Larson Lake
Sockeye Salmon Smolt
Data Report
2010–2012

Prepared by:
CIAA Staff
2013

The Larson Lake Project was made possible through an Alaska Sustainable Salmon Fund grant received from the Alaska Department of Fish and Game and the National Oceanic and Atmospheric Administration, and a State of Alaska Designated Legislative Grant.

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DISCLAIMER

The Cook Inlet Aquaculture Association (CIAA) conducts salmon enhancement and restoration projects in Area H, Cook, Inlet and associated waters. As an integral part of these projects a variety of monitoring and evaluation studies are conducted. The following data report is a synopsis of the monitoring and evaluation studies conducted for Larson Lake. This Larson Lake Data Report encompasses data collected from the 2010–2012 sockeye salmon smolt migrations.

The purpose of the data report is to provide a vehicle to distribute the information produced by the monitoring and evaluation studies. Data collected each year are presented with a summary of the information previously collected for comparative purposes. These reports are intended to provide a general description of project activity and are not an exhaustive evaluation of any restoration or enhancement project. The information presented in this report has not undergone an extensive review. As reviews are completed, the information may be updated and presented in other reports.

The Larson Lake Data Report was prepared by CIAA under award of the Alaska Sustainable Salmon Fund (45918) from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, administered by the Alaska Department of Fish and Game (ADF&G). The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the National Oceanic and Atmospheric Administration, the U.S. Department of Commerce, or ADF&G.

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Our equal employment opportunity philosophy applies to all aspects of employment with CIAA including recruiting, hiring, training, transfer, promotion, job benefits, pay, dismissal, and educational assistance.

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ACKNOWLEDGEMENTS

Many individuals and agencies contributed to the success of the Larson Lake Project. Appreciation is extended to Cook Inlet Aquaculture Association interns, seasonal assistants, and full-time staff who invested many hours in planning and executing this project over the years. Special thanks are also extended to the Alaska Department of Fish and Game for the support they provided during this project.

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TABLE OF CONTENTS

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LIST OF FIGURES

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LIST OF TABLES

This page was intentionally left blank

LIST OF APPENDICES

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ABSTRACT

As part of the continued evaluation of lakes in the Susitna River watershed to determine the sockeye salmon (*Onchorhynchus nerka*) abundance in key salmon producing lakes with and without northern pike (*Esox lucius*), Cook Inlet Aquaculture Association and the Alaska Department of Fish and Game agreed to monitor sockeye salmon smolt migrations from Larson Lake. Larson Lake was not known to have a population of invasive northern pike.

Limnological conditions are a key component in understanding Larson Lake productivity and rearing conditions. Water chemistry samples were collected 4 times each in 2010 and 2011. No water chemistry data were collected in 2012. Zooplankton samples were collected 5 times each in 2010 and 2011, and 4 times in 2012.

During the 2010 smolt migration, staff monitored environmental conditions at 5:00 PM from 21 May through 30 June. Water levels fluctuated 0.2 ft during that time period. Water temperatures averaged 16ºC (±2.1) [mean ± standard deviation] and ranged from 12 to 20ºC. Air temperatures averaged 16ºC (±3.9) and ranged from 10 to 27ºC. Twelve percent of the days were clear, 29% were partly cloudy, 24% were completely overcast, and 34% had measured rainfall.

The smolt migration was enumerated from 21 May through 30 June. During that time, an estimated 290,025 sockeye salmon smolt migrated from Larson Lake. Other fish captured during that time were 2,417 coho salmon smolt (*O. kisutch),* 1 Chinook salmon smolt (*O. tshawytscha*), 18 rainbow trout (*O. mykiss*), and 12 Arctic char (*Salvelinus alpinus*).

Throughout the migration, staff collected 1,520 sockeye salmon smolt, and took scale samples, weight, and measurements for fork length. Seventy-four samples were unreadable for age, so a total of 1,446 samples were used for analysis. Based on the samples read, there were 4 age classes. Within the sample, age-1 was the most abundant age class (95.0%), followed by age-2 (3.7%), age-3 (1.1%), and age-4 (0.1%). The average length of the sampled age-1 sockeye salmon smolt was 97.8 mm (±0.4) and the average weight was 9.4 g (±0.1). The average length of the age-2 sockeye salmon smolt was 113.5 mm (±2.4) and the average weight was 14.2 g (±1.1). The average length of the age-3 sockeye salmon smolt was 159.2 mm (±10.1) and the average weight was 52.9 g (±11.9). The length of the age-4 sockeye salmon smolt was 250.0 mm and the weight was 126.5 g.

During the same time period, staff also collected 451 coho salmon smolt, took scale samples, weight and measurements for fork length. Even though the project was focused on sockeye salmon, coho salmon were also sampled when present. Nineteen samples were unreadable for age, so a total of 432 samples were used for analysis. Based on the samples read, there were 5 age classes. Within the sample, age-2 was the most abundant age class (41.9%), followed by age-1 (35.4%), age-3 (19.2%), age-0 (3.2%), and age-4 (0.7%). The average length of the

sampled age-2 coho salmon smolt was 125.0 mm (±1.0) and the average weight was 18.9 g (±0.5). The average length of the age-1 coho smolt was 106.0 mm (±2.1) and the average weight was 12.1 g (±0.6). The average length of the age-3 coho smolt was 146.0 mm (±2.7) and the average weight was 29.1 g (±1.7). The average length of the age-0 coho salmon smolt was 72.0 (±4.0) and the average weight was 4.6 g (±0.7). The length of the age-4 coho salmon smolt was 181.0 and the weight was 27.5 g.

During the 2011 smolt migration, staff monitored environmental conditions at 5:00 PM from 14 May through 15 July. Water temperatures averaged 13ºC (±4.8) and ranged from 4 to 20ºC. Air temperatures averaged 15 ºC (±3.1) and ranged from 9 to 22ºC. None of the days were clear, 76% were partly cloudy, 19% were completely overcast, and 5% had measured rainfall. A total of 57 mm of rain fell during that period.

The smolt migration was enumerated from 14 May through 15 July. During that time, 207,276 sockeye salmon smolt were captured while migrating from Larson Lake. Other fish captured during that time were 1,386 coho salmon smolt and 21 rainbow trout.

Throughout the migration, staff collected 1,710 sockeye salmon smolt, took scale samples, weight, and measurements for fork length. Five samples were unreadable for age, so a total of 1,705 samples were used for analysis. Based on the samples read, there were 2 age classes. Within the sample, age-1 was the most abundant age class (78.6%), followed by age-2 (21.4%). The average length of the sampled age-1 sockeye salmon smolt was 107.6 mm (±1.6) and the average weight was 9.1 g (±0.2). The average length of the age-2 sockeye salmon smolt was 109.8 mm (±1.1) and the average weight was 10.8 g (±0.4).

During the same time period, staff also collected 523 coho salmon smolt, took scale samples, weight and measurements for fork length. Twelve samples were unreadable for age, so a total of 511 samples were used for analysis. Based on the samples read, there were 3 age classes. Within the sample, age-2 was the most abundant age class (81.2%), followed by age-3 (13.1%) and age-1 (5.7%). The average length of the sampled age-2 coho salmon smolt was 135.0 mm (±1.2) and the average weight was 18.9 g (±0.5). The average length of the age-3 coho salmon smolt was 152.0 mm (±3.2) the average weight was 28.6 g (±3.6). The average length of the age-1 coho salmon smolt was 87.0 mm (±5.5) and the average weight was 7.1 g (±2.7).

During the 2012 smolt migration, staff monitored environmental conditions at 5:00 PM from 15 May through 4 July. Water levels fluctuated 0.7 ft during that time period. Water temperatures averaged 13ºC (±5.3) and ranged from 5 to 24ºC. Air temperatures averaged 15ºC (±3.9) and ranged from 7 to 26ºC. Four percent of the days were clear, 51% were partly cloudy, 31% were overcast, and 14% had measured rainfall. A total of 109 mm of rain fell during that period.

The smolt migration was enumerated from 16 May through 30 June. During that time, 113,158 sockeye salmon smolt were captured while migrating from Larson Lake. Other fish captured during that time were 1,278 coho salmon smolt, 57 rainbow trout, and 4 Arctic char.

Throughout the migration, staff collected 1,520 sockeye salmon smolt, took scale samples, weight, and measurements for fork length. A total of 869 representative samples (approximately 290 each from the beginning, middle, and end of the migration) were used for analysis. Based on the samples read, there were 3 age classes. Within the sample, age-1 was the most abundant age class (92.5%), followed by age-2 (6.8%) and age-3 (0.7%). The average length of the sampled age-1 sockeye salmon smolt was 91.1 mm (±0.5) and the average weight was 7.9 g (±1.6). The average length of the age-2 sockeye salmon smolt was 101.8 mm (±1.7) and the average weight was 9.8 g (±0.6). The average length of the age-3 sockeye salmon smolt was 157.2 mm (±20.7) and the average weight was 38.8 g (±13.3).

During the same time period, staff collected 295 coho salmon smolt, took scale samples, weight, and measurements for fork length. Two were readable samples and were used for analysis, so a total of 293 scale samples were used for analysis. Based on the samples read, there were 3 age classes. Within the sample, age-2 was the most abundant age class (58.0%), followed by age-1 (22.5%), and age-3 (19.5%). The average length of the sampled age-2 coho salmon smolt was 126.5 mm (±1.8) and the average weight was 20.8 g (±0.7). The average length of the age-1 coho salmon smolt was 84.1 mm (±3.1) and the average weight was 6.4 g (±0.8). The average length of the age-3 coho salmon smolt was 161.1 mm (±7.3) and the average weight was 41.9 g (±4.3).

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INTRODUCTION AND PURPOSE

To better understand the recent low adult sockeye salmon (*Onchorhynchus nerka*) returns to Upper Cook Inlet, Cook Inlet Aquaculture Association (CIAA), in cooperation with the Alaska Department of Fish and Game (ADF&G), is assessing sockeye salmon populations at several key salmon producing lakes with and without northern pike (*Esox lucius*) in the Susitna River drainage. The overall objective of this effort is to enumerate smolt and adult returns and to assess the characteristics of these populations in terms of age composition, sex, and size. When present, coho salmon were also sampled for age composition, sex, and size. Additionally, for some lake systems, CIAA and/or ADF&G are recording environmental conditions and water quality measurements as well as taking genetic samples; and performing mark-recapture studies and hydroacoustic surveys. The goal is to collect sound biological data to provide the foundation on which decisions for management and rehabilitation strategies can be made. Understanding the adult-to-juvenile relationship will allow management biologists to analyze and evaluate the production and rearing condition of each lake.

The enumeration of smolt salmon migrations from Larson Lake was completed all years of a three-year effort (2010–2012) to enumerate juvenile sockeye salmon migrations from the Susitna River drainage. Larson Lake was chosen for enumeration because it is one of the three main sockeye salmon producing lakes in the drainage. Northern pike were not known to be present.

