

**English Bay Lakes
Salmon Enhancement
Progress Report
2012**

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This year's operation of the English Bay Lakes Salmon Enhancement Project was made possible through enhancement taxes paid by the commercial fishermen in Area H, Cook Inlet and associated waters and through the harvest and sale of surplus fish.

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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 progress report is a synopsis of the monitoring and evaluation studies conducted for the English Bay Lake salmon enhancement project.

The purpose of the progress 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 later progress reports.

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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

The 2012 English Bay Lakes smolt migration, fry release, adult count, and gamete collection was conducted by the Cook Inlet Aquaculture Association (CIAA) in cooperation with the Nanwalek Village Council. Appreciation is extended to the full-time and seasonal staff at English Bay Lakes and Trail Lakes Hatchery. Appreciation is extended to the Nanwalek Village Council and the Alaska Department of Fish and Game for their continued support.

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ABSTRACT

The English Bay Lakes (EBL) sockeye salmon (*Oncorhynchus nerka*) enhancement project has been operating for over twenty years and has been modified several times. This project consists of an eggtake from the EBL system, the incubation and rearing of the resultant fry/smolts and their release back to the EBL system, Port Graham Bay and Tutka Bay Lagoon. Cook Inlet Aquaculture Association (CIAA) began assisting with the project in 2004, when eggs from the EBL system were transferred to Trail Lakes Hatchery (TLH) for incubation and rearing. In 2010, the EBL sockeye enhancement project was formally transferred from the Port Graham Hatchery to Trail Lakes Hatchery. In 2012, CIAA also took over the project to enumerate and characterize the smolt and adult sockeye migrations.

In 2012, 213,000 sockeye salmon fall fry (BY11) were released into Second Lake (English Bay Lakes system). At the time of release, the sockeye fall fry averaged 2.8 grams. All released fry were of English Bay Lake origin and were the progeny from non-enhanced (wild) parents as determined by otolith collection during the 2011 eggtake.

Smolt migration monitoring began on 06 May and continued daily until 04 July. During this time, a total of 113,400 sockeye smolts were counted through the traps. In addition to the sockeye salmon smolts, 6,718 coho salmon smolts and 66,436 pink salmon fry migrated from the lake.

Based on otolith marks (n=328), 19.2% ($\pm 4.4\%$) of the emigrating sockeye smolts were enhanced. An estimated 86.6% ($\pm 3.44\%$) smolts were age 1 and 13.4% ($\pm 3.44\%$) were age 2. The average length and weight of the age 1 sockeye smolts was 66 mm (± 1.0 SE) and 2.4 g (± 0.3 SE) respectively. The age 2 sockeye smolts were 68 mm (± 1.1 SE) and 2.8 g (± 0.3 SE).

Adult migration monitoring began on 03 June and continued daily until 18 July. Monitoring stopped prior to run completion due to logistical issues. An estimated 3,705 adult sockeye returned to English Bay Lakes in 2012. Based on scale analysis (n=71), the returning sockeye salmon were age 1.2 (27.5%), age 1.3 (41.2%), age 2.2 (3.9%) and age 2.3 (27.5%).

On September 12, 2012, a total of 432,000 sockeye salmon eggs were collected from 192 females and 192 males and shipped to Trail Lakes Hatchery where they were fertilized using a delayed fertilization technique. Approximately, 383,600 (88.79%) eggs survived to the eyed stage. Only those eggs determined to be from non-enhanced parents will be reared to the fall fry stage and released into English Bay Second Lake in October 2013.

INTRODUCTION AND PURPOSE

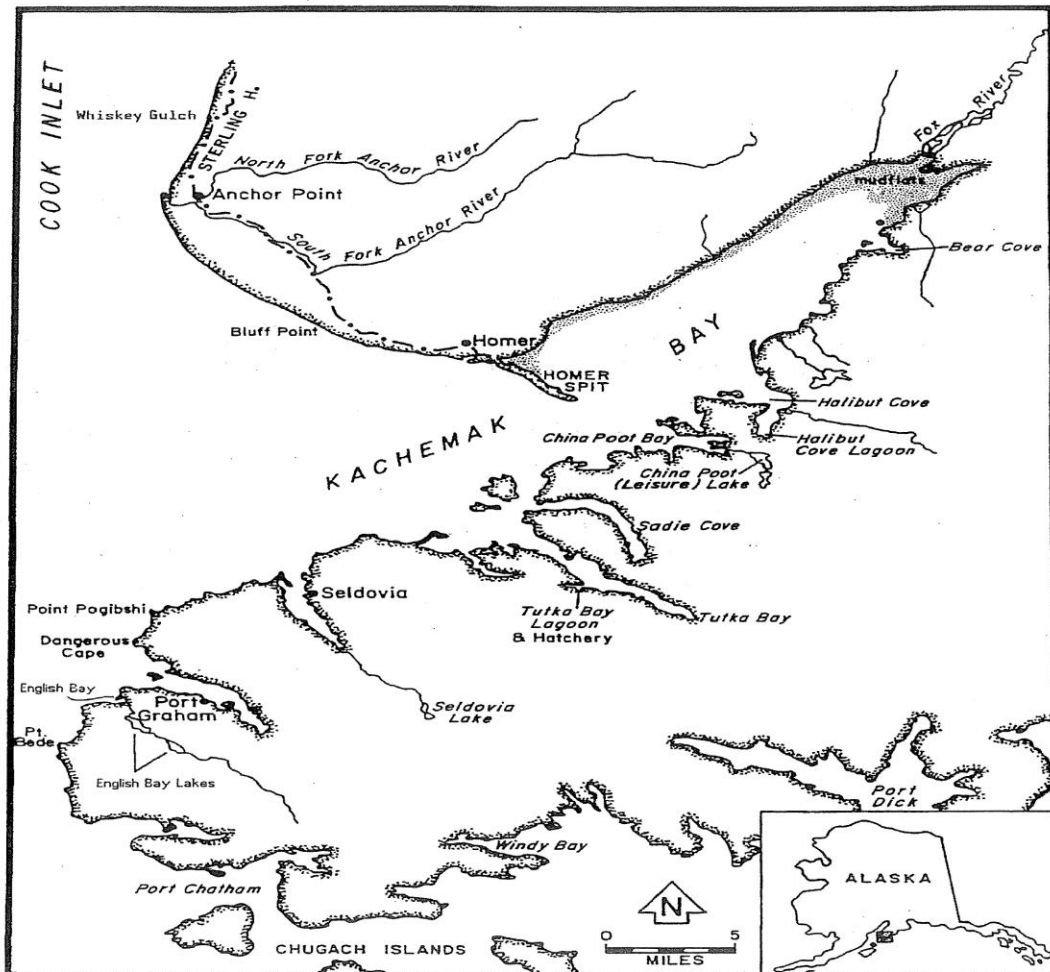
English Bay Lakes (EBL) is located on Alaska's Kenai Peninsula near the community of Nanwalek, Alaska. The English Bay Lakes system is a chain of five small lakes with a total surface area of approximately 200 hectares. The sockeye salmon (*Oncorhynchus nerka*) enhancement project has been operating for over twenty years and has been modified several times. Currently this project consists of an eggtake from the EBL system, the incubation and rearing of the resulting fry/smolt and their release back to the EBL system, Port Graham Bay and Tutka Bay Lagoon. Starting in 2012, Cook Inlet Aquaculture Association (CIAA) took over the operation to enumerate and characterize the smolt and adult migrations.

