

**Shell Lake
Sockeye Salmon Smolt
Data Report
2010–2012**

**Prepared by:
Nathan Weber, Biologist
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The Shell Lake Project was made possible through a 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 Shell Lake. This Shell Lake Data Report encompasses data collected from the 2010 through the 2012 sockeye smolt migrations as it falls under the Alaska Sustainable Salmon Fund grant.

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 Shell Lake Data Report was prepared by CIAA under award of the Alaska Sustainable Salmon Fund (AKSSF) 45918 from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and administered by the Alaska Department of Fish and Game (ADF&G). The statements, findings, conclusions, and recommendations are those of the author 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 Shell Lake Project from 2010 through 2012. Appreciation is extended to the 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 go to the Cook Inlet Aquaculture Association Board of Directors and the Alaska Department of Fish and Game for the support they provided during this project.

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ABSTRACT

As part of the continued evaluation of lakes in the Susitna River watershed to determine the sockeye salmon (*Oncorhynchus nerka*) abundance in key salmon producing lakes with and without northern pike (*Esox lucius*), Cook Inlet Aquaculture Association (CIAA) and the Alaska Department of Fish and Game (ADF&G) agreed to monitor sockeye salmon smolt migrations from Shell Lake.

The 2010 Shell Lake salmon smolt migration was enumerated from 24 May and continued daily until 22 June. The reported ice-out from local residents was 21 May and the staff arrived and constructed the collection facility on 24 May. During the migration 2,733 sockeye (*O. nerka*) salmon smolt and 111 coho salmon (*O. kisutch*) smolt were captured leaving Shell Lake. On 27 May, smolt trap panels were unanchored due to strong water flow from approximately 6 PM to 10 PM when staff was harvesting northern pike in the lake. It is not known the number of fish that may have migrated during this time when the collection facility was not intact. Staff collected 366 sockeye scale samples of which 365 samples were readable. The age composition of the sockeye salmon migration was largely comprised of age-2 class at 95.6% ($\pm 0.01\%$), followed by age-1 class at 4.1% ($\pm 1.4\%$), and age-3 class at 0.3%. Age-2 sockeye smolt had an average length 140 mm (± 1.0 mm) and average weight 28.3 g (± 0.6 g). Age-1 sockeye smolt had average length 112 mm (± 6.6 mm) and average weight 14.4 g (± 1.5 g). There was one age-3 sockeye smolt that measured 203 mm in length and weighed 76.2 g. Staff also made measurements on 83 migrating coho salmon smolt. Age-2 coho smolt was the largest class at 56.9% ($\pm 0.8\%$) with an average length 123 mm (± 2.1 mm) and average weight 20.3 g (± 1.0 g). Age-1 coho smolt class followed comprising of 43.1% ($\pm 1.3\%$) with an average length 114 mm (± 3.1 mm) and average weight 16.2 g (± 1.2 g). Other fish counted during this time were 9 adult rainbow trout (*O. mykiss*), and 200 longnose sucker (*Catostomus catostomus*).

The 2011 Shell Lake salmon smolt migration was enumerated from 17 May and continued daily until 23 June. The reported ice-out from staff was 28 May and the staff arrived and constructed the collection facility on 17 May. During the migration 17 sockeye salmon (*O. nerka*) smolt and 187 coho salmon (*O. kisutch*) smolt were captured leaving Shell Lake. The smolt collection facility was under constant stress from lake ice, high water and large woody debris. On 25 May, panels were unanchored due to high water and lake ice chunks ripped a section in the fyke net. Ice chunks traveling from the lake required the crew to open panels to allow free passage downstream from 12 PM to 2 PM on 26 May, and again on 27 May at times 1–2 PM, 5–6 PM, and 7:30–11:30 PM. The trap was relocated farther downstream of a series of waterfalls on 1 June in order to see if smolt were avoiding the trap facility. It is not known the number of fish that may have migrated during the periods when the collection facility was not intact. Staff collected 17 sockeye scale samples of which all samples were readable. The age composition of the sockeye salmon migration was largely comprised of age-3 class at 82.4% ($\pm 1.2\%$) and

followed by age-2 class at 17.6% ($\pm 17.3\%$). Age-3 sockeye smolt had an average length 179 mm (± 6.3 mm) and average weight 55.5 g (± 5.8 g). Age-2 sockeye smolt had average length 154 mm (± 16.0 mm) and average weight 36.9 g (± 10.2 g). Staff also made measurements on 174 migrating coho salmon smolt. Age-2 coho smolt was the largest class at 82.2% ($\pm 0.1\%$) with an average length 140 mm (± 1.7 mm) and average weight 29.9 g (± 1.1 g). Age-1 coho smolt class followed comprising of 15.3% ($\pm 1.4\%$) with an average length 121 mm (± 5.3 mm) and average weight 19.5 g (± 2.2 g). The proportion of age-3 smolt class was 3.1% ($\pm 4.2\%$) with an average length 156 mm (± 2.8 mm) and average weight 41.7 g (± 3.5 g). Other fish counted during this time were 14 adult rainbow trout (*O. mykiss*), and 8 longnose sucker (*C. catostomus*).

The 2012 Shell Lake salmon smolt migration was enumerated from 18 May and continued daily until 20 June. The reported ice-out from staff was 28 May and the staff arrived and constructed the collection facility on 18 May. During the migration 23 sockeye salmon (*O. nerka*) smolt and 124 sockeye salmon fry were captured leaving Shell Lake. Staff collected 22 sockeye scale samples of which all samples were readable. The age composition of the sockeye salmon migration was largely comprised of age-2 class at 77.3% ($\pm 1.2\%$), followed by age-3 class at 18.2% ($\pm 11.6\%$), and age-1 class at 4.5%. Age-2 sockeye smolt had an average length 134 mm (± 7.9 mm) and average weight 25.8 g (± 4.3 g). Age-3 sockeye smolt had average length 229 mm (± 68.9 mm) and average weight 120.8 g (± 84.8 g). There was one age-1 sockeye smolt that measured 99 mm in length and weighed 9.0 g. There were no measurements collected from sockeye fry. Other fish counted during this time were 3 adult rainbow trout (*O. mykiss*), and 1 Dolly Varden (*Salvelinus malma*).

In addition to smolt monitoring, CIAA assisted ADF&G in harvesting and sampling northern pike in Shell Lake from 2010–2012. The final results from the 2010–2012 northern pike sampling are expected to be published by ADF&G at a later date.

INTRODUCTION AND PURPOSE

To better understand the recent low adult sockeye salmon (*Oncorhynchus nerka*) returns to the Susitna River drainage system, the Cook Inlet Aquaculture Association (CIAA), in cooperation with the Alaska Department of Fish and Game (ADF&G), assessed 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 was to enumerate the smolt and adult returns and assessed the characteristics of these populations in terms of age composition, sex and size. Additionally, for some lake systems, environmental conditions and water quality measurements were collected as well as genetic samples, mark-recapture studies, and hydroacoustic surveys. The goal was 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 salmon smolt migrations from Shell Lake was performed in all three years of the 3-year Susitna River Salmon Monitoring Project. Shell Lake was chosen for enumeration because invasive northern pike were known to be present and because the lake is a historically salmon-producing system.

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PROJECT AREA

Shell Lake is located in the Yentna River basin of the larger Susitna River drainage (Figure 1). Shell Lake is classified in under the Anadromous Waters Catalog (AWC) number 247-41-10200-2053-3205-4052-0010 (Johnson and Blanche, 2010). The lake covers 523.4 ha, has a maximum depth of 28.7 m, a mean depth of 11.9 m, 16.6 km of shoreline, and is located at an elevation 123 m above sea level (Kyle, et al. 1993). Shell Lake has 7 small tributaries and discharges southeast via Shell Creek to the Skwentna River (Figure 2). Limnology sampling took place at two sites labeled A and B on Figure 2. Smolt monitoring took place in Shell Creek (AWC 247-10200-2053-3205-4052) in all three years of the study.