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PROJECT AREA

Larson Lake is located in the foothills of the Talkeetna Mountains approximately 10 km east of Talkeetna, Alaska (Figure 1). The lake is located at 62º 20' W latitude, and 149º 53' N longitude. The lake lies near Bald Mountain and has a surface elevation of 186 m. Larson Lake has a surface area of 1.8 x $10^6 m^2$, total volume of 29.1 x 10^6 m^3, mean depth of 16.4 m, and a maximum depth of 42.6 m (Figure 2) (Spafard and Edmundson, 2000). There are two unnamed tributaries of Larson Lake. The lake's discharge forms Larson Creek, which flows 2.5 km to the Talkeetna River.

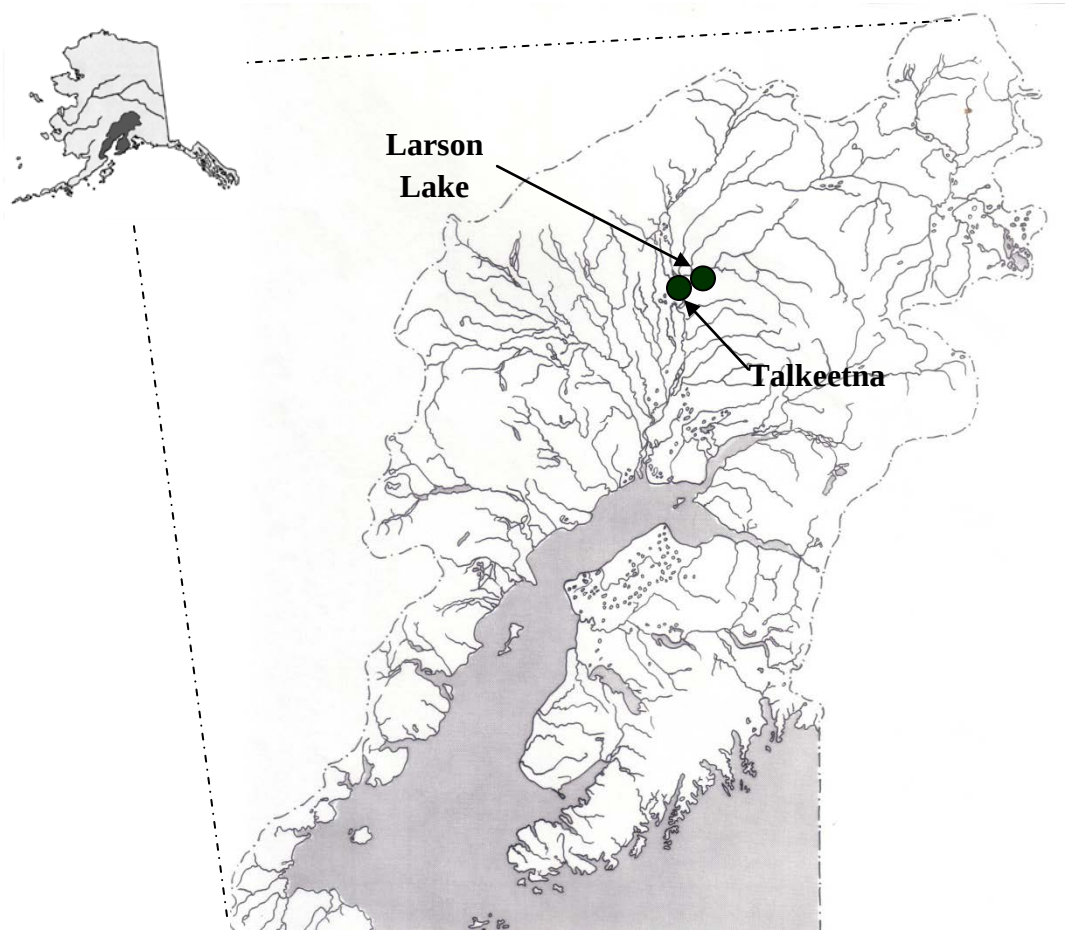

Figure 1: Larson Lake in relation to Cook Inlet and Alaska

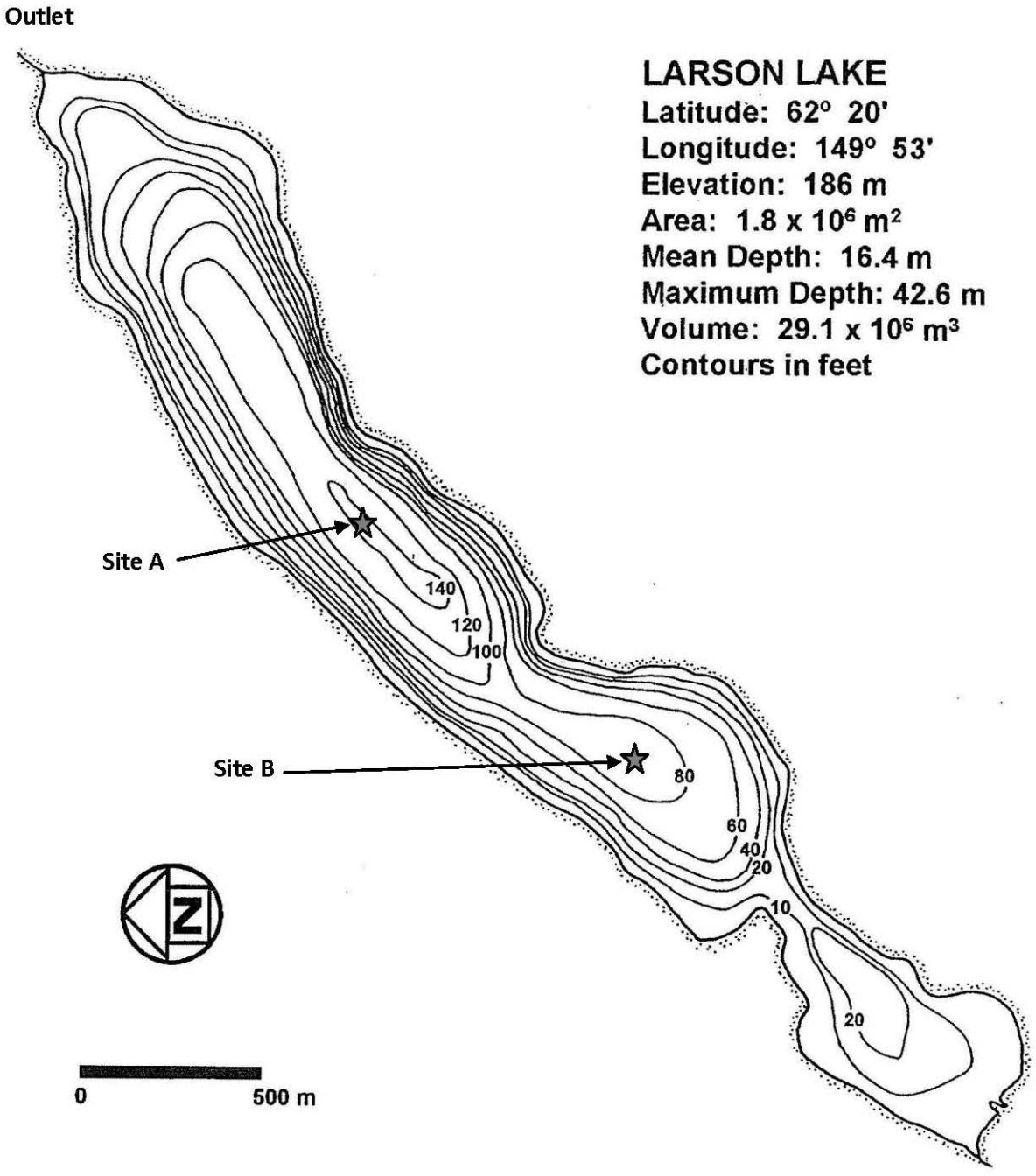

Figure 2: Bathymetric map of Larson Lake with limnology sampling sites

METHODS

Limnological Sampling

To assess water quality, limnological samples were collected between June and September of each year (2010, 2011, and 2012). However, in 2012 only zooplankton samples were collected and analyzed. Each sample consisted of a primary (A), and secondary (B) site (Figure 2). Measurements taken at the primary site were dissolved oxygen, temperature, light penetration profile, Secchi disk transparency, and zooplankton densities. Water samples taken at both 1 m and the hypolimnion were analyzed by ADF&G for phosphorous, carbon, chlorophyll a, phaeophytin a, nitrogen, calcium, magnesium, iron, conductivity, pH, alkalinity, turbidity, and color. The secondary site was sampled for zooplankton and Secchi disk transparency only. Sample collection and analysis procedures are described in Koenings, et al. (1987).

Environmental Conditions

To assess the environmental conditions during the sockeye salmon smolt migration at Larson Lake percent cloud cover was visually estimated, water level fluctuation recorded to the nearest 0.01 ft, precipitation measured to the nearest millimeter, and water and air temperatures (Celsius) were recorded at 5:00 PM daily. Standard CIAA procedures were followed for collecting these observations (CIAA, 2010, 2011, 2012).

Smolt Collection

To enumerate the smolt migration, a collection facility was temporarily placed in Larson Creek, approximately 10 meters downstream from the outlet of Larson Lake. A trap installed in mid-to-late May that was comprised of a modified fyke net attached to a double compartment live box, was positioned in the main flow of the creek. There were two leads composed of vexar paneling, which were anchored upstream to each bank and functioned by directing smolts into the trap. The use of the vexar paneling enabled staff to sample the entire width of the creek to ensure a total smolt count.

Smolt Enumeration

Typically, traps are checked at least 5 times daily and smolts were enumerated. At times during which the smolt migration exceeded 2,000 fish per hour, staff employed a 10% sub-sampling method where smolt were counted 10% of every hour at random two-minute intervals while the remaining smolt were allowed to pass freely through the trap in order to mitigate smolt stress and overcrowding. The 10% counts are then used to estimate the number of smolt that passed during that specified time period. The Larson Lake Smolt Procedures Manual (2010, 2011, 2012) describes the 10% sub-sampling method in detail. Due to procedural error, hourly count data for 2012 were not recorded; therefore, the appendix is not provided. Daily numbers for each species captured were called into the CIAA office.

Smolt Characteristics

Age (scales), weight, and length (AWL) data were collected from a subsample of the migrating smolts. Random samples (up to n=40 for sockeye, and n=20 for coho) were collected daily. Each smolt collected for evaluation was first anesthetized with MS-222, then fork length[1] measured to the nearest millimeter and weighed to the nearest 0.1 gram. Approximately 10 scales were removed from the primary growth area[2] and mounted on a glass slide for subsequent age determination. The procedures for AWL procedures are described in the Larson Lake Smolt Procedures Manual (CIAA, 2010, 2011, 2012).

[1] Fork length is defined as the length from the tip of the snout to the fork of the tail.

[2] Primary growth area is located above the lateral line on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin.

RESULTS

Limnological Sampling

Staff collected water chemistry samples 4 times each in 2010 and 2011. The study plan did not include water chemistry data collection in 2012. A summary of limnological conditions provided by ADF&G is listed in Table 1. Zooplankton samples were collected 5 times each in 2010 and 2011, and 4 times in 2012. Seasonal biomass and densities are listed in Table 1. Details pertaining to species and size can be found in Appendices 12–14.