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PROJECT AREA

English Bay Lakes is located on Alaska's Kenai Peninsula near the community of Nanwalek, Alaska (Figure 1). It is a system comprised of a chain of five small lakes with a total surface area of approximately 200 hectares. Second and Third lakes are the two primary salmon producers.

Figure 1- General location of English Bay Lakes System (Edmundson et al. 1992)



Second Lake has a surface area of $0.70 \times 10^6 \text{ m}^2$ (150 acres), a mean lake depth of 10.9 m, a maximum depth of 25.9 m and a total volume of $7.6 \times 10^6 \text{ m}^3$ (Figure 2). Third Lake, drains into Second Lake, has a surface area of $0.72 \text{ m} \times 10^6 \text{ m}^2$ (166 acres), a mean lake depth of 14.7 m, a maximum depth of 29 m, and a total volume of $10.6 \times 10^6 \text{ m}^3$ (Figure 3). The hydraulic residence time is approximately 15 days for Second Lake and 35 days for Third Lake. Total annual outflow of Second Lake is more than 20 times greater than its volume and for Third Lake the outflow is nearly 10 times its volume (Edmundson et al. 1992).

Figure 2 - Bathymetric overview of Second Lake (Edmundson et al. 1992)

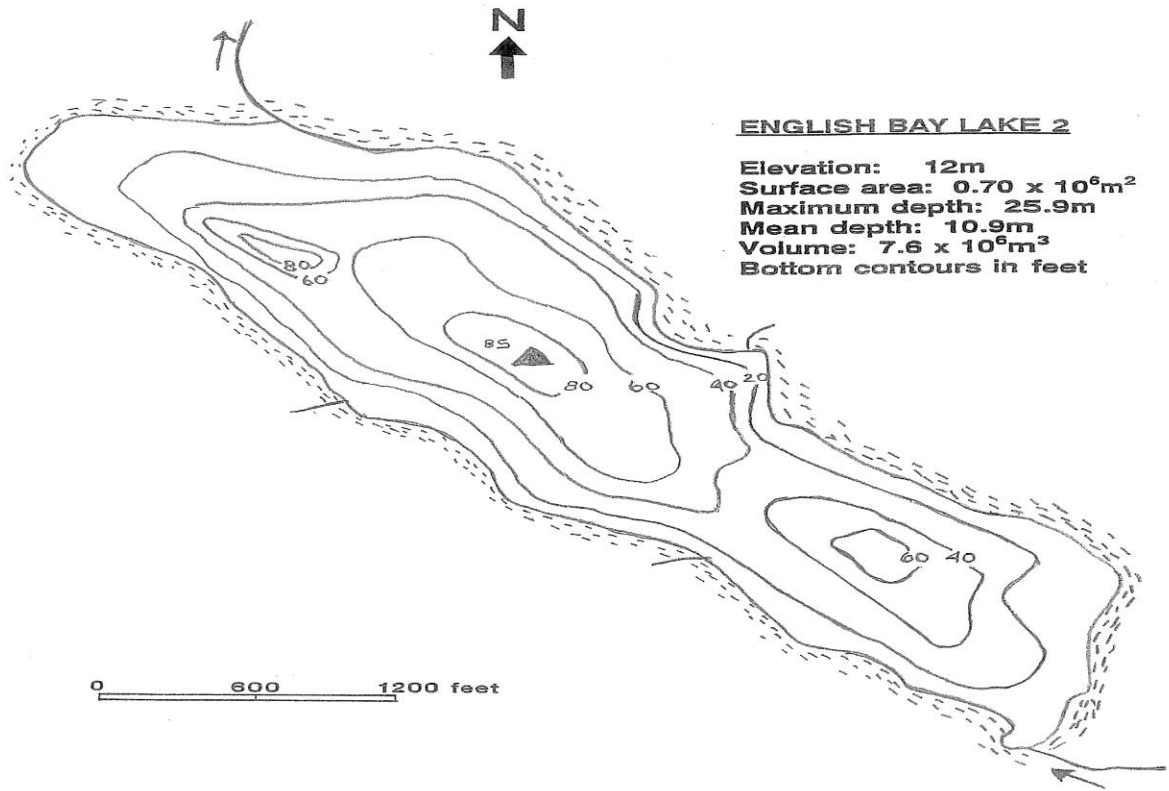
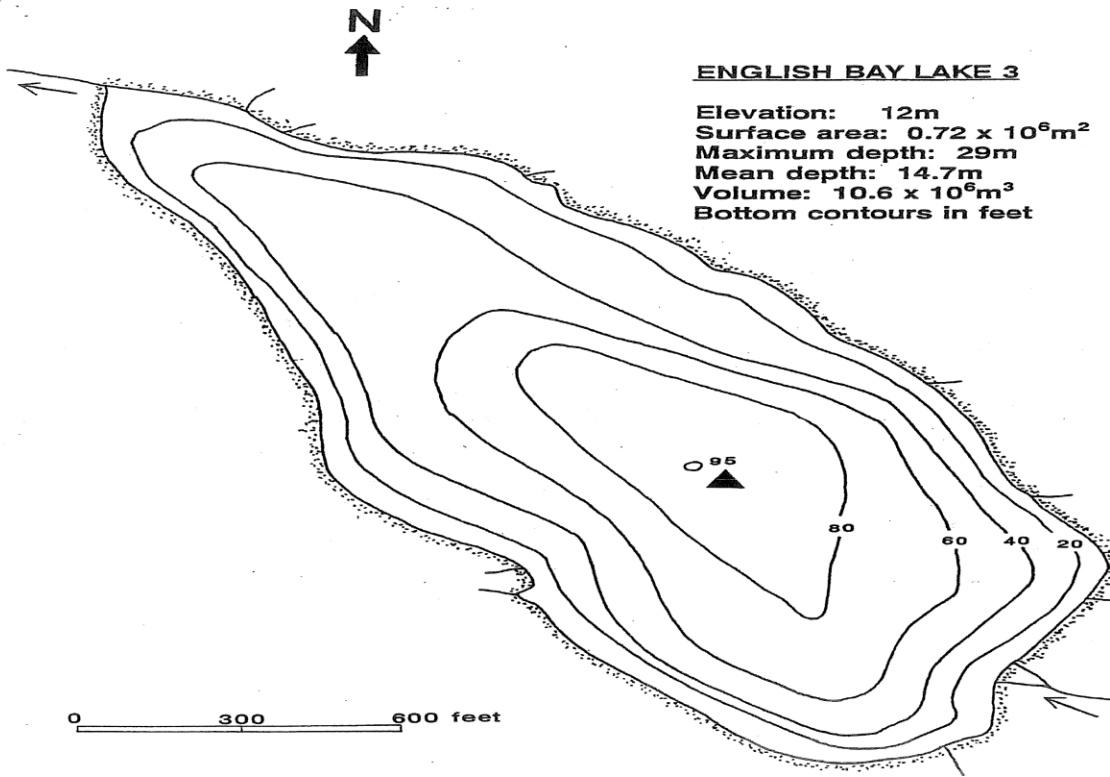


