

**Shell Lake
Sockeye Salmon
Data Report
2009-2011**

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The Shell Lake Project was made possible through an Alaskan Sustainable Salmon Fund grant received from the Alaska Department of Fish & 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 2009 through the 2011 adult sockeye escapements as it falls under the Alaskan 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 Alaskan Sustainable Salmon Fund 45888 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(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 Shell Lake Project from 2009 through 2011. 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 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 adult sockeye salmon returns to Shell Lake. Shell Lake was known to have a population of northern pike and salmon escapement monitoring has been conducted periodically since 1972 by means of a physical counting weir, aerial or ground surveys.

The 2009 Shell Lake adult salmon escapement was enumerated from 15 July and continued daily until 7 September. During this time 4,968 adult sockeye (*O. nerka*) salmon passed through the weir in Shell Creek. During the adult enumeration staff collected 642 scale samples of which 569 samples were analyzed for age composition. The age composition of the sockeye salmon escapement was largely comprised of age group 1.2 at 85.06%, followed by age group 1.3 at 9.84%, age group 2.3 at 2.80%, and age group 2.2 at 2.30%. Male sockeye salmon comprised 55.72% of the escapement with an average length of 519 mm (\pm 2% S.E.). Female sockeye salmon comprised 44.29% of the escapement with an average length of 501 mm (\pm 2% S.E.).

The 2010 Shell Lake adult salmon escapement was enumerated from 15 July and continued daily until 2 September. During this time an estimated 2,223 adult sockeye (*O. nerka*) salmon passed through the weir in Shell Creek. During the adult escapement staff collected 487 scale samples of which 368 samples were analyzed for age composition. The age composition of the sockeye salmon escapement was largely comprised of age group 1.3 at 63.10%, followed by age group 1.2 at 30.42%, age group 2.2 at 4.86%, and age group 2.3 at 1.62%. Male sockeye salmon comprised 47.03% of the escapement with an average length of 551 mm (\pm 2% S.E.). Female sockeye salmon comprised 52.97% of the escapement with an average length of 519 mm (\pm 2% S.E.).

The 2011 Shell Lake adult salmon escapement was enumerated from 17 July and continued daily until 24 August. During this time 937 adult sockeye (*O. nerka*) salmon passed through the weir

in Shell Creek. No fish were collected for age, sex or length determination due to few returning salmon.

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), 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 the smolt and adult returns and to assess the characteristics of these populations in terms of age composition, sex and size. Additionally, for some lake systems, environmental conditions and water quality measurements are being collected as well as genetic samples, 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 adult salmon returns to Shell Lake was performed in all three years of the 3-year effort to enumerate sockeye salmon returns to the Susitna River drainage. Shell Lake was chosen for enumeration because invasive northern pike were known to be present and to provide escapement data for comparison with historical adult salmon returns.

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PROJECT AREA

Shell Lake is located in the Yentna River basin of the larger Susitna River drainage. Shell Lake is classified in under Anadromous Waters Catalog (AWC) number 247-41-10200-2053-3205-4050-0010 (Cook Inlet Regional Planning Team, 2007). 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 seven small tributaries and discharges southeast via Shell Creek to the Skwentna River. Monitoring activities took place in Shell Creek (AWC 247-10200-2053-3205-4052) in all three years of the study.

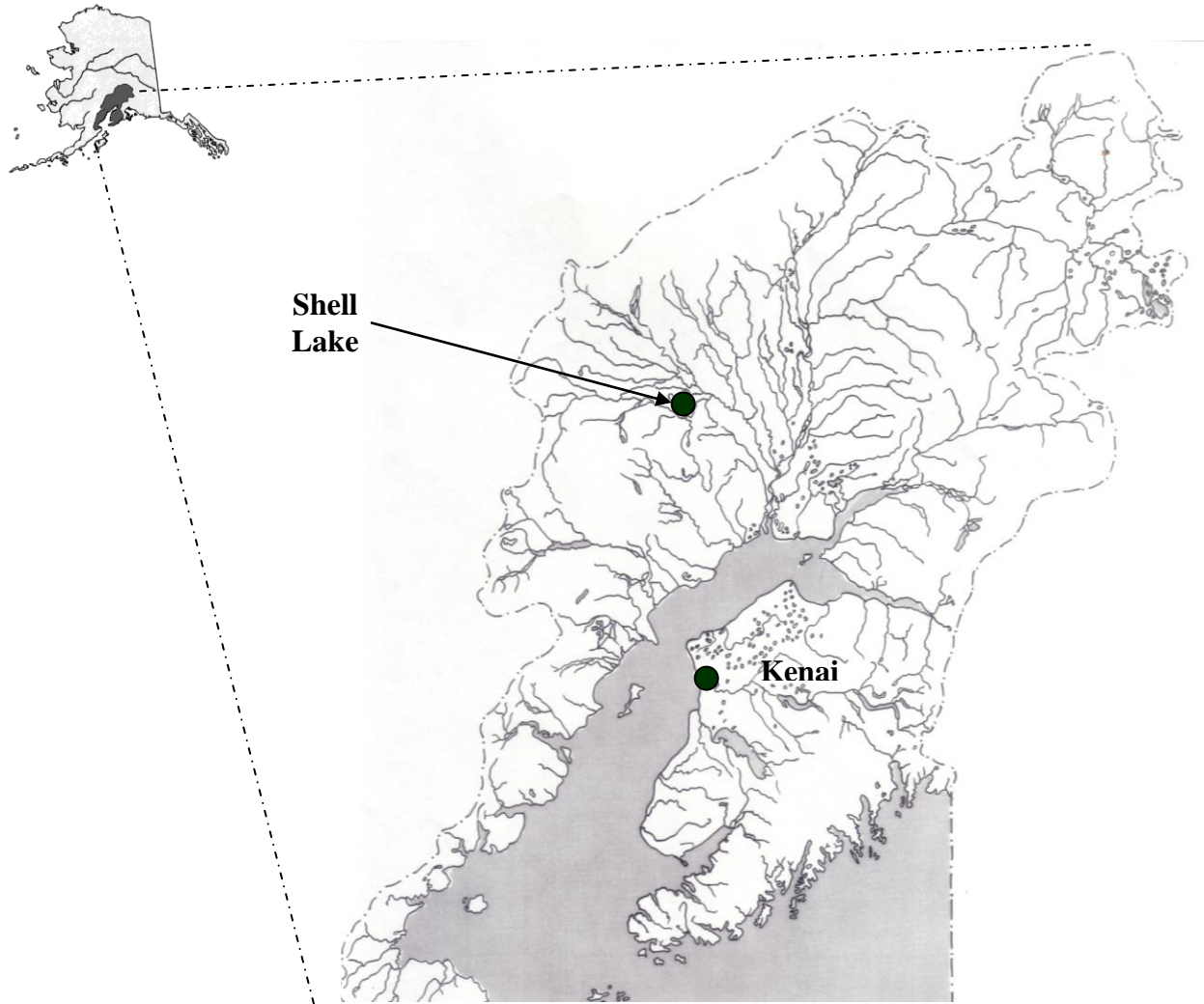


Figure 1 Shell Lake in Relation to Cook Inlet and Alaska

SHELL LAKE

Latitude: 61° 58'
Longitude: 151° 33'
Elevation: 123 m
Area: $5.2 \times 10^6 \text{ m}^2$
Mean Depth: 11.9 m
Maximum Depth: 28.7 m
Volume: $62.3 \times 10^6 \text{ m}^3$
Contours in feet