Table 1: Average open water season water quality characteristics of Larson Lake.

AVERAGE WATER QUALITY - 1 METER

Year	TP (ug/l)	TFP (ug/l)	FRP (ug/l)	TKN* (ug/l)	NH3+NH4 (ug/l)	NO2+NO3 (ug/l)	TN:TP	RSi (ug/l)	Org C (ug/l)	Chla (ug/l)	Phaeo (ug/l)	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb (NTU)	Color (Pt)	Ca (mg/l)	Mg (mg/l)	Fe (ug/l)
2010	7.2	3.8	1.2	-	26.8	269.4	83 :1	3,357	241	2.11	0.41	78	6.7	13.3	0.6	9	7.1	0.9	30
2011	4.2	2.9	1.7	-	6.8	162.0	- -	3,164	180	0.87	0.25	76	7.2	14.4	0.3	14	7.2	0.8	16
2012	Not Sampled											Not Sampled							

AVERAGE WATER QUALITY - MIDHYPOLIMNION

Year	TP (ug/l)	TFP (ug/l)	FRP (ug/l)	TKN* (ug/l)	NH3+NH4 (ug/l)	NO2+NO3 (ug/l)	TN:TP	RSi (ug/l)	Org C (ug/l)	Chla (ug/l)	Phaeo (ug/l)	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb (NTU)	Color (Pt)	Ca (mg/l)	Mg (mg/l)	Fe (ug/l)
2010	12.7	4.3	1.2	-	29.4	298.2	52 :1	3,437	388	16.48	-0.58	80	6.6	12.9	0.7	10	7.2	0.9	21
2011	6.9	3.0	1.9	-	12.6	202.0	- -	3,167	338	11.31	-0.49	78	7.2	14.4	0.4	19	7.5	0.8	17
2012	Not Sampled											Not Sampled							

Year	Secchi Sta	Secchi (m)	Secchi Sta	Secchi (m)	Zooplankton biomass (mg/m^2)	Zooplankton density (no/m^2)	EZD Sta	EZD (m)	EZD Sta	EZD (m)
2010	A	6.3	B	6.1	1,322	423,692	A	12.1	B	10.8
2011	A	6.8	B	6.5	1,311	377,432	A	11.3	B	-
2012	A	7.6	B	7.4	1,424	411,747	Not Sampled		Not Sampled	

ADF&G provided water quality analysis.
EZD and secchi provided by CIAA.
* - TKN was not completed due to malfunctioning equipment.

Environmental Conditions

During the 2010 smolt migration, staff monitored environmental conditions at 5:00 PM from 21 May through 30 June. Water levels fluctuated 0.2 ft during that time period. Stream temperatures averaged 16ºC (±2.1) [mean ± standard deviation] and ranged from 12 to 20ºC. Air temperatures averaged 16ºC (±3.9) and ranged from 10 to 27ºC. Twelve percent of the days were clear, 29% were partly cloudy, 24% were completely overcast, and 34% had measured rainfall. Although precipitation data were recorded, the data collection was incorrect and thus not reported.

During the 2011 smolt migration, staff monitored environmental conditions at 5:00 PM from 14 May through 15 July. Stream stage levels were recorded in the field. However, the data collection method was incorrect and recorded data are not included in this report. Water temperatures averaged 13ºC (±4.8) and ranged from 4 to 20ºC. Air temperatures averaged 15 ºC (±3.1) and ranged from 9 to 22ºC. None of the days were clear, 76% were partly cloudy, 19% were completely overcast, and 5% had measured rainfall. A total of 57 mm of rain fell during that period.

During the 2012 smolt migration, staff monitored environmental conditions at 5:00 PM from 15 May through 4 July. Water levels fluctuated 0.7 ft during that time period. Water temperatures

averaged 13ºC (±5.3) and ranged from 5 to 24ºC. Air temperatures averaged 15ºC (±3.9) and ranged from 7 to 26ºC. Four percent of the days were clear, 51% were partly cloudy, 31% were overcast, and 14% had measured rainfall. A total of 109 mm of rain fell during that period.

Smolt Enumeration and Characteristics

2010

The smolt migration was enumerated from 21 May through 30 June. During that time, an estimated 290,025 sockeye salmon smolt migrated from Larson Lake. The 10% subsample method was used during 26 of the hourly smolt counts. Those time periods are indicated in the smolt hourly log (Appendix 7). Other fish captured during that time were 2,417 coho salmon smolt (*O. kisutch),* 1 Chinook salmon smolt (*O. tshawytscha*), 18 rainbow trout (*O. mykiss*), and 12 Arctic char (*Salvelinus alpinus*).

Throughout the migration, staff collected 1,520 sockeye salmon smolt, and took scale samples, weight and measurements for fork length. Seventy-four samples were unreadable for age, so a total of 1,446 samples were used for analysis. Based on the samples read, there were 4 age classes. Within the sample, age-1 was the most abundant age class (95.0%), followed by age-2 (3.7%), age-3 (1.1%) and age-4 (0.1%). The average length of the sampled age-1 sockeye salmon smolt was 97.8 mm (±0.4) and the average weight was 9.4 g (±0.1). The average length of the age-2 sockeye salmon smolt was 113.5 mm (±2.4) and the average weight was 14.2 g (±1.1). The average length of the age-3 sockeye salmon smolt was 159.2 mm (±10.1) and the average weight was 52.9 g (±11.9). The length of the age-4 sockeye salmon smolt was 250.0 mm and the weight was 126.5 g (Table 2).

During the same time period, staff also collected 451 coho salmon smolt, took scale samples, weight and measurements for fork length. Nineteen samples were unreadable for age, so a total of 432 samples were used for analysis. Based on the samples read, there were 5 age classes. Within the sample, age-2 was the most abundant age class (41.9%), followed by age-1 (35.4%), age-3 (19.2%), age-0 (3.2%) and age-4 (0.7%). The average length of the sampled age-2 coho salmon smolt was 125 mm (±1.0) and the average weight was 18.9 g (±0.5). The average length of the age-1 coho smolt was 106 mm (±2.1) and the average weight was 12.1 g (±0.6). The average length of the age-3 coho smolt was 146 mm (±2.7) and the average weight was 29.1 g (±1.7). The average length of the age-0 coho salmon smolt was 72 (±4.0) and the average weight was 4.6 g (±0.7). The length of the age-4 coho salmon smolt was 181 and the weight was 27.5 g (Table 3).

Table 2: Larson Lake 2010–2012 sockeye salmon smolt AWL summary

	Age class (%)								Mean length (mm)								Mean weight (g)							
Smolt Year	Age 1	95% C.I.	Age 2	95% C.I.	Age 3	95% C.I.	Age 4	95% C.I.	Age 1	SD	Age 2	SD	Age 3	SD	Age 4	SD	Age 1	SD	Age 2	SD	Age 3	SD	Age 4	SD
2010	95.0%	(±0.0%)	3.7%	(±0.4%)	1.1%	(±0.7%)	0.1%	-	97.8	0.4	113.5	2.4	159.2	10.1	250.0	-	9.4	0.1	14.2	1.1	42.9	11.9	126.5	-
2011	78.6%	(±0.0%)	21.4%	(±0.1%)	NS	NS	NS	NS	107.6	1.6	109.8	1.1	NS	NS	NS	NS	9.1	0.2	10.8	0.4	NS	NS	NS	NS
2012	92.5%	(±0.0%)	6.8%	(±0.4%)	0.7%	(±1.7%)	NS	NS	91.1	0.5	101.8	1.7	157.2	20.7	NS	NS	7.9	1.6	9.8	0.6	38.8	13.3	NS	NS
Mean	88.7%		10.6%		0.4%		0.0%		98.8		108.4		157.2		0.0		8.8		11.6		38.8		0.0	

NS = No Sample

Table 3: Larson Lake 2010–2012 coho salmon smolt AWL summary

	Age Class (%)									Mean length (mm)										Mean weight (g)									
Smolt Year	Age 0	95% C.I.	Age 1	95% C.I.	Age 2	95% C.I.	Age 3	95% C.I.	Age 4	95% C.I.	Age 0	SD	Age 1	SD	Age 2	SD	Age 3	SD	Age 4	SD	Age 0	SD	Age 1	SD	Age 2	SD	Age 3	SD	Age 4	SD
2010	3.2%	(±1.3%)	35.4%	(±0.3%)	41.9%	(±0.2%)	19.2%	(±0.4%)	0.7%	-	72.0	4.0	106.0	2.1	125.0	1.0	146.0	2.7	181.0	-	4.6	0.7	12.1	0.6	18.9	0.5	29.1	1.7	27.5	-
2011	NS	NS	5.7%	(±0.8%)	81.2%	(±0.0%)	13.1%	(±0.5%)	NS	NS	NS	NS	87.0	5.5	135.0	1.2	152.0	3.2	NS	NS	NS	NS	7.1	2.7	18.9	0.4	28.6	3.6	NS	NS
2012	NS	NS	22.5%	(±0.6%)	58.0%	(±0.2%)	19.5%	(±0.6%)	NS	NS	NS	NS	84.1	3.1	126.5	1.8	161.1	7.3	NS	NS	NS	NS	6.4	0.8	20.8	0.7	41.9	4.3	NS	NS
Mean	3.2%		21.2%		60.4%		16.3%		0.0%		0.0		92.4		128.8		161.1		0.0		0.0		8.5		19.5		41.9		0.0	

NS = No Sample

2011

The smolt migration was enumerated from 14 May through 15 July. During that time, 207,276 sockeye salmon smolt were captured while migrating from Larson Lake. The 10% subsample method was not used. Other fish captured during that time were 1,386 coho salmon smolt and 21 rainbow trout.

Throughout the migration, staff collected 1,710 sockeye salmon smolt, took scale samples, weight and measurements for fork length. Five samples were unreadable for age, so a total of 1,705 samples were used for analysis. Based on the samples read, there were 2 age classes. Within the sample, age-1 was the most abundant age class (78.6%), followed by age-2 (21.4%). The average length of the sampled age-1 sockeye salmon smolt was 107.6 mm (±1.6) and the average weight was 9.1 g (±0.2). The average length of the age-2 sockeye salmon smolt was 109.8 mm (±1.1) and the average weight was 10.8 g (±0.4) (Table 2).

During the same time period, staff also collected 523 coho salmon smolt, took scale samples, weight and measurements for fork length. Twelve samples were unreadable for age, so a total of 511 samples were used for analysis. Based on the samples read, there were 3 age classes. Within the sample, age-2 was the most abundant age class (81.2%), followed by age-3 (13.1%) and age-1 (5.7%). The average length of the sampled age-2 coho salmon smolt was 135.0 mm (±1.2) and the average weight was 18.9 g (±0.5). The average length of the age-3 coho salmon smolt was 152.0 mm (±3.2) the average weight was 28.6 g (±3.6). The average length of the age-1 coho salmon smolt was 87.0 mm (±5.5) and the average weight was 7.1 g (±2.7) (Table 3).