Figure 3 - Bathymetric overview of Third Lake (Edmundson et al. 1992)



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METHODS

In general, English Bay Lake salmon egg take, hatchery incubation, fry rearing, smolt enumeration and adult escapement monitoring follow procedures recommended by ADF&G.

Environmental Conditions

Daily observations completed at 5:00 P.M. throughout the summer field season, included percent cloud cover, precipitation to the nearest millimeter, air temperature, water temperature and stage height. Between May 19 and May 20 no data was recorded. Between July 4 - 18, again no data was recorded.

Smolt Enumeration

To enumerate the smolt migration, two smolt traps were temporarily placed in English Bay River approximately 0.29 miles downstream of First Lake. Each smolt trap consisted of a modified net with nylon mesh leads and a double compartment live box. Each trap connected to each other and covered the entire width of the river, so that all migrating smolts had to go through either one of the traps (Figure 3).

For smolt enumeration, fish migrating downstream were directed by the net into a live box where they were captured, temporarily held, identified to species, counted and released downstream. Total counts of smolts migrating from the lake were made until the migration of fish exceeded 2,000 to 3,000 fish per hour. When this occurred, a 10% sub-sampling procedure was used to enumerate the migrating smolts.

To enumerate migrating smolts with the 10% sub-sampling procedure, the counting period was divided into 20 minute intervals. During each 20 minute interval, migrating fish were directed into the live-box for two minutes and then counted. During the remaining 18 minutes, migrating smolts were passed through the weir structure uncounted. The two-minute smolt count was

multiplied by 10 to estimate the number of smolts migrating during the twenty minute interval.

Figure 3. The English Bay Lakes smolt traps.



Assuming the two minute sub-sampling intervals were randomly distributed throughout sub-sampling¹ and smolt moved through the weir randomly, the total smolt migration was estimated as follows:

If:

T_c = number of fish counted with the total count procedure,

\hat{T}_s = number of fish counted with the 10% sub-sampling procedure,

\hat{T} = the total smolt migration,

y = the number of fish counted in each two minute sub-sampling interval,

¹ Predetermined randomly selected 2 minute subsampling intervals assured random distribution within each 20 minute period.

$n =$ the number of two minute sub-sampling intervals sampled,
and
 $N =$ the number of possible two minute sub-sampling intervals,

Then:

$$\hat{T} = T_c + \hat{T}_s$$

and the variance is,

$$v(\hat{T}_s) = N^2 \left((N - n) / N \right) \sum (y_i - \bar{y})^2 / (n(n - 1))$$

And:

$$C.I._{\alpha=95\%} \text{ for } \hat{T}_s = \pm 2 \sqrt{v(\hat{T}_s)}$$

The variance about the estimated smolt migration, \hat{T} , is equal to the variance about \hat{T}_s , because T_c is a total count with 0 variance.

Smolt Characteristics and Enhanced Contribution

CIAA has released sockeye fall fry to English Bay Lakes since 2008. However, 2012 was the first year in which CIAA was also responsible for the smolt enumeration and population characteristics. To evaluate the success of the enhancement project, staff collected a sample of sockeye smolts migrating to determine age, weight, and length characteristics of the population as well as the number of hatchery and naturally produced smolts. All fish released by CIAA have been thermally marked².

In 2012, the smolts collected for measurement, age determination, and otolith removal were to have been sampled in proportion to the daily smolt migration. This was to have been accomplished by collecting every 50th sockeye smolt that passed through the smolt trap. The numbering sequence began when the first fish passed through the trap and continued consecutively until the smolt migration was complete. However, due to lack of oversight and diligence by staff, the sampling was not performed in proportion to the daily smolt migration. Age, weight and length measurements were collected from 381 sockeye smolts (0.34%), but

² The otolith mark is a hatchery induced thermal band produced by controlled temperature changes during incubation.

sample collection occurred predominantly during the mid portion of the run and may not be representative of the total run.

Each smolt collected for evaluation was first measured to the nearest millimeter for fork length³ and weighed to the nearest 0.1 gram. Several scales were then removed from the primary growth area⁴ and mounted on a glass slide for subsequent age determination. Finally, otoliths were removed and placed in a labeled one dram vial filled with a 10% ethanol solution. At CIAA office, each otolith was checked for a hatchery mark following procedures described by Glick and Shields (1993).

Sockeye smolt characteristics, the proportion of enhanced sockeye smolt and the proportion of age 1 and 2 sockeye smolt in the migrating population, were estimated with the following notations and formulas provided by ADF&G.

If:

N = total number of migrating smolts,

N_h = number of smolts in stratum h, ($N = \sum N_h$),

n = total number of smolts sampled,

n_h = number of smolts sampled in stratum h, ($n = \sum n_h$),

a = total number of enhanced smolts sampled,

a_h = number of enhanced smolts sampled in stratum h, ($a = \sum a_h$),

$p_h = a_h / n_h$, The proportion of enhanced smolts in stratum h,

$q_h = 1 - p_h$, The proportion of wild smolts in stratum h,

c_i = number of age = i smolts sampled,

c_{hi} = number of age = i smolts sampled in stratum h, ($c_i = \sum c_{hi}$),

$l_{hi} = c_{hi} / n_{hi}$, The proportion of age = i smolts in stratum h,

$m_{hi} = 1 - l_{hi}$, The proportion of other than age = i smolts in stratum h,

³ Standard fork length was measured from the tip of the snout to the fork of the tail.

⁴ 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.

$f = n / N$, The sampling fraction (assumed equal in all strata),

$W_h = N_h / N$, The stratum weight, and,

y = the weight or length of the smolt.

Then the proportion of enhanced smolts, \hat{P} , was estimated as:

$$\hat{P} = a / n; \quad \text{with a variance of} \quad v(\hat{P}) = (1 - f)(1 / n) \sum W_h p_h q_h;$$

which, under proportional allocation, is like the usual simple random sample estimate.

