English Bay Sockeye Enhancement Project

Draft Progress Report

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ABSTRACT

Sockeye salmon, Oncorhynchus nerka, production in the English Bay Lake system have declined in recent years prompting commercial and subsistence fishing closures. Annual escapements did not increase in response to the closures. A fry stocking program was initiated in 1990. Out-migrating smolt were below threshold size. Low primary and secondary productivity of the English Bay System limited the extent of the stocking program. In 1991, a portion of the stocked fry (98,943) were placed in a net pen and reared to pre-smolt size (4.6 g) before release in September. Twelve percent of the pen reared fry and 5 % of the direct release fry were marked with coded wire tags to evaluated overwintering survival. Ending fry density was 8.0 kg/^{3}. Fry were released early due to an outbreak of furunculosis and a gill parasite infestation. Total fry mortality throughout the pen rearing was 14,186. Despite the high mortality, the results were encouraging.

The project was expanded in 1992 to 171,398 fry apportioned into six net pens. At release in mid-October, the mean weight of these fry was 8.0 g, Ending densities ranged from 4.8-6.9 kg/m^3. Total fry mortality was 10,118.

Smolt out-migration was monitored in 1988, 1990, 1991 and 1992. All coded wire tagged smolt recovered during the 1992 smolt emigration originated from the net pen. Mean size of the Age 1 smolt increased from 68mm, 2.9 g to 75mm, 3.8 g. Ninty-seven percent of the smolt in 1992 were Age 1, compared to 63 % in 1991.

INTRODUCTION

The English Bay River is located near the southwestern tip of the Kenai Peninsula on lower Cook Inlet, approximately 40 km southwest of Homer, AK. Sockeye Salmon, Oncorhynchus nerka, Pink Salmon, Oncorhynchus gorbusca, Coho Salmon, Oncorhynchus kisutch, utilize the English Bay drainage. Sockeye salmon escapement has been monitored periodically by weir counts and aerial survey since 1927 (Appendix 1). The total return over the past 30 years ranged from 3,300 - 44,000, and averaged 16,700 sockeye (Edmundson et al. 1992). During the late 1970's to early 1980's, total adult sockeye returns ranged from 11-20,000 fish, which approached the level of production (980,000 sockeye fry) that has been estimated from an euphotic volume (EV) rearing capacity model for the drainage (Koenings and Burkett 1987) (Edmondson et al 1992). However, 1985-1991 escapements averaged only 10 percent of the maximum historic level. Efforts by the Alaska Department of Fish and Game (ADF&G) to stem the decline of sockeye returns through regulatory management techniques were not successful (Edmundson et al. 1992). In order to increase production, ADF&G Fisheries Rehabilitation, Enhancement and Development Division (FRED), under contract with the Chugach Regional Resources Commission (CRRC), a Native tribal organization concerned with natural resource issues in the Chugach Region of Southcentral Alaska, initiated a fry stocking program in 1990 to supplement wild fry production. However, Age 1 smolts emigrating from the English Bay lakes in 1991 were not substantially greater than threshold size (60 mm; 2.2 g), indicating rearing conditions were near capacity (Geiger and Koenings 1991). Low densities and smaller sized zooplankton within the English Bay Lakes along with small smolt size suggested intense competition for food (Carpenter et al. 1985: Kyle et al. 1988).

Studies by FRED indicated that a lake fertilization effort to increase food production might not succeed at increasing sockeye production because of the rapid flushing rate of the English Bay drainage (Edmundson et al. 1992). FRED concluded that in order to balance juvenile fry densities with existing forage base, the total juvenile spring fry recruitment must not exceed 500,000 sockeye. This would limit escapement to 4,000 adults (2,000 females x 2,450 eggs/female x 10 percent survival) (Edmundson et al. 1992). In an attempt to increase sockeye escapement without harming the existing

forage base, a pre-smolt stocking project was implemented. A pre-smolt stocking project involves rearing fry in net pens throughout the growing season. Pen rearing fry would have minimal impact on zooplankton density , size and biomass, and provide a safe environment for fry to obtain pre-smolt size upon release in the Fall. In 1991, FRED initiated four interrelated enhancement activities. These activities included: 1) enumerating out-migrating sockeye smolt, 2) pen rearing a portion of the stocked fry, 3) a coded wire nose tag (CWT) marking program to evaluate fry to smolt and smolt to adult survival of both pen reared fry and direct release fry, and 4) continuation of in-system sockeye egg collection.

In June, 1991, 98,943 fry were placed in one net pen (volume 48.9 $m^{3)}$ located in Second Lake. An additional 155,931 fry were directly released into Third lake. Twelve percent of the pen fry and five percent of the direct release fry were coded wire tagged to evaluate fry to smolt, and smolt to adult survival. Pen reared fry suffered high mortalities (14,186) due to poor feeding techniques and the combined outbreak of furunculosis ("furunc") and Trichophyra, a gill parasite. It was difficult to determine which "dis-ease" was causing the mortalities. Furunc could be treated with medicated feed but treatment for the gill parasite presented its own problems (treatment involved a formalin bath of 1:6,000 for 1 hour). To prevent further horizontal transmission of both agents in the crowded net pen FRED decided to release the remaining 84,757 fry on September 18. Despite high mortalities, the results of the net pen experiment were encouraging. At release, pre-smolt averaged 4.6 grams. Ending density was 8.0 kg/m^3.

In 1992, the net pen rearing experiment was expanded to 171,398 fry. The fry were apportioned into six net pens (118,900 fry were also directly released into Second lake) and 9.7 percent of them were coded wire tagged. To stem the risk of another outbreak of furunculosis and Trichophyra, and achieve an average pre-smolt size of 5.0 grams upon release, fry densities in each pen were intended to remain at or below 4.0 kg/m^3.

An additional element to the net pen rearing involved the application of an experimental vaccine for Infectious Hematopoietic Necrosis Virus (IHNV) to 19,978 fry . These fry were marked by a

left ventral fin clip. Another pen with similar fry density was used as a control.

Sockeye smolt out-migrations were monitored intermittently in 1988, 1990, 1991. In 1992, a total count of the smolt out-migration was attempted and subsamples of marked smolt (CWT) were collected to evaluate fry to smolt survivals for both pen reared and direct released fry.

Adult sockeye escapement was monitored by aerial survey from 1988 to 1992. However in 1992, in addition to aerial survey, a weir was constructed near the mouth of the English Bay River to obtain a total count of the escapement.

In 1989, 427,474 eggs were collected; 255,074 eggs in 1990 and 572,000 in 1991. One million ninety-four thousand eggs were collected in 1992.

The intent of this document is to serve as a progress report on enhancement activities conducted in the English Bay drainage since 1988 and to provide a foundation for guiding further activities. The goal of the enhancement project is to develop lake pen rearing techniques for a 1 million smolt production module that can be expanded or duplicated to produce a return of 300,000 to 400,000 adult sockeye. A return of this size will support subsistence and local commercial fisheries along with a value added processing operation within the village of Nanwalek (formally English Bay). The goal of the project will be met by the following objectives:

1) Produce sufficient numbers of pre-smolt of the right size and condition (4 to 5 grams) for the spring out-migration.

2) Develop prophylactic techniques for protecting the fry and pre-smolt against gill parasites and other disease infestations.

3) Develop a pen rearing techniques that are efficient and prevents the spread of any disease infestations.

4) Train the residents of Nanwalek to run all aspects of the project within five years.

STUDY AREA

The English Bay lakes (59° 20'N, 151° 45'W) are located near the southwestern tip of the Kenai Peninsula on lower Cook Inlet approximately 40 km southwest of the city of Homer, Alaska (Figure 1). The village of Nanwalek (formally English Bay) is situated at the base of a narrow spit of land at the head of English Bay. A 14 hectare tidewater lagoon behind the spit forms the mouth of the English Bay River. The lagoon's average depth is 1.8 meters at MLLW. Indigenous people are Alutiiq and Nanwalek is Alutiiq for the "place by the lagoon". Historically, the area has been used as a summer fishing camp by coastal dwellers from villages along the southern coast of the Kenai Peninsula and Prince William Sound. Recorded history for the area can be traced to 1741 when Europeans first explored the Gulf of Alaska.

The English Bay River drainage is a moderately steep walled valley that runs approximately 11.3 km in length. There are five lakes within the drainage, each separated by varying lengths of river. The lakes are assigned an ascending numerical name, moving up the drainage from the river's mouth. Total lake area is 154 ha. The project's emphasis was in Second and Third lake. Second lake has a surface area of 60.7 ha, a mean lake depth of 10.9 m, a maximum depth of 25.9 m and a total volume of 7.6×10^6 m^3 (Figure 2). Third lake (Figure 3) is 67.2 ha with a mean depth of 14.7 m, a maximum depth of 29 m, and a total volume of 10.6×10^6 m^3 (Edmundson et al. 1992). The watershed encompasses 63 km^2 and has a mean annual precipitation of 300 cm. The hydraulic residence time (the time it takes for the total volume of water to be replaced) is 15 days for Second lake and 35 days for Third lake (Edmundson et al. 1992). Total annual outflow of Second lake is more than 20 times greater than its volume and the outflow of Third lake is 10 times its volume (Edmundson et al. 1992).

Three species of Pacific Salmon; sockeye, pink and coho utilize the English Bay drainage. Resident dolly varden, Salvelinus malma, are also found throughout the drainage. ADF&G suspects a segment of the dolly varden population are from other Kenai Peninsula dolly varden populations might use the English Bay drainage for over-wintering (ADF&G Sport Fish biologist personal communication).