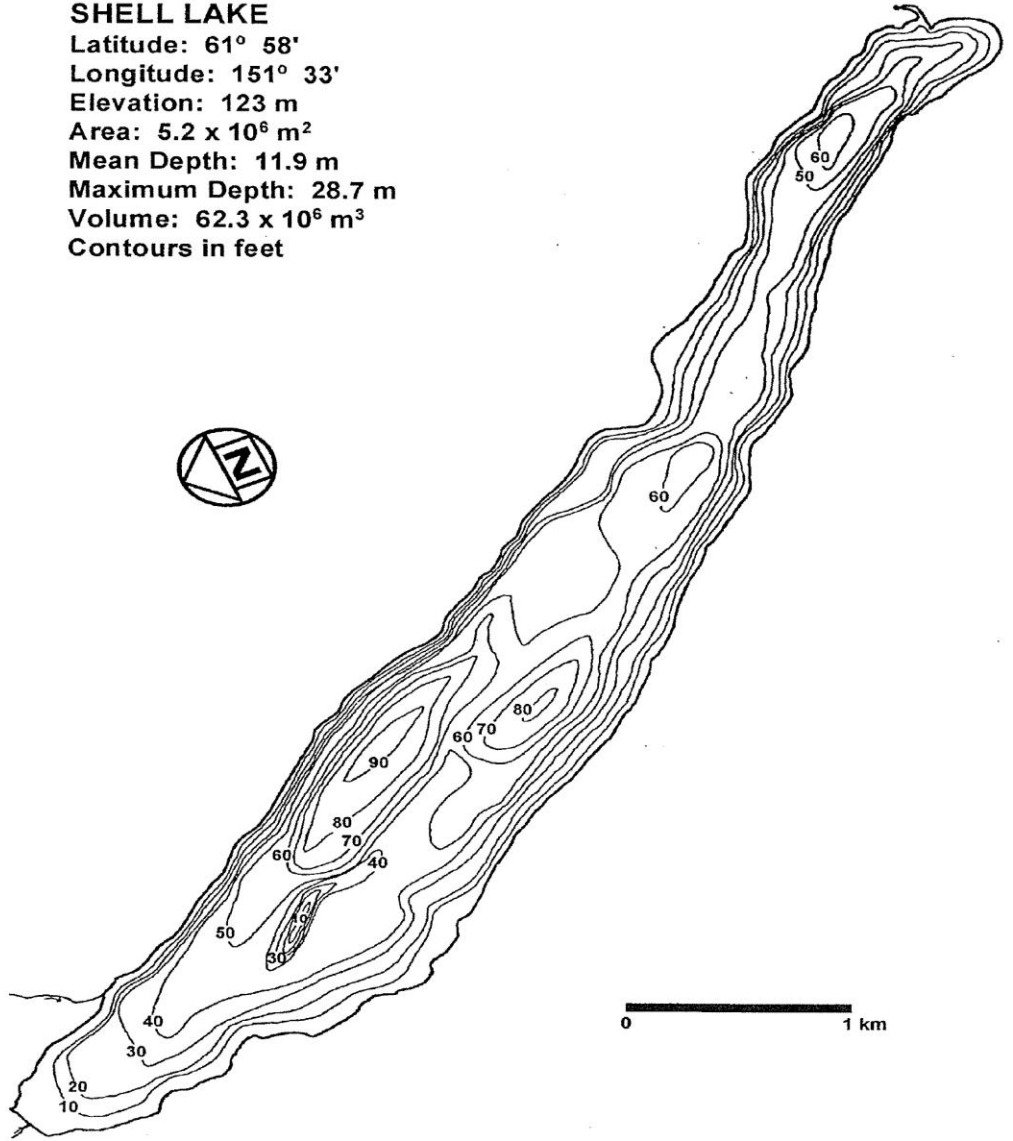


Figure 2 Bathymetric Map of Shell Lake

METHODS

Standard Cook Inlet Aquaculture Association (CIAA) procedures were followed for collecting data for environmental conditions and adult enumerations and were consistent from 2009 through 2011 (Cook Inlet Aquaculture Association Staff, 2009).

Environmental Conditions

To assess the environmental conditions during the adult sockeye salmon migration to Shell Lake, percent cloud cover was visually estimated, stream stage 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 P.M. each day. It should be noted that the stream stage measurements are not comparable from year to year.

Adult Enumeration

To enumerate and collect adult salmon returning to Shell Creek, a counting weir was temporarily installed in Shell Creek each year from 2009 to 2011. The weir was constructed of 1.9 cm galvanized pipe and 7.6 cm aluminum channel. The galvanized pipe was picketed through 1.9 cm holes in the aluminum channel spaced 2.54 cm apart.

Field personnel visually identified to species and counted the adult fish as they ascended Shell Creek. By removing one or two pickets, fish were permitted to pass through the weir. Initially counts were made at least twice a day. As the number of adult fish passing through the weir increased, counts were made more frequently. Field personnel also visually checked each fish as it passed through the weir for a numbered tag inserted by ADF&G as part of a mark-recapture study. The data was submitted to ADF&G at the end of each year for analysis.

In addition to the enumeration of the adult salmon escapement, the sex, age and standard fork length¹ of the returning population of sockeye salmon was also assessed by collecting a sample of sockeye salmon as they passed through the weir. The sex of each adult sockeye salmon

¹Standard fork length was defined as the measurement from mid-eye to the fork of the tail.

collected was visually determined and the standard fork length measured to the nearest millimeter. For age evaluation, field personnel removed a scale from the primary growth area². All scales were submitted to ADF&G for age determination. All captured fish were unharmed and released upstream.

During 2009 and 2010, up to 40 adult sockeye salmon were randomly collected each day. A total of 642 sockeye salmon were collected in 2009 of which 569 were analyzed and 487 in 2010 of which 368 were analyzed. Due to the few numbers of adult sockeye salmon returning to Shell Creek in 2011, no adult sockeye salmon were collected for sampling. CIAA field personnel only enumerated the escapement to prevent unnecessary stress on the fish.

From 2009 through 2011 beaver dams were routinely monitored in Shell Creek to assist in fish passage to spawning grounds during the adult escapement. Aerial surveys via fixed wing aircraft were typically conducted in conjunction with field camp visits every seven to ten days. The surveys began at the confluence of Shell Creek and Skwentna River and traveled upstream approximately 3.8 miles “as the crow flies”. Staff counted the number of beaver dams in the creek as well as any adult salmon below and/or above each dam. Staff determined if dismantling was warranted if the dam restricted water flow necessary for upstream salmon migration. Most surveys were completed in one pass to determine if any beaver dam(s) justified dismantling. To dismantle the beaver dam(s), field personnel were transported via helicopter to the confluence of Shell Creek and Skwentna River. The crew began at the beaver dam closest to the confluence and continued upstream to each subsequent dam. Each dam was dismantled by hand where a section approximately three to five feet wide in the deepest part of the stream channel was removed.