The total number of enhanced smolts, \hat{A} , was also estimated as:

$$\hat{A} = N(a / n) = N\hat{P};$$

with a variance of:

$$v(\hat{A}) = N^2(1 - f)(1 / n) \sum W_h p_h q_h = N^2 v(\hat{P}).$$

Since samples sizes were fairly large and \hat{P} was not extreme, the normal approximation, without a correction for continuity, could be used to develop the relative error. Thus, the 95% confidence interval estimate for \hat{P} and \hat{A} is:

$$\hat{P} \pm 1.96\sqrt{v(\hat{P})} \quad \text{and} \quad \hat{A} \pm 1.96\sqrt{v(\hat{A})};$$

and, the relative error is:

$$R.E. = \left(1.96\sqrt{v(\hat{P})} / (\hat{P})\right)100 \quad \text{and} \quad R.E. = \left(1.96\sqrt{v(\hat{A})} / (\hat{A})\right)100.$$

The proportion of age = i smolt in the smolt migration was also estimated as:

$$\hat{L}_i = c_i / n; \quad \text{with a variance of} \quad v(\hat{L}_i) = (1 - f) \frac{1}{n} \sum_h W_h l_{hi} m_{hi};$$

and, the total number of age = i smolts was estimated as:

$$\hat{C}_i = N(\hat{L}_i); \quad \text{with a variance of} \quad v(\hat{C}_i) = N^2 v(\hat{L}_i).$$

Confidence interval (95%) estimates for age-class proportion and abundance, assuming 2 age-classes, are:

$$\hat{L}_i \pm 2.24\left(\sqrt{v(\hat{L}_i)}\right) \quad \text{and} \quad \hat{C}_i \pm 2.24\left(\sqrt{v(\hat{C}_i)}\right).$$

Mean weight or length of age = i smolt was also estimated as:

$$\bar{y}_i = \frac{\sum_h \sum_j y_{hij}}{c_i};$$

with an approximate variance estimate of:

$$v(\bar{y}_i) \cong \frac{1}{\hat{C}_i^2} \sum_h \frac{N_h^2(1-f)}{n_h(n_h-1)} \left[\sum_j (y_{hij} - \bar{y}_{hi})^2 + c_{hi}(1 - c_{hi}/n_h)(\bar{y}_{hi} - \bar{y}_i)^2 \right].$$

The confidence interval (95%) estimate for the mean weight and length is:

$$\bar{y}_i \pm 1.96 \left(\sqrt{v(\bar{y}_i)} \right).$$

Adult Escapement

To enumerate and collect adult sockeye salmon returning to the English Bay Lakes, a counting weir was temporarily installed. The weir was constructed of 1.9 cm galvanized pipe and 7.6 cm aluminum channel spaced 2.54 cm apart.

Field personnel visually identified to species and counted the adult fish as they ascended English Bay River. 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.

In addition to the enumeration of the adult sockeye salmon escapement, the sex, age and standard fork length of the returning population was also assessed by collecting a sample as they passed through the weir. The sex of each adult sockeye salmon 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 area. All captured fish were unharmed and released upstream.

During the course of the adult migration, it was noted that when sampling occurred the adult fish located behind the weir were exhibiting signs of stress. For this reason, sampling of the adult sockeye salmon was not continued. Only 71 adult sockeye salmon were sampled, with most of these occurring in the later part of June.

Gamete Collection, Incubation and Rearing - Sockeye

Male and female adult sockeye salmon from the spawning areas were killed and stripped of their gametes. Each contributing parent was numbered and the mating crosses recorded. The gametes were shipped to Trail Lakes Hatchery for fertilization, incubation and rearing. In addition to removing the gametes, staff also collected the otoliths from both the male and female parents. During the eggtake, sixty female fish were sampled for routine disease screening (included bacteriology, BKD and virology).

At Trail Lakes Hatchery, each mating cross was recorded and the fertilized eggs were placed into heath stacks until they reach the eyed stage. Otoliths were ground, polished and read. Any hatchery crossed pairings were removed from the English Bay Lakes back-stocking program at the eyed stage and placed into general production for stocking at Tutka Bay Lagoon (smolts) or Kirschner Lake (spring fry). Only those crossings in which both parents were determined to be wild (non-enhanced), were kept for back-stocking into Second Lake. Resulting progeny will be reared at Trail Lakes Hatchery until October at which time they will be transported via fixed wing aircraft to Second Lake and released.

Fish Transport and Stocking

For stocking, all fry were transported by truck from Trail Lakes Hatchery to Trail Lakes in oxygenated transport tanks. Fry were then transferred to oxygenated tanks located in a fixed wing aircraft. Fry were flown to Second Lake where they were released.

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RESULTS AND DISCUSSION

Environmental Conditions

The environmental conditions recorded in 2012 are presented in Appendix 1. Data was not recorded on 19 and 20 May and from 04 July to 18 July. Between 06 May and 03 July, the average air temperature was 10.4°C ($\pm 4.0^\circ\text{C}$) while water temperature averaged 7.6°C ($\pm 2.9^\circ\text{C}$) (Table 1). Average stage height was 1.3 ft (± 0.23 ft).

Table 1 - Environmental conditions observed at English Bay Lakes, 2012.

Year	Total Days	Clear	No. of Days				Days Meas. Precip	Precip (mm)	Temperature (C)			
			<50% Cloud Cover	>50% Cloud Cover	100% Overcast	Rain			Air		Water	
								Avg	Range	Avg	Range	
2012	57	17	17	9	10	4	21	152	10.4	(3-20)	7.6	(2-12)

Rain days are counted as days with measurable precipitation and 100% overcast is measured as those days indicated as 100% overcast with or without measurable precipitation

Smolt Enumeration - Sockeye

Enumeration of Bear Lake sockeye smolts occurred between 06 May and 04 July. A total of 113,400 sockeye smolts migrated from English Bay Lakes in 2012 (Appendix 2). The 10% sub-sampling procedure was not used. In addition to the sockeye salmon smolts, 6,718 coho salmon smolts and 66,436 pink fry migrated from the lake.

A total of 381 sockeye smolt otoliths were collected of which 328 were readable. However, 70% of these samples were collected between 19 May and 07 June, hence biasing the sampling to the early part of the run. Keeping this in mind in interpreting the data, an estimated 86.6% ($\pm 3.4\%$) smolts were age 1 and 13.4% ($\pm 3.4\%$) were age 2. The age 1.0 smolts averaged 65.5 mm (± 1.0 mm) in length and 2.38 g (± 0.29 g) in weight. The age 2.0 smolts averaged 68.4 mm (± 1.1 mm) in length and 2.79 g (± 0.3 g) in weight (Table 52). Based on the presence of hatchery induced thermal marks in the otoliths of 328 smolts, it was estimated that 19.2% ($\pm 4.4\%$) of the

sockeye smolts were of hatchery origin (Table 2).

Table 2 - English Bay Lakes sockeye smolt characteristics.