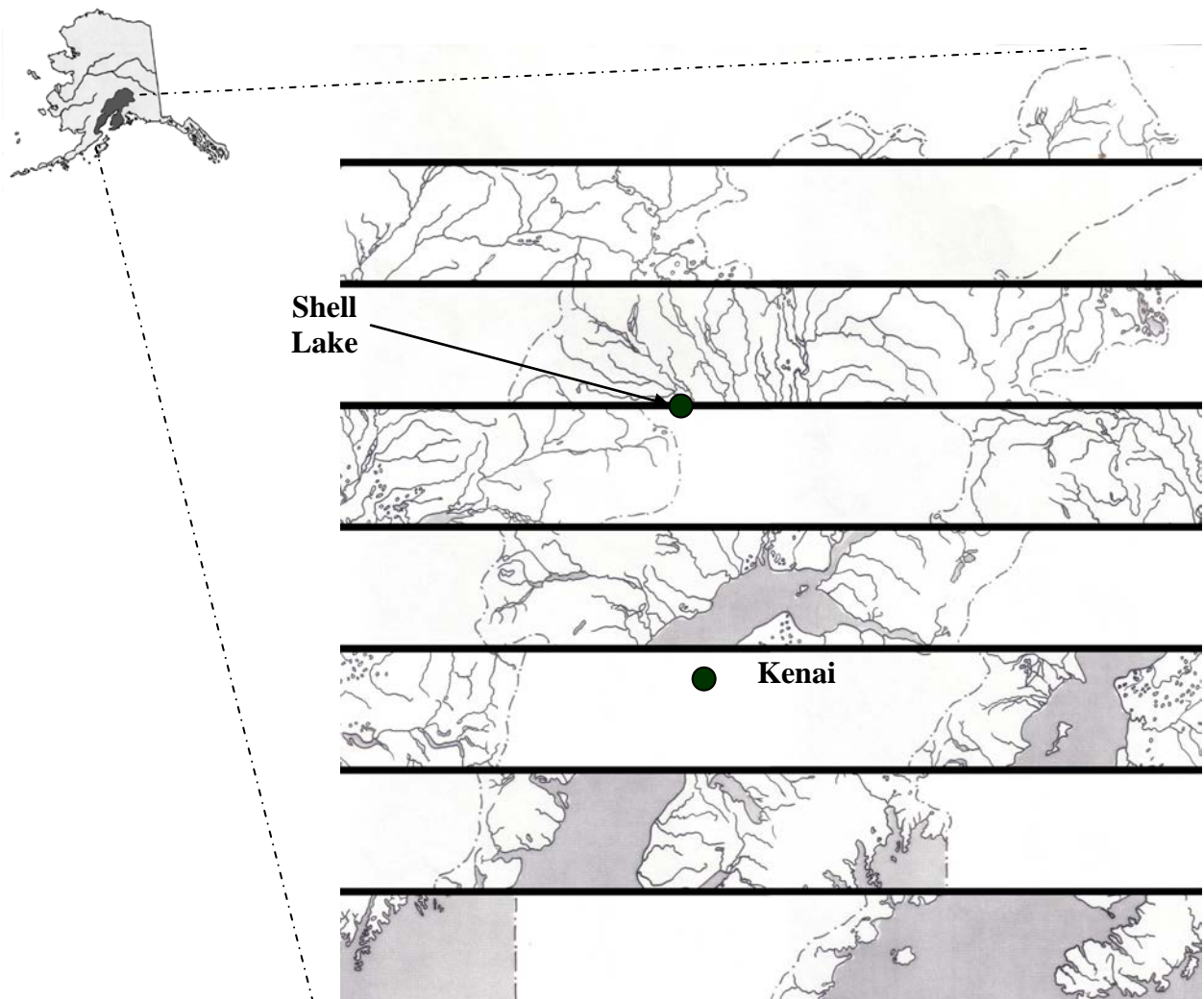


Figure 1. Shell Lake in Relation to Cook Inlet and Alaska

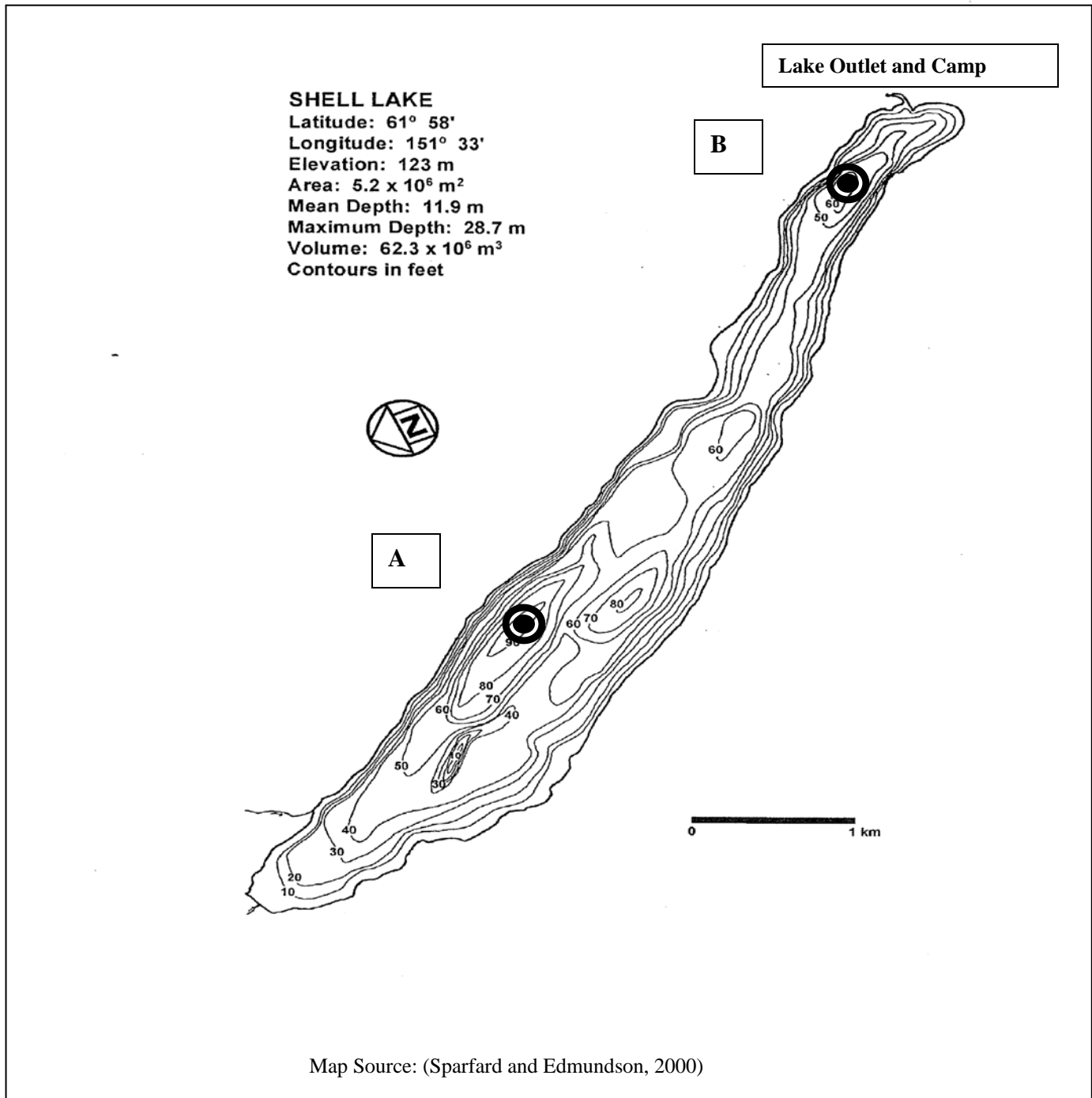


Figure 2. Bathymetric Map of Shell Lake Showing Limnology Sampling Sites A and B, Lake Outlet, and Personnel Camp

METHODS

Limnological Sampling

Assessments of water quality occurred during the open water season, May through August. For 2010 and 2011 water chemistry plus zooplankton samples were collected. However, in 2012, only zooplankton samples were collected. One primary site (A), with GPS coordinates 61° 57.700 N and 151° 33.302 W, was sampled for dissolved oxygen, temperature, light transmission profile, Secchi disk transparency, and zooplankton densities. Samples for analysis of phosphorous, carbon, chlorophyll *a*, phaeophytin *a*, nitrogen, calcium, magnesium, iron, conductivity, pH, alkalinity, turbidity, and color were also collected with a Van Dorn horizontal configuration sampler one meter below the surface and from the midhypolimnion. One secondary site (B), with GPS coordinates 61° 56.487 N and 151° 31.293 W, was limited to the zooplankton density and Secchi disk transparency. Water samples were collected by CIAA and water analysis completed by ADF&G. Sample collection and analysis procedures are described by Koenings, et al. (1986).

Environmental Conditions

To assess the environmental conditions during the salmon smolt migration to Shell Lake, percent cloud cover was visually estimated, water level fluctuations in Shell Creek were measured to the nearest tenth of a foot, precipitation measured to the nearest millimeter, and water and air temperatures measured to the nearest degree centigrade. All measurements were all recorded at 5:00 PM each day (CIAA Staff, 2009).

Smolt Enumeration

To enumerate the smolt migration, a smolt trap was temporarily placed in Shell Creek. The smolt trap consisted of a modified fyke net with Vexar® netting leads and a double compartment live-box. The leads and fyke net funneled migrating smolt into the live-box. A swing gate remotely controlled by the trap operators directed smolt into one of two live-box compartments where they were enumerated and a sample was collected. A total count was made during the smolt migrations.

Smolt Characteristics

The Shell Lake smolt characteristics were assessed by collecting a sample of the migrating smolts and measured for age, weight, and length. Throughout each day, field personnel randomly collected sockeye (up to 40 per day) and coho samples (up to 20 per day). Each smolt collected for evaluation was first measured to the nearest millimeter for fork length¹ and then weighed to the nearest 0.1 g. Several scales were also removed from the primary growth area² and mounted on a glass slide for subsequent age determination. Scale samples were read by CIAA full-time staff at headquarters in Kenai.

¹ Standard fork length was measured from the tip of the snout to the fork of the tail.

² The 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 AND DISCUSSION

Limnological Conditions

Limnological conditions are a key component in understanding Shell Lake productivity and rearing conditions in this monitoring study. A summary of limnological conditions is listed below (Table 1 and Table 2). Analysis for limnological conditions was provided by ADF&G.

Table 1. Summary of Open Water Season Water Quality Characteristics

AVERAGE WATER QUALITY - 1 METER																					
Year	TP (ug/l)	TPP (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)	EZD Sta (m)	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb (NTU)	Color (Pt)	Ca (mg/l)	Mg (mg/l)	Fe (ug/l)	Secchi Sta (meters)
2006	11.2	4.3	3.7	302.7	16.1	559.2	170 :1	4,202	749	1.39	0.46	A 6.0	32	5.6	10.1	0.4	22	4.3	0.5	85	A 4.0
2007	7.6	4.2	3.7	253.7	12.5	480.8	213 :1	4,205	484	0.99	0.36	A 7.5	37	6.7	15.3	0.5	11	4.8	0.7	44	A 5.1
2008	14.0	11.3	2.4	233.2	13.4	417.4	103 :1	3,875	220	0.79	0.50	A 8.3	31	6.7	13.1	0.6	20	3.9	0.8	62	A 4.1
2009	12.1	8.1	1.3	222.0	8.1	393.8	113 :1	3,778	241	1.03	0.45	A 7.8	35	6.5	12.8	0.6	15	4.4	1.0	51	A 4.3
2010	7.0	3.9	1.6	ND	10.7	422.7	ND :1	3,972	166	0.94	0.28	A 9.0	35	6.6	12.1	0.5	18	4.1	1.1	64	A 5.0
2011	6.3	3.0	2.5	ND	7.7	314.3	ND :1	3,670	223	1.35	0.44	A 7.9	34	7.1	13.9	0.5	20	4.3	1.1	71	A 4.4

AVERAGE WATER QUALITY - HYPOLIMNION																					
Year	TP (ug/l)	TPP (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)	EZD Sta (m)	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb (NTU)	Color (Pt)	Ca (mg/l)	Mg (mg/l)	Fe (ug/l)	Secchi Sta (meters)
2006	7.6	4.2	3.7	253.7	12.5	480.8	213 :1	4,205	484	0.99	0.36	B 7.5	37	6.7	15.3	0.5	11	4.8	0.7	44	B 5.1
2007	11.2	4.3	3.7	302.7	16.1	559.2	170 :1	4,202	749	1.39	0.46	B 6.0	32	5.6	10.1	0.4	22	4.3	0.5	85	B 4.0
2008	8.7	6.2	2.3	210.1	10.2	467.1	172 :1	3,929	175	0.54	0.49	B 7.4	31	6.5	12.7	0.5	20	4.0	0.9	61	B 4.4
2009	9.4	5.9	1.6	204.6	9.6	480.4	162 :1	3,928	141	0.41	0.41	B 7.6	35	6.4	12.5	0.5	17	4.4	1.0	50	B 4.4
2010	7.6	4.7	1.7	ND	23.7	446.4	ND :1	4,159	170	0.50	0.39	B ND	37	6.5	12.3	0.4	18	4.1	1.2	74	B 4.9
2011	6.7	3.3	2.3	ND	9.2	375.5	ND :1	3,837	176	0.64	0.36	B ND	35	7.3	13.7	0.5	20	4.3	1.0	73	B 4.6

EZD and Secchi provided by CIAA.

Open water season only.

ND = No Data

TKN results are not available due to equipment failure.

Table 2. Summary of Seasonal Density and Biomass of Zooplankton Population

Year	Density	Biomass
	Seasonal Mean (No/m2)	Seasonal Weighted Mean (mg/m2)
2006	147,436	440
2007	281,941	791
2008	132,824	533
2009	231,291	621
2010	367,056	1,008
2011	243,464	707
2012	183,337	646

Environmental Conditions

During the 2010 smolt migration, environmental conditions were monitored from 25 May through 22 June. Stream levels fluctuated +1.00 foot during this time. Stream temperatures

averaged 12°C and ranged from 8 to 17°C. Air temperatures averaged 16°C and ranged from 8 to 25°C. None of the days were clear, 52% were partly cloudy, and 48% were completely overcast. Measurable rain was recorded on 19 days during the smolt migration. A total of 56 mm of rain fell during this period.

During the 2011 smolt migration, environmental conditions were monitored from 18 May through 23 June. Environmental conditions were separated into two periods, 18 May through 31 May (Period 1) and 1 June through 23 June (Period 2) when the smolt trap was relocated on June 1. During Period 1, stream levels fluctuated +0.46 feet. Stream temperatures averaged 5°C and ranged from 3 to 9°C. Air temperatures averaged 18°C and ranged from 10 to 26°C. Thirty-six percent of the days were clear, 43% were partly cloudy, and 21% were completely overcast. Measurable rain was recorded on 4 days and a total of 2 mm of rain fell during this period. During Period 2, stream levels fluctuated +0.47 feet. Stream temperatures averaged 7°C and ranged from 0 to 16°C. Air temperatures averaged 17°C and ranged from 10 to 26°C. None of the days were clear, 74% were partly cloudy, and 26% were completely overcast. Measurable rain was recorded on 9 days and a total of 22 mm of rain fell during this period.