2012

The smolt migration was enumerated from 16 May through 30 June. During that time, 113,158 sockeye salmon smolt were captured while migrating from Larson Lake. The 10% subsampling method was not used. Other fish captured during that time were 1,278 coho salmon smolt, 57 rainbow trout, and 4 Arctic char.

Throughout the migration, staff collected 1,520 sockeye salmon smolt, took scale samples, weight and measurements for fork length. A total of 869 representative samples (approximately 290 each from the beginning, middle, and end of the migration) were used for analysis. Based on the samples read, there were 3 age classes. Within the sample, age-1 was the most abundant age class (92.5%), followed by age-2 (6.8%) and age-3 (0.7%). The average length of the sampled age-1 sockeye salmon smolt was 91.1 mm (±0.5) and the average weight was 7.9 g (±1.6). The average length of the age-2 sockeye salmon smolt was 101.8 mm (±1.7) and the average weight was 9.8 g (±0.6). The average length of the age-3 sockeye salmon smolt was 157.2 mm (±20.7) and the average weight was 38.8 g (±13.3) (Table 2).

During the same time period, staff collected 295 coho salmon smolt, took scale samples, weight, and measurements for fork length. Two were readable samples and were used for analysis, so a total of 293 scale samples were used for analysis. Based on the samples read, there were 3 age classes. Within the sample, age-2 was the most abundant age class (58.0%), followed by age-1 (22.5%), and age-3 (19.5%). The average length of the sampled age-2 coho salmon smolt was 126.5 mm (±1.8) and the average weight was 20.8 g (±0.7). The average length of the age-1 coho salmon smolt was 84.1 mm (±3.1) and the average weight was 6.4 g (±0.8). The average length of the age-3 coho salmon smolt was 161.1 mm (±7.3) and the average weight was 41.9 g (±4.3) (Table 3).

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RECOMMENDATIONS

Larson Lake is one of the major sockeye salmon producers in the Susitna River drainage. Because invasive northern pike are present in many of the lakes in the area, it is important to estimate the smolt migration every five years to monitor the health of the population. Any future data collection should be consistent with previous monitoring efforts in order to provide comparative data.

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APPENDICES

Appendix 1: Larson Lake 2010 environmental conditions

Smolt Migration

Date	Sky	Precip. (mm)	Stage * (ft)	Water Temp. (^{o}C)	Air Temp. (^{o}C)
5/21/2010	1	ND	0.00	12	20
5/22/2010	1	ND	0.00	12	20
5/23/2010	3	ND	0.06	13	20
5/24/2010	1	ND	0.06	14	25
5/25/2010	4	ND	0.02	14	17
5/26/2010	1	ND	0.02	17	27
5/27/2010	2	ND	-0.04	16	18
5/28/2010	5	ND	-0.04	16	21
5/29/2010	2	ND	0.02	16	18
5/30/2010	5	ND	-0.10	16	17
5/31/2010	3	ND	-0.04	16	18
6/1/2010	4	ND	-0.05	15	17
6/2/2010	4	ND	-0.05	17	16
6/3/2010	5	ND	0.00	13	11
6/4/2010	5	ND	0.00	12	10
6/5/2010	4	ND	-0.05	19	16
6/6/2010	3	ND	-0.10	17	20
6/7/2010	4	ND	-0.05	15	17
6/8/2010	5	ND	-0.05	15	13
6/9/2010	5	ND	-0.10	14	13
6/10/2010	4	ND	-0.10	15	16
6/11/2010	5	ND	-0.10	15	12
6/12/2010	4	ND	-0.10	15	13
6/13/2010	3	ND	-0.10	15	21
6/14/2010	5	ND	-0.10	15	14
6/15/2010	5	ND	-0.10	14	11
6/16/2010	5	ND	-0.10	14	11
6/17/2010	5	ND	-0.10	14	11
6/18/2010	5	ND	-0.10	15	14
6/19/2010	5	ND	-0.10	15	11
6/20/2010	2	ND	-0.10	17	19
6/21/2010	2	ND	-0.10	20	21
6/22/2010	4	ND	-0.10	18	18
6/23/2010	3	ND	-0.10	19	18
6/24/2010	3	ND	-0.10	19	18
6/25/2010	2	ND	-0.10	20	19
6/26/2010	4	ND	-0.10	17	15
6/27/2010	4	ND	-0.10	15	14
6/28/2010	1	ND	-0.10	18	12
6/29/2010	5	ND	-0.10	17	14
6/30/2010	2	ND	-0.10	17	16
Total		ND			
Avg.		ND	-0.06	16	16
Min.		ND	-0.10	12	10
Max.		ND	0.06	20	27

* - Does not reflect actual depth, only water level fluctuation

Summary of Cloud Cover - Percent of Days

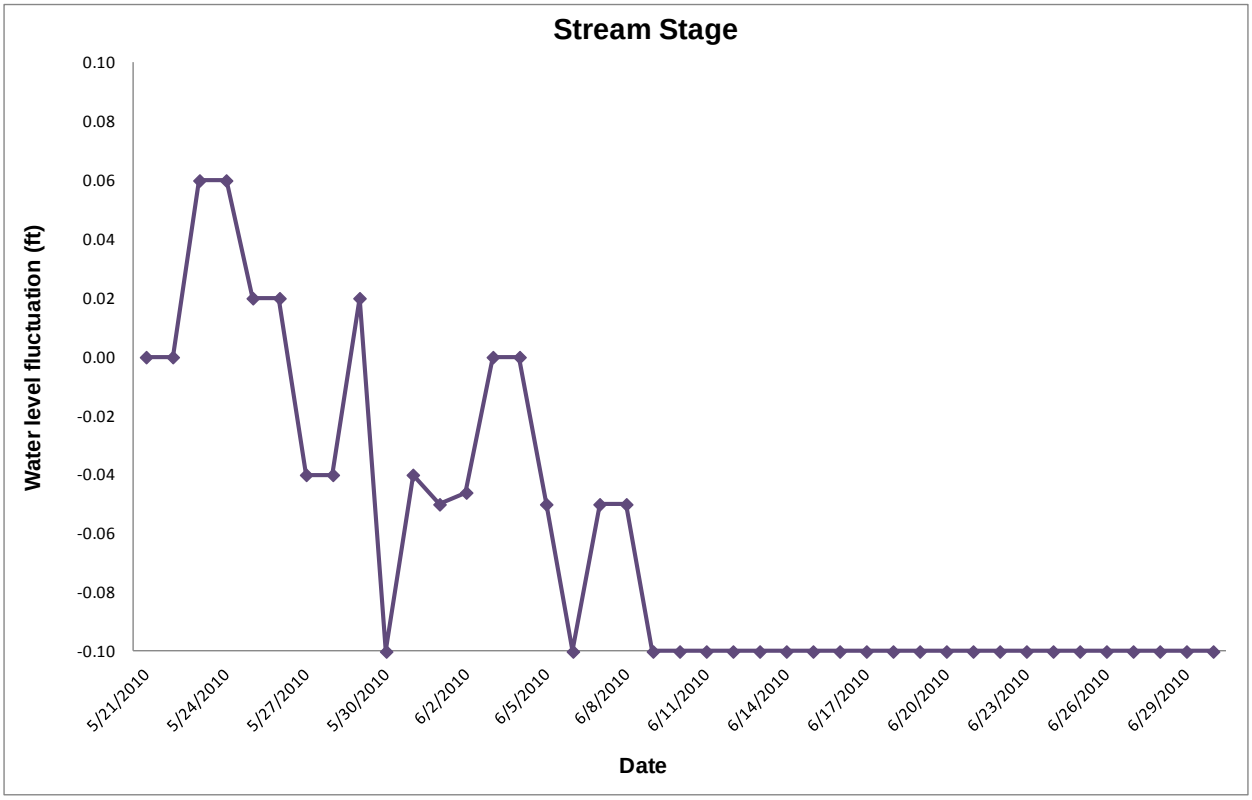
	No. Days	Clear	Partly Cloudy	Overcast	Rain
Smolts	41	12%	29%	24%	34%

ND = No Data

1= Clear
2= Cloud Cover <50%
3= Cloud Cover >50%
4= Overcast
5= Rain

In 2010, although precipitation data were recorded, the data collection method was incorrect.

Appendix 2: Larson Lake 2010 water level fluctuation



Appendix 3: Larson Lake 2011 environmental conditions

Smolt Migration

Date	Sky	Precip. (mm)	Stage * (ft)	Water Temp. (^{o}C)	Air Temp. (^{o}C)
5/14/2011	2	ND	ND	ND	ND
5/15/2011	2	0	ND	ND	ND
5/16/2011	2	0	ND	4	12
5/17/2011	3	0	ND	4	9
5/18/2011	2	0	ND	5	12
5/19/2011	2	0	ND	6	10
5/20/2011	2	0	ND	5	15
5/21/2011	3	0	ND	5	11
5/22/2011	3	0	ND	5	11
5/23/2011	2	0	ND	5	17
5/24/2011	2	0	ND	5	13
5/25/2011	2	0	ND	6	15
5/26/2011	2	0	ND	7	ND
5/27/2011	2	0	ND	7	21
5/28/2011	2	0	ND	9	15
5/29/2011	2	0	ND	9	18
5/30/2011	2	0	ND	10	17
5/31/2011	4	0	ND	10	13
6/1/2011	4	0	ND	10	11
6/2/2011	3	0	ND	11	15
6/3/2011	4	1	ND	11	14
6/4/2011	4	6	ND	11	18
6/5/2011	2	11	ND	11	15
6/6/2011	2	1	ND	12	14
6/7/2011	2	0	ND	12	13
6/8/2011	2	0	ND	13	14
6/9/2011	2	0	ND	13	15
6/10/2011	2	0	ND	13	15
6/11/2011	3	0	ND	13	12
6/12/2011	3	0	ND	13	14
6/13/2011	3	0	ND	13	10
6/14/2011	3	2	ND	12	12
6/15/2011	3	1	ND	12	13
6/16/2011	2	0	ND	13	17
6/17/2011	2	0	ND	14	19
6/18/2011	2	0	ND	16	17
6/19/2011	2	0	ND	12	15
6/20/2011	4	10	ND	13	15
6/21/2011	2	0	ND	15	16
6/22/2011	2	0	ND	15	15
6/23/2011	2	0	ND	17	18
6/24/2011	2	0	ND	20	22
6/25/2011	3	1	ND	15	14
6/26/2011	4	2	ND	16	15
6/27/2011	4	4	ND	17	12
6/28/2011	3	3	ND	17	18
6/29/2011	3	0	ND	18	20
6/30/2011	3	1	ND	19	19
7/1/2011	4	0	ND	18	17
7/2/2011	5	3	ND	16	12
7/3/2011	4	1	ND	16	14
7/4/2011	3	0	ND	16	17
7/5/2011	2	9	ND	19	20
7/6/2011	2	1	ND	20	21
7/7/2011	2	0	ND	20	20
7/8/2011	4	0	ND	19	16
7/9/2011	3	0	ND	19	17
7/10/2011	4	0	ND	19	17
7/11/2011	5	1	ND	17	13
7/12/2011	4	1	ND	16	12
7/13/2011	3	1	ND	17	18
7/14/2011	5	1	ND	17	16
7/15/2011	3	1	ND	20	21
Total		57			
Avg.		1	-	13	15
Min.		0	-	4	9
Max.		11	-	20	22

* - Does not reflect actual depth, only water level fluctuation.