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

Environmental Conditions

During the 2009 adult sockeye migration, environmental conditions were monitored from 15 July through 7 September. Stream stage measurements averaged 0.55 feet and ranged from 0.38 to 0.66 feet. Stream temperatures averaged 17°C and ranged from 3 to 20°C. Air temperatures averaged 17°C and ranged from 9 to 25°C. Nine percent of the days were clear, 45% were partly cloudy, and 46% were completely overcast. Measurable rain was recorded on 35 days during the adult migration. A total of 262 mm of rain fell during this period.

During the 2010 adult sockeye migration, environmental conditions were monitored from 15 July through 2 September. Stream stage measurements averaged 2.02 feet and ranged from 1.62 to 2.36 feet. Stream temperatures averaged 15°C and ranged from 13 to 20°C. Air temperatures averaged 16°C and ranged from 11 to 22°C. Four percent of the days were clear, 44% were partly cloudy, and 52% were completely overcast. Measurable rain was recorded on 37 days during the adult migration. A total of 257 mm of rain fell during this period.

During the 2011 adult sockeye migration, environmental conditions were monitored from 17 July through 24 August. Stream stage measurements averaged 0.90 feet and ranged from 0.78 to 1.20 feet. Stream temperatures averaged 16°C and ranged from 13 to 23°C. Air temperatures averaged 16°C and ranged from 10 to 26°C. Ten percent of the days were clear, 33% were partly cloudy, and 57% were completely overcast. Measurable rain was recorded on 28 days during the adult migration. A total of 194 mm of rain fell during this period.

Adult Enumeration

The 2009 Shell Lake adult salmon escapement was enumerated from 15 July and continued daily until 7 September. During this time 4,968 adult sockeye (*O. nerka*) salmon returned to Shell Creek. Other fish counted during this time were 2 adult pink (*O. gorbuscha*) salmon. During the adult enumeration staff collected 642 scale samples of which 569 samples were analyzed for age

composition. The age composition of the sockeye salmon escapement was largely comprised of age group 1.2 at 85.06%, followed by age group 1.3 at 9.84%, age group 2.3 at 2.80%, and age group 2.2 at 2.30%. Male sockeye salmon comprised 55.72% of the escapement with an average length of 519 mm ($\pm 2\%$ S.E.). Female sockeye salmon comprised 44.29% of the escapement with an average length of 501 mm ($\pm 2\%$ S.E.).

On 28 July 2009, field personnel surveyed the creek for beaver dams hindering fish passage. Visibility was considered good. During the survey, 4 active beaver dams were observed with fish holding below the lowest dam. Fish were also observed holding in Shell Creek near the confluence of the Skwentna River, however turbid water reduced visibility for a count. To assist fish into Shell Lake, all 4 beaver dams blocking fish migration were notched. No fish were observed ascending the dams while the crew was on-site. On 29 July 2009, field personnel enumerated 475 adult sockeye salmon through the weir.

The 2010 Shell Lake adult salmon escapement was enumerated from 15 July and continued daily until 2 September. During this time an estimated 2,223 adult sockeye (*O. nerka*) salmon returned to Shell Creek. Other fish counted during this time were 3 adult pink salmon. During the adult escapement staff collected 487 scale samples of which 368 samples were analyzed for age composition. The age composition of the sockeye salmon escapement was largely comprised of age group 1.3 at 63.10%, followed by age group 1.2 at 30.42%, age group 2.2 at 4.86%, and age group 2.3 at 1.62%. Male sockeye salmon comprised 47.03% of the escapement with an average length of 551 mm ($\pm 2\%$ S.E.). Female sockeye salmon comprised 52.97% of the escapement with an average length of 519 mm ($\pm 2\%$ S.E.).

It should be noted the number of salmon enumerated as they passed through the weir in 2010 is not a complete count of the salmon escapement to Shell Lake. On August 4th and 5th, the counting weir was tampered with and pickets were removed for several hours without surveillance by CIAA staff. An unknown number of fish may have migrated upstream or downstream during this time.

In January 2011, a Shell Lake resident reported to CIAA that an estimated 1,000 dead pre-spawned adult sockeye salmon from the 2010 escapement were observed in the lake after the conclusion of field activities. No attempts were made to collect moribund fish for analysis.

The 2011 Shell Lake adult salmon escapement was enumerated from 17 July and continued daily until 24 August. During this time 937 adult sockeye (*O. nerka*) salmon returned to Shell Creek. No fish were collected for age, sex or length determination due to few returning salmon. Other fish counted during this time were 1 adult coho (*O. kisutch*) salmon. Twenty fish were counted with ADF&G tags during this time.

Table 1 Summary of Shell Lake Sockeye Salmon Escapement and Population Characteristics

Year	Escapement	Age Classes							
		1.2		1.3		2.2		2.3	
		(%)	Lth(mm)	(%)	Lth(mm)	(%)	Lth(mm)	(%)	Lth(mm)
2009	4,968	85.06%	504	9.84%	554	2.30%	516	2.80%	566
2010	2,223	30.42%	497	63.10%	553	4.86%	510	1.62%	562
2011	973	ND	ND	ND	ND	ND	ND	ND	ND
Mean	2,721	57.74%	501	36.47%	543	3.58%	509	2.21%	553
Min	973	30.42%	497	9.84%	528	2.30%	443	1.62%	538
Max	4,968	85.06%	504	63.10%	554	4.86%	574	2.80%	566

After the 2011 adult salmon return was completed, Shell Lake residents again notified CIAA of dead pre-spawned adult sockeye salmon in the lake. On 5 September, staff traveled to the lake to survey the lake and estimated 25-30 dead pre-spawned adult sockeye salmon near the outlet of the lake. Staff collected one adult female sockeye salmon and shipped it to the ADF&G Pathology Laboratory for analysis. ADF&G could not make a determination on the cause of death as the fish was too decomposed at the time of collection. CIAA staff made a second survey of Shell Lake on 14 September and did not observe any dead or moribund fish at that time.

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RECOMMENDATIONS

The Shell Lake sockeye salmon return is showing a declining trend and three factors appear to be evident. One factor contributing to the declining population trend may be northern pike predation on juvenile salmonids. The magnitude of their impact is inconclusive; however work towards suppressing northern pike populations may be a significant benefit in restoring salmon populations. Secondly, observations of dead pre-spawned sockeye salmon may also be a factor for the decline in salmon production which requires further investigation. Efforts to closely monitor future returning adult salmon and collect samples of recently dead or moribund pre-spawned sockeye salmon to determine cause of death should be made. And third, beaver dam barriers to salmon migration have been a persistent problem in Shell Creek and continued work to temporarily modify these barriers will facilitate the spawning migration of future salmon returns.