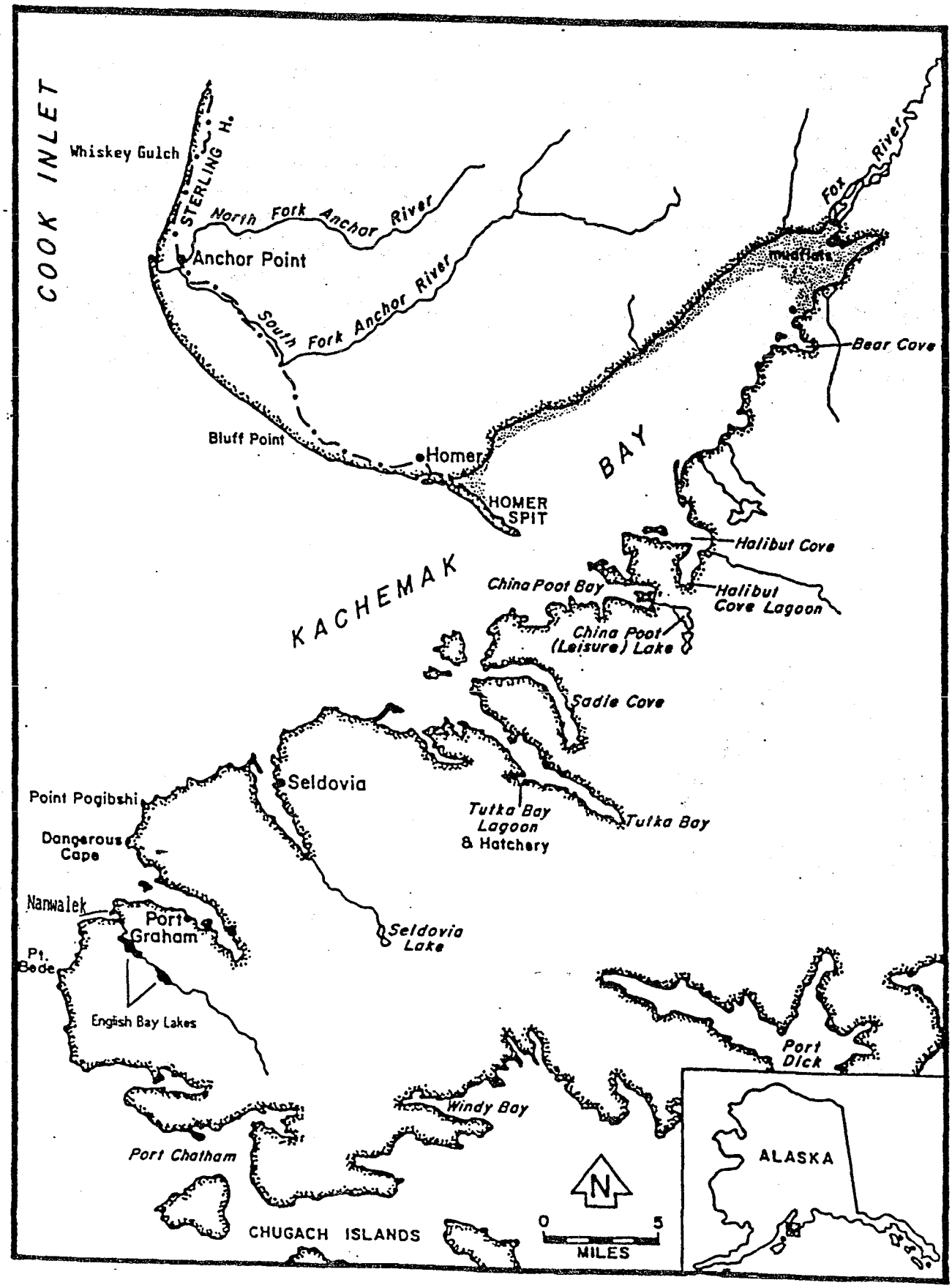

Figure 1. Geographic location of the English Bay Lakes in lower Cook Inlet (Edmundson et al. 1992).

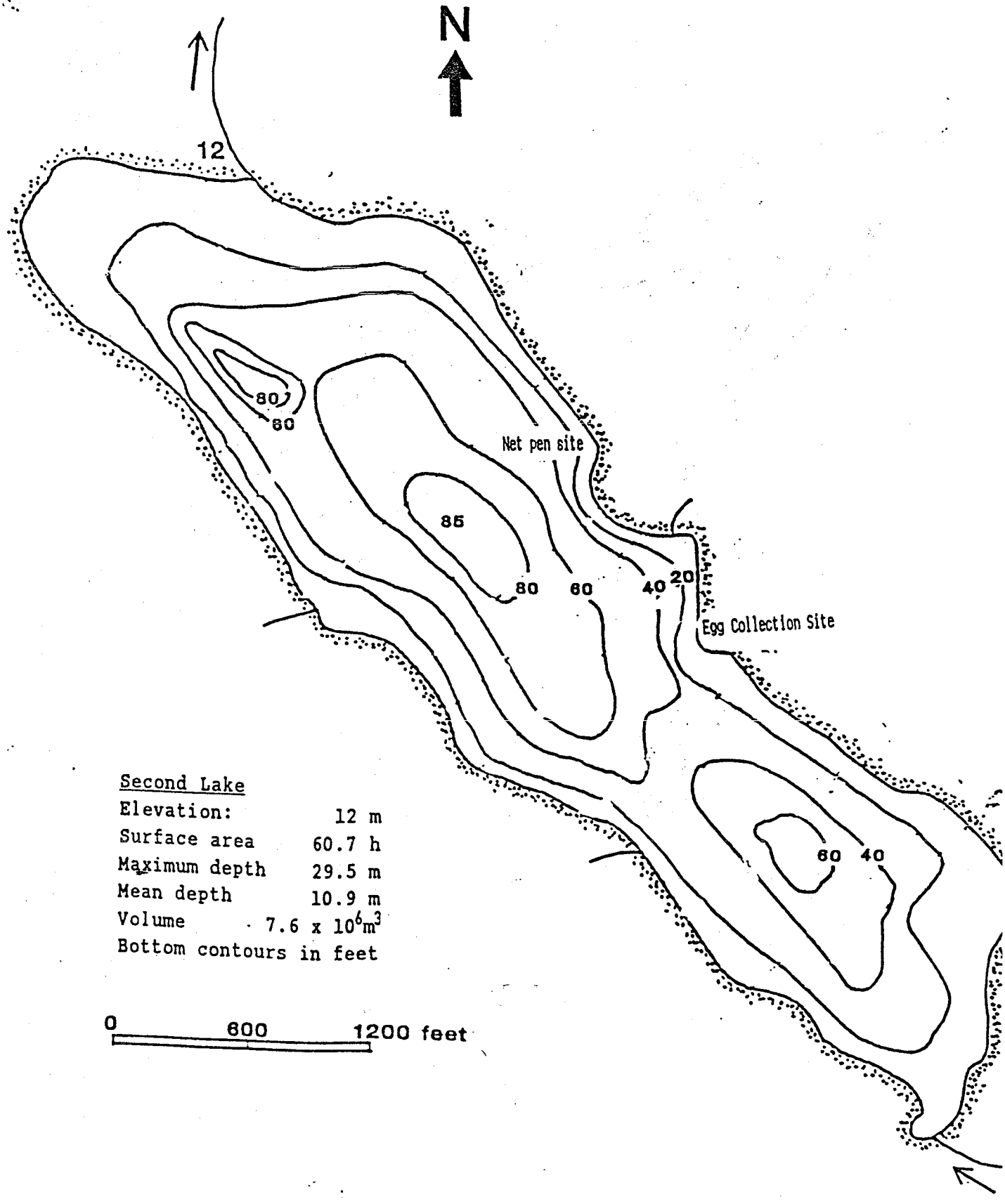

Figure 2. Morphometric map of Second Lake in the English Bay drainage showing location of the net pen and egg collection sites (Edmundson et al. 1992).

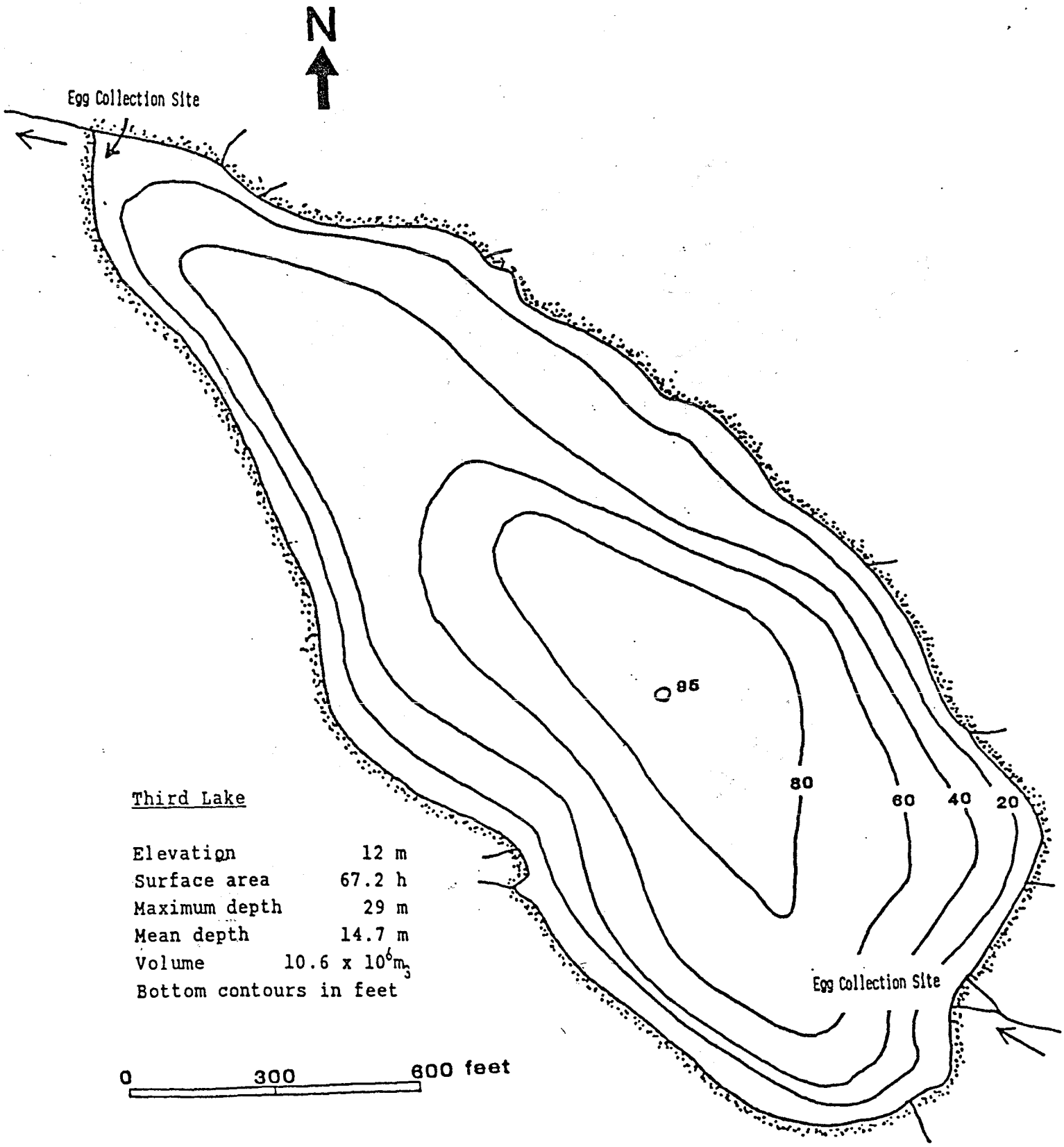

Figure 3. Morphometric map of Third lake in the English Bay drainage showing the location of the egg collection sites (Edmundson et al. 1992).