Summary of Cloud Cover - Percent of Days

	No. Days	Clear	Partly Cloudy	Overcast	Rain
Smolt	63	0%	76%	19%	5%

ND = No Data

1= Clear
2= Cloud Cover <50%
3= Cloud Cover >50%
4= Overcast
5= Rain

In 2011, although stream stage data were collected, the data collection method was incorrect.

Appendix 4: Larson Lake 2012 environmental conditions

Date	Sky	Precip. (mm)	Stage * (ft)	Water Temp. (^{o}C)	Air Temp. (^{o}C)
5/15/2012	2	ND	ND	ND	ND
5/16/2012	2	0	0.0	6	13
5/17/2012	2	0	0.1	6	13
5/18/2012	3	0	0.2	7	11
5/19/2012	3	0	0.2	5	12
5/20/2012	3	0	0.2	5	14
5/21/2012	4	0	0.2	5	18
5/22/2012	3	0	0.3	5	13
5/23/2012	2	ND	0.3	5	16
5/24/2012	5	ND	0.4	5	7
5/25/2012	3	1	0.4	7	11
5/26/2012	4	0	0.5	8	13
5/27/2012	5	2	0.6	8	9
5/28/2012	3	1	0.7	8	14
5/29/2012	2	2	0.7	8	12
5/30/2012	3	0	0.7	9	14
5/31/2012	4	0	0.6	10	11
6/1/2012	3	2	0.6	11	12
6/2/2012	4	6	0.6	10	14
6/3/2012	4	1	0.6	10	13
6/4/2012	4	1	0.6	9	11
6/5/2012	1	1	0.5	11	16
6/6/2012	5	3	0.5	10	10
6/7/2012	4	1	0.5	13	16
6/8/2012	4	1	0.4	12	14
6/9/2012	4	3	0.4	13	15
6/10/2012	4	0	0.3	13	14
6/11/2012	4	2	0.3	13	14
6/12/2012	5	7	0.3	13	8
6/13/2012	3	4	0.3	14	15
6/14/2012	2	1	0.3	14	14
6/15/2012	3	0	0.3	13	16
6/16/2012	2	0	0.3	14	21
6/17/2012	3	0	0.2	15	18
6/18/2012	4	8	0.3	16	12
6/19/2012	4	1	0.2	18	20
6/20/2012	3	3	0.2	20	20
6/21/2012	2	ND	0.2	ND	ND
6/22/2012	1	23	0.2	24	26
6/23/2012	2	0	0.2	22	25
6/24/2012	5	3	0.2	19	14
6/25/2012	4	6	0.1	20	15
6/26/2012	3	10	0.2	17	15
6/27/2012	4	1	0.2	18	21
6/28/2012	5	5	0.2	16	11
6/29/2012	3	6	0.2	18	19
6/30/2012	2	0	0.2	19	19
7/1/2012	3	0	0.1	18	17
7/2/2012	4	0	0.2	18	15
7/3/2012	5	ND	0.1	21	12
7/4/2012	3	7	0.2	18	16
Total		109			
Avg.		2	0.3	13	15
Min.		0	0.0	5	7
Max.		23	0.7	24	26

* - Does not reflect actual depth, only water level fluctuation

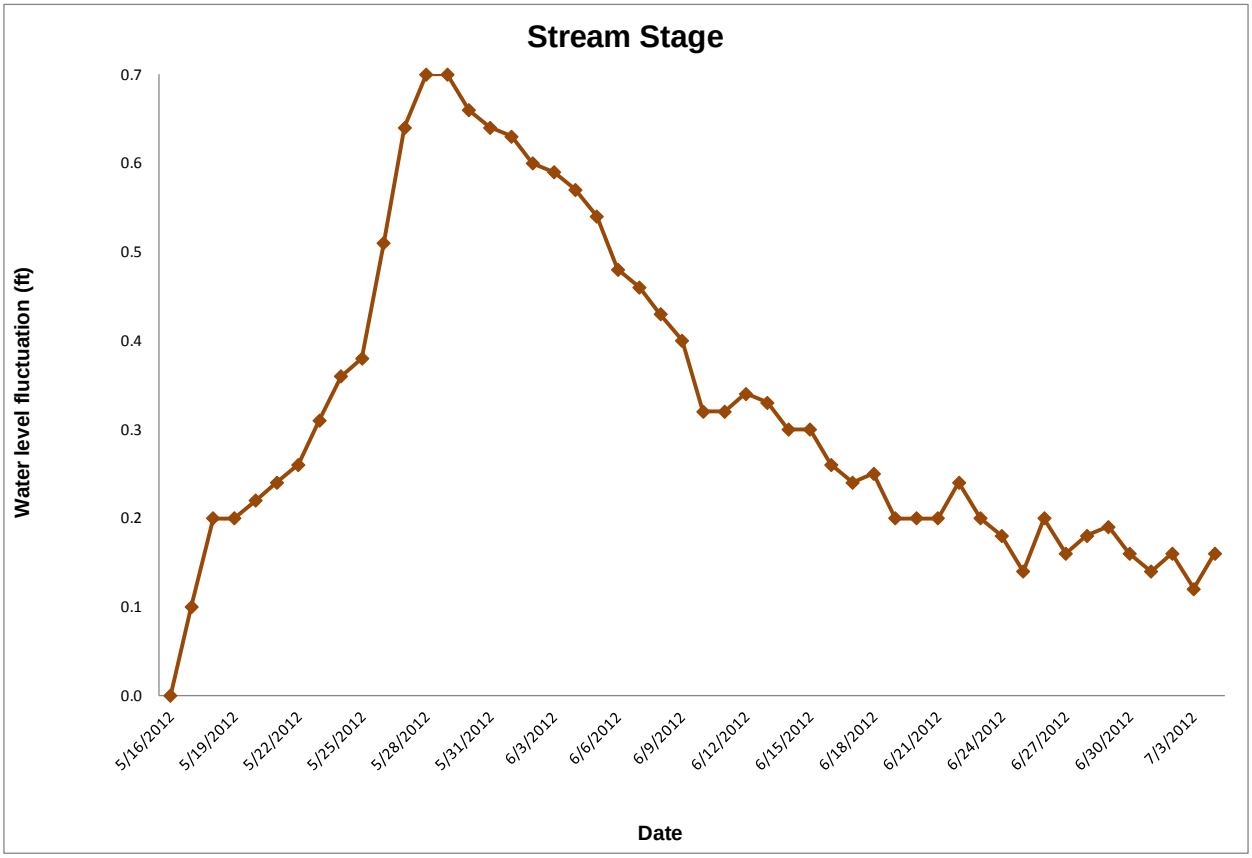
Summary of Cloud Cover - Percent of Days

	No. Days	Clear	Partly Cloudy	Overcast	Rain
Smolts	51	4%	51%	31%	14%

ND = No Data

1= Clear
2= Cloud Cover <50%
3= Cloud Cover >50%
4= Overcast
5= Rain

Appendix 5: Larson Lake 2012 water level fluctuation



Appendix 6: Larson Lake 2010 daily smolt migration

	Sockeye		Coho		Chinook	Pink	Chum	Rainbow	Arctic Char
Date	Daily	Total	Daily	Total	Daily	Daily	Daily	Daily	Daily
5/21/2010	7,466	7,466	0	0	0	0	0	4	0
5/22/2010	5,344	12,810	5	5	0	0	0	1	1
5/23/2010	21,005	33,815	0	5	0	0	0	1	0
5/24/2010	1,091	34,906	2	7	0	0	0	0	0
5/25/2010	35,482	70,388	3	10	0	0	0	0	0
5/26/2010	65,372	135,760	10	20	0	0	0	0	0
5/27/2010	70,989	206,749	0	20	0	0	0	0	0
5/28/2010	9,883	216,632	7	27	0	0	0	0	0
5/29/2010	6,429	223,061	6	33	0	0	0	0	0
5/30/2010	4,090	227,151	0	33	0	0	0	0	0
5/31/2010	6,571	233,722	12	45	0	0	0	0	0
6/1/2010	2,839	236,561	15	60	0	0	0	1	0
6/2/2010	2,536	239,097	47	107	0	0	0	0	0
6/3/2010	10	239,107	9	116	0	0	0	0	0
6/4/2010	943	240,050	50	166	0	0	0	0	0
6/5/2010	1,379	241,429	8	174	0	0	0	0	0
6/6/2010	5,929	247,358	162	336	0	0	0	0	0
6/7/2010	6,211	253,569	169	505	0	0	0	0	0
6/8/2010	1,405	254,974	92	597	0	0	0	0	0
6/9/2010	2,898	257,872	178	775	0	0	0	0	1
6/10/2010	4,918	262,790	223	998	1	0	0	0	0
6/11/2010	3,697	266,487	40	1,038	0	0	0	0	0
6/12/2010	745	267,232	71	1,109	0	0	0	0	0
6/13/2010	3,032	270,264	114	1,223	0	0	0	0	2
6/14/2010	3,068	273,332	131	1,354	0	0	0	0	0
6/15/2010	914	274,246	144	1,498	0	0	0	0	1
6/16/2010	4,355	278,601	201	1,699	0	0	0	0	0
6/17/2010	3,652	282,253	109	1,808	0	0	0	0	1
6/18/2010	1,669	283,922	137	1,945	0	0	0	0	0
6/19/2010	1,621	285,543	149	2,094	0	0	0	0	0
6/20/2010	485	286,028	66	2,160	0	0	0	2	0
6/21/2010	622	286,650	77	2,237	0	0	0	2	2
6/22/2010	373	287,023	56	2,293	0	0	0	0	2
6/23/2010	1,110	288,133	61	2,354	0	0	0	0	0
6/24/2010	512	288,645	7	2,361	0	0	0	1	0
6/25/2010	214	288,859	21	2,382	0	0	0	0	0
6/26/2010	216	289,075	0	2,382	0	0	0	5	0
6/27/2010	312	289,387	16	2,398	0	0	0	0	0
6/28/2010	106	289,493	9	2,407	0	0	0	0	0
6/29/2010	6	289,499	2	2,409	0	0	0	1	0
6/30/2010	456	289,955	5	2,414	0	0	0	0	2
7/1/2010	70	290,025	3	2,417	0	0	0	0	0
Total		290,025		2,417	1	0	0	18	12