During the 2012 smolt migration, environmental conditions were monitored from 18 May through 21 June. Stream levels fluctuated +1.16 feet. Stream temperatures averaged 7°C and ranged from 4 to 14°C. Air temperatures averaged 17°C and ranged from 8 to 31°C. Thirty-one percent of the days were clear, 34% were partly cloudy, and 34% were completely overcast. Measurable rain was recorded on 13 days and a total of 23 mm of rain fell during this period.

Smolt Enumeration

The 2010 Shell Lake salmon smolt migration was enumerated from 24 May and continued daily until 22 June. The reported ice-out from local residents was 21 May and the staff arrived and constructed the collection facility on 24 May. During the migration 2,733 sockeye salmon (*O. nerka*) smolt and 111 coho salmon (*O. kisutch*) smolt were captured leaving Shell Lake (Table 3 and 4). Other fish counted during this time were 9 adult rainbow trout (*O. mykiss*), and 200 longnose sucker (*C. catostomus*). On 27 May, smolt trap panels were unanchored due to strong water flow from approximately 6 PM to 10 PM when staff was away harvesting northern pike in the lake. Fish had free travel up and downstream during this period, but highly unlikely many juvenile salmon migrated during this time.

The 2011 Shell Lake salmon smolt migration was enumerated from 17 May and continued daily until 23 June. The reported ice-out from staff was 28 May and the staff arrived and constructed the collection facility on 17 May. During the migration 17 sockeye salmon (*O. nerka*) smolt and

187 coho salmon (*O. kisutch*) smolt were captured leaving Shell Lake. Other fish counted during this time were 14 adult rainbow trout (*O. mykiss*), and 8 longnose sucker (*C. catostomus*). The smolt collection facility was under constant stress from lake ice, high water and large woody debris. On 25 May, panels were unanchored due to high water. An ice chunk also ripped a section from the fyke net on 25 May. Ice chunks traveling from the lake required the crew to open panels to allow free passage downstream from 12 PM to 2 PM on 26 May, and again on 27 May at times 1–2 PM, 5–6 PM, and 7:30–11:30 PM. The trap was relocated farther downstream of a series of waterfalls on 1 June in order to see if smolt were avoiding the trap facility. Fish had free travel up and downstream during this period, but doubtful that many juvenile salmon migrated during this time.

The 2012 Shell Lake salmon smolt migration was enumerated from 18 May and continued daily until 20 June. The reported ice-out from staff was 28 May and the staff arrived and constructed the collection facility on 18 May. During the migration 23 sockeye salmon (*O. nerka*) smolt and 124 sockeye salmon fry were captured leaving Shell Lake. Other fish counted during this time were 3 adult rainbow trout (*O. mykiss*), and 1 Dolly Varden (*S. malma*). The crew remained on-site until 11 August to harvest northern pike (*E. lucius*).

Smolt Characteristics

In 2010, staff collected 366 sockeye scale samples of which 365 samples were readable. The age composition of the sockeye salmon migration was largely comprised of age-2 class at 95.6% ($\pm 0.01\%$), followed by age-1 class at 4.1% ($\pm 1.4\%$), and age-3 class at 0.3%. Age-2 sockeye smolt had an average length 140 mm (± 1.0 mm) and average weight 28.3 g (± 0.6 g). Age-1 sockeye smolt had average length 112 mm (± 6.6 mm) and average weight 14.4 g (± 1.5 g). There was one age-3 sockeye smolt which measured 203 mm in length and weighed 76.2 g (Table 3).

Staff also made measurements on 83 migrating coho salmon smolt. Age-2 coho smolt was the largest class at 56.9% ($\pm 0.8\%$) with an average length 123 mm (± 2.1 mm) and average weight 20.3 g (± 1.0 g). Age-1 coho smolt class followed comprising of 43.1% ($\pm 1.3\%$) with an average length 114 mm (± 3.1 mm) and average weight 16.2 g (± 1.2 g).

In 2011, staff collected 17 sockeye scale samples of which all samples were readable. The age composition of the sockeye salmon migration was largely comprised of age-3 class at 82.4% ($\pm 1.2\%$) and followed by age-2 class at 17.6% ($\pm 17.3\%$). Age-3 sockeye smolt had an average length 179 mm (± 6.3 mm) and average weight 55.5 g (± 5.8 g). Age-2 sockeye smolt had average length 154 mm (± 16 mm) and average weight 36.9 g (± 10.2 g).

Staff also made measurements on 174 migrating coho salmon smolt. Age-2 coho smolt was the largest class at 82.2% ($\pm 0.1\%$) with an average length 140 mm (± 1.7 mm) and average weight 29.9 g (± 1.1 g). Age-1 coho smolt class followed comprising of 15.3% ($\pm 1.4\%$) with an average length 121 mm (± 5.3 mm) and average weight 19.5 g (± 2.2 g). The proportion of age-3 smolt class was 3.1% ($\pm 4.2\%$) with an average length 156 mm (± 2.8 mm) and average weight 41.7 g (± 3.5 g) (Table 4).

In 2012, staff collected 22 sockeye smolt scale samples of which all samples were readable. The age composition of the sockeye salmon migration was largely comprised of age-2 class at 77.3% ($\pm 1.2\%$), followed by age-3 class at 18.2% ($\pm 11.6\%$), and age-1 class at 4.5%. Age-2 sockeye smolt had an average length 134 mm (± 7.9 mm) and average weight 25.8 g (± 4.3 g). Age-3 sockeye smolt had average length 229 mm (± 68.9 mm) and average weight 120.8 g (± 84.8 g). There was one age-1 sockeye smolt which measured 99 mm in length and weighed 9.0 g. There were no measurements collected from sockeye fry and juvenile coho salmon were not available for measurement.

Table 3. Summary of Sockeye Salmon Smolt Characteristics, 1987, 2007–2012

Smolt Year	Migration	Age Class (%)						Mean length (mm)						Mean weight (g)					
		Age 1	95% C.I.	Age 2	95% C.I.	Age 3	95% C.I.	Age 1	95% C.I.	Age 2	95% C.I.	Age 3	95% C.I.	Age 1	95% C.I.	Age 2	95% C.I.	Age 3	95% C.I.
1987	83,273	86%	ND	11%	ND	3%	ND	94	ND	124	ND	163	ND	6.8	ND	15.3	ND	38.0	ND
2007	80,600	95%	($\pm 0.02\%$)	5%	($\pm 1.08\%$)	0%	ND	110	(± 0.6)	143	(± 10.6)	ND	ND	12.7	(± 0.3)	27.7	(± 5.7)	ND	ND
2008	3,200	84%	($\pm 0.1\%$)	16%	($\pm 0.8\%$)	0%	ND	100	(± 0.8)	137	(± 3.8)	ND	ND	9.0	(± 0.9)	20.2	(± 1.9)	ND	ND
2009	68,651	94%	($\pm 0.01\%$)	6%	($\pm 0.4\%$)	0%	ND	101	(± 0.6)	149	(± 4)	ND	ND	10.6	(± 0.3)	28.9	(± 2.2)	ND	ND
2010	2,733	4%	($\pm 1.4\%$)	96%	($\pm 0.1\%$)	0%	ND	112	(± 7)	140	(± 1)	ND	ND	14.4	(± 1.5)	28.4	(± 0.6)	ND	ND
2011	17	0%	ND	18%	($\pm 17\%$)	82%	($\pm 16\%$)	ND	(± 7)	154	(± 16)	179	(± 6)	ND	ND	36.9	(± 10)	55.5	(± 5.8)
2012	23	5%	ND	77%	($\pm 1.3\%$)	18%	($\pm 11.6\%$)	99	ND	134	(± 7.9)	229	(± 68.9)	9.0	ND	25.8	(± 4.3)	121	(± 84.8)
Mean	34,071	53%		33%		15%		103		140		190		10.4		26.2		71.4	

ND = No Data

Table 4. Summary of Coho Salmon Smolt Characteristics, 1987, 2007–2012

Smolt Year	Migration	Age Class (%)						Mean length (mm)						Mean weight (g)					
		Age 1	95% C.I.	Age 2.0	95% C.I.	Age 3	95% C.I.	Age 1	95% C.I.	Age 2	95% C.I.	Age 3	95% C.I.	Age 1	95% C.I.	Age 2.0	95% C.I.	Age 3	95% C.I.
1987	1,903	4%	ND	81%	ND	15%	ND	75	ND	128	ND	149	ND	4.6	ND	21.4	ND	35.5	ND
2007*	69	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2008*	23	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2009*	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2010	111	43%	($\pm 1.3\%$)	57%	($\pm 0.1\%$)	0%	ND	114	(± 3.1)	123	(± 2.1)	ND	ND	16.2	(± 1.2)	20.3	(± 1.0)	ND	ND
2011	184	15%	($\pm 1\%$)	82%	($\pm 0.1\%$)	3%	($\pm 4.2\%$)	121	(± 5.3)	140	(± 1.7)	156	(± 2.8)	19.5	(± 2.1)	29.9	(± 1.0)	41.7	(± 3.5)
2012*	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mean	328	21%		73%		6%		103		130		153		13.4		23.9		38.6	

ND = No Data

*Migrations with too few fish to sample.

Discussion

Since smolt monitoring began in 2007, sockeye smolt migrations from Shell Lake have been unpredictable and have declined to numbers that may not be sustainable to support future populations. Prior to 2007, CIAA conducted a smolt enumeration in 1987 where 83,273 sockeye salmon were counted and were largely comprised of age-1 smolt (86%), followed by age-2 smolt (11%), and age-3 smolt (3%) (Marcuson, 1987). Data displayed in Table 3 show the smolt migrations in 1987, 2007 and 2009 had similar total counts, age composition, and physical characteristics. The erratic fluctuations occurred in 2008 when 3,200 sockeye smolt were counted leaving the lake and again from 2010 through 2012 when the total sockeye smolt counts sharply declined. There were incidences in 2010 and 2011 when lake ice and strong water flow caused the collection facility not to be fish tight, but it is doubtful many fish migrated based on the recorded time of day.

Initial speculation of low sockeye smolt migrants was largely thought to be related to northern pike predation on juvenile salmon in the lake. From 2010 through 2012, data was collected by CIAA staff to assist ADF&G in examining the diet composition of harvested northern pike stomach contents. The final results from the 2010–2012 northern pike sampling are expected to be published by ADF&G at a later date.

Another factor to consider in the decline of salmon production was the discovery of a parasitic infection that caused pre-spawned mortality in adult sockeye salmon in the lake. This occurrence was first reported in 2010, however it was only successfully documented by ADF&G Fish Pathology Section in late 2012. Due to the discovery of the infection and poor sockeye smolt migrations in 2011 and 2012, CIAA decided to conduct a gamete collection in order to preserve the genetic lineage of sockeye salmon at Shell Lake. The surviving sockeye progeny plan to be returned as smolt to Shell Lake in 2014.

The purpose of this report was to document monitoring activities that were granted under the AKSSF award leading up to June 30, 2012. Data collected at Shell Lake after June 30 will be published in the Shell Lake Sockeye Salmon Data Report 2013. This report will include data collected as a result from CIAA-funded activities including the northern pike harvest and sockeye salmon gamete collection.

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RECOMMENDATIONS

Monitoring activities at Shell Lake in 2013 should include the smolt enumeration as well as the northern pike harvest. Additional data are necessary to better understand the declining trend in migrating smolt and the suppression of northern pike may help native fish rehabilitate. Baseline data collected from past migrations will also allow for a comparison of any changes that may take place to the smolt migration once hatchery-reared sockeye smolt are returned to Shell Lake in spring 2014.