Two known species of gill parasite, Salimincola and Trichophyra, are prevelant. Costia, another external parasite is also present. Furunculosis and IHNV have been observed (Appendices 2,3 & 4).

METHODS

Smolt Trap

In 1988, a trap consisting of a holding pen, fyke net and six meter leads was placed in the outlet of Second lake, from 21 June to 23 June, to monitor out-migrating sockeye smolt. The trap fished approximately 67 percent of the river channel. Smolt were not sampled in 1989. The trap was reinstalled in 1990 from 9 June to 11 June and May 24. In 1991 the trap was reinstalled and fished intermittently, 12 to 24 hours, from 25 May to 14 July (Edmundson et al 1992). However, there were difficulties in maintaining the trap's integrity due to the combined effect of flash flooding and wave action in Second lake.

A new trap site was selected in 1992 that filter the entire river channel, allowing a total count of the out-migrating smolt. The site was located 610 meters upstream from the river's mouth. The stream morphology of this site dispersed stream flow over a wide, shallow bar which minimized trap wash out during flood periods. To effectively trap the entire river channel the trap leads were constructed with 30.5 m long, 5.08 cm dia. aluminum pipe. A 1260 denier nylon filament vinyl encapsulated nylon mesh (mesh size 10 threads/2.54cm) was hung from the top rail of the aluminum fence and anchored to the river's bottom with sand bags. The damming effect of the long leads was minimized by reducing angle of each lead to river's flow. A fyke net was attached to the tapered end of the trap leads, funneling out-migrating fish into the holding compartment (Figure 4).

The smolt trap was monitored nightly, every hour, for 12 hours between 5PM and 5AM from 11 April to 15 July. Sockeye smolt did not emigrate during the 12 hour time period 5 AM to 5PM. Total counts of sockeye and coho smolt, and adult dolly varden char, were obtained. Pink smolt were not enumerated. The timing of the pink smolt out-migration was recorded.

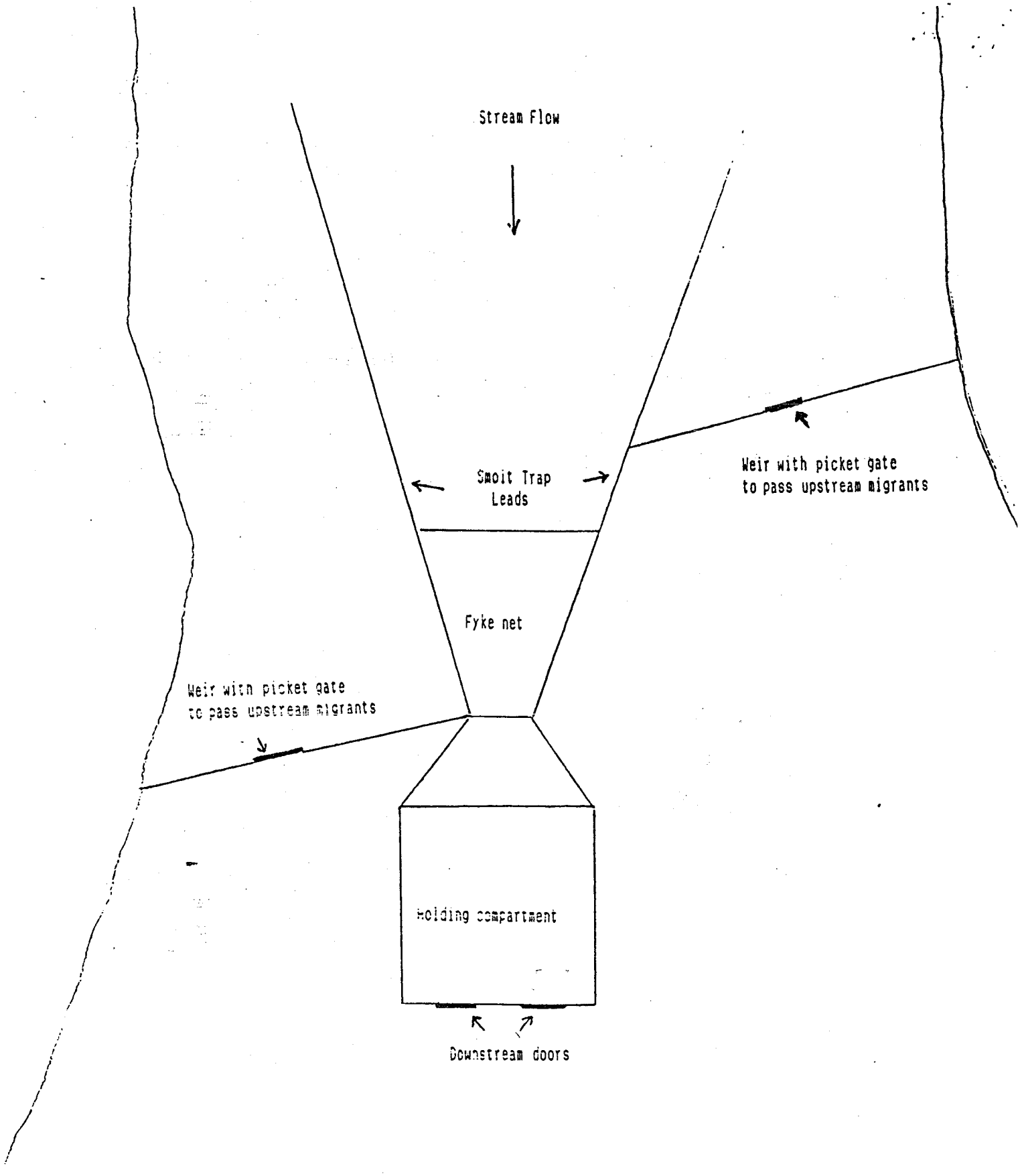

Figure 4. Schematic drawing of the 1992 smolt trap and adult weir, English Bay drainage.

Representative samples of sockeye smolt were measured for length, weight and age. Fork length was measured to the nearest millimeter. Weights were measured to the nearest 0.1 grams on a digital scale. Scale samples were obtained from the primary growth area, mounted on glass microscopic slides and examined with a microfiche reader to determine age groups. Daily counts of out-migrating smolts were apportioned to age groups. Water temperature (^{0} C) was collected daily with a hand held thermometer.

From 13 May to 7 July, smolt were randomly sampled each night and examined for adipose fin clips (adipose fin clips indicated the smolt had been tagged with coded wire nose tags). One hundred fifty-one fin clipped smolt were collected and sent to the ADF&G Tag Lab in Juneau, AK for processing. Recovered tags were used to evaluate fry to smolt survival for both net pen and direct release fry.

Pen Reared Fry and Direct Release Fry

All fry were transported to English Bay by fixed wing aircraft (float plane) equipped with internal fish transport tanks. Fry were released from the tanks when the aircraft was on the water.

In 1991, 254,874 fry were transported to English Bay: 98,943 fry were held in one net pen measuring 3.6 x 3.6 x 3.6 meters (48.9 m^3) and the remaining 155,931 fry were directly released in Third Lake. The net pen was located midway along the northeast shore of Second Lake. The initial mesh size of the net pen was 3.17 mm. When fry reached 2 grams they were transferred to another net pen with the same volume but a larger, 6.35 mm mesh. The pen was suspended from styrofoam flotation logs. Fry were fed every hour, 16 hours a day. Mortalities were recorded daily. Twelve percent (12,043) of the pen reared fry, and 5.4 percent (8,031) of the direct release fry, were marked with coded wire nose tags and an adipose fin clip.

In 1992, six net pens were placed in the same location in second lake. Initially, each of the six net pens measured 1.8 x 3.6 x3.6 meters (volume of 24 m^3) with mesh size 3.17 mm. To minimize the

outbreak of disease, fry densities in each pen were intended to remain at or below 4.0 kg/m^3 throughout the pen rearing. All pens were numbered for identification purposes. On June 8, 154,792 fry were apportioned into pens 1-5.

Fry in pens 1 & 2 were used in an experiment to test a new vaccine for Infectious Hematopoietic Necrosis Virus (IHNV). Initial number of fry placed in pens 1 and 2 was 20,458 and 19,992, respectively. On July 16, fry in pen # 2 were treated with the experimental vaccine (these fry were also marked with a left ventral fin clip. Fry in pen #1 served as the control. The vaccine was contained in a 208.2 L barrel. All fry in pen #2 were immersed in the vaccine for three minutes and then returned to pen 2. Fry densities for both pens were similar, and fry remained in these two, 24 m^3 pens until release in October.

The remaining 114,342 fry were visually apportioned into pens 3, 4 & 5 (approximately 38,114 fry/pen). When these fry averaged 1.7 grams they were transferred to larger, 48.9 m^3 pens with 6.35 mm mesh.