Year	Number		% No.			Age Composition								Average Length (mm)				Average Weight (g)					
			Hatch.	95%CI	Wild	0.0	95%CI	1.0	95%CI	2.0	95%CI	3.0	95%CI	0.0	1.0	CI	2.0	CI	0.0	1.0	CI	2.0	CI
2012	113,400	0	19.2	4.4	91,600			98,200	3,900	15,200	3,900			66	1.0	68	1.1			2.4	0.3	2.8	0.3
Avg.	113,400	0	19.2	4.4	91,600			98,200	3,900	15,200	3,900			66	1.0	68	1.1			2.4	0.3	2.8	0.3
Total	113,400					0		98,200		15,200		0											

Average Length rounded to nearest mm, Average Weight rounded to nearest 0.1 g. All other figures have been rounded to nearest 100 fish.

Adult Escapement - Sockeye

Adult sockeye salmon began arriving at the weir on 03 June 2012 and continued to migrate until 18 July 2012 (Appendix 3). During this time, 3,705 adults were captured and counted at the weir (Table 3). Samples were collected from 71 adult fish between 13 June and 08 July, again biasing for the early part of the run. Keeping this in mind in interpreting the data, the returning major age groups for adult sockeye included ages 1.3 (41.2%), 1.2 (27.4%), 2.3 (27.4%) and 2.3 (3.9%).

A summary of mean age and length, by age class, for adult sockeye salmon escapement to English Bay Lakes for 2012 is presented in Appendix 3.

Table 3 - English Bay Lakes adult sockeye characteristics.

Year	Weir Return Total	Sockeye Salmon Age Composition										
		0.2	1.1	0.3	1.2	0.4	1.3	2.1	2.2	2.3	3.2	3.3
2012	3,705	0	0	0	1,017	0	1,526	0	145	1,017	0	0
Avg	3,705	0	0	0	1,017	0	1,526	0	145	1,017	0	0
% of Avg	100%	0.0%	0.0%	0.0%	27.4%	0.0%	41.2%	0.00%	3.9%	27.4%	0.00%	0.0%

Hatchery Activities

Stocking

In 2012, 213,000 sockeye fall fry (BY11; 4H) were released into English Bay Lake. These fish will migrate in 2013/2014 as smolts. At the time of release, the sockeye fry averaged 2.8 g.

Eggtake

On 12 September, 2012, a total of 432,000 sockeye salmon eggs were collected. A total of 412 broodfish (includes broodstock, mortalities and inviable) were used providing an average fecundity of 2,250 eggs/female. A total of 192 females and 192 males were crossed at 1:1 ratio. Of the 384 broodfish used, six fish did not have their otoliths recovered. This left 378 otoliths to be analyzed. Of these 378 otoliths, 4 fish (1.06%) were determined to have a thermal mark (enhanced fish) while the remaining 373 (98.42%) did not (1 sample could not be read). Once the eggs reached the eyed stage, those crosses which were a) identified with a thermal mark, b) could not be read and c) otoliths were not recoverable, were removed from the English Bay Lakes back-stocking group and moved into general production for stocking at either Tutka Bay Lagoon (smolts) or Kirschner Lake (spring fry).

A total of 225,000 eyed eggs were segregated for the English Bay Lakes back-stocking and 158,600 eyed eggs for the Tutka Bay and/or Kirschner stocking. Overall survival to the eyed stage was 88.79%.

Table 4 provides an overview of egg collection activities for enhancement at English Bay Lakes since brood year 2007.

Table 4 - English Bay Lake egg collection activities BY 2007 - 2012.

Brood Year	Brood Stock	Sockeye		%
		Green Eggs	Eyed Eggs	
2007	372	510,000	409,000	80.2
2008				
2009	240	307,000	288,000	93.8
2010	1,023	1,113,000	1,013,000	91.0
2011	2,100	2,504,876	2,204,262	88.0
2012	412	432,022	383,597	88.8
Total		4,866,898	4,297,859	
Ave				88.4

Fry-to-Smolt Survival

Migrating smolts in 2012 were stocked either as fry in 2010 (BY09 - Age 2) and 2011 (BY10 - Age 1). Based on age classification from otoliths/scales, the fry-to-smolt survival for each brood year of fry stocking can be determined. Total smolt migration count (count plus fish sampled for otolith and mortalities) was used to determine fry to smolt survival. This information is summarized in Table 5.

Table 5 - English Bay Lakes Fry-to-Smolt Survival

Brood Year	Escap.	No. Fry Stocked	Size (g)	No. Smolt	Hatch. Smolt	% Hatch. Survival
2007	ND	246,000	2.83			
2008	ND	0				
2009	ND	202,000	3.4	<i>15,190</i>	<i>2,916</i>	<i>1.44%</i>
2010	ND	203,300	2.86	<i>98,167</i>	<i>18,848</i>	<i>9.27%</i>
2011	ND	213,000	2.78			
2012	3,293					
Ave	3,293	172,860	2.968	56,679	10,882	5.36%

RED and in italics are incomplete brood years.

RECOMMENDATIONS

Greater diligence and oversight by staff is necessary to ensure the success of this project. It is important to determine the population characteristics and the performance of the fish, both stocked from the hatchery and those which occur naturally, in order to determine the best action to take to achieve maximum returns to the English Bay Lakes system.

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LITERATURE CITED

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APPENDICES

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Appendix 1 - English Bay Lakes 2012 - Environmental Conditions

Date	Sky	Precip. (mm)	Upper Gauge (ft)	Water Temp (oC)	Air Temp (oC)
1-May					
2-May					
3-May					
4-May					
5-May					
6-May	4	5.00	0.90	4.0	
7-May	2	5.00	0.90	4.0	
8-May	3	0.00	0.90	3.0	
9-May	5	6.00	1.00	4.0	4.0
10-May	5	31.00	1.20	4.0	4.1
11-May	4	23.00	1.20	4.5	4.0
12-May	4	18.00	1.20	2.0	3.4
13-May	2	7.00	1.20	4.0	4.0
14-May	1	0.00	1.10	5.0	4.2
15-May	1	0.00	1.00	5.0	4.2
16-May	1	0.00	1.00	5.0	4.1
17-May	1	0.00	1.00	5.0	4.3
18-May	2	0.00	1.10	4.0	4.1
19-May	-	-	-	-	-
20-May	-	-	-	-	-
21-May	2	0.00	1.10	4.0	8.0
22-May	2	0.00	1.20	4.0	11.0
23-May	1	0.00	1.30	8.0	12.0
24-May	4	7.00	1.70	4.0	8.0
25-May	2	0.00	1.70	5.0	12.0
26-May	1	0.00	1.80	5.0	11.0
27-May	2	0.00	1.60	5.0	12.0
28-May	2	0.00	1.50	4.0	11.0
29-May	4	5.50	1.50	7.0	8.0
30-May	2	0.00	1.40	7.0	11.0
31-May	2	0.00	1.30	7.0	12.0