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LITERATURE CITED

- Cook Inlet Aquaculture Association Staff. 2009. Shell Lake Procedures Manual. Cook Inlet Aquaculture Association 40610 Kalifornsky Beach Road Kenai, Alaska 99611.
- Cook Inlet Regional Planning Team. 2007. Cook Inlet Regional Salmon Enhancement Planning, Phase II Plan: 2006-2025, page 6-70.
- Kyle, G.B., King, B.E., Peltz, L.R., and Edmundson, J.A. 1993. Susitna Drainage Sockeye Salmon Investigations: 1993 Annual Report on Fish and Limnological Surveys. Alaska Department of Fish and Game. Division of Commercial Fisheries Management and Development. Juneau, AK, page 40.
- Spafard, M. A. and J. A. Edmundson. 2000. A morphometric atlas of Alaskan lakes: Cook Inlet, Prince William Sound, and Bristol Bay areas. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report No. 2A00-23, page 75.

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APPENDICES

Appendix 1 Shell Lake 2009 – Environmental Conditions

Adult Migration						
Date	Sky	Precip. (mm)	Stage (ft)	Flow	Water Temp. (°C)	Air Temp. (°C)
15-Jul	2	0.0	0.38	ND	20	25
16-Jul	5	0.0	0.46	ND	20	22
17-Jul	3	19.0	0.48	ND	17	19
18-Jul	4	1.0	0.48	ND	19	22
19-Jul	5	4.0	0.48	ND	18	20
20-Jul	4	1.0	0.48	ND	19	20
21-Jul	3	1.5	0.49	ND	18	19
22-Jul	5	4.0	0.48	ND	18	16
23-Jul	5	5.5	0.48	ND	17	15
24-Jul	4	1.0	0.46	ND	18	15
25-Jul	5	0.5	0.46	ND	18	15
26-Jul	5	20.0	0.50	ND	18	12
27-Jul	4	10.0	0.50	ND	17	16
28-Jul	5	3.5	0.50	ND	17	15
29-Jul	3	24.0	0.55	ND	17	18
30-Jul	3	0.0	0.62	ND	15	19
31-Jul	3	15.0	0.66	ND	13	14
1-Aug	3	0.0	0.61	ND	16	20
2-Aug	3	0.0	0.59	ND	16	19
3-Aug	1	0.0	0.59	ND	17	24
4-Aug	4	0.0	0.58	ND	18	18
5-Aug	4	5.0	0.58	ND	18	18
6-Aug	4	15.0	0.59	ND	17	17
7-Aug	2	0.0	0.58	ND	17	19
8-Aug	1	0.0	0.57	ND	19	21
9-Aug	2	0.0	0.57	ND	18	20
10-Aug	2	0.0	0.55	ND	18	19
11-Aug	2	0.0	0.55	ND	18	19
12-Aug	4	0.5	0.56	ND	16	13
13-Aug	5	3.0	0.58	ND	16	12
14-Aug	5	16.0	0.56	ND	16	14
15-Aug	3	18.0	0.57	ND	15	17
16-Aug	3	19.0	0.57	ND	17	19
17-Aug	2	3.0	0.56	ND	16	19
18-Aug	4	12.0	0.58	ND	16	15
19-Aug	2	7.0	0.57	ND	15	16
20-Aug	1	0.0	0.57	ND	16	21
21-Aug	1	0.0	0.58	ND	17	22
22-Aug	3	0.0	0.58	ND	15	17
23-Aug	5	11.0	0.58	ND	15	16
24-Aug	3	0.0	0.57	ND	16	16
25-Aug	2	0.0	0.56	ND	15	15
26-Aug	5	10.0	0.57	ND	15	13
27-Aug	3	6.0	0.57	ND	16	17
28-Aug	5	0.5	0.57	ND	16	14
29-Aug	2	15.0	0.60	ND	16	14
30-Aug	3	2.0	0.60	ND	16	18
31-Aug	4	0.0	0.60	ND	15	12
1-Sep	5	1.3	0.60	ND	15	10
2-Sep	5	2.5	0.59	ND	14	9
3-Sep	2	3.0	0.59	ND	16	17
4-Sep	2	0.0	0.57	ND	15	17
5-Sep	1	0.0	0.57	ND	15	18
6-Sep	2	0.5	0.58	ND	14	15
7-Sep	4	2.0	0.60	ND	15	12
Total		262				
Avg.		4.8	0.55	ND	17	17
Min.		0.0	0.38	ND	13	9
Max.		24.0	0.66	ND	20	25

Ice Out = 14-May

	No. Days	Meas. Rain	Partly Overcast	Partly Cloudy	Clear
Adults	55	64%	46%	45%	9%

1.0 = Clear
 2.0 = Cloud Cover <50%
 3.0 = Cloud Cover >50%
 4.0 = Overcast
 5.0 = Rain

Appendix 2 Shell Lake 2009 – Daily Adult Escapement

Date	Sockeye		Coho	King	Pink	Chum	Rainbow	D.V.
	Daily Escapement	Total Return	Daily Escapement	Daily Escapement	Daily Escapement	Daily Escapement	Daily Escapement	Daily Escapement
15-Jul	0	0	0	0	0	0	0	0
16-Jul	0	0	0	0	0	0	0	0
17-Jul	0	0	0	0	0	0	0	0
18-Jul	0	0	0	0	0	0	0	0
19-Jul	0	0	0	0	0	0	0	0
20-Jul	0	0	0	0	0	0	0	0
21-Jul	0	0	0	0	0	0	0	0
22-Jul	0	0	0	0	0	0	0	0
23-Jul	0	0	0	0	0	0	0	0
24-Jul	0	0	0	0	0	0	0	0
25-Jul	0	0	0	0	0	0	0	0
26-Jul	0	0	0	0	0	0	0	0
27-Jul	0	0	0	0	0	0	0	0
28-Jul	0	0	0	0	0	0	0	0
29-Jul	475	475	0	0	0	0	0	0
30-Jul	114	589	0	0	0	0	0	0
31-Jul	32	621	0	0	0	0	0	0
1-Aug	21	642	0	0	0	0	0	0
2-Aug	0	642	0	0	0	0	0	0
3-Aug	2	644	0	0	0	0	0	0
4-Aug	191	835	0	0	0	0	0	0
5-Aug	41	876	0	0	0	0	0	0
6-Aug	0	876	0	0	0	0	0	0
7-Aug	3	879	0	0	0	0	0	0
8-Aug	11	890	0	0	0	0	0	0
9-Aug	4	894	0	0	0	0	0	0
10-Aug	9	903	0	0	0	0	0	0
11-Aug	0	903	0	0	0	0	0	0
12-Aug	0	903	0	0	0	0	0	0
13-Aug	0	903	0	0	0	0	0	0
14-Aug	1,114	2,017	0	0	0	0	0	0
15-Aug	2,036	4,053	0	0	0	0	0	0
16-Aug	501	4,554	0	0	2	0	0	0
17-Aug	10	4,564	0	0	0	0	0	0
18-Aug	0	4,564	0	0	0	0	0	0
19-Aug	9	4,573	0	0	0	0	0	0
20-Aug	17	4,590	0	0	0	0	0	0
21-Aug	83	4,673	0	0	0	0	0	0
22-Aug	11	4,684	0	0	0	0	0	0
23-Aug	4	4,688	0	0	0	0	0	0
24-Aug	0	4,688	0	0	0	0	0	0
25-Aug	9	4,697	0	0	0	0	0	0
26-Aug	0	4,697	0	0	0	0	0	0
27-Aug	112	4,809	0	0	0	0	0	0
28-Aug	47	4,856	0	0	0	0	0	0
29-Aug	40	4,896	0	0	0	0	0	0
30-Aug	22	4,918	0	0	0	0	0	0
31-Aug	13	4,931	0	0	0	0	0	0
1-Sep	0	4,931	0	0	0	0	0	0
2-Sep	9	4,940	0	0	0	0	0	0
3-Sep	0	4,940	0	0	0	0	0	0
4-Sep	0	4,940	0	0	0	0	0	0
5-Sep	12	4,952	0	0	0	0	0	0
6-Sep	10	4,962	0	0	0	0	0	0
7-Sep	6	4,968	0	0	0	0	0	0
Total	4,968		0	0	2	0	0	0