Appendix 7: Larson Lake 2010 smolt hourly log

	AM						PM												AM					
	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00	1:00	2:00	3:00	4:00	5:00
5/21/2010																			100	6401*			965	
5/22/2010																			600	3816*	480	448		
5/23/2010																		1235*	8350*	6540*	4880*			
5/24/2010									0			0							856			235		
5/25/2010																		4669*	11390*			1513*	17910*	
5/26/2010												0						29619*	12050*	6710*	16590*	403*		
5/27/2010												12706*	22940*	12470*	3910*	6734*		2291*	2310*	1080*			2028*	4520*
5/28/2010												3583	1720*	94	259	668	2627	932					0	
5/29/2010											1752	1484	2374			436			383			0		
5/30/2010									0			1036				628	1108	1381				0		
5/31/2010												583	358			270	893	3169	1139				159	
6/1/2010												0	254	242				675	1656			12		
6/2/2010												108	0					1110	1006	312				0
6/3/2010											0				0			2			8		0	
6/4/2010												0					317	365	243			18		
6/5/2010												0				23	564	1				791	0	
6/6/2010												778	1824	530				2609	177			11		
6/7/2010												1467	952	860				1598	258				1076	
6/8/2010												0					856	538				11	0	
6/9/2010												0		2326	226				40				306	
6/10/2010												56	1698	341					2761				62	
6/11/2010												40				0				1402	1814	441		
6/12/2010												0		0					690	55			0	
6/13/2010													26	332	0				432	1799	142		301	
6/14/2010													56	133	0			2382	274			131	92	
6/15/2010												121						64	0				273	456
6/16/2010													99	0				950	1900	1406			0	
6/17/2010													621	83	0			574	1483			701	190	
6/18/2010												64					66	207	223				878	231
6/19/2010													0				428	982			107	104		
6/20/2010												14	34	0				289	40			36	72	
6/21/2010													74				124	28			89	304		
6/22/2010													0	0				35	235	15		88	0	
6/23/2010														0	172	136	0				198	517	87	
6/24/2010															0	120	0			190	139	63	0	
6/25/2010															0			152	38	2		22		
6/26/2010															0	0		125	83			8		
6/27/2010															26			49	117			67	53	
6/28/2010															92	14	0				0			
6/29/2010														0			0					6		
6/30/2010																69	179	0				208		
7/1/2010																			26	9				35

* - 10% subsampling method was used during the indicated time periods.

Appendix 8: Larson Lake 2011 daily smolt migration

	Sockeye		Coho		Chinook	Pink	Chum	Rainbow	Arctic Char
Date	Daily	Total	Daily	Total	Daily	Daily	Daily	Daily	Daily
5/14/2011	0	0	0	0	0	0	0	0	0
5/15/2011	8	8	0	0	0	0	0	1	0
5/16/2011	18	26	0	0	0	0	0	1	0
5/17/2011	3	29	1	1	0	0	0	0	0
5/18/2011	7	36	0	1	0	0	0	5	0
5/19/2011	1	37	1	2	0	0	0	6	0
5/20/2011	33	70	8	10	0	0	0	3	0
5/21/2011	1	71	1	11	0	0	0	4	0
5/22/2011	252	323	1	12	0	0	0	0	0
5/23/2011	412	735	3	15	0	0	0	0	0
5/24/2011	735	1,470	0	15	0	0	0	0	0
5/25/2011	1,409	2,879	2	17	0	0	0	0	0
5/26/2011	2,168	5,047	2	19	0	0	0	0	0
5/27/2011	6,381	11,428	4	23	0	0	0	0	0
5/28/2011	360	11,788	0	23	0	0	0	0	0
5/29/2011	2,452	14,240	3	26	0	0	0	0	0
5/30/2011	4,831	19,071	0	26	0	0	0	0	0
5/31/2011	5,129	24,200	3	29	0	0	0	0	0
6/1/2011	2,926	27,126	3	32	0	0	0	0	0
6/2/2011	12,194	39,320	6	38	0	0	0	0	0
6/3/2011	2,398	41,718	0	38	0	0	0	0	0
6/4/2011	3,275	44,993	8	46	0	0	0	0	0
6/5/2011	7,409	52,402	63	109	0	0	0	1	0
6/6/2011	13,378	65,780	18	127	0	0	0	0	0
6/7/2011	4,821	70,601	47	174	0	0	0	0	0
6/8/2011	31,047	101,648	93	267	0	0	0	0	0
6/9/2011	6,959	108,607	78	345	0	0	0	0	0
6/10/2011	2,823	111,430	61	406	0	0	0	0	0
6/11/2011	8,190	119,620	63	469	0	0	0	0	0
6/12/2011	5,213	124,833	75	544	0	0	0	0	0
6/13/2011	3,343	128,176	46	590	0	0	0	0	0
6/14/2011	4,214	132,390	49	639	0	0	0	0	0
6/15/2011	975	133,365	32	671	0	0	0	0	0
6/16/2011	5,140	138,505	101	772	0	0	0	0	0
6/17/2011	6,367	144,872	73	845	0	0	0	0	0
6/18/2011	34,017	178,889	87	932	0	0	0	0	0
6/19/2011	3,384	182,273	97	1,029	0	0	0	0	0
6/20/2011	5,613	187,886	108	1,137	0	0	0	0	0
6/21/2011	5,621	193,507	61	1,198	0	0	0	0	0
6/22/2011	1,120	194,627	22	1,220	0	0	0	0	0
6/23/2011	2,944	197,571	28	1,248	0	0	0	0	0
6/24/2011	455	198,026	3	1,251	0	0	0	0	0
6/25/2011	2,551	200,577	30	1,281	0	0	0	0	0
6/26/2011	1,496	202,073	5	1,286	0	0	0	0	0
6/27/2011	496	202,569	36	1,322	0	0	0	0	0
6/28/2011	1,044	203,613	29	1,351	0	0	0	0	0
6/29/2011	1,880	205,493	24	1,375	0	0	0	0	0
6/30/2011	1,657	207,150	9	1,384	0	0	0	0	0
7/1/2011	117	207,267	2	1,386	0	0	0	0	0
7/2/2011	0	207,267	0	1,386	0	0	0	0	0
7/3/2011	0	207,267	0	1,386	0	0	0	0	0
7/4/2011	0	207,267	0	1,386	0	0	0	0	0
7/5/2011	0	207,267	0	1,386	0	0	0	0	0
7/6/2011	0	207,267	0	1,386	0	0	0	0	0
7/7/2011	0	207,267	0	1,386	0	0	0	0	0
7/8/2011	0	207,267	0	1,386	0	0	0	0	0
7/9/2011	0	207,267	0	1,386	0	0	0	0	0
7/10/2011	0	207,267	0	1,386	0	0	0	0	0
7/11/2011	0	207,267	0	1,386	0	0	0	0	0
7/12/2011	0	207,267	0	1,386	0	0	0	0	0
7/13/2011	0	207,267	0	1,386	0	0	0	0	0
7/14/2011	8	207,275	0	1,386	0	0	0	0	0
7/15/2011	1	207,276	0	1,386	0	0	0	0	0
Total		207,276		1,386	0	0	0	21	0

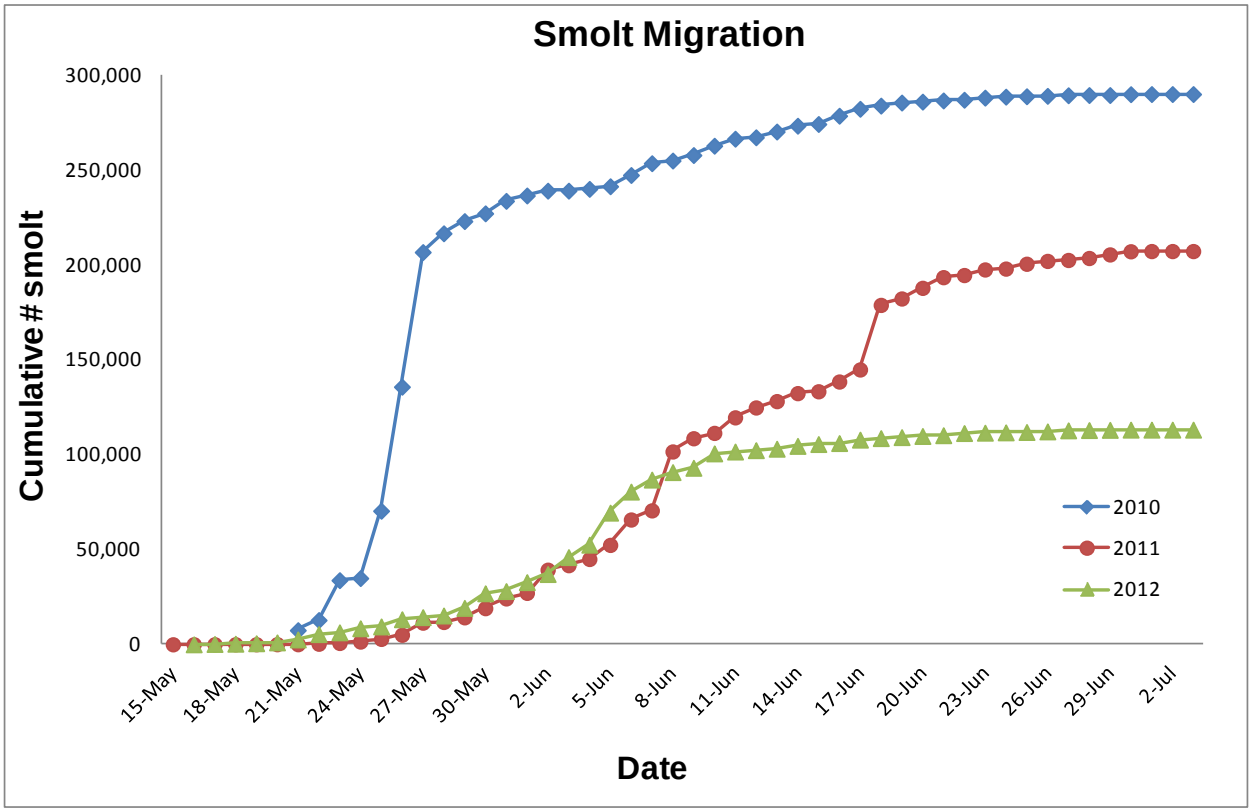
Appendix 9: Larson Lake 2011 smolt hourly log