An additional 16,606 fry were placed in pen 6 on June 25. (The delay in getting fry in pen 6 was due to the timing of the egg collections in 1991 and the cold water temperatures at Big Lake hatchery. As a result, the timing of the emergent fry in the hatchery was protracted). All fry in pen # 6 were marked with coded wire nose tags and an adipose fin clip. These marked fry were intended to represent the average size of all pen reared fry. Recovery of these marked fry in the future will be used to evaluate fry to smolt survivals and smolt to adult survivals as well as provide information on the contribution of pen reared fish to the commercial fishery.

In 1992, all fry were initially fed Moore Clark "000" semi-moist starter every one half hour, 16 hours a day, from 6AM to 10PM. The feeding schedule was adjusted to match day length as the season progressed. Fry were fed an amount of food equal to five percent of the total biomass in each pen each day. In September and October, fry were fed three percent of their biomass. Total biomass estimates were determined approximately every 10 days by subsampling fry in each pen. Subsamples of fry from individual

pens were weighed and counted to determine a mean weight for that subsample. Three subsamples from each pen were then combined to calculate the mean weight of the fry for the entire pen. Total fry biomass in each pen was determined by multiplying the mean fry weight by the total number of fry in that pen. Fry mortalities from each pen were recorded daily to update the total number of fry per pen. For sanitation, all net pens were brushed and scraped clean of fish waste three times/week.

A method for treating external parasites was developed. Treatment involved immersing fry in a formalin bath containing 1 part formalin to 6,000 parts water for one hour (29.5 ml formalin to 177,600 ml water) A fish tote measuring 1.14 x 1.06 x 0.64 meters (0.77 m^3) was used to contain the formalin bath. Oxygen was delivered to the bath at 2 liters per minute. Approximately 6,500 fry were immersed in the formalin bath at one time.

Water temperature profiles and dissolved oxygen concentrations (D.O.) in the pens and in middle of the Second lake were collected periodically throughout the summer (Appendix 5).

Adult Escapement

Prior to 1992, estimated sockeye escapements were derived from either peak aerial counts or adjusted aerial counts based on conditions and time of surveys (Bucher and Hammarstrom 1992)
In 1992, a weir was installed in The English Bay River approximately 610 meters upstream from the mouth. The weir was incorporated into the smolt trap and was constructed with 2.54 x 5.08 cm mesh wire fence (Figure 4). Conduit pickets were secured to two areas of the fence. Pickets were pulled to allow upstream migrants to pass through the weir and be enumerated. The weir was monitored hourly between 5PM and 5AM, and approximately every four hours between 5AM and 5PM.

Representative samples of adult sockeye passing through the weir were measured to the nearest millimeter, from mid-eye to the fork of the tail. Weights were recorded to the nearest 0.10 kilogram and a preferred scale from each measured fish was collected. Scale samples were aged by ADF&G. Gender was not recorded.

Egg Collection

Eggs were collected in 1989 and in proceeding years. A weir was installed in mid-July at the inlet of Third Lake to collect broodstock. The weir functioned to concentrate broodstock which were then collected by beach seine and placed into net pens until ready to spawn. When broodstock were insufficient in Third Lake, effort shifted to Second Lake. Eggs were fertilized on site and transported to ADF&G Tutka hatchery in 1989, and ADF&G Big Lake Hatchery in 1990 and 1991. For all years proceeding 1989, eggs were collected between 7 August and 23 September.

In 1992, the weir was installed at inlet to Third lake on July 14. When insufficient numbers of broodstock were not present behind the weir, broodstock collection shifted to the outlet of Third Lake and then to in Second Lake.

Two methods were used to collect and fertilize the eggs in 1992. Both methods followed ADF&G FRED division disinfecting guidelines for egg collections. One method, known as delayed fertilization, involves keeping gametes from individual fish in separate, individual plastic bags. The bags were then placed in coolers with ice and flown to ADF&G's Big Lake Hatchery where they were fertilized. The other method involved fertilizing the eggs on site, packaging them in coolers with ice and transporting them to the hatchery. The on site method has been preferred over delayed fertilization because it has traditionally yielded higher fertilization percentages. However, new techniques in the delayed fertilization method were experimented with to increase egg fertility. Improving the delayed fertilization technique would eliminate logistical problems associated with on site fertilization at remote sites, and also reduce expenses associated with remote egg collections (the on sit method is expensive, requiring an extra amount of equipment, a larger crew and a larger aircraft).

A problem with the delayed fertilization method in the past has been the lack of collecting adequate amounts of sperm from male broodstock. To circumvent this problem, male broodstock were placed in a solution of MS-222 (4 grams/236 ml) for 2-3 minutes before clubbing and milking the fish. At the hatchery, sperm was

activated with seven percent saline solution (non iodized table salt) when the gametes were united. Tests by hatchery personnel revealed sperm motility lasted up to 10 seconds longer than sperm subjected to hatchery well water (personal communication Howard Delo). These two procedures were also used during the on site fertilization method. There were five egg collections, three were by delayed fertilization and two by on site fertilization. Egg fertility resulting from these two methods are presented.

RESULTS

Smolt Out-migration

In 1988, 550 sockeye smolt were captured from 21-23 June. One hundred of these smolt were sampled for length and weight. Mean length of all 100 smolt was 63 mm (range 53-74 mm). Mean weight was 2.2 grams (range 1.2-3.5 grams).

Smolt were not sampled in 1989. In 1990, the smolt out-migration was monitored from 9 June to 11 June. Seventy-five smolt were enumerated. Six of these smolt were measured for length (range 68-75mm) and weight (range 2.5-4.0 grams).

In 1991, the smolt trap was intermittently fished between 24 May to 14 July, capturing 16,597 sockeye smolt (Appendix 6). This count represents a minimum number of out-migrating smolt since the trap fished 67 percent of the river channel and washed out twice due to flooding. Sampling revealed that a significant number of smolts were migrating prior to installation of the trap on 25 May, and the migration peaked during 13-17 June when over 5,000 smolts were captured (Edmundson et al 1992). Age, weight and length data was collected on 195 smolt. Sixty-three percent (5,056) of the smolt were Age 1 and 37 percent (2,932) were Age 2. Mean length for Age 1 smolt was 68 mm (range 51-90 mm). The mean weight for Age 1 smolt was 2.9 grams (range 1.2-6.0 grams). Mean length and weight for Age 2 smolt was 75mm (61-90mm) and 3.8 grams (1.8-6.6 grams), respectively (Table 1).

In 1992, the smolt trap was installed in a new location approximately 610 meters upstream from the mouth of the river on 11

April. Water temperature was 0 ° C. The trap was pulled on 29 April due to large numbers of pink smolt that were impinged on the trap leads. Fifty-five sockeye smolt were enumerated between 11-29 April. The trap was reinstalled between 13 May and 15 July. On 13 May, the out-migrating sockeye smolt numbered less than 10 per night (Appendix 7). By 23 May the integrity of the trap could not be maintained due to increased stream flow. The trap leads were shortened to 12 meters and positioned in the thalwag, capturing 80 to 90 percent of the river's flow. The out-migration peaked between 26 May and 11 June, averaging 1,907 smolt per night. During the peak of the emigration, 32,419 (75%) sockeye smolt emigrated. The largest number of sockeye smolt emigrating in a 12 hour period (5AM-5PM) was 7,886 on 27 May. The water temperature was 10 ° C. A total of 43,409 sockeye smolt were enumerated between 11 April and 15 July.

Age, weight and length data was collected from 400 sockeye smolt. Ninety-seven percent of the out-migrating smolt were Age 1, three percent Age 2. Age 1 smolt averaged 75 mm in length and 3.8 grams. Age 2 smolt averaged 74 mm in length and 3.5 grams (Table 1).

Table 1. Weighted number, percent, mean length (mm) and, mean weight (grams) of sockeye smolt, by age class, from English Bay, 1991-1992.

	1991			1992		
	Age 1	Age 2	Combined	Age 1	Age 2	Combined
Number	10,456	6,141	16,597	42,107	1,302	43,409
Percent	63	37	100	97	3	100
Length	68	75	69	75	74	75
L Range	51-90	61-90	51-90	56-117	65-80	56-117
Weight	2.9	3.8	3.0	3.8	3.5	3.7
W Range	1.2-6.0	1.8-6.6	1.2-6.6	1.2-10.7	2.4-4.8	1.2-10.7

One hundred sixty-four CWT smolt were observed (Table 2). Coded wire tags were recovered in 125 smolt, no tags were found in 26

smolt and 13 tagged smolt were lost. The first CWT was collected on May 13, the last was collected on July 7. Seventy-three percent (111) of the CWT smolt were sampled in May. Mean length was 88 mm (ranged 50-104mm). Mean weight was 5.7 g (range 1.9-9.3 grams).

Insufficient numbers of tagged smolt were recovered during the peak of the smolt emigration to accurately estimate fry to smolt over-winter survival. However, a minimum estimate of 50% overwintering survival can be obtained from three observations:

1) All recovered tagged smolt were raised in the net pen in 1991. No coded wire tagged smolts were recovered from the fry that were directly released in the lake in 1991.

2) The mean size of all tagged smolt that were recovered was 88.2 mm and 5.6 g; while the mean size of all emigrating Age 1 smolt was 75 mm, 3.8 g. Mean size of all Age 1 smolt in 1991 was 68 mm, 2.9 g. The increase size of Age 1 smolt in 1992 would suggest that the bulk of the Age 1 smolt were from the net pen rearing.

3) Studies of presmolt stocking at Leisure Lake, 47 km northeast of English Bay, revealed 52-70% overwintering fry survivals in the mid-1970's prior to artificial lake fertilization (Bechtol and Dudiak 1988). If we assume a 50 percent overwinter survival of the 1991 pen reared fry, and assume tagged and untagged fry have equal mortality, then 42,379 fry out of the 84,757 fry released in 1991 survived to smolt. The total number smolt emigrating in 1992 was 43,409. Ninty-seven percent of these smolt (42,106) were Age 1.

