, Sixmile Creek Drainage, 2003-2006 and 2009

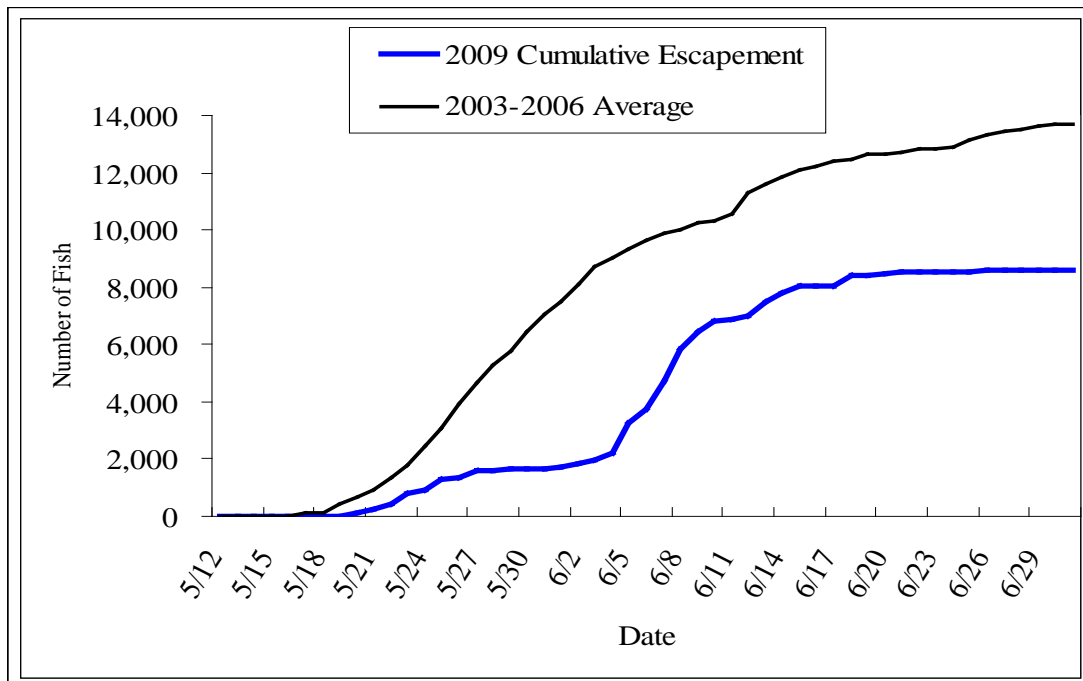
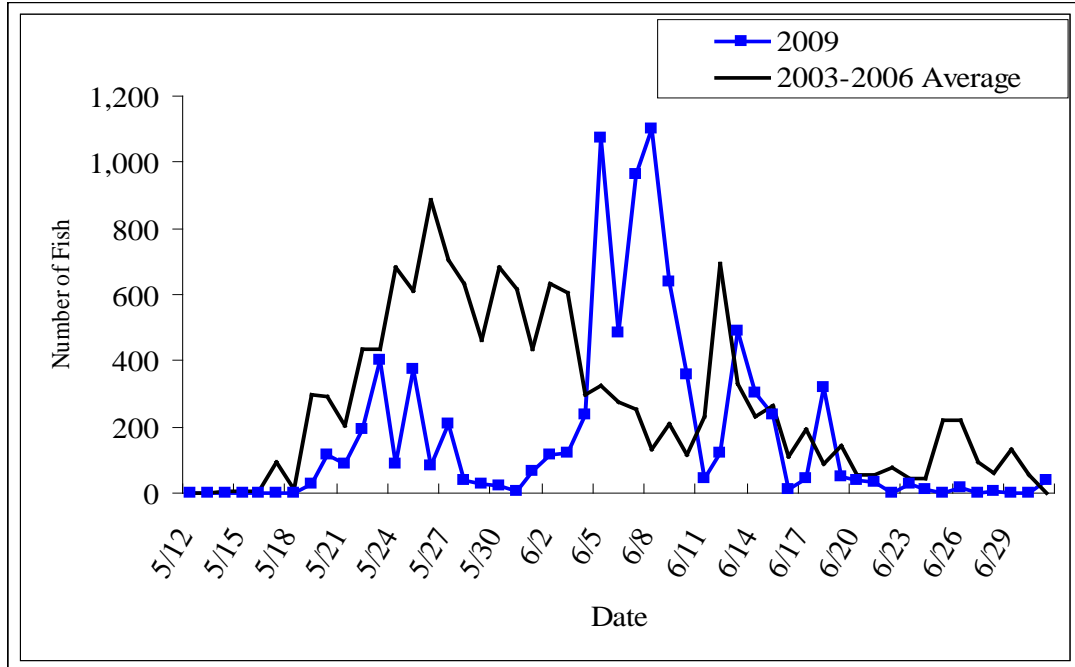
Date	2003	2004	2005	2006	2009	Ave 03-06
5/12				0		0
5/13				0		0
5/14				4		4
5/15		4		1		3
5/16	21	2		2		8
5/17	1	126		1		43