Appendix 3 Shell Lake 2009 - Age, Sex and Length Composition of Sockeye Salmon Escapement

Sample period: 15 July - 7 September	Age Group				Total
	1.2	1.3	2.2	2.3	
Males	2,410	235	44	78	2,768
Percent	48.52%	4.74%	0.89%	1.57%	55.72%
Sample Size	276	27	5	9	317
Mean Lth (mm)	512	566	533	578	519
Std. Error	2	5	14	8	2
Females	1,816	253	70	61	2,200
Percent	36.55%	5.10%	1.41%	1.23%	44.29%
Sample Size	208	29	8	7	252
Mean Lth (mm)	493	543	505	550	501
Std. Error	2	5	8	10	2
Both Sexes	4,226	489	114	139	4,968
Percent	85.06%	9.84%	2.30%	2.80%	100.00%
Sample Size	484	56	13	16	569
Mean Lth (mm)	504	554	516	566	511
Std. Error	1	3	7	6	1

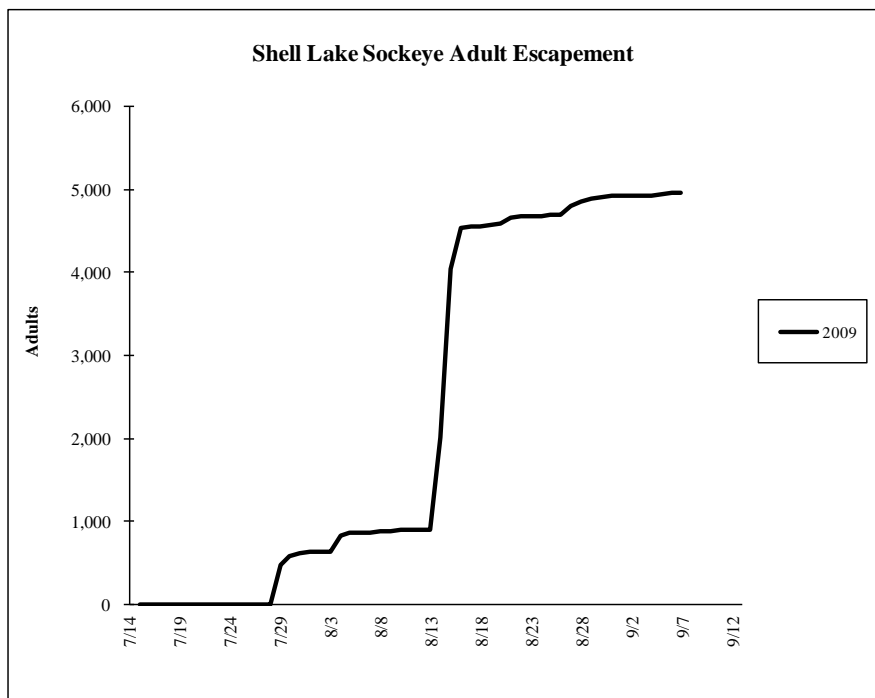
Appendix 4 Shell Lake 2009 – Hourly Adult Sockeye Escapement

Date	AM												Hour												No.	
	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5		
15-Jul																										0
16-Jul				0		0					0		0		0				0							0
17-Jul					0					0		0		0		0			0							0
18-Jul			0		0					0		0		0		0			0							0
19-Jul				0		0				0		0		0		0			0							0
20-Jul				0	0					0		0		0				0								0
21-Jul					0					0		0		0		0			0							0
22-Jul					0		0			0		0		0		0			0							0
23-Jul					0		0			0		0		0		0			0							0
24-Jul					0		0			0		0		0		0			0							0
25-Jul					0		0			0		0		0		0			0							0
26-Jul					0					0		0		0		0			0							0
27-Jul							0			0		0		0		0			0							0
28-Jul										0		0		0		0			0							0
29-Jul				12	18	10	60	100		97	153		23			2										475
30-Jul					20	25	15			15	30	9	0	0												114
31-Jul					10	5	0			12	0	0	5	0	0		0									32
1-Aug				0	3	8	4			0		1	2	0	3											21
2-Aug				0	0	0				0		0	0	0	0											0
3-Aug				0	0	0				0	0	2	0	0	0											2
4-Aug				0	10	15	15			0	0	90	20	30	11	0										191
5-Aug				5	2	28	2			3	0	1	0	0												41
6-Aug					0	0				0	0		0	0	0											0
7-Aug					0	0				0	0		0	0	0											3
8-Aug					2	5				0		3		1		0										11
9-Aug				0	3	0						0		0	0	1										4
10-Aug				0	2	6				0	1		0	0	0											9
11-Aug					0	0		0		0		0		0	0											0
12-Aug					0	0				0	0			0	0											0
13-Aug														0		0										0
14-Aug					10	6	9			10	5		100	250	300	276	134	14								1,114
15-Aug					20	35				60	360	570	435	320	200	36										2,036
16-Aug														60	120	250	71									501
17-Aug						2	5			0		3		0		0										10
18-Aug				0	0	0					0			0	0											0
19-Aug				0	0									2	5	2										9
20-Aug				0	5	0					3	1		6	0	2	0									17
21-Aug											0	0	0	5	25	10	12	17	14							83
22-Aug						0	0					2	5	0		4										11
23-Aug					0	0	2			2						0	0	0								4
24-Aug						0						0				0										0
25-Aug										0						5	2	2								9
26-Aug											0					0	0									0
27-Aug					0	20				45			30	5	12											112
28-Aug								24		10		10	3													47
29-Aug								10		3	10				8	9										40
30-Aug								5		6		2			5	4										22
31-Aug								7		0		2	4													13
1-Sep								0		0			0	0	0											0
2-Sep								0		6			1	0	2											9
3-Sep								0					0	0												0
4-Sep								0			0			0	0											0
5-Sep					12	0						0														12
6-Sep						4	0						6													10
7-Sep										2	4															6
																										4,968

Appendix 5 Shell Lake 2009 – Update

Misc. Activities		
Ice-out:	14-May	(approximate date)
Adult Crew On-site:	15-Jul	
Adult Crew Off-site:	7-Sep	