	AM						PM												AM					
	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00	1:00	2:00	3:00	4:00	5:00
5/15/2011					0		0			0		0	0	0	0	0		0	3	3	0	2		
5/16/2011							0			1	0	0	0	0	0	0	0	1	4	1	8	4	0	
5/17/2011							0			0		0	0	0		0	0	0	0	2	1	0		
5/18/2011							0												4	0	2	1	0	
5/19/2011						0		0		0		0	0	0	0	0	0	0	0	1	0	0		
5/20/2011							0		0			0	0	0	0	0	0	0	8	8	10	3	4	
5/21/2011							0		0		0	0		0	0	0	0	0	0	0	1	0		
5/22/2011						0		0		0		0	0	0	0	0	0	0	0	0	189	63	0	
5/23/2011							0				0	1	0	0	0	0	71	0	1	162	88	89		
5/24/2011						0		0		1		1		1	0	0	1	0	36	257	269	169	0	
5/25/2011							0		0		0	0		0	0	0	0	0	650	315	300	144	0	
5/26/2011							0		0		0	0		0		1	0	0	39	1941	170	17	0	
5/27/2011							0		0		0	0	0	0		0	0	204	882	4452	511	332	0	
5/28/2011							0		0		0	0		0		0	0	0	180	74	12	94	0	
5/29/2011							0		0			0	0	0	0	0	0	599	384	1277	193			
5/30/2011							0		0			0	0	0	0	0	0	551	7	380	3823	70	0	
5/31/2011							0		0		0	0		0	0	0	234	868	1380	1445	1165	37	0	
6/1/2011							0		0		0	0	0	0	0	0	2	142	1544	1231	0	0		
6/2/2011							0		0		0	0	0	0	0	0	0	2120	2794	3676	2570	636	398	0
6/3/2011								85	0	0	365	0	0	0	16	0	0	671	768	425	68	0		
6/4/2011								0		0		0		0	64	0	0	619	1839	200	553			
6/5/2011							0		0		0	0		0	0	27	739	1273	1700	807	1196	567	624	
6/6/2011								0		0		0	0	1174	293	641	964	1339	499	1338	970	5485	675	
6/7/2011							0		0		0	0	0	291	0	1386	137	248	836	766	751	406	0	
6/8/2011							0		0		0	2520	1180	1671	3581	1857	2830	11342	4756	529	505	276	0	
6/9/2011							0		0		0	0	653	800	1017	1182	1473	781	1011	37				
6/10/2011								0		0		0	216	117	168	74	79	1248	452	243	226	0		
6/11/2011									1773	346	880	99	256	485	793	211	619	841	673	184	980			
6/12/2011							0	181	0	0	584	982	439	425	577	498	414	564	534	15				
6/13/2011								0		0		0	349	1097	0	0	612	373	848	56	8			
6/14/2011							0		0		0	0	0	260	346	825	103	208	2467	5				
6/15/2011								0		0		0		0	0	593	226	97	58	1	0			
6/16/2011								0		0		0	845	207	923	1261	289	453	91	1072	0			
6/17/2011			732					0		0		0		0	736	1340	1218	713	870	758	0			
6/18/2011								0		0		821	1286	1512	1095	1369	7956	12162	6075	1609	132			
6/19/2011								0		0		0	229	0	882	1311	0	806	156	0				
6/20/2011								0		0		0	0	940	1308	682	1293	1301	88	156	0			
6/21/2011								0		0		708	357	407	852	49	80	1107	480	1181	400	0		
6/22/2011								0		0		0	239	22	264	0	0	246	124	0				
6/23/2011								0		0		0	201	101	201	493	669	1015	113	151	0			
6/24/2011								0		0		0	0	0	0	0	0	384	0	71	0			
6/25/2011								0		0		0	0	0	0	708	407	231	403	102	0			
6/26/2011								0		0		0	0	0	3	0	182	773	525	13	0			
6/27/2011								0		0		0		0		0	333	132	31	0				
6/28/2011								0		0	84	0	0	0	0	0	794	0	11	155	0			
6/29/2011															120		0	514	633	129	323	161		
6/30/2011												0						622	870	48	117			
7/1/2011												0					0		0	2	40	75		
7/2/2011												0			0		0		0		0	0		
7/3/2011												0					0		0		0		0	
7/4/2011												0					0		0		0			
7/5/2011												0							0		0			
7/6/2011												0									0			
7/7/2011												0									0			
7/8/2011												0							0		0			
7/9/2011												0									0			
7/10/2011												0								0				
7/11/2011												0							0					
7/12/2011												0		0					0					
7/13/2011												0							0					
7/14/2011												0								3	5			
7/15/2011												0								0				

Appendix 10: Larson Lake 2012 daily smolt migration

	Sockeye		Coho		Chinook	Pink	Chum	Rainbow	Arctic Char
Date	Daily	Total	Daily	Total	Daily	Daily	Daily	Daily	Daily
5/16/2013	10	10	2	2	0	0	0	0	0
5/17/2013	194	204	4	6	0	0	0	6	0
5/18/2013	129	333	5	11	0	0	0	4	0
5/19/2013	242	575	5	16	0	0	0	4	0
5/20/2013	449	1,024	33	49	0	0	0	0	0
5/21/2013	1,562	2,586	4	53	0	0	0	1	0
5/22/2013	2,803	5,389	13	66	0	0	0	2	0
5/23/2013	942	6,331	3	69	0	0	0	3	0
5/24/2013	2,136	8,467	10	79	0	0	0	5	0
5/25/2013	967	9,434	8	87	0	0	0	1	0
5/26/2013	3,790	13,224	11	98	0	0	0	7	0
5/27/2013	1,115	14,339	6	104	0	0	0	3	0
5/28/2013	863	15,202	4	108	0	0	0	0	0
5/29/2013	4,016	19,218	2	110	0	0	0	1	0
5/30/2013	7,686	26,904	2	112	0	0	0	3	0
5/31/2013	1,170	28,074	0	112	0	0	0	0	0
6/1/2013	4,712	32,786	5	117	0	0	0	0	4
6/2/2013	4,263	37,049	2	119	0	0	0	3	0
6/3/2013	8,931	45,980	0	119	0	0	0	2	0
6/4/2013	6,545	52,525	2	121	0	0	0	3	0
6/5/2013	16,884	69,409	22	143	0	0	0	0	0
6/6/2013	11,092	80,501	12	155	0	0	0	1	0
6/7/2013	6,329	86,830	14	169	0	0	0	1	0
6/8/2013	3,952	90,782	7	176	0	0	0	0	0
6/9/2013	2,270	93,052	3	179	0	0	0	0	0
6/10/2013	7,590	100,642	29	208	0	0	0	1	0
6/11/2013	973	101,615	30	238	0	0	0	0	0
6/12/2013	727	102,342	108	346	0	0	0	0	0
6/13/2013	762	103,104	155	501	0	0	0	1	0
6/14/2013	1,498	104,602	66	567	0	0	0	0	0
6/15/2013	963	105,565	87	654	0	0	0	1	0
6/16/2013	519	106,084	43	697	0	0	0	0	0
6/17/2013	1,803	107,887	144	841	0	0	0	0	0
6/18/2013	806	108,693	29	870	0	0	0	1	0
6/19/2013	526	109,219	29	899	0	0	0	1	0
6/20/2013	604	109,823	29	928	0	0	0	1	0
6/21/2013	400	110,223	19	947	0	0	0	0	0
6/22/2013	1,143	111,366	113	1,060	0	0	0	0	0
6/23/2013	188	111,554	26	1,086	0	0	0	0	0
6/24/2013	168	111,722	29	1,115	0	0	0	0	0
6/25/2013	199	111,921	21	1,136	0	0	0	0	0
6/26/2013	306	112,227	80	1,216	0	0	0	1	0
6/27/2013	555	112,782	46	1,262	0	0	0	0	0
6/28/2013	153	112,935	7	1,269	0	0	0	0	0
6/29/2013	118	113,053	6	1,275	0	0	0	0	0
6/30/2013	105	113,158	3	1,278	0	0	0	0	0
Total		113,158		1,278	0	0	0	57	4

Appendix 11: Larson Lake 2010–2012 total sockeye salmon smolt migration



Appendix 12: Larson Lake 2010 macrozooplankton summary

Macrozooplankton Body Size (mm)

Date:	30-May	18-Jun	1-Jul	6-Jul	20-Sep	Seasonal Means: Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m²)	Weighted Biomass (mg/m²)
Ergasilus									
Ovig Ergasilus									
Epischura	0.64		1.71	1.42	1.45	1.31	1.38	18	21
Ovig Epischura									
Diaptomus	0.77	1.11	1.19	1.14	1.19	1.08	1.13	291	331
Ovig Diaptomus			1.20		1.29	1.25	1.27	8	8
Cyclops	0.80	0.82	0.84	0.84	0.81	0.82	0.82	665	662
Ovig. Cyclops	1.11	1.22	1.23	1.25	1.27	1.22	1.21	40	39
Bosmina	0.53	0.48	0.56	0.49	0.58	0.53	0.51	191	178
Ovig. Bosmina	0.69	0.61	0.62	0.62	0.68	0.64		3	
Daphnia l.	0.56	0.83	0.92	0.88	0.73	0.78	0.82	110	119
Ovig. Daphnia l.	1.09	1.15	1.22	1.19	1.04	1.14	1.06	60	52
Daphnia g.									
Ovig Daphnia g.									
Holopedium		0.72	0.83	0.75		0.7667	0.758184	11	11
Ovig Holopedium		0.93				0.93	0.93	7	7
Chydorinae									
Ovig Chydorinae									
Copepod Nauplii									
							TOTAL:	1,403	1,428

Macrozooplankton Density (No/m²)

Date:	30-May	18-Jun	1-Jul	6-Jul	20-Sep	Seasonal Mean (No/m²)
Ergasilus						
Ovig Ergasilus						
Epischura	1,146		2,038	3,057	1,070	1,828
Ovig Epischura						
Diaptomus	16,624	84,331	41,274	46,624	83,087	54,388
Ovig Diaptomus			510		1,426	968
Cyclops	151,529	231,083	233,885	230,446	558,074	281,003
Ovig. Cyclops	8,025	13,248	6,624	6,879	1,426	7,240
Bosmina	4,777	84,841	99,873	156,688	13,194	71,875
Ovig. Bosmina	2,293	764	510	382	357	861
Daphnia l.	191	5,860	59,108	36,306	100,917	40,476
Ovig. Daphnia l.	382	1,529	2,548	3,057	41,722	9,848
Daphnia g.						
Ovig Daphnia g.						
Holopedium		2,548	1,529	1,529		1,869
Ovig Holopedium		764				764
Chydorinae						
Ovig Chydorinae						
Copepod Nauplii						
					Total:	471,120

Larson Lake Site A 2010

Macrozooplankton Body Size (mm)

Date:	30-May	18-Jun	1-Jul	6-Jul	20-Sep	Seasonal Means: Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m²)	Weighted Biomass (mg/m²)
Ergasilus									
Ovig Ergasilus									
Epischura	0.65	1.61	1.74	1.68	1.69	1.47	1.65	28	38
Ovig Epischura									
Diaptomus	0.73	1.04	1.17	1.16	1.19	1.06	1.09	288	311
Ovig Diaptomus				1.22	1.22	1.22	1.22	16	16
Cyclops	0.85	0.78	0.84	0.86	0.84	0.83	0.84	402	406
Ovig. Cyclops	1.11	1.10	1.27	1.20	1.26	1.19	1.17	37	36
Bosmina	0.56	0.45	0.58	0.51	0.57	0.53	0.51	237	213
Ovig. Bosmina	0.68	0.62		0.70	0.58	0.65	0.63	41	39
Daphnia l.	0.82	0.80	0.91	0.92	0.74	0.84	0.82	110	105
Ovig. Daphnia l.	1.19	1.07	1.16	1.22	1.01	1.13	1.09	47	44
Daphnia g.									
Ovig Daphnia g.									
Holopedium	0.59	0.63		0.72		0.65	0.63	9	8
Ovig Holopedium									
Chydorinae									
Ovig Chydorinae									
Copepod Nauplii									
							Total:	1,217	1,216

Macrozooplankton Density (No/m²)