Table 3. (Continuation)

<b>Date</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2009</b>	<b>Ave 03-06</b>
5/17	1	126		1		43
5/18	21	7		0		9
5/19	8	402		13	26	141
5/20	165	407	92	44	114	177
5/21	220	185	121	118	86	161
5/25	864	319	312	986	375	620
5/26	460	616	309	1,919	83	826
5/27	731	266	229	1,897	209	781
5/28	445	714	365	229	38	438
5/29	673	63	125	1,424	28	571
5/30	275	693	20	1,316	23	576
5/31	1,047	172	595	781	8	649
6/1	506	74	447	836	64	466
6/2	688	41	961	882	117	643
6/3	521	394	660	418	123	498
6/4	128	92	600	90	238	228
6/5	384	13	608	254	1,071	315
6/6	243	140	265	350	483	250
6/7	1,104	37	96	107	963	336
6/8	111	25	234	114	1,103	121
6/9	478	47	274	65	636	216
6/10	173	22	129	174	357	125
6/11	1,076	0	143	29	44	312
6/12	3,660	58	144	62	123	981
6/13	1,536	7	134	148	488	456
6/14	779	26	132	223	303	290
6/15	573	18	344	230	237	291
6/16	96	11	190	113	10	103
6/17	134	2	161	596	42	223
6/18	20	12	118	188	318	85
6/19	14	17	366	30	47	107
6/20	6	16	88	72	38	46
6/21	3	5	122	53	35	46
6/22	9	1	213	14	0	59
6/23	2	35	62	12	29	28
6/24			27	73	12	50
6/25			308	16	0	162
6/26			218	188	18	203
6/27			88	80	0	84
6/28			20	129	3	75
6/29			27	297	1	162
6/30			28	100	0	64
7/1					40	40
<b>Total</b>	<b>20,113</b>	<b>6,004</b>	<b>9,575</b>	<b>17,221</b>	<b>8,614</b>	<b>13,683</b>

Figure 3.- Average daily (top) and cumulative (bottom) emigration timing for sockeye salmon smolts, Sixmile Creek Drainage, 2009 compared to the 2003-2006 average (13,683).



## Adult Escapement

From 13 July through 1 Sept a total of 3,342 sockeye, 197 coho, and 2,703 pink salmon were counted escaping into the Sixmile Creek Drainage (Table 4).

A total of 3,334 sockeye, 178 coho, and 3 pink salmon were counted passing through the weir into Lower Sixmile Lake. Two stream surveys were conducted to count fish spawning below the weir, primarily pink salmon. The first stream survey was conducted under good conditions on 21 August and 2,700 pink, 14 sockeye, and 42 coho salmon were counted. The final stream survey was conducted on 1 September under good conditions and 375 pink, 8 sockeye, and 19 coho salmon were counted below the weir. Counts of sockeye and coho salmon from the final stream survey were added to the final escapement numbers. Counts of pink salmon passing through the weir and from the peak stream survey were combined for the total escapement of pink salmon. It is understood that the pink salmon estimate is biased low due to a) salmon missed during the survey and b) salmon that spawned and disappeared between surveys.

## Age, Sex, and Size Estimates

A total of 355 sockeye salmon were sampled for age, sex, and length information producing 277 readable scales (Table 5). The dominant age class for sockeye was age-1.2 (82%), followed by age-1.1 (13%), age-1.3 (4%), and age-2.2 (1%) (Table 5). The sex ratio of adult sockeye salmon was 39% male and 61% female (Table 6). The mean length of male sockeye salmon was 419 mm (range 300-625 mm) while females averaged 484 mm (range 360-570 mm) (Table 7).