Adult Migration			
Dates:	15-Jul	to	7-Sep
			No. %
Sockeyes:			4,968 100%
Mortalities:			-
Age 1.2:			4,226 85.06%
Age 1.3:			488 9.84%
Age 2.2:			114 2.30%
Age 2.3:			139 2.80%
Coho:			0
King:			0
Pink:			2
Chum:			0
Rainbow:			0
Dolly Varden:			0



Appendix 6 Shell Lake 2010 – Environmental Conditions

Adult Migration					
Date	Sky	Precip. (mm)	Stage (ft)	Water Temp. (°C)	Air Temp. (°C)
15-Jul	4	5.0	ND	20	22
16-Jul	2	0.0	1.66	18	22
17-Jul	4	0.0	1.62	16	ND
18-Jul	5	11.0	1.62	15	15
19-Jul	4	4.0	1.64	15	15
20-Jul	4	6.0	1.66	15	12
21-Jul	4	5.0	1.68	15	17
22-Jul	3	3.0	1.68	16	21
23-Jul	4	0.5	1.66	16	16
24-Jul	4	0.3	1.62	15	16
25-Jul	5	9.0	1.64	14	12
26-Jul	5	25.0	1.70	14	13
27-Jul	2	6.5	1.78	16	20
28-Jul	4	1.0	1.78	14	13
29-Jul	5	3.0	1.80	14	12
30-Jul	5	3.0	1.80	16	17
31-Jul	4	10.0	1.84	16	17
1-Aug	3	0.8	1.84	17	17
2-Aug	4	0.0	1.84	16	17
3-Aug	4	0.0	1.84	18	21
4-Aug	5	34.0	1.94	16	16
5-Aug	2	25.0	2.20	15	16
6-Aug	3	2.5	2.24	15	15
7-Aug	5	1.0	2.26	15	13
8-Aug	5	1.5	2.26	15	13
9-Aug	5	25.0	2.30	15	13
10-Aug	2	5.0	2.34	14	15
11-Aug	5	3.0	2.36	14	15
12-Aug	3	4.5	2.32	14	15
13-Aug	5	1.0	2.30	14	16
14-Aug	4	7.0	2.30	16	16
15-Aug	5	4.0	2.32	15	14
16-Aug	3	16.0	2.32	14	11
17-Aug	3	8.0	2.32	14	11
18-Aug	2	0.0	2.30	15	15
19-Aug	2	0.0	2.28	15	16
20-Aug	1	0.0	2.26	16	18
21-Aug	2	0.5	2.24	16	16
22-Aug	2	0.0	2.20	16	16
23-Aug	2	0.0	2.18	16	19
24-Aug	1	0.0	2.18	18	21
25-Aug	2	0.0	2.16	18	21
26-Aug	3	0.0	2.12	17	18
27-Aug	4	0.5	2.08	14	14
28-Aug	5	15.0	2.08	13	12
29-Aug	2	1.0	2.12	14	14
30-Aug	2	1.0	2.10	17	16
31-Aug	3	0.0	2.10	16	17
1-Sep	3	4.0	2.10	15	15
2-Sep	2	4.5	2.10	16	15
Total		257			
Avg.		5.1	2.02	15	16
Min.		0.0	1.62	13	11
Max.		34.0	2.36	20	22

Ice out = 21-May

Summary of Cloud Cover - Percent of Days					
	No.	Meas.	Partly		Clear
	Days	Rain	Overcast	Cloudy	
Adults	50	74%	52%	44%	4%

1.0 = Clear
 2.0 = Cloud Cover <50%
 3.0 = Cloud Cover >50%
 4.0 = Overcast
 5.0 = Rain

ND = No Data

Appendix 7 Shell Lake 2010 – Daily Adult Escapement

Date	Sockeye		Coho	King	Pink	Chum	Rainbow	D.V.
	Daily Escapement	Total Return	Daily Escapement	Daily Escapement	Daily Escapement	Daily Escapement	Daily Escapement	Daily Escapement
15-Jul	0	0	0	0	0	0	0	0
16-Jul	0	0	0	0	0	0	0	0
17-Jul	0	0	0	0	0	0	0	0
18-Jul	0	0	0	0	0	0	0	0
19-Jul	0	0	0	0	0	0	0	0
20-Jul	0	0	0	0	0	0	0	0
21-Jul	0	0	0	0	0	0	0	0
22-Jul	0	0	0	0	0	0	0	0
23-Jul	0	0	0	0	0	0	0	0
24-Jul	0	0	0	0	0	0	0	0
25-Jul	0	0	0	0	0	0	0	0
26-Jul	0	0	0	0	0	0	0	0
27-Jul	389	389	0	0	0	0	0	0
28-Jul	0	389	0	0	0	0	0	0
29-Jul	6	395	0	0	0	0	0	0
30-Jul	0	395	0	0	0	0	0	0
31-Jul	333	728	0	0	2	0	0	0
1-Aug	667	1,395	0	0	0	0	0	0
2-Aug	282	1,677	0	0	0	0	0	0
3-Aug	9	1,686	0	0	0	0	0	0
4-Aug	209	1,895	0	0	0	0	0	0
5-Aug	52	1,947	0	0	0	0	0	0
6-Aug	0	1,947	0	0	0	0	0	0
7-Aug	3	1,950	0	0	0	0	0	0
8-Aug	1	1,951	0	0	0	0	0	0
9-Aug	3	1,954	0	0	0	0	0	0
10-Aug	1	1,955	0	0	0	0	0	0
11-Aug	7	1,962	0	0	0	0	0	0
12-Aug	21	1,983	0	0	0	0	0	0
13-Aug	40	2,023	0	0	0	0	0	0
14-Aug	84	2,107	0	0	1	0	0	0
15-Aug	0	2,107	0	0	0	0	0	0
16-Aug	21	2,128	0	0	0	0	0	0
17-Aug	15	2,143	0	0	0	0	0	0
18-Aug	61	2,204	0	0	0	0	0	0
19-Aug	0	2,204	0	0	0	0	0	0
20-Aug	16	2,220	0	0	0	0	0	0
21-Aug	3	2,223	0	0	0	0	0	0
22-Aug	0	2,223	0	0	0	0	0	0
23-Aug	0	2,223	0	0	0	0	0	0
24-Aug	0	2,223	0	0	0	0	0	0
25-Aug	0	2,223	0	0	0	0	0	0
26-Aug	0	2,223	0	0	0	0	0	0
27-Aug	0	2,223	0	0	0	0	0	0
28-Aug	0	2,223	0	0	0	0	0	0
29-Aug	0	2,223	0	0	0	0	0	0
30-Aug	0	2,223	0	0	0	0	0	0
31-Aug	0	2,223	0	0	0	0	0	0
1-Sep	0	2,223	0	0	0	0	0	0
2-Sep	0	2,223	0	0	0	0	0	0
Total	2,223		0	0	3	0	0	0

Appendix 8 Shell Lake 2010 - Age, Sex and Length Composition of Sockeye Salmon Escapement

Sample period: 27 July - 21 August	Age Group				Total
	1.2	1.3	2.2	2.3	
Males	235	732	48	30	1,045
Percent	10.58%	32.94%	2.16%	1.35%	47.03%
Sample Size	39	121	8	5	173
Mean Lth (mm)	511	565	518	569	551
Std. Error	5	2	11	14	2
Females	441	670	60	6	1,178
Percent	19.85%	30.15%	2.70%	0.27%	52.97%
Sample Size	73	111	10	1	195
Mean Lth (mm)	489	540	504	525	519
Std. Error	4	2	6		2
Both Sexes	676	1,402	108	36	2,223
Percent	30.42%	63.10%	4.86%	1.62%	100.00%
Sample Size	112	232	18	6	368
Mean Lth (mm)	497	553	510	562	534
Std. Error	3	2	6	14	1

Lengths taken to the nearest 5 mm.