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APPENDICES

Appendix 1. Shell Lake 2010 – Environmental Conditions

Date	Sky	Water		Flow	Water	Air
		Precip. (mm)	Fluctuation (ft)		Temp. (°C)	Temp. (°C)
24-May	ND	ND	ND	ND	ND	ND
25-May	2	0.0	2.05	ND	10	20
26-May	2	0.0	1.99	ND	12	23
27-May	3	0.0	1.89	ND	16	22
28-May	4	0.5	1.81	ND	15	20
29-May	3	0.0	1.77	ND	12	25
30-May	3	0.5	1.69	ND	13	18
31-May	3	1.3	1.62	ND	15	24
1-Jun	3	0.0	1.57	ND	10	20
2-Jun	2	0.0	1.51	ND	16	23
3-Jun	5	2.5	1.49	ND	8	9
4-Jun	5	9.5	1.44	ND	8	8
5-Jun	3	0.5	1.41	ND	13	20
6-Jun	2	0.7	1.34	ND	12	17
7-Jun	4	4.0	1.32	ND	17	12
8-Jun	4	0.4	1.31	ND	9	11
9-Jun	4	1.9	1.26	ND	11	14
10-Jun	3	0.4	1.22	ND	9	14
11-Jun	4	0.0	1.20	ND	12	16
12-Jun	4	0.3	1.19	ND	11	14
13-Jun	3	0.2	1.13	ND	11	20
14-Jun	5	0.7	1.08	ND	10	13
15-Jun	5	8.5	1.12	ND	9	9
16-Jun	5	15.0	1.13	ND	9	10
17-Jun	5	3.0	1.11	ND	10	10
18-Jun	4	3.5	1.09	ND	11	14
19-Jun	5	3.0	1.10	ND	11	12
20-Jun	3	0.0	1.10	ND	14	13
21-Jun	2	0.0	1.09	ND	15	21
22-Jun	3	0.0	1.05	ND	13	20
Total		56				
Avg.		1.9		ND	12	16
Min.		0.0	1.05	ND	8	8
Max.		15.0	2.05	ND	17	25
Summary of Cloud Cover - Percent of Days						
	No. Days	Meas. Rain	Partly Overcast	Partly Cloudy	Clear	
Smolts	29	66%	48%	52%	0%	
1 = Clear 2 = Cloud Cover <50% 3 = Cloud Cover >50% 4 = Overcast 5 = Rain						
ND = No Data						

Appendix 2. Shell Lake 2010 – Macrozooplankton Density and Biomass, Site A and B

Lake:	Shell							
Station:	A							
Depth (m):	10m-14m							
Year:	2010							
	<i>Macrozooplankton Density</i> (no./m ²)							
Date:	22-Jun	16-Jul	1-Aug	23-Sep	Seasonal Mean (No/m ²)			
Ergasilus								
Ovig Ergasilus								
Epischura		1,720	1,019	1,274	1,338			
Ovig Epischura								
Diaptomus	49,936	112,930	84,076	24,841	67,946			
Ovig Diaptomus		382	382		382			
Cyclops	40,796	73,949	28,790	370,382	128,479			
Ovig Cyclops	11,592	4,968	1,146	637	4,586			
Bosmina	5,573	1,338	510	155,414	40,709			
Ovig Bosmina				2,229	2,229			
Daphnia l	48,599	102,994	9,299	58,917	54,952			
Ovig Daphnia l	1,115	4,395	1,911	19,745	6,792			
Daphnia g.								
Ovig Daphnia g.								
Holopedium	11,592	8,217	764	14,013	8,647			
Ovig Holopedium	669	191	127	2,548	884			
Chydorinae								
Ovig Chydorinae								
Copepod Nauplii								
Heterocope			255		255			
					Total: 317,197			
	<i>Body Size</i> (mm)				SEASONAL MEANS			
Date:	22-Jun	16-Jul	1-Aug	23-Sep	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m ²)	Weighted Biomass (mg/m ²)
Ergasilus								
Ovig Ergasilus								
Epischura		1.36	1.50	1.16	1.34	1.33	14	14
Ovig Epischura								
Diaptomus	0.76	0.96	1.08	1.11	0.98	0.97	287	284
Ovig Diaptomus		1.20	1.37		1.29	1.29	4	4
Cyclops	0.84	0.78	0.85	0.79	0.82	0.80	323	302
Ovig Cyclops	1.13	1.12	1.24	1.19	1.17	1.14	32	30
Bosmina	0.52	0.56	0.51	0.48	0.52	0.48	28	23
Ovig Bosmina				0.61	0.61	0.61	2	2
Daphnia l	1.13	0.92	0.95	0.85	0.96	0.95	222	213
Ovig Daphnia l	1.37	1.32	1.06	0.99	1.19	1.06	49	36
Daphnia g.								
Ovig Daphnia g.								
Holopedium	0.82	0.83	0.87	0.77	0.82	0.80	22	21
Ovig Holopedium	1.35	1.10	1.22	0.92	1.15	1.02	6	4
Chydorinae								
Ovig Chydorinae								
Copepod Nauplii								
Heterocope			3.50		3.50	3.50	40	40
					TOTAL:		1,030	973

Lake: Shell Station: B Depth (m): 10m-14m Year: 2010	<i>Macrozooplankton Density</i> (no./m ²)				Seasonal Mean (No/m ²)
Date:	22-Jun	16-Jul	1-Aug	23-Sep	
Ergasilus		764			764
Ovig Ergasilus					
Epischura		764	2,484	1,338	1,529
Ovig Epischura					
Diaptomus	172,166	144,713	90,573	7,580	103,758
Ovig Diaptomus			191		191
Cyclops	122,484	30,828	61,720	152,038	91,768
Ovig. Cyclops	9,554	4,076	1,529		5,053
Bosmina	4,777	1,529	5,732	444,522	114,140
Ovig. Bosmina	382			11,146	5,764
Daphnia l.	47,197	19,618	17,580	112,803	49,300
Ovig. Daphnia l.	1,146	764	4,204	27,197	8,328
Daphnia g.					
Ovig Daphnia g.					
Holopedium	11,847	9,427	8,981	102,994	33,312
Ovig. Holopedium	1,146	4,076	573	6,242	3,009
Chydorinae					
Ovig Chydorinae					
Copepod Nauplii					
	Total:				416,915
	<i>Body Size</i> (mm)				SEASONAL MEANS
	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m ²)	Weighted Biomass (mg/m ²)	
Ergasilus					
Ovig Ergasilus					
Epischura		1.41	1.48	1.63	
Ovig Epischura					
Diaptomus	0.83	0.95	1.01	1.13	
Ovig Diaptomus			1.22		
Cyclops	0.83	0.71	0.84	0.84	
Ovig. Cyclops	1.16	1.06	1.22		
Bosmina	0.56	0.59	0.49	0.50	
Ovig. Bosmina	0.79			0.62	
Daphnia l.	1.06	1.05	0.81	0.83	
Ovig. Daphnia l.	1.43	1.43	1.05	1.01	
Daphnia g.					
Ovig Daphnia g.					
Holopedium	0.91	0.93	0.68	0.78	
Ovig. Holopedium	1.26	1.03	0.94	1.04	
Chydorinae					
Ovig Chydorinae					
Copepod Nauplii					
	TOTAL:		1,173	1,043	

Appendix 3. Shell Lake 2010 – Water Quality Characteristics

Date	Sta	Depth (m)	TP (ug/l)	TFP (ug/l)	FRP (ug/l)	TKN (ug/l)	NH ₃ +NH ₄ +NO ₂ +NO ₃			RSi (ug/l)	Org C (ug/l)	Chla (ug/l)	Phaeo (ug/l)	EZD	
							(ug/l)	(ug/l)	TN:TP					Sta	(m)
5/28/2010	A	1	10.0	5.6	1.7	ND	8.3	279.2	ND :1	3,977	258	1.42	0.26	A	6.8
5/28/2010	A	10	8.2	5.5	1.4	ND	9.7	400.7	ND :1	4,062	141	0.91	0.24		
6/22/2010	A	1	5.4	3.7	2.1	ND	14.1	564.5	ND :1	3,987	109	0.59	0.27	A	8.1
6/22/2010	A	11	7.4	3.6	1.9	ND	16.7	461.9	ND :1	4,176	147	0.38	0.57		
7/16/2010	A	1	7.6	3.1	1.2	ND	6.0	365.2	ND :1	3,955	164	1.02	0.21	A	12.1
7/16/2010	A	15	8.3	5.8	1.8	ND	31.9	517.0	ND :1	4,165	228	0.35	0.28		
8/1/2010	A	1	4.9	3.2	1.5	ND	14.3	481.7	ND :1	3,967	134	0.71	0.39	A	9.1
8/1/2010	A	11	6.3	3.8	1.7	ND	36.3	406.1	ND :1	4,232	164	0.36	0.45		
Mean	1 - Meter		7.0	3.9	1.6	ND	10.7	422.7	ND :1	3,972	166	0.94	0.28	A	9.0
Min			4.9	3.1	1.2	ND	6.0	279.2	ND :1	3,955	109	0.59	0.21		6.8
Max			10.0	5.6	2.1	ND	14.3	564.5	ND :1	3,987	258	1.42	0.39		12.1
Mean	Hypolimnion		7.6	4.7	1.7	ND	23.7	446.4	ND :1	4,159	170	0.50	0.39		
Min			6.3	3.6	1.4	ND	9.7	400.7	ND :1	4,062	141	0.35	0.24		
Max			8.3	5.8	1.9	ND	36.3	517.0	ND :1	4,232	228	0.91	0.57		

Date	Sta	Depth (m)	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb (NTU)	Color (Pt)	Ca (mg/l)	Mg (mg/l)	Fe (ug/l)	Secchi	
											Sta	(meters)
5/28/2010	A	1	33	6.5	12.3	0.7	22	4.1	1.0	75	A	3.5
5/28/2010	A	10	35	6.5	12.3	0.4	19	4.1	1.0	87	B	3.5
6/22/2010	A	1	35	6.7	12.5	0.4	18	4.1	1.0	51	A	6.5
6/22/2010	A	11	36	6.6	12.5	0.4	17	4.0	1.2	56	B	5.5
7/16/2010	A	1	35	6.5	11.7	0.4	17	4.1	1.0	60	A	5.0
7/16/2010	A	15	37	6.4	12.6	0.5	20	4.2	1.3	75	B	4.5
8/1/2010	A	1	36	6.6	12.0	0.4	15	4.0	1.2	71	A	5.0
8/1/2010	A	11	38	6.4	11.9	0.4	17	3.9	1.2	77	B	6.0
Mean	1 - Meter		35	6.6	12.1	0.5	18	4.1	1.1	64	A	5.0
Min			33	6.5	11.7	0.4	15	4.0	1.0	51		3.5
Max			36	6.7	12.5	0.7	22	4.1	1.2	75		6.5
Mean	Hypolimnion		37	6.5	12.3	0.4	18	4.1	1.2	74	B	4.9
Min			35	6.4	11.9	0.4	17	3.9	1.0	56		3.5
Max			38	6.6	12.6	0.5	20	4.2	1.3	87		6.0