## Run Timing

Peak sockeye salmon escapement was from 24 July through 29 July when an estimated 2,269 fish or 68% of the total escapement passed through the weir (Table 8). Daily sockeye escapement peaked on 25 July when 582 fish were counted through the weir followed by a slightly smaller escapement of 537 fish on 27 July (Fig 4). Sockeye salmon escapement in 2009 was two days earlier than the average mid-point (50%) of the return since 2000.

Table 4.- Daily and cumulative adult escapement counts by salmon species, Sixmile Creek Drainage, 2009

Date	Sockeye		Coho		Pink		Temp ( C )
	Daily	Cum	Daily	Cum	Daily	Cum	Daily
7/12							
7/13	0	0	0	0	0	0	
7/14	0	0	0	0	0	0	
7/15	0	0	0	0	0	0	
7/16	0	0	0	0	0	0	21.5
7/17	0	0	0	0	0	0	22.5
7/18	0	0	0	0	0	0	21.0
7/19	0	0	0	0	0	0	21.0

Table 4. (Continuation)

Date	Sockeye		Coho		Pink		Temp ( C )
	Daily	Cum	Daily	Cum	Daily	Cum	Daily
7/20	0	0	0	0	0	0	20.0
7/21	0	0	0	0	0	0	19.5
7/22	0	0	0	0	0	0	19.0
7/23	0	0	0	0	0	0	18.0
7/24	358	358	0	0	0	0	17.0
7/25	582	940	0	0	0	0	17.0
7/26	268	1,208	0	0	0	0	17.0
7/27	537	1,745	3	3	0	0	17.0
7/28	264	2,009	0	3	0	0	17.0
7/29	260	2,269	0	3	0	0	17.0
7/30	86	2,355	0	3	0	0	17.0
7/31	181	2,536	0	3	0	0	17.0
8/1	70	2,606	0	3	0	0	17.0
8/2	100	2,706	4	7	2	2	16.0
8/3	12	2,718	0	7	1	3	17.0
8/4	14	2,732	0	7	0	3	17.0
8/5	44	2,776	1	8	0	3	17.0
8/6	76	2,852	1	9	0	3	17.0
8/7	21	2,873	2	11	0	3	17.0
8/8	37	2,910	6	17	0	3	17.0
8/9	74	2,984	21	38	0	3	17.0
8/10	32	3,016	5	43	0	3	17.0
8/11	64	3,080	7	50	0	3	17.0
8/12	31	3,111	6	56	0	3	17.0
8/13	13	3,124	3	59	0	3	17.0
8/14	13	3,137	0	59	0	3	17.0
8/15	37	3,174	2	61	0	3	17.0
8/16	61	3,235	3	64	0	3	16.0
8/17	17	3,252	7	71	0	3	16.0
8/18	16	3,268	20	91	0	3	16.0
8/19	14	3,282	21	112	0	3	16.0
8/20	15	3,297	20	132	0	3	16.0
8/21	8	3,305	18	150	0	3	16.0
8/22	9	3,314	4	154	0	3	16.0
8/23	4	3,318	3	157	0	3	16.0
8/24	5	3,323	2	159	0	3	16.0
8/25	5	3,328	11	170	0	3	16.0
8/26	1	3,329	0	170	0	3	15.0
8/27	1	3,330	0	170	0	3	15.0
8/28	0	3,330	5	175	0	3	15.0
8/29	4	3,334	2	177	0	3	15.0
8/30	0	3,334	0	177	0	3	15.0
8/31	0	3,334	1	178	0	3	15.0

Table 4. (Continuation)

	<b>Sockeye</b>		<b>Coho</b>		<b>Pink</b>	
<b>Date</b>						
9/1	0	3,334	0	178	0	3
<b>Total</b>		<b>3,334</b>		<b>178</b>		<b>3</b>
						17.1
<b>Stream Surveys</b>						
8/21		14		42		2,700
9/1		8		19		375
<b>Total Esc.</b>		<b>3,342</b>		<b>197</b>		<b>2,703</b>

Table 5.- Age composition of sockeye salmon escapement, Sixmile Drainage, 2009.

	<b>Age Group</b>				
	<b>1.1</b>	<b>1.2</b>	<b>1.3</b>	<b>2.2</b>	<b>Total</b>
Sample Size	37	226	11	3	277
Proportion	0.13	0.82	0.04	0.01	
SE	0.02	0.02	0.01	0.01	
Number of Fish	445	2,720	132	36	3,334
SE	68	78	39	21	

Table 6.- Sex composition of sockeye salmon escapement, Sixmile Creek Drainage, 2009.