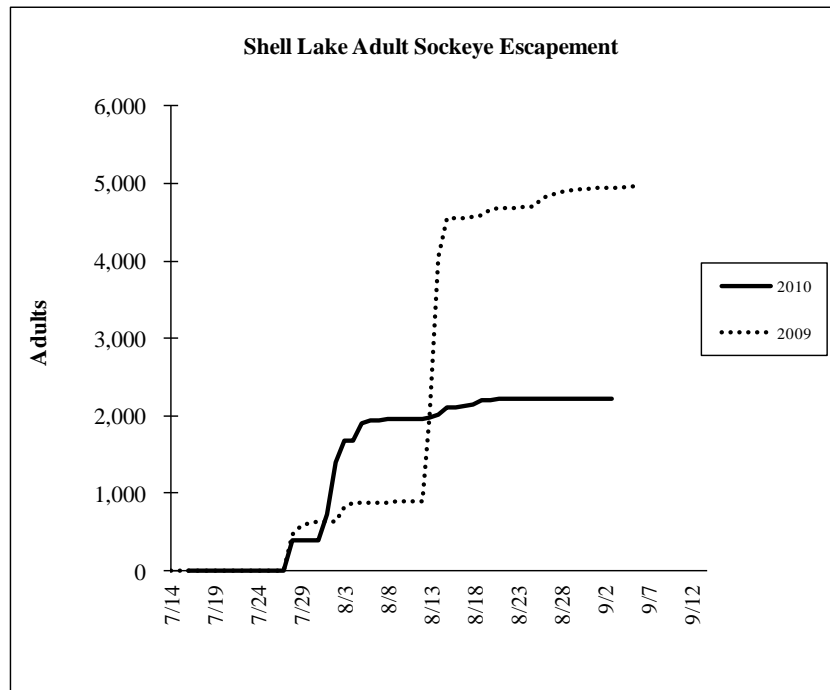
Appendix 9 Shell Lake 2010 – Hourly Adult Sockeye Escapement

Date	AM					Hour												No.							
	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10		11	12	1	2	3	4	5
15-Jul					0							0						0							0
16-Jul						0						0						0							0
17-Jul						0						0						0							0
18-Jul						0						0						0							0
19-Jul						0						0						0							0
20-Jul						0						0						0							0
21-Jul						0						0						0							0
22-Jul						0						0						0							0
23-Jul						0						0			0		0								0
24-Jul						0						0			0		0								0
25-Jul						0		0		0		0			0		0								0
26-Jul						0		0		0		0			0		0								0
27-Jul								389				0			0		0								389
28-Jul				0		0		0		0		0			0		0								0
29-Jul						0		2		4		0			0		0								6
30-Jul						0		0		0		0			0		0								0
31-Jul								64				0					269								333
1-Aug						5				23					639										667
2-Aug						1						245			36										282
3-Aug						0				4					5										9
4-Aug						0						209					0								209
5-Aug						0		0		0		52					0								52
6-Aug						0		0		0		0					0								0
7-Aug				0		0		3		0		0			0		0								3
8-Aug				0		0		1		0		0			0		0								1
9-Aug				0		0		0		0		3				0									3
10-Aug				0		0		0		0		1				0									1
11-Aug				0		0		0		0		7			0		0								7
12-Aug				0		0		0		0		21			0		0								21
13-Aug				0		0			20			0			20										40
14-Aug				0		0		0		9					75										84
15-Aug				0		0		0		0		0			0		0								0
16-Aug						21						0			0		0								21
17-Aug				0		0		0		0		15					0								15
18-Aug				0		0		6				55					0								61
19-Aug				0		0		0		0		0					0								0
20-Aug				0		0		0		0		13			3		0								16
21-Aug				0		0		0		0		3			0		0								3
22-Aug				0		0		0		0		0					0								0
23-Aug				0		0		0		0		0			0		0								0
24-Aug				0		0		0		0		0					0								0
25-Aug				0		0		0		0		0					0								0
26-Aug				0		0		0		0		0					0								0
27-Aug				0		0		0		0		0					0								0
28-Aug				0		0		0		0		0					0								0
29-Aug				0		0		0		0		0					0								0
30-Aug				0		0		0		0		0				0									0
31-Aug				0		0		0		0		0				0									0
1-Sep				0		0		0		0		0				0									0
2-Sep				0		0		0		0		0				0									0
																									2,223

Appendix 10 Shell Lake 2010 – Update

Misc. Activities		
Ice-out:	21-May	(approximate date)
Adult Crew On-site:	15-Jul	
Adult Crew Off-site:	2-Sep	

Adult Migration				
Dates:	15-Jul	to	2-Sep	
			No.	%
Sockeyes:			2,223	100%
Mortalities:			0	
Age 1.2:			676	30.42%
Age 1.3:			1,402	63.10%
Age 2.2:			108	4.86%
Age 2.3:			36	1.62%
Coho:			0	
King:			0	
Pink:			3	
Chum:			0	
Rainbow:			0	
Dolly Varden:			0	



Appendix 11 Shell Lake 2011 – Environmental Conditions

Adult Migration						
Date	Sky	Precip. (mm)	Stage (ft)	Flow	Water Temp. (°C)	Air Temp. (°C)
17-Jul	3	1.0	ND	ND	16	12
18-Jul	4	3.0	0.79	ND	17	14
19-Jul	1	4.0	0.80	ND	17	20
20-Jul	2	0.8	0.80	ND	20	21
21-Jul	2	0.0	0.80	ND	19	22
22-Jul	1	0.0	0.78	ND	23	26
23-Jul	4	3.0	0.78	ND	16	16
24-Jul	5	30.0	0.78	ND	16	14
25-Jul	5	13.0	0.81	ND	17	15
26-Jul	3	0.5	0.83	ND	17	16
27-Jul	1	0.0	0.82	ND	20	21
28-Jul	1	0.0	0.81	ND	20	22
29-Jul	2	0.0	0.81	ND	19	22
30-Jul	5	1.0	0.80	ND	20	18
31-Jul	5	7.0	0.81	ND	19	15
1-Aug	5	3.5	0.80	ND	15	13
2-Aug	5	26.0	0.83	ND	14	12
3-Aug	5	29.0	0.92	ND	16	14
4-Aug	4	4.0	0.92	ND	15	11
5-Aug	3	0.8	0.94	ND	15	19
6-Aug	4	1.0	0.91	ND	14	10
7-Aug	2	8.0	0.94	ND	14	16
8-Aug	4	0.8	0.94	ND	14	13
9-Aug	5	11.0	0.96	ND	14	14
10-Aug	5	0.4	0.99	ND	15	16
11-Aug	2	0.0	0.97	ND	15	19
12-Aug	4	0.3	0.99	ND	15	16
13-Aug	3	0.3	0.95	ND	16	19
14-Aug	3	0.0	0.94	ND	16	17
15-Aug	2	0.0	0.93	ND	16	18
16-Aug	2	0.0	0.90	ND	19	23
17-Aug	5	3.0	0.92	ND	17	19
18-Aug	5	4.3	0.93	ND	15	14
19-Aug	5	16.0	0.95	ND	13	12
20-Aug	5	17.0	1.00	ND	15	14
21-Aug	3	0.0	1.00	ND	15	17
22-Aug	4	0.0	1.10	ND	15	14
23-Aug	5	5.5	1.20	ND	16	12
24-Aug	4	0.5	1.10	ND	15	15
Total		194				
Avg.		5.0	0.90	ND	16	16
Min.		0.0	0.78	ND	13	10
Max.		30.0	1.20	ND	23	26