The unanswered question is what has happened to the direct release fry and natural production? Refining the tag recovery subsampling will be necessary to accurately evaluate survival of all fry.

The pink salmon smolt out-migration was between 11 April and 25 May; they were not enumerated. The dolly varden char out-migration coincided with the out-migration of pink salmon (Appendix 7). Dolly varden were first observed on 18 April. The largest number of dolly varden emigrants peaked to 2,180 on 20 May. The abundance of large dolly varden declined after 29 May. The total number of

Table 2. Coded Wire tags recovered from 1992 sockeye smolt, English Bay.

Date	Day total	# sub-sampled	AD clips observed	# tags recovered	no tag found	Head lost
411-429	55	0	-----	-----	-----	----
513	7	4	1	1		
514	7	4	1	1		
515	4	4	1	1		
516	5	0	----	0		
517	26	0	----	0		
518	37	37	2	2		
519	29	29	5	5		
520	57	57	7	6	1	
521	164	164	25	20	5	
522	871	871	21	18	3	
523	65	65	4	0		4
524	-----*	0	----	0		
525	474	92	9	7	2	
526	999	80	5	4	1	
527	7,886	80	16	11	5	
528	1,283	40	3	3		
529	2,118	40	2	0		2
530	1,788	40	5	5		
531	2,409	40	7	6	1	
601	2,757	40	7	0		7
602	2,233	82	3	3		
603	2,832	83	0	0		
604	985	114	4	4		
605	2,009	131	1	1		
606	1,122	90	5	3	2	
607	1,034	193	2	1	1	
608	856	105	2	2		
609	613	106	0	0		
610	451	93	0	0		
611	1,049	130	4	3	1	
612	803	98	0	0		
613	547	84	1	1		
614	854	110	0	0		
615	463	103	1	1		

Date	Day total	# sub-sampled	AD clips observed	# tags recovered	no tag found	Head lost
616	535	90	0	0		
617	378	82	1	1		
618	859	101	3	2	1	
619	605	104	3	2	1	
620	535	91	2	1	1	
621	502	87	0	0		
622	244	85	0	0		
623	202	79	2	2		
624	221	0	----	0		
625	151	75	3	2	1	
626	193	87	3	3		
627	482	#	----	0		
628	------*	0	----	0		
629	40	0	----	0		
630	353	86	0	0		
701	162	75	0	0		
702	148	93	0	0		
703	195	81	1	1		
704	76	62	0	0		
705	203	81	0	0		
706	136	80	0	0		
707	138	80	2	2		
708	38	38	0	0		
709	29	29	0	0		
710	8	8	0	0		
711	10	10	0	0		
712	17	17	0	0		
713	6	6	0	0		
714	18	18	0	0		
715	33	33	0	0		
Total	43,409	4,877	164	125	26	13

* = washout

\# = holding pen washed away

All were Tag #13-01-020105 from net pen

emigrating dolly varden was 10,981.

Coho smolt numbers were consistent throughout the sampling period. The total number of coho smolt enumerated was 5,590.

Net Pen Rearing and Direct Release of Fry

In 1991, a total of 254,874 fry were transported to the English Bay drainage for release. Thirty-nine percent (98,943) of these fry were placed in one net pen (48.9 m^3) located in Second Lake on 11 June. These fry averaged 0.21 grams. Initial fry density was 0.40 kg/m^3. The remaining 155,931 fry were directly released in Third Lake.

Total fry mortality was 14,186 and resulted from a combination of poor feeding techniques and overcrowding (Balland 1992). In late August and early September, the gill parasite Trichophyra and Furunculosis were diagnosed as the cause of fry mortality. At that time it was difficult to determine which agent was causing the mortalities; Trichophyra or furunculosis. Furunculosis could be treated with medicated feed but treatment for the gill parasite presented logistical difficulties of having no container in which to do the formalin treatment. (treatment involved a formalin bath of 1:6,000 for 1 hour). To prevent further mortalities through horizontal transmission of both agents in the crowded net pen, the fry were released. It was assumed that the moribund fry would be targeted by predator species. On 18 September, the remaining 84,757 were released. Despite the high mortalities the results of the net pen rearing were encouraging. At release, fry averaged 4.7 g at 8.0 kg/m^3 (Table 3).

Table 3. Mean weights (g), percent weight gain, density (kg/m^3) and pen volume (m^3) of penned fry from June 11 and September 18, 1991 at Second Lake in the English Bay drainage.

Date	Mean weight	% gain	No. of fry in pen	Density kg/m³	Pen volume
June 11	.21	--	98,943	0.40	48.9
July 26	1.09	419.0	92,935	2.07	48.9
August 2	1.61	47.7	90,620	2.98	48.9
August 12	1.81	12.4	88,701	3.28	48.9
September 3	3.20	76.8	87,914	5.75	48.9
September 18	4.66	45.6	84,757	8.00	48.9

In 1992, 290,298 fry were stocked in Second Lake in June. Fifty-nine percent (171,398) of the fry were apportioned into six net pens and 41 percent (118,900) were directly released in Second Lake. On June 8, initial mean weight of all fry in pen numbers 1,2,3,4 and 5 was 0.25 g; densities were 0.2 kg/m^3 in pens 1 and 2, and 0.39 kg/m^3, respectively. Fry were placed in pen 6 on June 25. Mean weight was 0.22 g at 0.15 kg/m^3. Fry in pen 6 were coded wire tagged to evaluate future survival rates. Despite the 18 day delay in placing these fry in pen 6 they grew rapidly. Mean weights for all fry ranged from 1.7-2.50 g by 30 July (Table 4).

Fry directly released in Second Lake on June 25, 1992 were 0.189 grams. None of these fry were marked.

On July 16, 19,978 fry in Pen 2 were subjected to an experimental IHNV vaccine. Fry averaged 1.5 grams. Water temperature was 15 ^{0} C. All fry were emersed in the vaccine for three minutes. There were 1,365 mortalities associated with the vaccination. Mortalities were probably due to the large number of fry vaccinated at one time and warm water temperature.

Fry mortalities in all six net pens were less than 1% by July 31 (Table 5). The large number of fry mortality in pen 2 by July 31 was due to the IHNV vaccination. By 15 August there was a 959% increase in mortality in pen 1 and a 47% increase in pen 3. Fry mortality in pens 4 and 5 increased 27% and 11%, respectively.

Table 4. Mean weights (g), density (kg/m3) and pen volume (m3) of pen reared fry from 8 June to 14 October, 1992 at Second Lake in the English Bay drainage.

		PEN 1						PEN 2						PEN 3					
Date		Mean Weight	Wt. gain (g/day)	% wt change	# of fry in pen	Density	Pen volume	Mean Weight	Wt. gain (g/day)	% wt change	# of fry in pen	Density	Pen volume	Mean Weight	Wt. gain (g/day)	% wt change	# of fry in pen	Density	Pen volume
June	8	0.25	----	----	20,458	0.21	24.5	0.25	----	----	19,992	0.20	24.5	0.25	----	----	38,114	0.39	24.5
	29	0.72	0.02	188.0	20,391	0.60	24.5	0.80	0.03	220.0	19,899	0.65	24.5	0.72	0.02	188.0	37,916	1.11	24.5
July	7	1.05	0.04	45.8	20,332	0.87	24.5	1.14	0.04	42.5	19,858	0.92	24.5	0.91	0.02	26.4	37,832	1.41	24.5
	14	1.30	0.04	23.8	20,325	1.08	24.5	1.50	0.05	31.6	19,846	1.22	24.5	1.13	0.03	24.2	37,812	1.74	24.5
	21	1.70	0.06	30.8	20,318	1.41	24.5	2.00	0.07	33.3	18,465	1.51	24.5	1.37	0.03	21.2	37,799	2.11	24.5
	30	1.86	0.02	9.4	20,305	1.54	24.5	2.50	0.06	25.0	18,440	1.88	24.5	2.20	0.09	60.6	37,748	1.70	48.9
Aug	5	2.79	0.16	50.0	20,297	2.32	24.5	3.34	0.14	33.6	18,398	2.51	24.5	2.75	0.09	25.0	37,706	2.12	48.9
	27	4.18	0.06	49.8	19,344	3.31	24.5	5.00	0.08	49.7	18,157	3.71	24.5	4.60	0.08	67.3	37,581	3.54	48.9
Sept	7	4.80	0.06	14.8	17,715	3.48	24.5	6.20	0.11	24.0	18,069	4.58	24.5	6.03	0.15	35.4	37,324	4.76	48.9
	14*	5.70	0.13	18.8	16,398	3.80	24.5	7.80	0.23	25.8	17,922	5.71	24.5	7.10	0.12	14.0	37,232	5.41	48.9
	27							8.30	0.03	6.4	17,904	6.07	24.5	8.50	0.09	19.7	37,080	6.45	48.9
Oct	14							9.40	0.07	13.3	17,870	6.86	24.5	9.20	0.05	8.2	37,046	6.97	48.9
Mean			0.06						0.08						0.07				