<b>Sex</b>	<b>M</b>	<b>F</b>	<b>Total</b>
Sample Size	140	215	355
Proportion	0.39	0.61	
SE	0.03	0.03	
Number of Fish	1,315	2,019	3,334
SE	87	87	

Table 7.- Length composition at age of sockeye salmon escapement, Sixmile Creek Drainage, 2009

<b>Length at Age</b>					
<b>Male</b>	<b>1.1</b>	<b>1.2</b>	<b>1.3</b>	<b>2.2</b>	<b>Total</b>
Sample Size	36	66			102
Proportion	0.13	0.24			0.37
SE	0.02	0.03			
Number of Fish	433	794			1,228
SE	67	85			
Ave Length (mm)	363	450			419
Min Length (mm)	300	380			300
Max Length (mm)	510	625			625
<b>Female</b>					
Sample Size	1	160	11	3	175
Proportion	0.00	0.58	0.04	0.01	0.63
SE	0.00	0.03	0.01	0.01	
Number of Fish	12	1,926	132	36	2,106
SE	12	99	39	21	
Ave Length (mm)	360	482	515	510	484
Min Length (mm)	360	400	450	450	360
Max Length (mm)	360	570	560	550	570

Table 8.- Historical sockeye salmon escapement counts by date, Sixmile Creek, 1988 to 2009

Date	Year																				
	1988	1989	1990	1991	1992	1993	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
07/01																				0	
07/02																				0	
07/03																				0	
07/04																					
07/05																					
07/06																					
07/07																					
07/08													4							1	
07/09																				0	
07/10													1							0	
07/11																				0	
07/12																				0	
07/13																				0	
07/14																1				0	0
07/15																				0	0
07/16										2										0	0
07/17										3										0	0
07/18										1				0						0	0
07/19														0						1	0
07/20					28					3			149	0						0	0
07/21					26					17			133	0		5				1	0
07/22		11				114				17			285	0		107			1	0	0

Table 8.- (Continuation)

Date	Year																				
	1988	1989	1990	1991	1992	1993	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
07/23	20		2		15	286				43		518	300 1,18	0		100			1	0	0
07/24	0	14	42		1	12			94	487		178	8	0		18			1	8	358
07/25	105	13	25	12	1	337			183	184		78	405	328	158	0	276		4	516	582
07/26	112		14		11	211		40		56		21	26	173	251	2	124			344	268
07/27	110	50		48	178	207	111	87		48		3	130	476	364	2	22		219	100	537
07/28	100	180		17	18	204	180	71	176	4			286	300	394	13	2		14	32	264
07/29	125	180		88		492	80	128	87	154		200	297	363	279	24	2		1	9	260
07/30	112	112	15	84		20	230		70	20		180	91	162	132	321	31	205	3	67	86
07/31				37		107	175		73	20		133	305	59	176	301	160	359	80	112	181
08/01	60		83	37		101	230	120	198	21		44	151	91	95	43	92	50	171	46	70
08/02	154	151	134	23		53	301		16	0		38	59	40	44	26	72	2	34	31	100
08/03	234	86	234		45		453			138		24	45	86	88	41	40	3	13	17	12
08/04	215	124	235	198	32	33	243	45	84	48		5	70	76	86	59	35	3	7	21	14
08/05	134		124	22			227	0	104	0		33	26	65	128	30	50	154	36	20	44
08/06	117	86	117	47	25	17	320			115	386		11	49	70	9	21	84	125	2	76
08/07	74	43	74	223	15	44	730	101	105	56	206	48	16	67	83	17	51	39	37	9	21
08/08	54		54	58	51		42			0	1	17			34	62	14	41	1	14	37
08/09	51		91	43		34	564	340		56	7	3	13	62	58	39	28	18	5	15	74
08/10	53	35	53	187	23		45	204		40		30		28	18	147	37	12	9	5	32
08/11	0			52	40	230	13		171	29			9	30	11	38	14	33	22	22	64
08/12	0			33	190	40	48	10		25	4	4	2		82	22	16	15	48	9	31
08/13	25		28	78		40	39		282	24	14	3		42	22	31	16	70	6	21	13