Date	Sky	Precip. (mm)	Upper Gauge (ft)	Water Temp (oC)	Air Temp (oC)
1-Jun	1	0.00	1.10	8.0	12.0
2-Jun	1	0.00	1.10	8.0	13.0
3-Jun	1	4.00	1.10	8.0	15.0
4-Jun	2	2.00	1.60	8.0	10.0
5-Jun	1	0.00	1.50	8.0	10.0
6-Jun	4	1.00	1.50	8.0	10.0
7-Jun	1	0.50	1.40	8.0	9.0
8-Jun	3	0.00	1.42	8.0	11.0
9-Jun	4	0.50	1.50	8.0	10.0
10-Jun	3	0.00	1.50	8.0	9.0
11-Jun	3	7.00	1.50	9.0	9.0
12-Jun	2	0.00	1.50	8.0	10.0
13-Jun	3	0.00	1.50	8.0	7.0
14-Jun	4	0.00	1.50	8.0	10.0
15-Jun	2	0.00	1.50	8.0	12.0
16-Jun	3	0.00	1.40	9.0	11.0
17-Jun	2	0.00	1.40	9.0	16.0
18-Jun	1	0.00	1.40	10.0	13.0
19-Jun	2	0.00	1.50	11.0	14.0
20-Jun	4	0.50	1.40	10.0	15.0
21-Jun	1	0.50	1.40	11.0	14.0
22-Jun	1	0.00	1.30	11.0	17.0
23-Jun	1	0.00	1.40	12.0	20.0
24-Jun	4	8.00	1.40	12.0	13.0
25-Jun	5	15.00	1.40	11.0	9.0
26-Jun	3	3.00	1.30	11.0	12.0
27-Jun	3	1.00	1.30	11.0	13.0
28-Jun	2	0.00	1.20	12.0	14.0
29-Jun	1	0.00	1.10	12.0	14.0
30-Jun	2	0.00	1.00	12.0	13.0

Sky Conditions

- 1 = clear
- 2 = less than 50% cloud cover
- 3 = more than 50% cloud cover
- 4 = 100% overcast

Appendix 1 (continued). English Bay Lakes 2012 - Environmental Conditions

Date	Sky	Precip. (mm)	Upper Gauge (ft)	Water Temp (oC)	Air Temp (oC)
1-Jul	1	0.00	1.00	12.0	20.0
2-Jul	3	0.00	1.00	12.0	13.0
3-Jul	5	1.50	0.90	12.0	9.0
4-Jul					
5-Jul					
6-Jul					
7-Jul					
8-Jul					
9-Jul					
10-Jul					
11-Jul					
12-Jul					
13-Jul					
14-Jul					
15-Jul					
16-Jul					
17-Jul					
18-Jul					
19-Jul					
20-Jul					
21-Jul					
22-Jul					
23-Jul					
24-Jul					
25-Jul					
26-Jul					
27-Jul					
28-Jul					
29-Jul					
30-Jul					
31-Jul					

Sky Conditions

- 1 = clear
- 2 = less than 50% cloud cover
- 3 = more than 50% cloud cover
- 4 = 100% overcast
- 5 = rain

Appendix 2 - English Bay Lakes 2012 - Smolt Migration.

Date	Sockeye				Coho				Dolly Varden		Rainbow Trout	
	Daily	Otoliths	Cumm	% Smpl	Daily	Scales	Cumm	% Smpl	Daily	Cumm	Daily	Cumm
01-May			0				0					
02-May			0				0					
03-May			0				0					
04-May			0				0					
05-May			0				0					
06-May	2		2	0.00%	13		13	0.00%	0		0	
07-May	7		9	0.00%	29		42	0.00%	0		0	
08-May	20		29	0.00%	38		80	0.00%	0		0	
09-May	15		44	0.00%	42		122	0.00%	0		0	
10-May	75		119	0.00%	73		195	0.00%	0		0	
11-May	17		136	0.00%	25		220	0.00%	0		0	
12-May	4		140	0.00%	20		240	0.00%	0		0	
13-May	11		151	0.00%	23		263	0.00%	0		0	
14-May	36		187	0.00%	41		304	0.00%	0		0	
15-May	29		216	0.00%	58		362	0.00%	0		0	
16-May	60		276	0.00%	52		414	0.00%	0		0	
17-May	80		356	0.00%	102		516	0.00%	0		0	
18-May	103		459	0.00%	147		663	0.00%	0		0	
19-May	49	25	508	51.02%	48		711	0.00%	0		0	
20-May	65	25	573	38.46%	77		788	0.00%	0		0	
21-May	103	50	676	48.54%	80		868	0.00%	0		0	
22-May	180		856	0.00%	42		910	0.00%	0		0	
23-May	455		1,311	0.00%	77		987	0.00%	0		0	
24-May	874		2,185	0.00%	22		1,009	0.00%	0		0	
25-May	892		3,077	0.00%	52		1,061	0.00%	0		0	
26-May	614		3,691	0.00%	62		1,123	0.00%	0		0	
27-May	1,414		5,105	0.00%	88		1,211	0.00%	0		0	
28-May	1,628	50	6,733	3.07%	45		1,256	0.00%	0		0	
29-May	1,752	31	8,485	1.77%	86		1,342	0.00%	0		0	
30-May	1,020		9,505	0.00%	20		1,362	0.00%	0		0	
31-May	1,692		11,197	0.00%	75		1,437	0.00%	0		0	
01-Jun	451		11,648	0.00%	25		1,462	0.00%	0		0	
02-Jun	1,920		13,568	0.00%	133		1,595	0.00%	0		0	
03-Jun	3,169		16,737	0.00%	19		1,614	0.00%	0		0	
04-Jun	4,243		20,980	0.00%	248		1,862	0.00%	0		0	
05-Jun	7,668	52	28,648	0.68%	538		2,400	0.00%	0		0	
06-Jun	5,580	6	34,228	0.11%	287		2,687	0.00%	0		0	
07-Jun	7,589	32	41,817	0.42%	402		3,089	0.00%	0		0	
08-Jun	4,568		46,385	0.00%	390		3,479	0.00%	0		0	
09-Jun	7,065	20	53,450	0.28%	564	20	4,043	3.55%	0		0	
10-Jun	5,369	20	58,819	0.37%	514		4,557	0.00%	0		0	
11-Jun	4,381	20	63,200	0.46%	227	20	4,784	8.81%	0		0	
12-Jun	3,938		67,138	0.00%	193		4,977	0.00%	0		0	
13-Jun	3,449		70,587	0.00%	218	20	5,195	9.17%	0		0	
14-Jun	4,285		74,872	0.00%	251		5,446	0.00%	0		0	
15-Jun	2,595		77,467	0.00%	129		5,575	0.00%	0		0	
16-Jun	5,991		83,458	0.00%	280		5,855	0.00%	0		0	
17-Jun	4,965		88,423	0.00%	86		5,941	0.00%	0		0	
18-Jun	5,841		94,264	0.00%	192	20	6,133	10.42%	0		0	
19-Jun	4,564		98,828	0.00%	193	20	6,326	10.36%	0		0	
20-Jun	4,418	50	103,246	1.13%	65		6,391	0.00%	0		0	
21-Jun	3,158		106,404	0.00%	56		6,447	0.00%	0		0	
22-Jun	1,095		107,499	0.00%	31	10	6,478	32.26%	0		0	
23-Jun	876		108,375	0.00%	46		6,524	0.00%	0		0	
24-Jun	766		109,141	0.00%	22		6,546	0.00%	0		0	
25-Jun	671		109,812	0.00%	34		6,580	0.00%	0		0	
26-Jun	673		110,485	0.00%	27		6,607	0.00%	0		0	
27-Jun	650		111,135	0.00%	29		6,636	0.00%	0		0	
28-Jun	475		111,610	0.00%	22		6,658	0.00%	0		0	
29-Jun	400		112,010	0.00%	19		6,677	0.00%	0		0	
30-Jun	445		112,455	0.00%	11		6,688	0.00%	0		0	
01-Jul	396		112,851	0.00%	14		6,702	0.00%	0		0	
02-Jul	284		113,135	0.00%	7		6,709	0.00%	0		0	
03-Jul	115		113,250	0.00%	4		6,713	0.00%	0		0	
04-Jul	107		113,357	0.00%	5		6,718	0.00%	0		0	
Total	113,357	381	113,357	0.34%	6,718	110	6,718	1.64%	0	0	0	0