Ice out = 28 May

Summary of Cloud Cover - Percent of Days					
	No. Days	Meas. Rain	Overcast	Partly Cloudy	Clear
Adults	39	72%	57%	33%	10%

Appendix 12 Shell Lake 2011 – Adult Escapement

Date	Sockeye			Coho	King	Pink	Chum	Rainbow	D.V.
	Daily Escapement	Tags	Total Return	Daily Escapement	Daily Escapement	Daily Escapement	Daily Escapement	Daily Escapement	Daily Escapement
17-Jul	0	0	0	0	0	0	0	0	0
18-Jul	0	0	0	0	0	0	0	0	0
19-Jul	0	0	0	0	0	0	0	0	0
20-Jul	0	0	0	0	0	0	0	0	0
21-Jul	0	0	0	0	0	0	0	0	0
22-Jul	0	0	0	0	0	0	0	0	0
23-Jul	0	0	0	0	0	0	0	0	0
24-Jul	0	0	0	0	0	0	0	0	0
25-Jul	0	0	0	0	0	0	0	0	0
26-Jul	0	0	0	0	0	0	0	0	0
27-Jul	0	0	0	0	0	0	0	0	0
28-Jul	0	0	0	0	0	0	0	0	0
29-Jul	0	0	0	0	0	0	0	0	0
30-Jul	0	0	0	0	0	0	0	0	0
31-Jul	0	0	0	0	0	0	0	0	0
1-Aug	0	0	0	0	0	0	0	0	0
2-Aug	0	0	0	0	0	0	0	0	0
3-Aug	219	2	219	0	0	0	0	0	0
4-Aug	16	0	235	0	0	0	0	0	0
5-Aug	30	0	265	0	0	0	0	0	0
6-Aug	58	0	323	0	0	0	0	0	0
7-Aug	62	2	385	0	0	0	0	0	0
8-Aug	15	0	400	0	0	0	0	0	0
9-Aug	16	2	416	0	0	0	0	0	0
10-Aug	43	0	459	0	0	0	0	0	0
11-Aug	33	0	492	0	0	0	0	0	0
12-Aug	0	0	492	0	0	0	0	0	0
13-Aug	0	0	492	0	0	0	0	0	0
14-Aug	0	0	492	0	0	0	0	0	0
15-Aug	0	0	492	0	0	0	0	0	0
16-Aug	0	0	492	0	0	0	0	0	0
17-Aug	0	0	492	0	0	0	0	0	0
18-Aug	96	0	588	0	0	0	0	0	0
19-Aug	0	0	588	0	0	0	0	0	0
20-Aug	5	0	593	0	0	0	0	0	0
21-Aug	281	10	874	1	0	0	0	0	0
22-Aug	35	2	909	0	0	0	0	0	0
23-Aug	24	1	933	0	0	0	0	0	0
24-Aug	4	1	937	0	0	0	0	0	0
Total	937	20		1	0	0	0	0	0

Appendix 13 Shell Lake 2011 - Age, Sex and Length Composition of Sockeye Salmon Escapement

	Age Group				Total
	1.2	1.3	2.2	2.3	
Males					ND
Percent					ND
Sample Size					ND
Mean Lth (mm)					ND
Std. Error					ND
Females					ND
Percent					ND
Sample Size	<u>NO SAMPLES WERE TAKEN IN 2011</u>				ND
Mean Lth (mm)					ND
Std. Error					ND
Both Sexes					ND
Percent					ND
Sample Size					ND
Mean Lth (mm)					ND
Std. Error					ND

Appendix 14 Shell Lake 2011 – Hourly Adult Sockeye Escapement

Date	Hour												No.											
	AM						PM																	
	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
17-Jul				0				0		0		0			0			0						0
18-Jul				0			0			0		0			0									0
19-Jul				0				0		0		0			0									0
20-Jul					0			0		0		0			0									0
21-Jul				0				0		0		0			0									0
22-Jul			0					0		0		0			0									0
23-Jul				0				0		0		0			0									0
24-Jul				0			0			0		0			0									0
25-Jul				0				0		0		0			0									0
26-Jul				0				0		0		0			0									0
27-Jul				0				0		0		0			0									0
28-Jul					0			0		0		0			0									0
29-Jul			0				0			0		0			0									0
30-Jul				0			0			0		0			0									0
31-Jul				0			0			0		0			0		0							0
1-Aug				0			0			0		0			0									0
2-Aug			0				0			0		0			0									0
3-Aug			0				0			134		0			85									219
4-Aug							0			9		0			7									16
5-Aug							13			17		0			0									30
6-Aug				58			0			0		0			0									58
7-Aug					62		0			0		0			0									62
8-Aug					0					15		0			0									15
9-Aug					2					14		0			0									16
10-Aug				30					0			13			0									43
11-Aug				0								33			0									33
12-Aug				0								0			0									0
13-Aug					0							0			0									0
14-Aug					0							0			0									0
15-Aug							0					0			0									0
16-Aug							0					0			0									0
17-Aug							0					0			0									0
18-Aug					96							0			0									96
19-Aug							0					0			0									0
20-Aug					0					5		0			0									5
21-Aug								221				60			0									281
22-Aug					35							0			24									35
23-Aug					0																			24
24-Aug				4																				4
																								937

Appendix 15 Shell Lake 2011 – Update

Misc. Activities		
Ice-out:	28-May	(approximate date)
Adult Crew On-site:	17-Jul	2011
Adult Crew Off-site:	24-Aug	2011

Adult Migration				
Dates:	17-Jul	to	24-Aug	
			No.	%
Sockeyes:			937	100%
Mortalities:			0	
Age 1.2:			ND	ND
Age 1.3:			ND	ND
Age 2.2:			ND	ND
Age 2.3:			ND	ND
Coho:			1	
King:			0	
Pink:			0	
Chum:			0	
Rainbow:			0	
Dolly Varden			0	