		PEN 4						PEN 5						PEN 6					
Date		Mean Weight	Wt. gain (g/day)	% wt change	# of fry in pen	Density	Pen volume	Mean Weight	Wt. gain (g/day)	% wt change	# of fry in pen	Density	Pen volume	Mean Weight	Wt. gain (g/day)	% wt change	# of fry in pen	Density	Pen volume
June	8	0.25	----	----	38,114	0.39	24.5	0.25	----	----	38,114	0.39	24.5	----	----	----	----	---	---
	25	---	----	----	----	----	----	---	----	---	----	----	----	0.22	----	----	16,606	0.15	24.5
	29	0.66	0.02	164.0	37,791	1.02	24.5	0.62	0.02	148.0	37,866	0.96	24.5	----	----	----	----	----	----
July	7	0.83	0.02	25.8	37,710	1.28	24.5	0.85	0.03	37.1	37,766	1.31	24.5	0.53	0.01	140.9	16,584	0.36	24.5
	14	1.20	0.05	44.6	37,693	1.65	24.5	1.30	0.06	52.9	37,747	2.00	24.5	0.81	0.04	52.8	16,573	0.55	24.5
	21	1.42	0.03	18.3	37,676	2.18	24.5	1.56	0.04	20.0	37,715	2.40	24.5	1.08	0.04	33.3	16,554	0.73	24.5
	30	1.70	0.03	19.7	37,657	1.31	48.9	1.70	0.02	9.0	37,618	1.31	48.9	1.70	0.07	57.4	16,542	1.15	24.5
Aug	5	2.29	0.10	34.7	37,638	1.76	48.9	2.26	0.09	32.9	37,463	1.73	48.9	2.00	0.05	17.6	16,533	1.35	24.5
	27	3.42	0.05	49.3	37,537	2.63	48.9	3.51	0.08	55.3	37,380	2.68	48.9	4.32	0.11	116.0	16,504	2.91	24.5
Sept	7	4.20	0.07	22.8	37,387	3.20	48.9	3.96	0.04	12.8	37,288	3.02	48.9	5.33	0.09	22.7	16,472	3.56	24.5
	14	4.90	0.10	16.7	37,054	3.71	48.9	5.10	0.16	28.8	37,065	3.87	48.9	6.60	0.19	24.5	16,412	4.42	24.5
	29	5.80	0.06	18.4	36,696	4.38	48.9	6.20	0.07	21.6	36,938	4.68	48.9	7.40	0.05	12.1	16,353	4.94	24.5
Oct	14	6.40	0.04	10.3	36,884	4.82	48.9	6.60	0.03	6.45	36,909	4.98	48.9	8.30	0.06	12.2	16,321	5.53	24.5
			0.05						0.06						0.07				

* fry escaped

Table 5. Fry numbers, number of mortalities and percent mortality of pen reared fry in Second Lake, English Bay Lakes, 1992

Date	PEN 1 Fry number	PEN 1 # of morts	PEN 1 % morts	PEN 2 Fry number	PEN 2 # of morts	PEN 2 % morts	PEN 3 Fry number	PEN 3 # of morts	PEN 3 % morts
BEGIN	20,458			19,992			38,114		
June 8-30	20,372	86	0.42	19,883	109	0.54	37,897	217	0.57
July 1-15	20,322	50	0.24	19,839	44	0.22	37,810	87	0.23
July 16-31	20,305	17	0.08	18,437	1,402	*7.60	37,742	68	0.18
Aug 1-15	20,125	180	0.89	18,224	213	1.16	37,642	100	0.27
Aug 16-31	19,031	1,094	5.74	18,139	85	0.46	37,563	79	0.21
Sept 1-15	16,298	2,733	16.7	17,992	147	0.81	37,167	396	1.07
Sept 16-30	TOTAL	4,160	20.3%	17,904	88	0.49	37,078	87	0.23
Oct 1-14				17,870	33	0.18	37,046	32	0.09
				TOTAL	2,121	10.6%		1,066	2.8%
				MINUS 1,365 MORTS DUE TO VACCINATION	756	3.8%			

Date	PEN 4 Fry number	PEN 4 # of morts	PEN 4 %	PEN 5 Fry number	PEN 5 # of morts	PEN 5 %	PEN 6 Fry number	PEN 6 # of morts	PEN 6 % morts
BEGIN	38,114			38,114			16,606		
June 8-30	37,762	352	0.93	37,839	275	0.72	16,603	3	0.19
July 1-15	37,688	74	0.19	37,741	98	0.25	16,572	31	0.19
July 16-31	37,655	33	0.08	37,590	151	0.40	16,535	37	0.22
Aug 1-15	37,613	42	0.11	37,422	168	0.44	16,520	15	0.09
Aug 16-31	37,504	109	0.29	37,367	55	0.14	16,496	24	0.15
Sept 1-15	37,054	450	1.21	37,065	302	0.81	16,412	84	0.51
Sept 16-30	36,895	158	0.42	36,936	127	0.34	16,351	59	0.36
Oct 1-14	36,836	59	0.16	36,909	27	0.07	16,321	30	0.18
		1,277	3.4%		1203	3.2%		283	1.7%

* mortality due to IHNV vaccine.

TOTAL FISH	TOTAL MORTS	% MORTALITY
171,398	10,110	5.9%
PENS 1 & 2		
40,450	6,281	15.5%
PENS 3,4,5 & 6		
130,948	3,829	2.9%

On 10 August samples of live fry were diagnoses to have Trichodina and gill hyperplasia. Trichondina is a protozoan parasite of low pathogenicity and is generally not considered to be a serious problem when seen in low numbers (Appendix 2). Treatment was not necessary. The fry showed gill hyperplasia due to feeding improper food size (Fry were feed 000 feed after running out of 1.3 feed. The smaller feed size irritated the gills and could have contributed to fry mortality). On 16 August another sample of live fry was diagnosed to have Ichthyobodo (formally Costia) in low numbers (Appendix 3). Unlike Tricodina, this protozoan parasite multiplies rapidly and can cause significant mortality. Ichthyobodo, can be treated by immersing the fry in a formalin bath (1:6,000) for one hour. Fry in Pen #1 were subjected to the formalin bath on August 22. There were no mortalities associated with the treatment.

By 31 August mortalities in pen 1 increased 507% from mid-August. Mortalities in pens 2, 3 and 5 decreased slightly. Mortalities in pens 4 and 6 increased 160% and 60%, respectively. On September 8, a sample of 50 live fry from pen 1 were diagnosed for furunculosis. It is caused by a water borne bacteria, Aeromonas salmonicida, which enters the fish through a scratch or through the digestive tract. Furunculosis produces a toxin that destroys the fish's defenses against disease and eventually kills the fish. This bacteria has been present in the English Bay drainage in the past. It is thought that the stress of the external parasites may have lowered the fry's immunity to the bacteria. Treatment involved feeding fry with medicated (oxytetracycline) feed at 3.75 grams/45.4 kg for 10 days. Medicated feed was ordered but was lost in shipment.

Fry mortalities from 1 -15 September continued to increase: 150% in pen 1; 73% in pen 2; 400% in pen 3; 313% in pen 4; 450% in pen 5 and 250% in pen 6. On September 15, unseasonably high winds (50 knots) damaged pen 1 and 16,298 fry contained within the pen escaped. Medicated feed arrived on 18 September and was feed to all remaining fry for 10 days. On 30 September mortalities in all pens decreased: 40% in pen 2; 78% in pen 3; 65% in pen 4; 58% in pen 5 and 30% in pen 6.

A total of 127,112 fry were released from pens 3,4 5 & 6 on 14 October. Water temperature was 6 °C The remaining 17,870 fry in pen 2 will be held in a pen overwinter. Fry growth rates in pens 1-6 averaged 0.06, 0.08, 0.07, 0.05, 0.06 and 0.07 grams per day, respectively (Table 4). Mean weight of fry in pens 2,3,4,5 & 6 at release was 8.0 grams, range 6.4-9.4 grams. Larger fry observed in pen 3 (compared to pens 4 and 5) suggests there were less fry in pen 3 than pens 4 and 5. This is probably due to visually apportioning 38,114 fry into each of these pens on June 8 (114,342 fry divided equally, assumed each pen initially contained 38,114 fry). Fry densities for pens 2,3,4,5 & 6 in mid October ranged from 4.8-6.9 kg/m_3. The combined number of fry released from pen 1 (on 15 September) and pens 3-6 on 14 October was 143,410. Total number of fry that survived the pen rearing was 161,280; combined fry mortality in <u>all</u> pens was 6% (10,118).pens.

ADULT ESCAPEMENT

Sockeye salmon escapement and commercial harvests for the English Bay Lakes from 1961-1992 are summarized in Figure 5 .

A weir for passing adult sockeye upstream was set up on June 9 and removed on July 24. Prior to June 8, the crew estimated escapement at 120 fish (these fish were observed at the base of the waterfall above the weir site). Initial water temperature was 12° C. Throughout the escapement period water temperatures ranged from 12°C to 15°C, averaging 13°C (Appendix 8).

The total sockeye escapement was 6,400. Eighty percent (5,117 fish) of the run occurred between June 19 and July 15, The largest number of adult sockeye enumerated was 421 on July 4. Fifty-nine percent of the returning adults were Age 1.3 (Table 6). Mean weight and length was 2.33 Kg, 547mm.