Appendix 3 - English Bay Lakes 2012 - Adult Sockeye Salmon Migration.

Date	Lake Escapement		Daily Total	Cumm. Total
	Sockeye	Morts		
21-May		0	0	0
22-May		0	0	0
23-May		0	0	0
24-May		0	0	0
25-May		0	0	0
26-May		0	0	0
27-May		0	0	0
28-May		0	0	0
29-May		0	0	0
30-May		0	0	0
31-May		0	0	0
01-Jun		0	0	0
02-Jun		0	0	0
03-Jun	0	0	0	0
04-Jun	0	0	0	0
05-Jun	10	0	10	10
06-Jun	30	0	30	40
07-Jun	1	0	1	41
08-Jun	35	0	35	76
09-Jun	0	0	0	76
10-Jun	4	0	4	80
11-Jun	30	0	30	110
12-Jun	10	0	10	120
13-Jun	5	0	5	125
14-Jun	37	0	37	162
15-Jun	3	0	3	165
16-Jun	14	0	14	179
17-Jun	12	0	12	191
18-Jun	0	0	0	191
19-Jun	0	0	0	191
20-Jun	64	0	64	255
21-Jun	37	0	37	292
22-Jun	38	0	38	330
23-Jun	236	0	236	566
24-Jun	356	0	356	922
25-Jun	35	0	35	957
26-Jun	208	0	208	1,165
27-Jun	24	0	24	1,189
28-Jun	214	0	214	1,403
29-Jun	193	0	193	1,596
30-Jun	144	0	144	1,740
01-Jul	46	0	46	1,786
02-Jul	73	0	73	1,859
03-Jul	91	0	91	1,950
04-Jul	47	0	47	1,997
05-Jul	183	0	183	2,180
06-Jul	55	0	55	2,235
07-Jul	69	0	69	2,304
08-Jul	380	0	380	2,684
09-Jul	210	0	210	2,894
10-Jul	149	0	149	3,043
11-Jul	250	0	250	3,293
12-Jul	0	0	0	3,293
13-Jul	59	0	59	3,352
14-Jul	137	0	137	3,489
15-Jul	5	0	5	3,494
16-Jul	90	0	90	3,584
17-Jul	54	0	54	3,638
18-Jul	67	0	67	3,705
Total	3,705	0	3,705	3,705

Appendix 4 - English Bay Lakes 2012 – Adult Sockeye Age and Sex Characteristics

	Age						Total
	1.1	1.2	1.3	2.1	2.2	2.3	
Sample Period:	03 June through 18 July						
Males (No.)	0	436	944	0	0	363	1,744
Percent	0.0%	25.0%	54.2%	0.0%	0.0%	20.8%	47.1%
Sample Size	0	6	13	0	0	5	24
Total Sample Size							32
Mean Length (mm)		523	572			567	567
Std. Deviation		37.0	18.5			35.5	43.1
Std. Error		15.1	5.1			15.9	7.6
Mean Weight (kg)		2.30	3.02			3.04	2.91
Std. Deviation		0.52	0.33			0.54	0.50
Std. Error		0.21	0.09			0.24	0.09
Females (No.)	0	581	581	0	145	654	1,961
Percent	0.0%	29.6%	29.6%	0.0%	7.4%	33.3%	52.9%
Sample Size	0	8	8	0	2	9	27
Total Sample Size							39
Mean Length (mm)		492	550		554	563	541
Std. Deviation		22.0	54.4		58.0	46.5	47.5
Std. Error		7.8	19.2		41.0	15.5	7.6
Mean Weight (kg)		1.78	2.56		2.10	2.43	2.30
Std. Deviation		0.28	0.87		0.14	0.24	0.56
Std. Error		0.10	0.31		0.10	0.08	0.09
Both Sexes (No.)	0	1,017	1,526	0	145	1,017	3,705
Percent	0.0%	27.5%	41.2%	0.0%	3.9%	27.5%	100.0%
Sample Size	0	14	21	0	2	14	51
Total Sample Size							71
Mean Length (mm)		505	563		554	565	553
Std. Deviation		32.1	36.8		58.0	41.5	47.1
Std. Error		8.6	8.0		41.0	11.1	5.6
Mean Weight (kg)		2.00	2.85		2.10	2.65	2.58
Std. Deviation		0.47	0.62		0.14	0.46	0.61
Std. Error		0.13	0.13		0.10	0.12	0.07

Total means for males, females and both sexes are generated from the total sample size