Appendix 4. Shell Lake 2010 – Daily Migration

Date	Sockeye			Coho			Chinook		Pink		Rainbow		Longnose Sucker	
	Daily	Mort.	Total	Daily	Mort.	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total
24-May	217	0	217	0	0	0	0	0	0	0	0	0	4	0
25-May	71	0	288	0	0	0	0	0	0	0	0	0	4	4
26-May	258	0	546	0	0	0	0	0	0	0	0	0	19	23
27-May	9	0	555	1	0	1	0	0	0	0	0	0	15	38
28-May	1,124	0	1,679	0	0	1	0	0	0	0	0	0	35	73
29-May	316	0	1,995	0	0	1	0	0	0	0	1	1	36	109
30-May	80	0	2,075	1	0	2	0	0	0	0	1	2	22	131
31-May	337	0	2,412	2	0	4	0	0	0	0	2	4	10	141
1-Jun	108	0	2,520	1	0	5	0	0	0	0	0	4	27	168
2-Jun	4	0	2,524	2	0	7	0	0	0	0	0	4	7	175
3-Jun	25	0	2,549	3	0	10	0	0	0	0	0	4	0	175
4-Jun	0	0	2,549	1	0	11	0	0	0	0	0	4	2	177
5-Jun	0	0	2,549	4	0	15	0	0	0	0	0	4	4	181
6-Jun	16	0	2,565	7	0	22	0	0	0	0	0	4	4	185
7-Jun	86	0	2,651	9	0	31	0	0	0	0	0	4	1	186
8-Jun	9	0	2,660	14	0	45	0	0	0	0	0	4	0	186
9-Jun	2	0	2,662	14	0	59	0	0	0	0	1	5	1	187
10-Jun	38	0	2,700	6	0	65	0	0	0	0	0	5	2	189
11-Jun	15	0	2,715	10	0	75	0	0	0	0	0	5	1	190
12-Jun	1	0	2,716	8	0	83	0	0	0	0	0	5	4	194
13-Jun	16	0	2,732	2	0	85	0	0	0	0	0	5	0	194
14-Jun	1	0	2,733	8	0	93	0	0	0	0	2	7	0	194
15-Jun	0	0	2,733	9	0	102	0	0	0	0	0	7	0	194
16-Jun	0	0	2,733	6	0	108	0	0	0	0	1	8	0	194
17-Jun	0	0	2,733	3	0	111	0	0	0	0	0	8	0	194
18-Jun	0	0	2,733	0	0	111	0	0	0	0	0	8	0	194
19-Jun	0	0	2,733	0	0	111	0	0	0	0	0	8	0	194
20-Jun	0	0	2,733	0	0	111	0	0	0	0	1	9	2	196
21-Jun	0	0	2,733	0	0	111	0	0	0	0	0	9	0	196
22-Jun	0	0	2,733	0	0	111	0	0	0	0	0	9	0	196
Total	2,733	0	2,733	111	0	111	0	0	0	0	9	9	200	200

Appendix 5. Shell Lake 2010 – Sockeye Smolt Hourly Count

Date	PM										AM					Total Hrs Counted Total Critical Hrs Counted % of Critical Hrs Counted No. Smolt Counted			
	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5				
24-May									0	0	37	103	77		5	5	56%	217	
25-May	0		0						0	0	0	68	3		7	0	0%	71	
26-May		0	0						0	0	0	109	58	91	8	0	0%	258	
27-May		0	0										9		3	0	0%	9	
28-May		0	0					0	128	419	567	10	0		8	0	0%	1,124	
29-May										44	206	19	47		4	5	56%	316	
30-May			0					0	0	3	7	64	6	0	8	6	67%	80	
31-May		0	0	0				0	28	89	206	14	0	0	0	11	1	11%	337
1-Jun		0	0	0				0	45	6	55	2	0		9	6	67%	108	
2-Jun		0	0					0	0	0	0	4	0	0	9	4	44%	4	
3-Jun		0	0							0	23	2			5	7	78%	25	
4-Jun		0	0					0	0	0	0	0	0		8	8	89%	-	
5-Jun			0					0	0	0	0	0	0		7	6	67%	-	
6-Jun			0	0				0	0	6	5	5			7	7	78%	16	
7-Jun		0	0							41	6	39			6	3	33%	86	
8-Jun			0							1	8	0	0		6	5	56%	9	
9-Jun			0					0	0	0	1	1	0		7	6	67%	2	
10-Jun			0					0	0	2	32	4			6	5	56%	38	
11-Jun			0					0	2	0	11	2	0		7	6	67%	15	
12-Jun			0					0	0	0	0	1	0		7	6	67%	1	
13-Jun			0					0	0	0	16	0	0		7	6	67%	16	
14-Jun			0					0	0	1	0	0			6	5	56%	1	
15-Jun			0					0	0	0	0	0	0		7	6	67%	-	
16-Jun		0	0	0				0	0	0	0	0	0		9	6	67%	-	
17-Jun			0	0				0	0	0	0	0	0		8	6	67%	-	
18-Jun			0	0				0	0	0	0	0	0		8	6	67%	-	
19-Jun			0					0	0	0	0	0	0		7	6	67%	-	

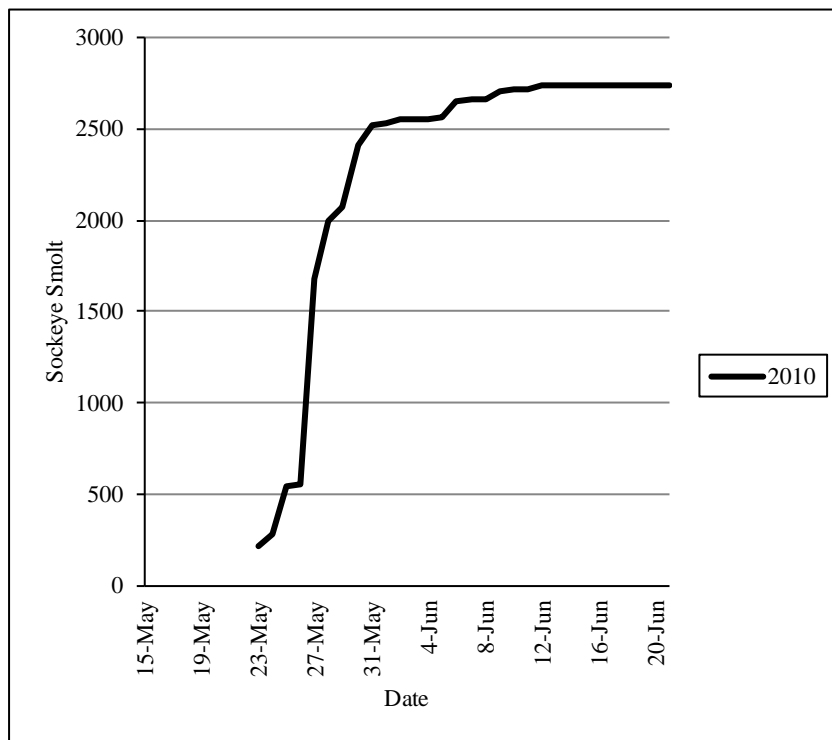
*Hours shaded in red are critical counting hours when smolt salmon migration typically occurs.

Appendix 6. Shell Lake 2010 – Update

Misc. Activities		
Ice-out:	21-May	(approximate date)
Smolt Crew On-site:	24-May	
Smolt Crew Off-site:	22-Jun	

Smolt Migration		
Dates:	24-May to 22-Jun	
	No.	%
Sockeyes:	2,733	100%
Mortalities:	0	0.0%
Age 1:	112	4.1%
Age 2:	2,613	95.6%
Age 3:	7	0.3%
Coho:	111	
Rainbow Trout:	9	
Long Nose Sucker:	200	

2010 Cumulative Sockeye Smolt Migration



Appendix 7. Shell Lake 2011 – Environmental Conditions

Date	Precip.		Stage		Water Temp. (°C)	Air Temp. (°C)
	Sky	(mm)	(ft)	Flow		
17-May	ND	ND	ND	ND	ND	ND
18-May	4	0.0	2.08	ND	3	ND
19-May	4	0.0	2.10	ND	3	10
20-May	3	0.3	2.05	ND	4	12
21-May	3	0.0	2.02	ND	4	16
22-May	3	0.5	2.00	ND	4	14
23-May	2	0.0	1.96	ND	5	17
24-May	1	0.0	1.90	ND	5	19
25-May	1	0.0	1.86	ND	6	18
26-May	2	0.0	1.85	ND	6	23
27-May	1	0.0	1.80	ND	4	24
28-May	3	0.9	1.77	ND	6	18
29-May	1	0.0	1.74	ND	7	22
30-May	1	0.0	1.66	ND	9	26
31-May	4	0.5	1.64	ND	6	16
Avg.		2	1.89			
Min.		0.2	1.64		5	18
Max.		0.0	2.10		3	10
		0.9			9	26
Summary of Cloud Cover - Percent of Days						
	No. Days	Meas. Rain	Overcast	Partly Cloudy		Clear
Smolts	15	11%	20%	40%		33%
Ice out = 28 May						

1-Jun	5	0.5	ND	ND	ND	17
2-Jun	4	0.0	1.45	ND	8	17
3-Jun	5	1.0	1.42	ND	6	ND
4-Jun	5	3.8	1.40	ND	5	10
5-Jun	3	2.0	1.36	ND	6	14
6-Jun	2	0.3	1.34	ND	9	17
7-Jun	4	1.0	1.32	ND	7	13
8-Jun	3	0.3	1.28	ND	10	15
9-Jun	3	0.0	1.26	ND	7	16
10-Jun	3	0.0	1.24	ND	7	ND
11-Jun	3	0.0	1.20	ND	7	15
12-Jun	3	0.0	1.18	ND	10	17
13-Jun	3	0.0	1.16	ND	7	17
14-Jun	3	0.0	1.14	ND	6	14
15-Jun	3	0.0	1.12	ND	8	15
16-Jun	2	0.0	1.10	ND	10	15
17-Jun	2	0.0	1.08	ND	15	21
18-Jun	2	0.0	1.06	ND	15	22
19-Jun	4	0.0	1.04	ND	10	18
20-Jun	3	7.5	1.04	ND	8	16
21-Jun	3	0.4	1.03	ND	12	17
22-Jun	3	0.0	1.00	ND	13	19
23-Jun	2	0.0	0.98	ND	16	ND
Total		22				
Avg.		0.5	1.19	ND	7	17
Min.		0.0	0.98	ND	3	0
Max.		7.5	1.45	ND	16	26
Summary of Cloud Cover - Percent of Days						
	No. Days	Meas. Rain	Overcast	Partly Cloudy		Clear
Smolts	23	39%	26%	74%		0%

*Two Environmental periods due to moved weather station on 1 June.