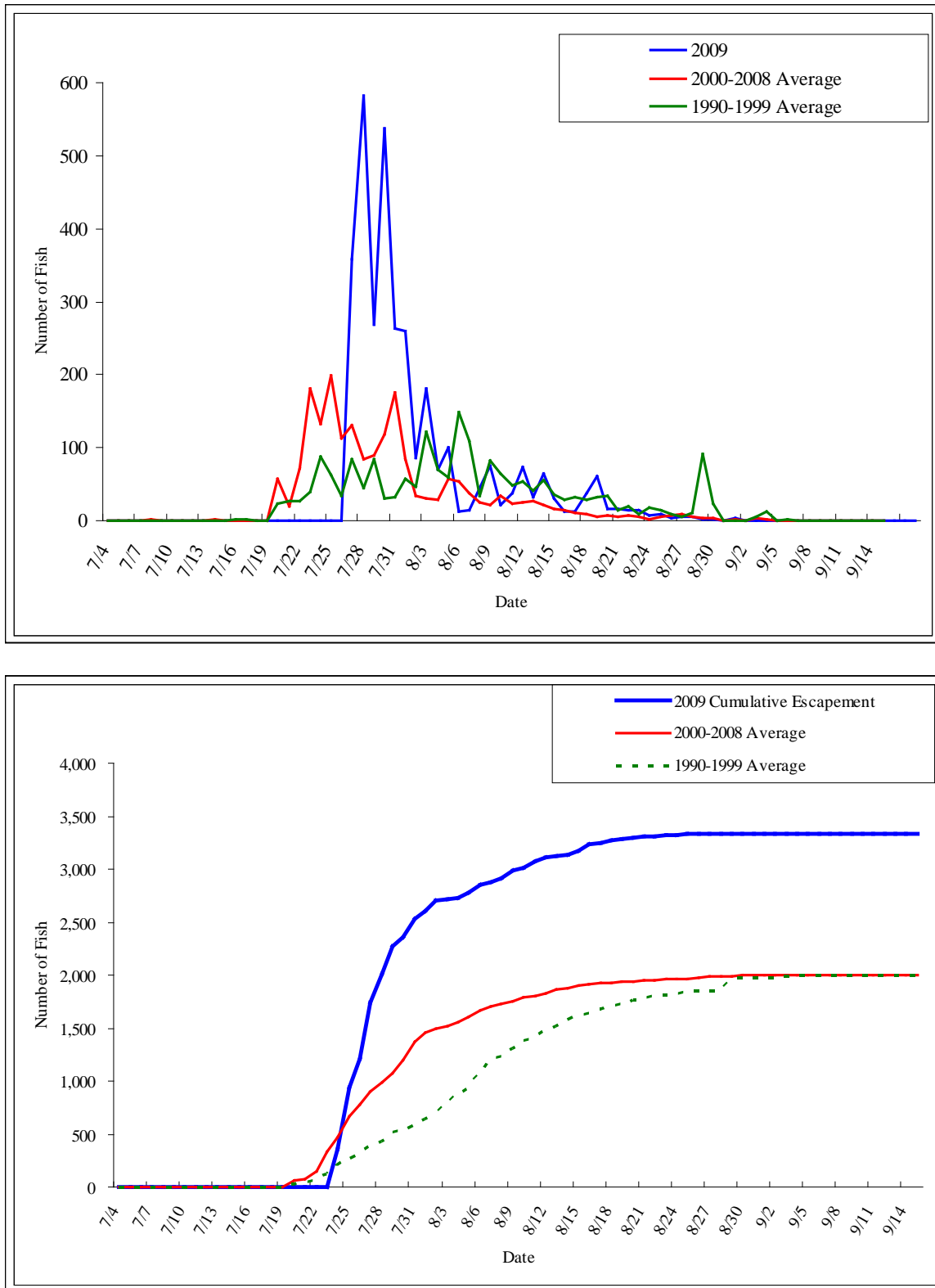
Table 8.- (Continuation)