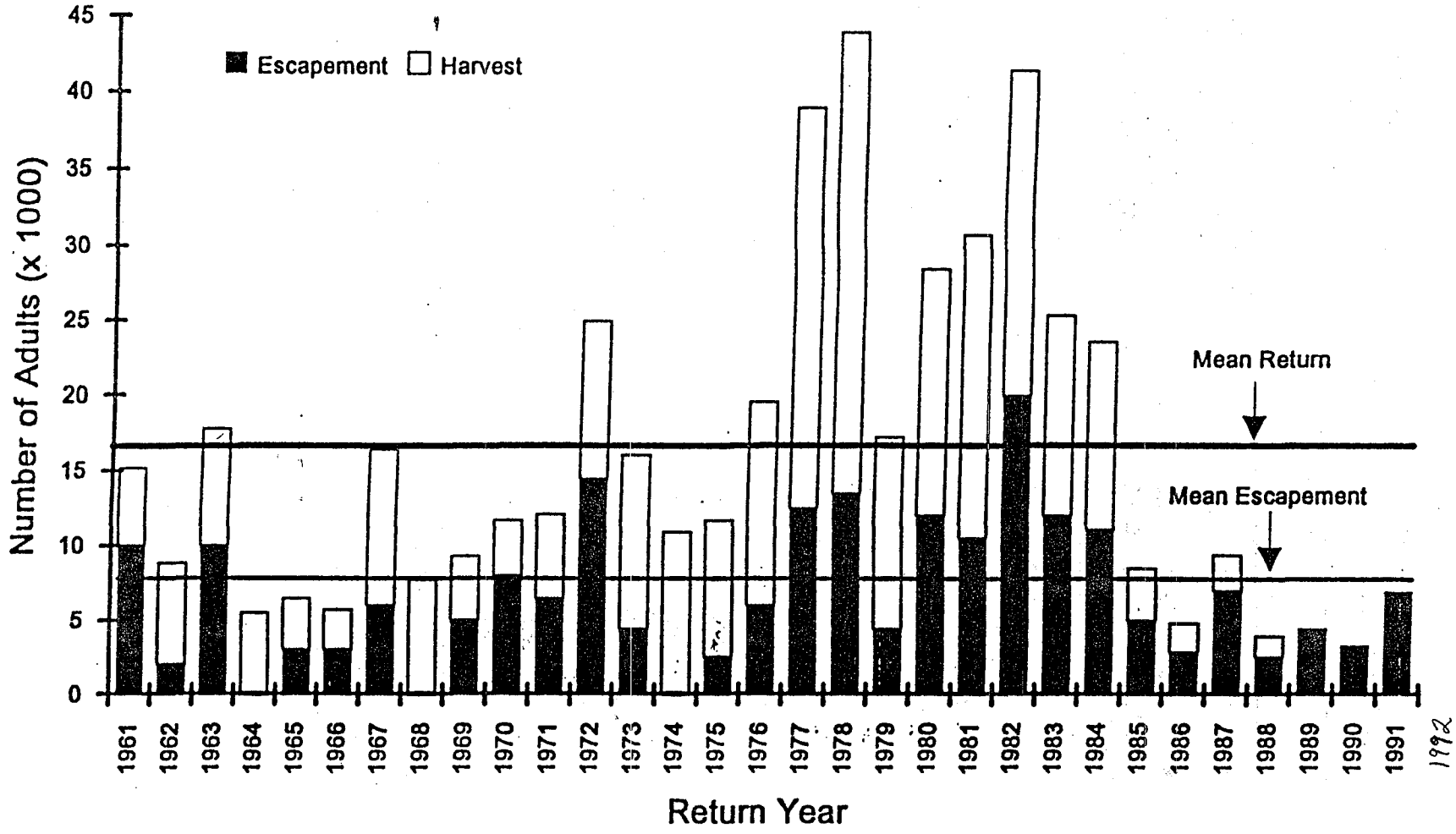

Figure 5. Adult Sockeye salmon escapements and commercial harvests for the English Bay Lakes, 1961-1991 (Edmundson et al. 1992).

Table 6. Summary of age composition of adult sockeye escapement in the English Bay River, 1992.

	Age Group							
	1.1	1.2	2.1	1.3	2.2	1.4	2.3	Total
Both Sexes	6	813	40	3,782	1,063	23	673	6,400
Percent	0.09	12.70	0.63	59.09	16.61	0.36	10.52	100
Sample Size	1	93	3	502	89	2	70	760
Mean Length (mm)	310	496	383	547	488	610	542	529
Mean Weight (kg)	0.60	1.73	0.82	2.33	1.65	3.79	2.19	2.12

Egg Collection

The on site fertilization method was used for all egg collections from 1989-1991. Results of all egg collections are presented in Table 7.

Table 7. Summary of sockeye salmon egg collections in the English Bay drainage, 1989-1992.

	Year			
	1989	1990	1991	1992
No. broodstock (M/F)	ND/192	100/191	137/225	467/499
Fecundity	2,226	2,347	2,544	2,340
No. eggs collected	427,474	448,300	572,000	1,094,300
No. eyed eggs	357,000	294,900	342,900	ND
Percent eyed eggs	83.5	65.8	59.9	ND
No. fry	355,347	255,074	290,298	ND
% survival eyed egg to fry	99.5	86.5	84.6	ND

In 1992, there were five egg collections, two by on site fertilization and three by delayed fertilization. A total of 467 females and 499 males were spawned and 1,094,000 eggs were collected (average 218,800 eggs per egg collection). Fecundity was estimated at 2,340 eggs. Four of the egg collections were in Third lake between 8 - 27 August. The fifth egg collection was in Second lake on 8 September.

The percentage of fertilized eggs (percentage of eggs showing cell division within 48 hours of fertilization) in 1992 were encouraging: 89 and 94 percent for eggs collected with the delayed fertilization method; and 84 and 85 percent with the on site fertilization method. No information is available at this time on the fertility of the 8 August egg collection using the delayed fertilization method (male broodstock were not anesthetized with MS-222 and sperm was not activated with saline solution).
In previous years, the percentage of fertilized eggs ranged from 60-66 percent. Male brood stock were not anesthetized and sperm was not activated with saline solution.

RECOMMENDATIONS

Results of the pen rearing were encouraging and provides a firm foundation to build on. Data from 1991 and 1992 shows that pen reared fry can reach pre-smolt size ranging from 4.6-9.0 grams and densitiies up to 8.0 kg/m^3. Future outbreaks of external parasites can be stemmed by prophylactic treatment. In both 1991 and 1992, furunculosis was observed in late August/ early September. Future outbreaks of furunculosis can be minimized by feeding fry medicated feed beginning in mid-August. Preventative treatment for these two agents will enable the pen rearing facility to expand in 1993. Recommendations for all aspects of the project are to:

1) Continue monitoring the smolt out-migration and adult escapement. Further modifications to the smolt trap configuration (installing two traps to disperse stream flow) might prevent the trap from periodically washing out.

2) Develop a statistically valid subsampling procedure for CWT

smolt to accurately assess in-lake, fry to smolt overwintering survival of both pen reared fry and direct release fry.

3) Increase pen rearing facility to raise 600,000 fry in 12 pens (50,000 fry/pen) and strive for ending densities of 8.0 kg/m^3. An additional 100,000 fry need to be released directly in Second Lake or Third Lake. Both groups of fry must be coded wire tagged for evaluation.

4) Continue to collect 1 million eggs using the delayed fertilization technique. This method had favorable results in 1992. Use of the delayed fertilization method would cut expenses associated with egg collections.

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Appendicies

Appendix 1. Summary of escapement counts in English Bay River, 1927-1992.

Date	Escapement	count type	Date	Escapement	count type
1927	19,197	w	1962	2,000	a
1928	24,025	w	1963	1,000	a
1929	15,407	w	1965	3,000	a
1930	18,858	w	1966	3,000	a
1931	18,878	w	1967	6,000	a
1932	22,933	w	1969	5,000	a
1934	1,655	p	1970	8,000	a
1935	15,851	w	1971	6,500	a
1936	15,767	w	1972	14,500	a
1937	14,857	w	1973	4,400	a
1938	16,779	w	1975	2,500	a
1939	48,777	w	1976	6,000	a
1940	30,357	w	1977	12,500	a
1941	26,905	w	1978	13,500	a
1947	15,000	e	1979	4,400	a
1948	15,000	e	1980	12,000	a
1949	9,760	ge	1981	10,500	a
1950	5,000	a	1982	20,000	a
1951	18,000	a	1983	12,000	a
1952	3,110	a	1984	11,100	a
1953	1,200	a	1985	5,000	a
1954	3,800	a	1986	2,800	a
1955	2,500	a	1987	7,000	a
1956	1,800	a	1988	2,500	a
1951	18,000	a	1989	4,500	a
1952	3,110	a	1990	3,300	a
1953	1,200	a	1991	7,000	a
1954	3,800	a	1992	6,400	w
1955	2,500	a	1990	3,300	a
1956	1,800	a	1991	7,000	a
1960	16,000	a	1992	6,400	w
1961	10,000	a			

Appendix 2. Pathology diagnosis for sockeye salmon fry from Second Lake, English Bay 1991.

ACCESSION NO: 92-0025

ALASKA DEPARTMENT OF FISH AND GAME
FISH PATHOLOGY SECTION, F.R.E.D. DIVISION
333 RASPBERRY ROAD, ANCHORAGE, AK 99518-1599

REPORT OF LABORATORY EXAMINATION

LOT (YEAR, STOCK, SPECIES): 1990 English Bay sockeye salmon, Oncorhynchus nerka

FACILITY: ADF&G/Homer/F.R.E.D. Division

CONTACT PERSON/ADDRESS: Tom Balland, 3298 Douglas Street Homer, AK 99603-7942

SAMPLE DATE: 09/10/91 **DATE SAMPLE RECEIVED:** 09/10/91

SPECIMEN TYPE: whole fish **LIFE STAGE:** fingerling **STATE:** on ice

NUMBER IN SAMPLE: 24 **WILD:** no

HISTORY/SIGNS: Low level mortality over several months with a sudden increase up to 1%/day.

REASON FOR SUBMISSION: Diagnostic

FINAL REPORT DATE: 10/09/91

CLINICAL FINDINGS:

NECROPSY:

MORIBUND:

3/8	hemorrhaging on fins
8/8	large numbers of Trichophrya sp. on gills
5/8	gas bubbles in gills
2/8	Saprolegnia on caudal fin
0/6	organisms on spleen squash

HEALTHY:

0/1	Trichophrya sp.
1/1	gas bubbles in gills
0/1	Saprolegnia present

BACTERIOLOGY: Kidneys struck on TSA at 25°C for 4 days.

3/6 positive for Aeromonas salmonicida

VIROLOGY:

0/2 pools (1 X 5 fish pool, 1 X 7 fish pool) positive for IHNV (0%). Quantal assay on EPC cell line at 15°C for 14 days. Blindpassed and held for an additional 7 days. Minimum level of detection = 50 infectious particles/ml.

DIAGNOSIS: Furunculosis and Trichophrya sp.

COMMENTS/RECOMMENDATIONS: These fingerling were held in a freshwater net pen at a remote site prior to release into the lake. The biologists were hoping to hold the fish until the water temperature decreased in order to reduce predation by other species present in the lake. At the time of sampling, mortality had spiked up to 1.2%/day but then subsequently dropped to 0.3-0.4%/day. The net pen situation complicated the possibility of treatment for both infections. If the fish were held long enough to do OTC treatment for furunculosis, (at least 2 weeks allowing some time for obtaining the feed) they would also need to be treated with formalin for the gill parasite or it would continue to spread. Gill parasites do not always cause significant mortality but the large numbers and their presence on every moribund fish would certainly implicate them in this case. With the logistical difficulties of having no container in which to do formalin treatment and a shortage of trained personnel, the biologists decided to release the fish. This would reduce the density of the fish and also horizontal transmission of both agents. Hopefully the predatory fish will target the moribund fish rather than the healthy ones. If this program is to be repeated next year, the program managers should consider making some contingency preparations in case another outbreak occurs.