Date:	30-May	18-Jun	1-Jul	6-Jul	20-Sep	Seasonal Mean (No/m²)
Ergasilus						
Ovig Ergasilus						
Epischura	382	955	1,911	5,732	1,223	2,041
Ovig Epischura						
Diaptomus	30,000	80,828	38,981	96,306	39,939	57,211
Ovig Diaptomus				2,675	1,630	2,153
Cyclops	245,732	125,924	70,701	165,478	216,200	164,807
Ovig. Cyclops	8,025	7,643	3,057	16,051	1,223	7,200
Bosmina	6,879	74,331	32,866	314,140	8,762	87,396
Ovig. Bosmina	5,159	34,586		764	204	10,178
Daphnia l.	1,529	7,452	44,331	31,338	90,881	35,106
Ovig. Daphnia l.	573	764	3,822	12,229	22,007	7,879
Daphnia g.						
Ovig Daphnia g.						
Holopedium	4,395	573		1,911		2,293
Ovig Holopedium						
Chydorinae						
Ovig Chydorinae						
Copepod Nauplii						
					Total:	376,263

Larson Lake Site B 2010

Average Weighted Biomass: 1,322 (mg/m²)

Average Seasonal Density: 423,692 (No/m²)

Appendix 13: Larson Lake 2011 macrozooplankton summary

Macrozooplankton Body Size (mm)

Date:	16-Jun	14-Jul	10-Aug	3-Sep	21-Sep	Seasonal Means: Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m²)	Weighted Biomass (mg/m²)
Ergasilus									
Ovig Ergasilus									
Epischura	0.52	1.38	1.54	1.50	1.75	1.34	1.40	24	28
Ovig Epischura									
Diaptomus	0.94	1.07	1.09	1.13	1.12	1.07	1.02	260	227
Ovig Diaptomus		1.19	1.08			1.14	1.08	156	136
Cyclops	0.91	0.86	0.95	0.94	0.85	0.90	0.89	532	513
Ovig. Cyclops	1.14	1.24	1.24	1.31	1.31	1.25	1.17	50	43
Bosmina	0.46	0.47	0.48	0.37	0.40	0.44	0.46	17	19
Ovig. Bosmina	0.71			0.50		0.61	0.67	2	3
Daphnia l.	0.54	0.91	0.79	0.91	0.88	0.81	0.89	206	258
Ovig. Daphnia l.			1.10	1.21	1.17	1.16	1.20	48	52
Daphnia g.									
Ovig Daphnia g.									
Holopedium		0.85	0.94	1.00		0.93	0.93	14	14
Ovig Holopedium									
Chydorinae									
Ovig Chydorinae									
Copepod Nauplii									
							TOTAL:	1,309	1,292

Macrozooplankton Density (No/m²)

Date:	16-Jun	14-Jul	10-Aug	3-Sep	21-Sep	Seasonal Mean (No/m²)
Ergasilus						
Ovig Ergasilus						
Epischura	1,274	1,783	3,312	4,586	764	2,344
Ovig Epischura						
Diaptomus	110,828	108,535	255	18,854	11,462	49,987
Ovig Diaptomus		764	49,936			25,350
Cyclops	168,153	90,191	132,229	103,185	427,916	184,335
Ovig. Cyclops	30,318	3,567	5,860	1,019	2,038	8,560
Bosmina	5,860	35,669	2,548	2,803	1,783	9,733
Ovig. Bosmina	1,019			255		637
Daphnia l.	510	510	7,643	196,178	152,827	71,534
Ovig. Daphnia l.			255	18,854	3,566	7,558
Daphnia g.						
Ovig Daphnia g.						
Holopedium		1,274	1,783	1,274		1,444
Ovig Holopedium						
Chydorinae						
Ovig Chydorinae						
Copepod Nauplii						
					Total:	361,481

Larson Lake Site A 2011

Macrozooplankton Body Size (mm)

Date:	16-Jun	14-Jul	10-Aug	3-Sep	21-Sep	Seasonal Means: Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m²)	Weighted Biomass (mg/m²)
Ergasilus									
Ovig Ergasilus									
Epischura	0.52	1.75	1.42	1.48	1.38	1.31	1.18	62	46
Ovig Epischura									
Diaptomus	0.91	1.09	1.09	1.13	1.10	1.06	1.00	415	350
Ovig Diaptomus		1.22	1.22			1.22	1.08	7	5
Cyclops	0.85	0.95	0.92	0.90	0.82	0.89	0.87	471	451
Ovig. Cyclops	1.12	1.25	1.29	1.34	1.32	1.26	1.19	35	31
Bosmina	0.43	0.49	0.46		0.39	0.44	0.48	91	109
Ovig. Bosmina	0.63	0.59	0.40			0.54	0.61	4	5
Daphnia l.	0.77	1.14	0.93	0.97	0.89	0.94	0.92	286	275
Ovig. Daphnia l.	0.83		1.38	1.26	1.22	1.17	1.24	42	48
Daphnia g.									
Ovig Daphnia g.									
Holopedium	0.72	0.88	0.89		0.88	0.84	0.89	8	9
Ovig Holopedium	0.60					0.6	0.6		
Chydorinae									
Ovig Chydorinae									
Copepod Nauplii									
							Total:	1,422	1,329

Macrozooplankton Density (No/m²)

Date:	16-Jun	14-Jul	10-Aug	3-Sep	21-Sep	Seasonal Mean (No/m²)
Ergasilus						
Ovig Ergasilus						
Epischura	6,115	1,274	16,306	3,822	4,585	6,420
Ovig Epischura						
Diaptomus	178,854	151,338	51,210	17,834	6,113	81,070
Ovig Diaptomus		1,529	255			892
Cyclops	220,127	84,586	121,274		248,599	168,647
Ovig. Cyclops	16,561	5,605	3,057	1,529	2,802	5,911
Bosmina	17,580	111,338	2,803	116,178	2,547	50,089
Ovig. Bosmina	1,529	2,548	255			1,444
Daphnia l.	2,038	1,274	39,745	141,911	170,402	71,074
Ovig. Daphnia l.	510		4,841	17,580	3,057	6,497
Daphnia g.						
Ovig Daphnia g.						
Holopedium	510	510	3,057		255	1,083
Ovig Holopedium	255					255
Chydorinae						
Ovig Chydorinae						
Copepod Nauplii						
					Total:	393,382

Larson Lake Site B 2011

Average Weighted Biomass: 1,311 (mg/m²)

Average Seasonal Density: 377,432 (No/m²)

Appendix 14: Larson Lake 2012 macrozooplankton summary

Macrozooplankton Body Size (mm)

Date:	18-Jun	16-Jul	15-Aug	24-Sep	Seasonal Means: Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus								
Ovig Ergasilus								
Epischura	0.58	1.45	1.56	1.66	1.31	1.22	40	32
Ovig Epischura								
Diaptomus	0.92	1.13	1.23	1.23	1.13	1.10	154	144
Ovig Diaptomus				1.19	1.19	1.19	3	3
Cyclops	0.90	0.90	0.80	0.92	0.88	0.87	965	953
Ovig. Cyclops	1.14	1.25	1.26	1.32	1.24	1.20	109	102
Bosmina	0.31	0.47	0.50	0.39	0.42	0.49	34	47
Ovig. Bosmina	0.36	0.60	0.54	0.46	0.49	0.50	1	1
Daphnia l.	0.91	0.98	0.96	0.92	0.94	0.95	121	123
Ovig. Daphnia l.		1.36	1.30	1.13	1.26	1.30	35	37
Daphnia g.								
Ovig Daphnia g.								
Holopedium	0.73	1.05	0.85	1.06	0.92	0.98	13	15
Ovig Holopedium	0.68	1.02			0.85	0.98	8	12
Chydorinae								
Ovig Chydorinae								
Copepod Nauplii								
						TOTAL:	1,484	1,470

Macrozooplankton Density (No/m^2)

Date:	18-Jun	16-Jul	15-Aug	24-Sep	Seasonal Mean (No/m^2)
Ergasilus					
Ovig Ergasilus					
Epischura	5,350	3,822	6,115	1,070	4,089
Ovig Epischura					
Diaptomus	30,573	37,261	21,911	12,685	25,608
Ovig Diaptomus				458	458
Cyclops	379,363	420,382	395,414	214,570	352,432
Ovig. Cyclops	35,669	22,611	16,051	1,834	19,041
Bosmina	764	25,796	56,306	2,292	21,290
Ovig. Bosmina	255	318	510	306	347
Daphnia l.	4,076	35,669	34,140	46,154	30,010
Ovig. Daphnia l.		5,414	6,115	2,140	4,556
Daphnia g.					
Ovig Daphnia g.					
Holopedium	764	3,503	764	458	1,372
Ovig Holopedium	255	1,911			1,083
Chydorinae					
Ovig Chydorinae					
Copepod Nauplii					
				Total:	460,286

Larson Lake Site A 2012

Macrozooplankton Body Size (mm)

Date:	18-Jun	16-Jul	15-Aug	24-Sep	Seasonal Means: Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus								
Ovig Ergasilus								
Epischura	0.57	1.95	1.51	1.40	1.36	1.20	63	44
Ovig Epischura								
Diaptomus	0.90	1.15	1.22	1.24	1.13	1.10	291	273
Ovig Diaptomus		1.36	1.38	1.58	1.44	1.42	2	2
Cyclops	0.91	0.98	0.88	0.89	0.92	0.92	584	585
Ovig. Cyclops	1.17	1.22	1.24	1.36	1.25	1.21	109	101
Bosmina	0.41	0.48	0.48	0.34	0.43	0.46	41	48
Ovig. Bosmina	0.68	0.61	0.55	0.51	0.59	0.56	2	2
Daphnia l.	0.88	0.99	0.96	0.99	0.96	0.99	253	271
Ovig. Daphnia l.	1.19	1.43	1.45	1.13	1.30	1.37	30	34
Daphnia g.								
Ovig Daphnia g.								
Holopedium	0.72	0.99	1.22	0.86	0.95	0.95	15	15
Ovig Holopedium		1.13			1.13	1.13		
Chydorinae								
Ovig Chydorinae								
Copepod Nauplii								
						Total:	1,391	1,377

Macrozooplankton Density (No/m^2)

Date:	18-Jun	16-Jul	15-Aug	24-Sep	Seasonal Mean (No/m^2)
Ergasilus					
Ovig Ergasilus					
Epischura	9,682	4,586	8,153	917	5,835
Ovig Epischura					
Diaptomus	56,051	70,510	51,210	15,130	48,225
Ovig Diaptomus		191	255	153	200
Cyclops	353,376	163,758	132,994	134,335	196,116
Ovig. Cyclops	31,338	33,057	9,172	1,987	18,889
Bosmina	1,529	40,318	42,548	12,226	24,155
Ovig. Bosmina	255	191	1,529	611	647
Daphnia l.	5,350	76,051	14,777	147,173	60,838
Ovig. Daphnia l.	510	9,554	2,038	2,904	3,752
Daphnia g.					
Ovig Daphnia g.					
Holopedium	764	4,204	255	764	1,497
Ovig Holopedium		3,057			3,057
Chydorinae					
Ovig Chydorinae					
Copepod Nauplii					
				Total:	363,208

Larson Lake Site B 2012

Average Weighted Biomass: 1,424 (mg/m^2)

Average Seasonal Density: 411,747 (No/m^2)