Appendix 8. Shell Lake 2011 – Macrozooplankton Density and Biomass, Site A and B

Lake:	Shell					
Station:	A					
Depth (m):	12m- 15m					
Year:	2011					
<i>Macrozooplankton Density</i> (no./m ³)						
Date:	14-Jun	17-Jul	11-Aug	29-Aug	6-Sep	Seasonal Mean (No/m ³)
Ergasilus						
Ovig Ergasilus						
Epischura	764	1,592	4,331	2,292	1,274	2,051
Ovig Epischura						
Diaptomus	15,669	21,019	31,592	13,296	11,975	18,710
Ovig Diaptomus				458	255	357
Cyclops	160,701	99,682	155,159	162,455	136,051	142,810
Ovig Cyclops	6,879	2,548	1,783	611	510	2,466
Bosmina	955	7,643	19,363	19,562	28,280	15,161
Ovig Bosmina		318	510		764	531
Daphnia l.	382	7,006	10,955	15,588	51,210	17,028
Ovig Daphnia l.			510	1,681	510	900
Daphnia g.						
Ovig Daphnia g.						
Holopedium	4,777	13,057	10,191	34,233	5,605	13,573
Ovig Holopedium		318	2,038	7,947		3,434
Chydorinae						
Ovig Chydorinae						
Copepod Nauplii						
Heterocope						
Total:						217,020
<i>Body Size</i> (mm)						SEASONAL MEANS
Date:	14-Jun	17-Jul	11-Aug	29-Aug	6-Sep	6-Sep
Ergasilus						
Ovig Ergasilus						
Epischura	1.40	1.23	1.16	1.21	1.34	
Ovig Epischura						
Diaptomus	0.66	1.09	1.15	1.19	1.17	
Ovig Diaptomus				1.29	1.28	
Cyclops	0.83	0.92	0.90	0.83	0.90	
Ovig Cyclops	1.16	1.24	1.21	1.19	1.28	
Bosmina	0.59	0.50	0.49	0.48	0.50	
Ovig Bosmina		0.56	0.61		0.57	
Daphnia l.	1.07	0.90	0.84	0.76	0.95	
Ovig Daphnia l.			1.30	1.15	1.06	
Daphnia g.						
Ovig Daphnia g.						
Holopedium	0.65	0.78	0.78	0.77	0.82	
Ovig Holopedium		0.88	0.89	0.99		
Chydorinae						
Ovig Chydorinae						
Copepod Nauplii						
Heterocope						
TOTAL:						694 687

Lake:	Shell						
Station:	B						
Depth (m):	12m-15m						
Year:	2011						
	<i>Macrozooplankton Density</i> (no./m ²)						Seasonal Mean (No/m ²)
Date:	14-Jun	17-Jul	11-Aug	29-Aug	6-Sep	6-Sep	
Ergasilus							
Ovig Ergasilus							
Epischura		3,631	6,879	4,279	318		3,777
Ovig Epischura							
Diaptomus		15,669	25,987	6,724	3,822		13,051
Ovig Diaptomus							
Cyclops	252,866	148,280	94,968	170,555	107,962		154,926
Ovig. Cyclops	10,191	1,146	573	1,223			3,283
Bosmina	22,357		43,758	91,696	120,701		69,628
Ovig. Bosmina		191	573	1,223	318		576
Daphnia l.		6,497	3,248	12,226	24,841		11,703
Ovig. Daphnia l.			382	1,426	955		921
Daphnia g.							
Ovig Daphnia g.							
Holopedium	637	11,083	4,395	26,694	10,510		10,664
Ovig. Holopedium			764	3,057	318		1,380
Chydorinae							
Ovig Chydorinae							
Copepod Nauplii							
							Total: 269,908
	<i>Body Size</i> (mm)						SEASONAL MEANS
Date:	14-Jun	17-Jul	11-Aug	29-Aug	6-Sep	6-Sep	
Ergasilus							
Ovig Ergasilus							
Epischura		1.25	1.38	1.20	1.55		Mean Length (mm) 1.35, Weighted Length (mm) 1.30, Biomass (mg/m ²) 39, Weighted Biomass (mg/m ²) 36
Ovig Epischura							
Diaptomus		1.08	1.17	1.23	1.17		Mean Length (mm) 1.16, Weighted Length (mm) 1.15, Biomass (mg/m ²) 90, Weighted Biomass (mg/m ²) 87
Ovig Diaptomus							
Cyclops	0.80	0.87	0.89	0.86	0.94		Mean Length (mm) 0.87, Weighted Length (mm) 0.86, Biomass (mg/m ²) 473, Weighted Biomass (mg/m ²) 450
Ovig. Cyclops	1.16	1.25	1.27	1.15			Mean Length (mm) 1.21, Weighted Length (mm) 1.17, Biomass (mg/m ²) 25, Weighted Biomass (mg/m ²) 23
Bosmina		0.55	0.52	0.49	0.51		Mean Length (mm) 0.52, Weighted Length (mm) 0.50, Biomass (mg/m ²) 48, Weighted Biomass (mg/m ²) 45
Ovig. Bosmina		0.68	0.65	0.58	0.56		Mean Length (mm) 0.62, Weighted Length (mm) 0.60, Biomass (mg/m ²) 1, Weighted Biomass (mg/m ²) 1
Daphnia l.		0.98	1.00	0.87	0.92		Mean Length (mm) 0.94, Weighted Length (mm) 0.92, Biomass (mg/m ²) 45, Weighted Biomass (mg/m ²) 42
Ovig. Daphnia l.			1.28	1.26	1.23		Mean Length (mm) 1.26, Weighted Length (mm) 1.25, Biomass (mg/m ²) 8, Weighted Biomass (mg/m ²) 8
Daphnia g.							
Ovig Daphnia g.							
Holopedium	0.38	0.82	0.72	0.85	0.88		Mean Length (mm) 0.73, Weighted Length (mm) 0.83, Biomass (mg/m ²) 20, Weighted Biomass (mg/m ²) 29
Ovig. Holopedium			0.88	1.03	1.02		Mean Length (mm) 0.98, Weighted Length (mm) 1.00, Biomass (mg/m ²) 6, Weighted Biomass (mg/m ²) 6
Chydorinae							
Ovig Chydorinae							
Copepod Nauplii							
							TOTAL: 754 726

Appendix 9. Shell Lake 2011 – Water Quality Characteristics

Date	Sta	Depth (m)	TP (ug/l)	TFP (ug/l)	FRP (ug/l)	TKN (ug/l)	NH3+NH4 NO2+NO3		TN:TP	RSi (ug/l)	Org C (ug/l)	Chla (ug/l)	Phaeo (ug/l)	EZD		
							(ug/l)	(ug/l)						Sta	(m)	
6/14/2011	A	1	7.0	ND	ND	ND			ND	:1	3,996	248	2.16	0.55	A	6.7
6/14/2011	A	12	6.1	3.5	1.7	ND	3.4	409.0	ND	:1	4,034	232	0.82	0.40		
7/17/2011	A	1	5.9	3.8	2.2	ND	7.2	335.0	ND	:1	3,586	191	0.76	0.22	A	7.9
7/17/2011	A	12	7.2	4.2	2.8	ND	15.9	409.0	ND	:1	3,793	135	0.46	0.33		
8/11/2011	A	1	5.5	2.4	2.5	ND	6.6	310.0	ND	:1	3,564	249	1.39	0.56	A	8.9
8/11/2011	A	10	6.0	2.5	2.2	ND	8.8	331.0	ND	:1	3,768	197	0.95	0.52		
9/6/2011	A	1	6.6	2.9	2.7	ND	9.4	298.0	ND	:1	3,532	203	1.09	0.41	A	7.9
9/6/2011	A	11	7.5	2.8	2.6	ND	8.8	353.0	ND	:1	3,754	140	0.32	0.18		
Mean	1 - Meter		6.3	3.0	2.5	-	7.7	314.3	-	:1	3,670	223	1.35	0.44	A	7.9
Min			5.5	2.4	2.2	0.0	6.6	298.0	120	:1	3,532	191	0.76	0.22		6.7
Max			7.0	3.8	2.7	0.0	9.4	335.0	106	:1	3,996	249	2.16	0.56		8.9
Mean	Hypolimnion		6.7	3.3	2.3	-	9.2	375.5	-	:1	3,837	176	0.64	0.36		
Min			6.0	2.5	1.7	0.0	3.4	331.0	122	:1	3,754	135	0.32	0.18		
Max			7.5	4.2	2.8	0.0	15.9	409.0	121	:1	4,034	232	0.95	0.52		

ND = No Data

Date	Sta	Depth (m)	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb (NTU)	Color (Pt)	Ca (mg/l)	Mg (mg/l)	Fe (ug/l)	Secchi	
											Sta	(meters)
6/14/2011	A	1	34	7.0	13.2	0.5		4.2	1.1	85	A	4.0
6/14/2011	A	12	34	6.9	13.6	0.5	20	4.3	1.0	89	B	4.5
7/17/2011	A	1	35	7.2	14.0	0.5	22	4.3	1.0	53	A	5.0
7/17/2011	A	12	35	6.8	13.9	0.4	23	4.2	1.0	72	B	5.5
8/11/2011	A	1	32	7.0	14.4	0.5	23	4.3	1.2	75	A	4.5
8/11/2011	A	10	31	8.5	13.5	0.5	24	4.3	1.0	76	B	4.0
9/6/2011	A	1	33	7.1	14.0	0.4	15	4.3	1.1	72	A	4.0
9/6/2011	A	11	38	6.8	13.8	0.4	14	4.3	1.1	54	B	4.5
Mean	1 - Meter		34	7.1	13.9	0.5	20	4.3	1.1	71	A	4.4
Min			32	7.0	13.2	0.4	15	4.2	1.0	53		4.0
Max			35	7.2	14.4	0.5	23	4.3	1.2	85		5.0
Mean	Hypolimnion		35	7.3	13.7	0.5	20	4.3	1.0	73	B	4.6
Min			31	6.8	13.5	0.4	14	4.2	1.0	54		4.0
Max			38	8.5	13.9	0.5	24	4.3	1.1	89		5.5

Appendix 10. Shell Lake 2011 – Daily Migration

Date	Sockeye			Coho			Chinook		Pink		Rainbow		Longnose Sucker	
	Daily	Mort.	Total	Daily	Mort.	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total
17-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19-May	0	0	0	0	0	0	0	0	0	0	0	0	1	0
20-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-May	0	0	0	0	0	0	0	0	0	0	0	0	1	0
23-May	0	0	0	1	0	1	0	0	0	0	1	1	0	0
24-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-May	0	0	0	0	0	0	0	0	0	0	0	0	1	1
27-May	0	0	0	1	0	1	0	0	0	0	0	0	0	1
28-May	0	0	0	0	0	1	0	0	0	0	0	0	1	2
29-May	0	0	0	3	0	4	0	0	0	0	0	0	0	2
30-May	5	0	5	2	0	6	0	0	0	0	1	1	0	2
31-May	1	0	6	1	0	7	0	0	0	0	0	1	0	2
1-Jun	0	0	6	0	0	7	0	0	0	0	0	1	0	2
2-Jun	1	0	7	3	0	10	0	0	0	0	0	1	0	2
3-Jun	0	0	7	4	0	14	0	0	0	0	0	1	0	2
4-Jun	0	0	7	8	0	22	0	0	0	0	0	1	1	3
5-Jun	0	0	7	13	0	35	0	0	0	0	0	1	0	3
6-Jun	7	0	14	24	0	59	0	0	0	0	1	2	0	3
7-Jun	1	0	15	19	0	78	0	0	0	0	1	3	0	3
8-Jun	0	0	15	26	0	104	0	0	0	0	0	3	0	3
9-Jun	0	0	15	11	0	115	0	0	0	0	1	4	0	3
10-Jun	0	0	15	17	0	132	0	0	0	0	1	5	1	4
11-Jun	0	0	15	22	0	154	0	0	0	0	0	5	0	4
12-Jun	0	0	15	8	0	162	0	0	0	0	1	6	1	5
13-Jun	0	0	15	6	0	168	0	0	0	0	1	7	0	5
14-Jun	1	0	16	3	0	171	0	0	0	0	0	7	0	5
15-Jun	0	0	16	5	0	176	0	0	0	0	0	7	0	5
16-Jun	1	0	17	2	0	178	0	0	0	0	0	7	0	5
17-Jun	0	0	17	3	0	181	0	0	0	0	3	10	0	5
18-Jun	0	0	17	2	0	183	0	0	0	0	2	12	0	5
19-Jun	0	0	17	1	0	184	0	0	0	0	0	12	1	6
20-Jun	0	0	17	1	0	185	0	0	0	0	1	13	0	6
21-Jun	0	0	17	0	0	185	0	0	0	0	0	13	0	6
22-Jun	0	0	17	1	0	186	0	0	0	0	0	13	0	6
23-Jun	0	0	17	0	0	186	0	0	0	0	0	13	0	6
Total	17	0	17	187	0	187		0		0		14		8