Appendix 5 - English Bay Lakes 2012 – Sockeye Smolt Hourly Counts

Time	6-May	7-May	8-May	9-May	10-May	11-May	12-May	13-May	14-May	15-May	16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	3-Jun	4-Jun	5-Jun	6-Jun			
6:00 AM																																			
7:00 AM																																			
8:00 AM																																			
9:00 AM						0			1		9	1	3	10		0									425						82	271			
10:00 AM			2				2																												
11:00 AM			5		7	5	0	0			3	0	0	7	2	1					18				98					343		350	1263		
12:00 PM			1						1	6															111					216	113				85
1:00 PM			3			0	0		6	3	2	0	3	0	5				0	18	3				10						415		298	446	93
2:00 PM			0		0		1		0	0			0	2	0	1				4	5	394	72	374	10	153	110		114					72	
3:00 PM			0			3			2	2	12	2	9	6	6	12	2			9	5	6	6	334	15	113	50	66					678	103	
4:00 PM		0	2	4			0		2	0	9	17	5	10	0	6	3		9	10	0	8	100	11	110	20			272	449	468	327	53		
5:00 PM		1	0	2	18	1	0		1	1	1	1	8	4	0	7	6	10	7	3	10	4	63	18	50	18	113	66	125		56	40			
6:00 PM		1	0	1	22	0	0	1		0	6	2	0	1	1	5	3	3	9	4	26	6	0	18	50	202	20	131	269	103	64				
7:00 PM		0	5	0	16	0	0	1	0	0	3	0	15	4	0	4	2	0		68	1	5	143	29	23	44	11	201	162	150	46				
8:00 PM		0	0	3	4	0	0	2	0	1	16	3	9	0	2	0	0	19		24	0	1	53	18	25	145	26	100	81	102	39				
9:00 PM		0	0	0	4	1	0	0	10	0		4	8	9	1	5	3	0		14			10	41	10	16		16	120	66	51	53			
10:00 PM	1	0	0	0	1	0	0	0	1	0	0	2	0	0	0	3	2	36	53	36	47	8	44	77	108	20		46	226	62	34	56			
11:00 PM	0	0	2	0	0	0	0	1	0	0	1	5	2	0	1	11	11	39	123	53	61	94	266	101	66	95	127	193	393	374	240	790			
12:00 AM	0	0	0	0	0	0	0	2	3	1	3	0	7	6	12	13	27	48	163	65	51	125	262	141	153	155	110	251	873	794					
1:00 AM	1	1	0	0	0	2	0	1	2	1	1	1	3	1	16	5	21	42	73	70	61	251	322	201	113	102	111	415		635	606				
2:00 AM	0	0	0	1	3	1	0	0	1	0	2	15	4	2	9	10	35	64	75	43	73	129	109	21	100	100	563		865	858					
3:00 AM	0	4	0	1	0	2	0	1	3	1	1	8	2	0	4	9	31	46	146	91	55	174	101	32	111	95		969	970	741					
4:00 AM				1	0	1	1	1	3	1	2	12	6	3	4	11	19	56	147	11	69	144	192		115	85			954	815					
5:00 AM				2	0	1	0	0	1	0	0	5	2	1	2	2	5	63	0	1	82	75	85		94	96							532		
Total	2	7	20	15	75	17	4	11	36	29	60	80	103	49	65	103	180	455	874	892	614	1414	1628	1752	1020	1692	451	1920	3169	4243	7668	5580			

Sockeye Time	7-Jun	8-Jun	9-Jun	10-Jun	11-Jun	12-Jun	13-Jun	14-Jun	15-Jun	16-Jun	17-Jun	18-Jun	19-Jun	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul							
6:00 AM		87										303		96					19	11	26	23	16												
7:00 AM		75	1141																18	17	32	0													
8:00 AM	583		305																9		20	40													
9:00 AM	382	142	381																																
10:00 AM	697	112	207	606																															
11:00 AM	162	105	132	88		166		281	413									90					58	60	50			17							
12:00 PM	249	100	161	123	207	86	921	171	153	739	481	389	415	344	335	109	112		89	106	64		24	24	35										
1:00 PM	311		93	183	148		115	135	100	186	286	253	134	88	153	66							30	19			10	12							
2:00 PM	128	195	129	178	152	300	93	160	77	209	218	236	196	57	105	75	90						21	26	28										
3:00 PM	468	144	118		111		66		78	224	265		171		72								22	26	16	13									
4:00 PM	238	130	104	308	202	206	149		67	151	268	386	130	68	67	59			31	33	50	25		28	24		8								
5:00 PM	194	124	108	164	161	160	60	711	95	205	188	287	161		77	57	68	34				45	11	21	21	22	17								
6:00 PM		124	102	131		135	86	194	97	162	129	215	114	57		43	92	21	57	37	25		21	20			5								
7:00 PM	252	79	96	86	235		284	112	83	195	124	77			111	52		34			34	22	18	17	19	20	19								
8:00 PM	88	105	76	86	158		108		98	171	141	105			60	48	45	27	56	25	17	31		23	19	22	11	29							
9:00 PM	151	74	124	65	237	187	207	94	103	137	205	210	125	853	79	0	42	39	37	16	29	23		19		36	11	15							
10:00 PM	204	74	150	100	125	93	212	108	106	139	208	234	157	762	132	71	55	32	27	14	35	32		43	36	27	20	8							
11:00 PM	184	373	201	262	260	119	152	91	241	246	189	131	606	206	74	58	56	37	30	56	30	73	28	25			15	11							
12:00 AM	902	238	509	341	240	277	178	246	291	409	238	197	332	447	147	69	39	121	56	47	78	55	30	19	20		12	7							
1:00 AM	631	463	654	505	442	392	255	551	328	472	228	403	515	394	184	85	64	87	47	39	57	39	18	23	32	22	9								
2:00 AM	341	487	675	392	462	521	342	315	484	539	334	424	428	308	329	71	48	63	33	39	45	27	24	35	24	29	11								
3:00 AM	620	550	748	623	435	489	348		641	424	488	498	147	407	79	43	34	26	27	40	20	24	21	24	28	13									
4:00 AM	757	760	482	681	642	382	466	178	671	417	665	581	112	427	78	62	31	34	31	26	9	23	26	29	18	11	7								
5:00 AM	231	216	197	508	162	284	180	249	685	464	697	294	79	267	59	61	24	25	24	22	7	21	21	22	26	8	10								
Total	7589	4568	7065	5369	4381	3938	3449	4285	2595	5991	4965	5841	4564	4418	3158	1095	879	766	671	673	650	475	400	445	396	284	115	107							

Appendix 6 - English Bay Lakes 2012 – Project Updates

Stocking & Misc. Activities

Crew on-site:	5-May		
Ice-out:	NA		
Crew off-site:	15-Jul		
Fry stocking:	12-Oct	213,000	2.78 g

Smolt Migration

Dates:	6-May to 4-Jul		
Sockeyes:			113,357
Percent age 1:	98,151	86.6%	
Percent age 2:	15,206	13.4%	
Percent age 3:		0.0%	
Percent hatchery:	21,773	19.2%	
Dolly Varden:	0	0	

Egg Take

Dates:	12-Sep to 12-Sep		
No. of broodstock used*:			412
Green eggs:			432,022
Fecundity:			2,250
Eyed eggs:			383,597
% Survival			88.8%

Adult Migration

Dates:	3-Jun to 18-Jul		
Total return:			3,705
Commercial & Sport Fish harvest:	0	0.0%	
Lake:		0.0%	
Mortalities	0		
Hatchery broodstock:	412		
Lake broodstock:	3,293		

*Includes mortalities and inviables