Date	Year																				
	1988	1989	1990	1991	1992	1993	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
08/14	0	30	1	142	15		28	328		17	3	1			40	12	65	7	10	18	13
08/15	25		25	76					187	13	3			36	41	21	18	5	11	3	37
08/16	0			71		223	45			9	3		23		44	9	18	16	5	3	61
08/17	0		15	85	21	218	36			12		3			32	14	7	8	4	0	17
08/18	0		12			126	31		149	0	3	5	4	11	15	6	41	11	10	9	16
08/19	0			10		166				0			5		9	1	17	16		2	14
08/20	0		34		20	12			135	0				19	3	7	9	9	4	1	15
08/21	0		20	51	8		20			0	1					7	7	6	2	1	8
08/22	0		18					25	72	0	2	1		15	2	0	9	10	8	2	9
08/23	227			31	5		11			0	4	1				1	12	3	8	0	4
08/24	0			21		63								1		7	3	1	1	0	5
08/25	0					25			36						10	0	10	3		0	5
08/26	0			0		16					7					13	6	1		0	1
08/27	0					11			18		2				9	28	5	1		1	1
08/28	0							15			6			1		15	0	4	2	0	0
08/29	0			200				79								3	4	0		0	4
08/30	0						80									4	2	3		0	0
08/31	0															0	5	0		0	0
09/01																1		0		0	
09/02																0		0		0	
09/03											3					3		0		0	
09/04											7					1		0		0	
09/05																	0		0		0

Table 8.- (Continuation)

	Year																				
Date	1988	1989	1990	1991	1992	1993	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
09/06											1					0		0		0	
09/07																0		0		0	
09/08																0		0		0	
09/09																					
Total	2,107	1,115	1,450	1,974	768	3,442	4,282	1,593	2,240	1,662	663	1,571	4,034	2,580	2,778	1,611	1,341	1,192	903	1,463	3,334

Figure 4.- Average daily (top) and cumulative (bottom) escapement timing for adult sockeye salmon, Sixmile Creek Drainage, 2009.



## DISCUSSION

The purpose of this study was to count the number of salmon smolts emigrating, and number of adult salmon escaping into the Sixmile Creek Drainage in anticipation of future requirements to monitor essential components of the critical habitat for the endangered Cook Inlet beluga whale. The successful monitoring efforts of 2009 season were procedurally similar to efforts during past seasons.

Sockeye and coho salmon smolts were counted from 19 May through 1 July 2009 meeting Objective 1. Peak sockeye salmon smolt run timing in 2009 was approximately a week later, 7 June, than the mid-point (50%) and below the 2003-2006 average emigration of 13,683. Sampling efforts to estimate age composition were sufficient to meet Objective 2 for emigrating sockeye salmon smolts. A sample goal size of 160 fish was set for sockeye smolts, with 273 fish being sampled producing 272 readable scales. Mean length at age data was collected to satisfy Task 1. The average weight and length of freshwater age-1 and age-2 smolts were larger than those sampled by Gotthardt in 2006.

Adult sockeye, coho, and pink salmon were counted escaping into the Sixmile Creek Drainage meeting Objective 3. The project concluded on 1 September, instead of the scheduled date of 15 September due to more than three consecutive days of less than 1% of the cumulative fish passage. The escapement of 3,334 adult sockeye salmon in 2009 was greater than the historical average of 1,938 and the fourth largest escapement of record. Peak run timing was five days earlier than the historic run timing, 1988-2008. Counts of coho (197) and pink salmon (3,073) were also recorded in 2009.

Sampling efforts were sufficient to estimate the major age classes of adult sockeye salmon, Objective 4. A sample size goal of 160 fish was set for adult sockeye salmon and 360 scales were taken producing 277 readable scales. Mean length at age data, task two, was also collected from sampled adult sockeye passing the weir and ranged from 300 mm to 625 mm.

A sex census of coho salmon was not conducted in 2009 and Objective 5 was not met. The crew leader recalled that there were more female than male coho passing through the weir.

Two stream surveys (21 August and 1 September) were conducted to meet Objective 6. The first was during the peak of the pink salmon return to count pink salmon (2,700) spawning below the weir and the second after the weir was pulled to count any adult salmon that were below the weir. The 1 September stream survey was not used in calculating the total escapement of pink salmon because those observations were assumed to be fish also observed 11 days earlier. The pink salmon return (2,703) in 2009 was the largest since counts were recorded in 2001.

Water temperature averaged 15.9 degrees Celsius during the smolt emigration and 17.1 degrees Celsius during the adult escapement and water clarity were good to excellent

during the duration of the project, Task 3. The historical peak daily smolt emigration typically occurs when the water temperature is between 16-17 degrees Celsius and the 2009 emigration was no exception. Likewise the adult escapement began when lake outlet temperatures dropped to 17 degrees Celsius.