Appendix 11. Shell Lake 2011 – Sockeye Smolt hourly Count

Date	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	Total Hrs Counted	Total Critical Hrs Counted	% of Critical Hrs Counted	
17-May																				0	0				2	2	22%	-
18-May													0	0	0					0	0	0	0	0	8	5	56%	-
19-May													0	0	0					0	0	0	0	0	8	5	56%	-
20-May								0	0				0	0			0			0	0	0	0	0	9	5	56%	-
21-May								0	0				0	0	0					0	0	0	0	0	9	0	0%	-
22-May								0	0				0	0						0	0	0	0	0	9	0	0%	-
23-May								0	0				0	0						0	0	0	0	0	9	0	0%	-
24-May								0	0				0	0	0			0		0	0	0	0	0	10	0	0%	-
25-May								0	0				0	0						0	0	0	0	0	8	4	44%	-
26-May								0	0	0			0	0	0					0	0	0	0	0	10	4	44%	-
27-May								0	0	0			0	0	0	0		0		0	0	0	0	0	13	4	44%	-
28-May								0	0	0			0	0	0					0	0	0	0	0	9	5	56%	-
29-May								0					0	0						0	0	0	0	0	7	4	44%	-
30-May	0							0					0	0	0	0				0	0	0	5	10	4	44%	5	
31-May	0												0	0						1	0	0	0	0	7	6	67%	1
1-Jun													0	0						0	0	0	0	0	5	4	44%	-
2-Jun								0	0				0	0						0	0	0	1	0	10	5	56%	1
3-Jun								0	0				0	0						0	0	0	0	0	9	5	56%	-
4-Jun													0	0						0	0	0	0	0	7	5	56%	-
5-Jun													0	0						0	0	0	0	0	9	6	67%	-
6-Jun													0	0						0	0	7	0	0	7	5	56%	7
7-Jun													0	0						0	1	0	0	0	8	6	67%	1
8-Jun													0	0						0	0	0	0	0	8	6	67%	-
9-Jun													0	0						0	0	0	0	0	7	5	56%	-
10-Jun													0	0						0	0	0	0	0	7	5	56%	-
11-Jun													0	0	0	0				0	0	0	0	0	7	5	56%	-
12-Jun													0	0						0	0	0	0	0	7	5	56%	-
13-Jun													0	0						0	0	0	0	0	7	5	56%	-
14-Jun													0	1	0					0	0	0	0	0	6	4	44%	1
15-Jun													0	0						0	0	0	0	0	7	5	56%	-
16-Jun													0	0	0	0				0	1	0	0	0	6	4	44%	1
17-Jun													0	0						0	0	0	0	0	6	4	44%	-
18-Jun													0	0						0	0	0	0	0	5	4	44%	-
19-Jun													0	0						0	0	0	0	0	5	4	44%	-
20-Jun													0	0						0	0	0	0	0	5	4	44%	-
21-Jun													0	0						0	0	0	0	0	5	4	44%	-
22-Jun													0	0						0	0	0	0	0	5	4	44%	-
23-Jun													0							0					1	0	0%	-

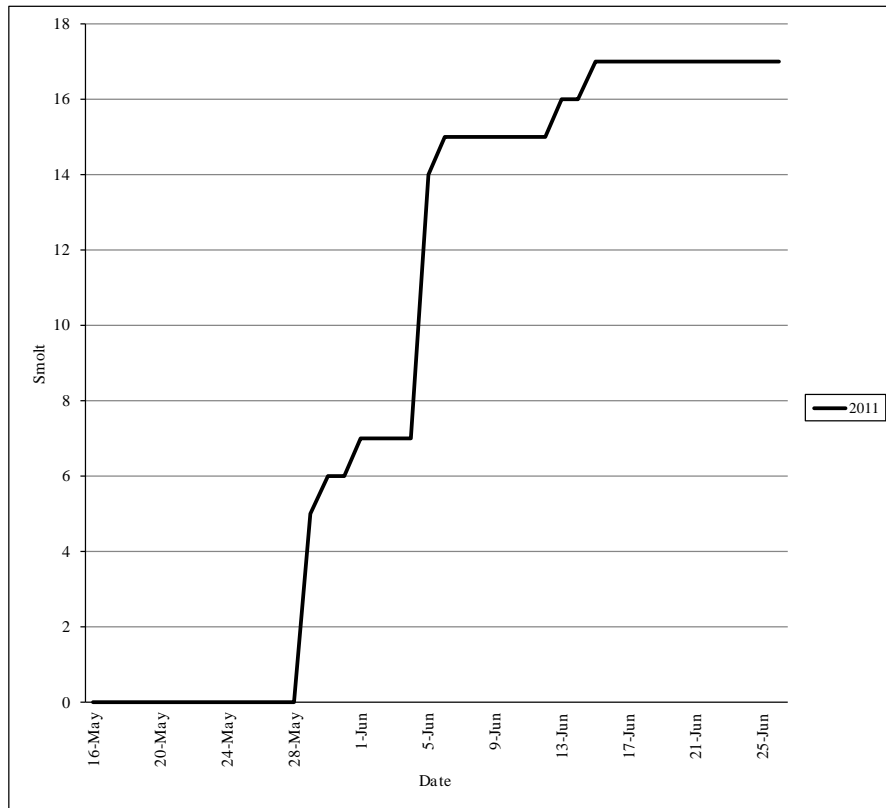
*Hours shaded in red are critical counting hours when smolt salmon migration typically occurs.

Appendix 12. Shell Lake 2011 – Update

Misc. Activities		
Ice-out:	28-May	(approximate date)
Smolt Crew On-site:	17-May	2011
Smolt Crew Off-site:	23-Jun	2011

Smolt Migration		
Dates:	17-May to 23-Jun	
	No.	%
Sockeyes:	17	100%
Mortalities:	0	0.0%
Age 1:	3	17.6%
Age 2:	14	82.4%
Coho:	187	
Rainbow Trout:	14	
Long Nose Sucker:	8	

2011 Cumulative Sockeye Smolt Migration



Appendix 13. Shell Lake 2012 – Environmental Conditions

Date	Sky	Precip. (mm)	Water Fluctuation (ft)	Water Temp. (°C)	Air Temp. (°C)
18-May	1	ND	ND	ND	ND
19-May	3	ND	ND	ND	ND
20-May	3	ND	ND	ND	ND
21-May	3	ND	ND	ND	ND
22-May	3	ND	ND	ND	ND
23-May	2	0.0	2.29	4	9
24-May	5	1.0	2.21	4	9
25-May	3	1.0	2.19	4	9
26-May	3	1.0	2.14	4	9
27-May	3	1.0	2.14	4	9
28-May	2	0.0	1.99	4	13
29-May	5	0.0	1.90	4	8
30-May	5	2.0	1.85	5	19
31-May	5	2.0	1.79	5	12
1-Jun	1	0.0	1.73	5	23
2-Jun	1	0.0	1.64	5	25
3-Jun	3	0.0	1.60	5	14
4-Jun	5	4.0	1.58	5	12
5-Jun	5	0.0	1.51	6	19
6-Jun	3	0.0	1.49	6	23
7-Jun	1	0.0	1.45	10	20
8-Jun	5	3.0	1.40	10	16
9-Jun	5	0.5	1.40	10	18
10-Jun	5	0.0	1.39	10	17
11-Jun	5	2.0	1.36	10	15
12-Jun	5	3.0	1.35	10	16
13-Jun	3	0.0	1.32	10	12
14-Jun	1	0.0	1.32	10	24
15-Jun	5	2.3	1.30	9	20
16-Jun	1	0.2	1.30	9	24
17-Jun	1	0.0	1.28	10	20
18-Jun	1	0.0	1.28	10	24
19-Jun	1	0.0	1.28	10	24
20-Jun	1	0.0	1.13	12	24
21-Jun	1	0.0	1.13	14	31
Total		23			
Avg.		0.8		7	17
Min.		0.0	1.13	4	8
Max.		4.0	2.29	14	31
Ice out = 28 May					
Summary of Cloud Cover - Percent of Days					
	No. Days	Meas. Rain	Overcast	Partly Cloudy	Clear
Smolt	35	37%	34%	34%	31%
1 = Clear					
2 = Cloud Cover <50%					
3 = Cloud Cover >50%					
4 = Overcast					
5 = Rain					
ND = No Data					

Appendix 14. Shell Lake 2012 – Macrozooplankton Density and Biomass, Site B

Lake:	Shell				
Station:	B				
Depth (m):	16				
Year:	2012				
<i>Macrozooplankton Density</i> (no./m ²)					
Date:	29-Jul	Seasonal Mean	(No/m ²)		
Ergasilus					
Ovig Ergasilus					
Epischura	2,102		2,102		
Ovig Epischura					
Diaptomus	41,083		41,083		
Ovig Diaptomus	955		955		
Cyclops	115,796		115,796		
Ovig. Cyclops	955		955		
Bosmina	17,580		17,580		
Ovig. Bosmina	573		573		
Daphnia l.	1,338		1,338		
Ovig. Daphnia l.	191		191		
Daphnia g.					
Ovig Daphnia g.					
Holopedium	382		382		
Ovig. Holopedium	382		382		
Chydorinae					
Ovig Chydorinae					
Copepod Nauplii					
		Total:	181,337		
SEASONAL MEANS					
	<i>Body Size</i> (mm)	Mean Length (mm)	Weighted Length (mm)	Weighted Biomass (mg/m ²)	Weighted Biomass (mg/m ²)
Ergasilus					
Ovig Ergasilus					
Epischura	1.49	1.49	1.49	29	29
Ovig Epischura					
Diaptomus	1.16	1.16	1.16	268	268
Ovig Diaptomus	1.32	1.32	1.32	9	9
Cyclops	0.82	0.82	0.82	273	273
Ovig. Cyclops	1.05	1.05	1.05	4	4
Bosmina	0.55	0.55	0.55	51	51
Ovig. Bosmina	0.57	0.57	0.57	2	2
Daphnia l.	0.99	0.99	0.99	6	6
Ovig. Daphnia l.	1.20	1.20	1.20	1	1
Daphnia g.					
Ovig Daphnia g.					
Holopedium	0.80	0.80	0.80	3	3
Ovig. Holopedium	1.00	1.00	1.00		
Chydorinae					
Ovig Chydorinae					
Copepod Nauplii					
		TOTAL:		646	646