Angler effort at the mouth of Sixmile Creek during the adult escapement was monitored; however the data were not recorded daily during the season, Task 4. From personal observations the angler impact on the Sixmile Creek sockeye escapement is minimal. Effort, catch and harvest estimates for Sixmile Creek from the Statewide Harvest Survey can be found in Appendix 2.

## **RECOMMENDATIONS**

1. This project should continue in future years even if Sixmile salmon are not officially identified as a critical component of the Cook Inlet beluga whale critical habitat. Sixmile Drainage has a long term adult escapement data set that should continue to be collected and monitored. More importantly the Sixmile salmon population is small, supports a small sport fishery and is potentially susceptible to the Northern Cook Inlet commercial fishery. This population of sockeye is most likely spawning- and rearing-habitat-limited and is not likely to support a much larger population. Of more concern would be the impacts of the sport fish harvest on the return of coho salmon which has averaged 56 fish from 2001-2008 with a record return of 197 in 2009.
2. Continue to enumerate smolt emigration. The shallow morphology of Sixmile Lake may make it susceptible to subtle warming above healthy levels for salmonids, a potential result of global climate change.
3. The current fish ladder should be replaced because it is perched and is a velocity barrier to juvenile salmonids trying to move into the lake to rear. We observed smolts released above the ladder become easy prey for rainbow trout congregating below the ladder. Their vulnerability was likely increased by the effects of the perched fish ladder.
4. Concern for sport fish harvest at the mouth of Sixmile Creek should precipitate a well designed creel survey and improved enforcement coverage. The fishery is predominantly on State lands below mean-high-tide preventing EAFB conservation staff from intervening in illegal activities.
5. A rainbow trout study on the impacts of smolt weirs on the modification of feeding behavior of rainbow trout would be ideal as this population is quite healthy and is a catch and release only fishery now. During the smolt emigration large numbers of rainbow trout congregate in the stream below the fish passage to spawn and feed on outmigrating smolts.

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The content and information contained in this report does not necessarily reflect the position or the policy of the U.S. Government, and no official endorsements should be inferred.

## **APPENDICIES**



# Appendix 1: Example of an uncompleted Standard Age, Weight, and Length form.

ALASKA DEPARTMENT OF FISH & GAME

STANDARD AGE WEIGHT LENGTH FORM VERSION 1.2

DESCRIPTION: \_\_\_\_\_

DATE:	YEAR	<div></div>
MONTH/DAY		<div></div>

SPECIES	<div></div>
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TYPE OF MEASUREMENT:	GEAR	<div></div>
LENGTH	CODE:	<div></div>
WEIGHT	MESH	<div></div>
FISHERY	INCHES	<div></div>
	EIGHTH'S	<div></div>
	SIZE	<div></div>

LOCATION OF SAMPLE:	<div></div>
SUBLOCATION OF SAMPLE:	<div></div>
PROJECT	<div></div>
NUMBER	<div></div>
PAGE NUMBER	<div></div>

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#	SEX	MATURITY INDEX	LENGTH OF FISH			WEIGHT OF FISH						
			100's	10's	1's	1000's	100's	10's	1's			
1			<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>
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29			<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>
30			<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>

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**Appendix 2: Effort (angler-days), catch and harvest information by species, Sixmile Creek, 2000-2008 (Source: Alaska Department of Fish and Game Sport Fish Division's annual *Alaska Sport Fishing Survey*)**

<b>Year</b>	<b>Effort</b>	<b>Coho</b>		<b>Sockeye</b>		<b>Chum</b>		<b>Pink</b>	
	<b>days</b>	<b>Catch</b>	<b>Harvest</b>	<b>Catch</b>	<b>Harvest</b>	<b>Catch</b>	<b>Harvest</b>	<b>Catch</b>	<b>Harvest</b>
2000	638	52	10	53	32	73	24	666	318
2001	535	166	58	213	58	168	0	321	64
2002	17	0	0	0	0	0	0	0	0
2003	1,135	548	238	641	428	544	0	900	121
2004	100	135	34	283	65	14	0	616	81
2005	258	0	0	34	34	0	0	35	12
2006	197	11	11	0	0	0	0	86	0
2007	1,361	591	591	16	16	112	7	1,181	637
2008	602	0	0	82	68	15	15	129	129
5- Yr Avg	504	147	127	83	37	28	4	409	172