Appendix 15. Shell Lake 2012 – Daily Migration

Date	Sockeye Smolt			Sockeye		Coho		Chinook		Pink		Rainbow		Dolly Varden	
	Daily	Mort.	Total	Fry	Daily	Mort.	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total
18-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24-May	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
25-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
26-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
27-May	2	0	2	0	0	0	0	0	0	0	0	0	0	0	1
28-May	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1
29-May	5	0	7	0	0	0	0	0	0	0	0	0	0	0	1
30-May	0	0	7	0	0	0	0	0	0	0	0	0	0	0	1
31-May	2	0	9	0	0	0	0	0	0	0	0	0	0	0	1
1-Jun	1	0	10	0	0	0	0	0	0	0	0	0	0	0	1
2-Jun	3	0	13	0	0	0	0	0	0	0	0	0	0	0	1
3-Jun	5	0	18	0	0	0	0	0	0	0	0	0	0	0	1
4-Jun	1	0	19	0	0	0	0	0	0	0	0	0	0	0	1
5-Jun	1	0	20	0	0	0	0	0	0	0	0	0	0	0	1
6-Jun	2	0	22	0	0	0	0	0	0	0	0	1	1	0	1
7-Jun	0	0	22	5	5	0	0	0	0	0	0	0	1	0	1
8-Jun	0	0	22	0	5	0	0	0	0	0	0	0	1	0	1
9-Jun	0	0	22	0	5	0	0	0	0	0	0	0	1	0	1
10-Jun	0	0	22	0	5	0	0	0	0	0	0	0	1	0	1
11-Jun	0	0	22	0	5	0	0	0	0	0	0	1	2	0	1
12-Jun	1	0	23	0	5	0	0	0	0	0	0	0	2	0	1
13-Jun	0	0	23	3	8	0	0	0	0	0	0	0	2	0	1
14-Jun	0	0	23	Many	8	0	0	0	0	0	0	0	2	0	1
15-Jun	0	0	23	5	13	0	0	0	0	0	0	0	2	0	1
16-Jun	0	0	23	0	13	0	0	0	0	0	0	1	3	0	1
17-Jun	0	0	23	0	13	0	0	0	0	0	0	0	3	0	1
18-Jun	0	0	23	0	13	0	0	0	0	0	0	0	3	0	1
19-Jun	0	0	23	0	13	0	0	0	0	0	0	0	3	0	1
20-Jun	0	0	23	0	13	0	0	0	0	0	0	0	3	0	1
Total	23	0	23		124		0		0		0		3		1

Appendix 16. Shell Lake 2012 – Sockeye Smolt Hourly Count

Date	AM					PM											AM					Total Hrs Counted	Total Critical Hrs Counted	% of Critical Hrs Counted	No. Sockeye Counted			
	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2					3	4	5
18-May																									8	8	89%	-
19-May	0	0	0																						9	5	56%	-
20-May																									7	6	67%	-
21-May																									7	0	0%	-
22-May																									7	0	0%	-
23-May																									6	0	0%	-
24-May																									6	0	0%	-
25-May																									6	6	67%	-
26-May																									7	5	56%	-
27-May																									8	5	56%	2
28-May																									11	5	56%	-
29-May																									12	5	56%	5
30-May																									11	6	67%	-
31-May																									11	7	78%	2
1-Jun																									11	7	78%	1
2-Jun																									12	8	89%	3
3-Jun																									12	7	78%	5
4-Jun																									12	8	89%	1
5-Jun																									6	6	67%	1
6-Jun																									2	1	11%	2
7-Jun																									11	7	78%	-
8-Jun																									11	7	78%	-
9-Jun																									11	7	78%	-
10-Jun																									11	7	78%	-
11-Jun																									11	7	78%	-
12-Jun																									1	1	11%	1
13-Jun																									11	7	78%	-
14-Jun																									11	7	78%	-
15-Jun																									11	7	78%	-
16-Jun																									11	7	78%	-
17-Jun																									11	7	78%	-
18-Jun																									11	7	78%	-
19-Jun																									11	7	78%	-
20-Jun																									11	7	78%	-

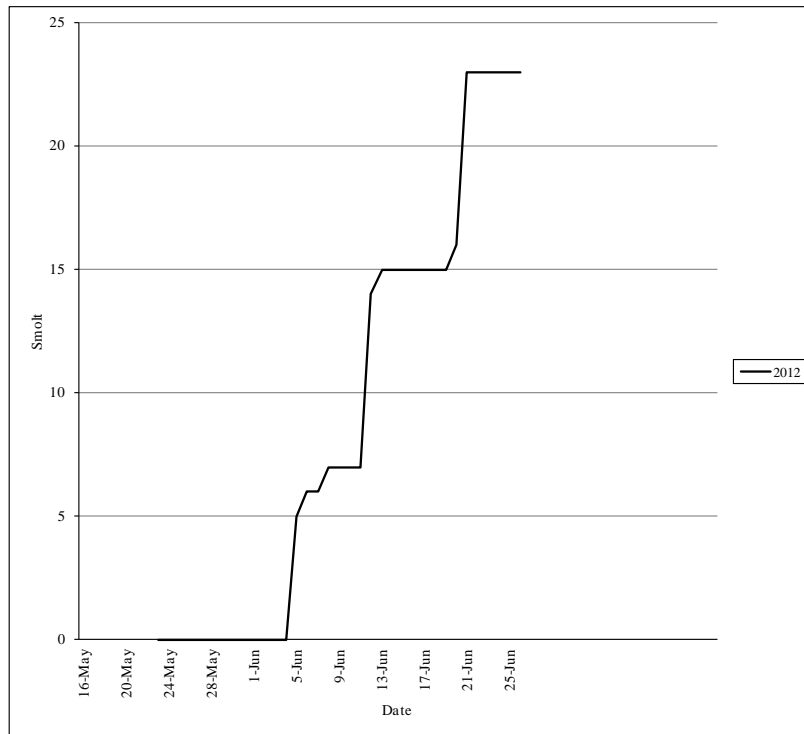
*Hours shaded in red are critical counting hours when smolt salmon migration typically occurs.

Appendix 17. Shell Lake 2012 – Update

Misc. Activities		
Ice-out:	28-May	(approximate date)
Crew On-site:	18-May	
Crew Off-site:	11-Aug	

Smolt Migration			
Dates:	18-May to 20-Jun		
	No.	%	
Sockeyes:	23	100%	
Mortalities:	0	0.0%	
Age 1:	1	4.5%	
Age 2:	18	77.3%	
Age 3:	4	18.2%	

2012 Cumulative Sockeye Smolt Migration



Appendix 18. Shell Lake 2012 – Historical Adult Sockeye Salmon Escapement

Year	Date	Creek count	Method	Comment	Lake count	Method	Comment
1972	7/26	5,000	ground				
1972	8/10	0	ground				
1972	8/18	0	ground				
1972	8/29	0			0	ground	
1972	8/29	50	aerial		640	aerial	
1973	7/15-8/14	26	weir				
1973	9/4				115	aerial	
1973	9/14	200	aerial		95	aerial	
1973		295	aerial		295	aerial	
1974	8/26	35	aerial		0	aerial	
1974	9/9	64	aerial		20	aerial	
1974	10/3	0	aerial		5	aerial	
1974	7/18-8/17	956	weir				
1975	7/26-8/15	2,027	weir				
1975	8/29	0	aerial		251	aerial	
1976	8/17	900					
1976	8/26	170			194		
1976	9/14	120			309		
1976		344			344	aerial	
1977	8/24	127			172		
1977	8/26				194		
1977	9/1				247	aerial	
1978	8/24				127		
1979	9/7	1,000			480		
1979					1,480		
1980					5,800		
1980	8/22				4,800		
1980	9/11				5,500		
1981	9/4	5,100			2,500		
1981	9/4				2,600		
1981	9/8				6,050		
1981	9/8				3,500		
1981	9/8				2,550		
1981	10/2				3,500		
1982	8/23				51		Poor cond.
1982	8/26				2,725		
1982	8/27				3,150		
1983	7/21				2,810		
1983	9/6	12,000					
1984	8/28	1,500			4,920		
1984	9/4	6,100			2,500		
1986	7/8-9/2	4,237	weir	*		weir	*
1990	8/27	40	aerial	*	25	aerial	*
1991	8/26	<1650	aerial	*	< 300	aerial	*
1992	9/2	<15	aerial	*	< 4,000	aerial	*
1993	8/24	850	aerial	*	< 200	aerial	*
1994	9/14	< 3,000	aerial	*	1,000's	aerial	*
1995	8/31	< 25,000	aerial	*			
1996	8/16	12,000	aerial	*			
1997	8/28	4,000	aerial	*	150	aerial	*
1999	9/7				3,515	aerial	*
2001	8/17	8,600	aerial	3,300 dead *		aerial	*
2002	8/13	< 6,000	aerial	*			
2003	8/6	< 11,500	aerial	< 700 dead *			
2005	8/14	< 1,000	aerial	*			
2006	7/15-8/19	69,800	weir	*			
2007	7/15-9/13	26,863	weir	*			
2008	7/14-9/3	2,620	weir	*			
2009	7/15-9/7	4,961	weir	*			
2010	7/15-9/2	2,223	weir	*			
2011	7/13-9/4	937	weir	*			
2012	ND	ND	ND	ND	ND	ND	ND

* = CIAA monitoring activity

ND = No Data

Appendix 19. Shell Lake – Historical Sockeye Salmon Smolt Migration

Date	1987	2007	2008	2009	2010
9-May	0	ND	ND	ND	ND
10-May	3	ND	ND	ND	ND
11-May	3	ND	ND	ND	ND
12-May	4	ND	ND	ND	ND
13-May	11	ND	ND	ND	ND
14-May	14	ND	ND	ND	ND
15-May	19	ND	ND	ND	ND
16-May	52	ND	ND	47	ND
17-May	61	ND	ND	92	ND
18-May	81	ND	ND	113	ND
19-May	94	ND	ND	190	ND
20-May	126	ND	ND	342	ND
21-May	295	ND	ND	355	ND
22-May	415	ND	ND	395	ND
23-May	563	ND	ND	466	ND
24-May	11,172	ND	ND	8,263	217
25-May	11,742	ND	ND	9,738	288
26-May	17,027	ND	ND	12,503	546
27-May	24,127	ND	ND	12,503	555
28-May	32,984	0	ND	12,507	1,679
29-May	36,198	0	ND	14,142	1,995
30-May	42,974	1	ND	14,146	2,075
31-May	42,989	13	ND	14,147	2,412
1-Jun	43,151	18	ND	14,284	2,520
2-Jun	43,941	18	ND	15,863	2,524
3-Jun	46,632	27	ND	42,232	2,549
4-Jun	46,857	71	392	44,439	2,549
5-Jun	47,726	1,157	482	45,551	2,549
6-Jun	52,782	1,308	636	65,376	2,565
7-Jun	54,172	1,563	681	66,270	2,651
8-Jun	57,923	1,678	1,323	66,517	2,660
9-Jun	59,167	3,780	2,088	66,839	2,662
10-Jun	59,570	3,792	2,286	67,104	2,700
11-Jun	59,809	9,804	2,294	67,449	2,715
12-Jun	62,623	10,595	2,296	67,487	2,716
13-Jun	62,981	10,613	2,296	67,516	2,732
14-Jun	64,383	50,914	2,783	68,422	2,733
15-Jun	64,796	64,854	2,915	68,478	2,733
16-Jun	65,685	76,045	2,918	68,646	2,733
17-Jun	67,793	78,512	3,063	68,647	2,733
18-Jun	68,939	79,482	3,130	68,648	2,733
19-Jun	69,621	79,488	3,134	68,657	2,733
20-Jun	71,995	79,758	3,143	68,657	2,733
21-Jun	72,160	79,758	3,181	68,700	2,733
22-Jun	74,794	79,758	3,183	ND	2,733
23-Jun	75,674	79,798	3,185	ND	ND
24-Jun	76,663	79,798	3,185	ND	ND
25-Jun	77,335	79,948	3,197	ND	ND
26-Jun	77,781	80,600	3,200	ND	ND
27-Jun	78,343	ND	ND	ND	ND
28-Jun	78,465	ND	ND	ND	ND
29-Jun	78,575	ND	ND	ND	ND
30-Jun	80,403	ND	ND	ND	ND
1-Jul	81,290	ND	ND	ND	ND
2-Jul	81,772	ND	ND	ND	ND
3-Jul	82,527	ND	ND	ND	ND
4-Jul	82,785	ND	ND	ND	ND
5-Jul	83,114	ND	ND	ND	ND
6-Jul	83,198	ND	ND	ND	ND
7-Jul	83,273	ND	ND	ND	ND

ND = No Data

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