FISH HEALTH INVESTIGATOR: Jill Follett, Tammy Burton

TECHNICAL ASSISTANCE: Norman Starkey

COPIES TO: FY92, Misc. Burkett, Meyers

Accession No: 92-0025

Appendix 3. Pathology diagnosis for sockeye salmon fry from Second Lake, English Bay 1992.

ACCESSION NO: 93-0011

ALASKA DEPARTMENT OF FISH AND GAME
FISH PATHOLOGY SECTION, F.R.E.D. DIVISION
333 RASPBERRY ROAD, ANCHORAGE, AK 99518-1599

REPORT OF LABORATORY EXAMINATION

LOT (YEAR, STOCK, SPECIES): *1991 English Bay sockeye salmon, Oncorhynchus nerka*

FACILITY: *ADF&G/FRED Division*

CONTACT PERSON/ADDRESS: *Mark Schollenberger, North Pacific Rim P.O. Box 3593 Homer, AK 99603*

SAMPLE DATE: *08/10/92 08/16/92* *DATE SAMPLE RECEIVED:* *08/10/92 08/17/92*

SPECIMEN TYPE: *whole fish* *LIFE STAGE:* *fingerling* *STATE:* *live*

NUMBER IN SAMPLE: *23* *WILD:* *no*

HISTORY/SIGNS: *Low level mortality after moving fish to net-pens.*

REASON FOR SUBMISSION: *Diagnostic.*

FINAL REPORT DATE: *08/25/92*

CLINICAL FINDINGS:

NECROPSY:

HEALTHY:
Sampled 08/10/92:
3/6 with few/moderate Trichodina on skin
4/6 with large numbers of gas bubbles in gill lamellae.
4/6 with gill hyperplasia
1/6 with cataract on one eye
0/6 with abnormal spleen, gut, or air bladder

Sampled 08/16/92:
6/17 with Ichthyobodo (Costia) on skin scrape
4/17 with Trichodina on skin scrape
4/17 with gas bubbles in tips of gill lamellae
1/17 with mild gill hyperplasia
0/14 with internal abnormalities

BACTERIOLOGY: *Kidneys struck on TSA at 25°C for 4 days.*

HEALTHY:
Sampled 08/10/92: 0/4 with growth

DIAGNOSIS: *Ichthyobodo, Trichodina, and dropout due to inappropriate feeding.*

COMMENTS: *These sockeye have experienced a very low level mortality (0.01%) since being transferred to net-pens about a week before the first sample was submitted to pathology. Mortality continued and went up to 0.2% in Pen #1. Half of the fish examined in the first sample had Trichodina present on the skin at low levels. Trichodina is a protozoan parasite of relatively low pathogenicity and is generally not considered to be a serious problem when seen in low numbers. The numbers seen in this case did not necessitate treatment. The gill hyperplasia may be attributed to the irregular feeding of these sockeye salmon. Due to lack of appropriately sized food, these fish were fed 000 for a period of time after they had already been on 1.3 mm food. Although all fish looked at appeared to have food present in the gut, the regression back to feeding mash to fish of this size (3 grams) will lead to poor nutrition and damaged gills. The feeding of starter diets to any size fish is very irritating to gills and should be limited.*

In the second sampling, most of the fish appeared to be healthy but Ichthyobodo (Costia) was found in low numbers on the skin scrapes. However, unlike Trichodina, this protozoan parasite may multiply rapidly under the right circumstances and cause significant mortality. The gas bubbles seen may be due to transporting the fish samples in unpressurized aircraft.

RECOMMENDATIONS: *Treat the affected pens with formalin at 1:6,000 for 1 hour. Since only Pen #1 was having mortality at this point, the facility manager was planning to treat that one first using a 4' X 4' tote for holding the fish during treatment. He was going to monitor the other pens and treat if it became necessary. Additional moribund fish should be examined, preferably on site to follow progression of the Ichthyobodo infection. Feeding problems should also be remedied by using appropriately sized food.*

Results discussed with Mark Schollenberger on 8/12 and 8/18.

FISH HEALTH INVESTIGATOR: *Jill Follett, Tammy Burton*
TECHNICAL ASSISTANCE: *Norman Starkey*
COPIES TO: *FY93, Misc., Burkett, Meyers, Schollenberger*

ACCESSION NO: 93-0033

ALASKA DEPARTMENT OF FISH AND GAME
FISH PATHOLOGY SECTION, F.R.E.D. DIVISION
333 RASPBERRY ROAD, ANCHORAGE, AK 99518-1599

REPORT OF LABORATORY EXAMINATION

LOT (YEAR, STOCK, SPECIES): *1991 English Bay sockeye salmon, Oncorhynchus nerka*

FACILITY: *ADF&G/FRED Division*

CONTACT PERSON/ADDRESS: *Mark Schollenberger, North Pacific Rim P.O. Box 3593 Homer, AK 99603*

SAMPLE DATE: *09/07/92* *DATE SAMPLE RECEIVED:* *09/08/92*

SPECIMEN TYPE: *whole fish* *LIFE STAGE:* *fingerling* *STATE:* *live*

NUMBER IN SAMPLE: *10* *WILD:* *no*

HISTORY/SIGNS: *Low level mortality; treated earlier this summer with formalin for Ichthyobodo and Trichodina. Furunculosis diagnosed in 1992 (92-0025).*

REASON FOR SUBMISSION: *Diagnostic.*

FINAL REPORT DATE: *10/01/92*

CLINICAL FINDINGS:

NECROPSY:

HEALTHY:
0/5 with parasites in skin scrape
1/5 with blister on dorsal surface
3/5 with gas bubbles in gills
1/5 with pale kidney

MORTALITIES:
0/5 with parasites in skin scrape
2/5 with hemorrhaging on jaw
3/3 with gills in poor condition most likely due to post-mortem changes.
5/5 with petechiae internally on organs or musculature
3/5 with pale kidney

FAT: *0/7 positive for Renibacterium salmoninarum*
4/7 positive for Aeromonas salmonicida
Only dead fish were A. salmonicida positive.

BACTERIOLOGY: *Four kidneys struck on TSA at 25°C for 4 days.*

HEALTHY: *0/2 bacteria isolated*

MORTALITIES: *2/2 A. salmonicida isolated*
Isolates were sensitive to oxytetracycline and Romet.

VIROLOGY: *0/5 positive (5 fish/pool) for IHNV (0%). Tissues processed by quantal assay on EPC cell line at 15°C for 14 days. Minimum level of detection = 50 infectious particles/gm of pooled sample. Tissue sample included kidney, liver, spleen and pyloric caecae.*

DIAGNOSIS: *Furunculosis.*

COMMENTS/RECOMMENDATIONS: *Mortality was apparently due to furunculosis. Treatment with oxytetracycline was recommended at 3.75 gms/100 lbs fish/day (new lower level as per FDA regulations) for 10 days. Three pens were present with one being vaccinated for IHN virus. The vaccinates were experiencing the least amount of mortality possibly a result of stimulation of the immune response by the vaccination process. Gas bubbles in gills were most likely due to transport in small unpressurized aircraft. Since this is the second consecutive year with a furunculosis outbreak, the managers may want to consider a furunculosis vaccine or prophylactic antibiotic therapy next year. The furunculosis vaccine is reported to be moderately successful.*

Results were telephoned to Dave Daisy on 09/08/92.

FISH HEALTH INVESTIGATOR: *Tammy Burton, Jill Follett*

TECHNICAL ASSISTANCE: *NA*

COPIES TO: *FY93, Misc., Burkett, Meyers, Daisy*

Appendix 4. Disease history of English Bay sockeye salmon, 1983-1992.

Access number	Sample Date	Brood year	Source	Age	Findings
840033	sc 08/10/83	wild	E.Bay	adult	45/66 IHNV(68.2%) recommend stocks with lower incidence of IHNV preferred for hatchery if available.
890005	sc 06/13/88	wild	E.Bay	smolt	5/8 w/Salmincola n/a
890020	sc 08/11/88	wild	E.Bay	adult	0/65 BKD 0/65 A. Sal. recommend suitable for broodstock use if eggs from this stock are for hatchery use.
00013	sc 08/10/89	wild	E.Bay	adult	6/60 IHNV
10014	sc 08/17/90	wild	E.Bay	adult	0/62 IHNV
20025	sc 09/10/91	1990	E.Bay	fry	8/8 Trichopyra parasite, 3/6 A.Sal. diagnosis: Furunculosis & Trichopyra, recommend otc feed and formalin bath.
930011	sc 08/10/92	1991	E.Bay	fry	Ichthyobodo, Trichodina. recommend formalin bath
930033	sc 09/07/92	1991	E.Bay	fry	Furunculosis. recommend otc feeding

Appendix 5. Water temperature (° C) and dissoloved oxygen (mg/l) concentrations in Second Lake, English Bay Lakes, 1992.

		PENS	
Date	Depth (m)	Water Temp	D.O.
7/16	surface	15	9.0
	1	15	9.0
	2	15	9.0
	3	15	9.0
	4	15	9.0
8/5	surface	15	9.0
	1	15	8.5
	2	15	8.5
	3	15	8.5
	4	15	8.5
8/11	surface	15	8.5
	1	15	8.5
	2	15	8.5
	3	15	8.5
	4	15	8.5
9/7	surface	11.5	10.5
	1	11.5	10.5
	2	11.5	10.5
	3	11.5	10.5
	4	11.5	10.5

Appendix 6. Daily smolt log, English Bay river, 1991.

Day	Date	Temp (C)	Sockeye Daily Total	Sockeye Cumulative Total
1	May 24	10	106	0
2	25	11	439	439
3	26	10	556	995
4	27	10	55	1050
5	28	10	20	1070
6	29	9	44	1114
7	30	9	100	1214
8	31	9	234	1448
9	June 1	9	581	2029
10	2	9	720	2749
11	3	9	253	3002
12	4	9	368	3370
13	5	9	531	3901
14	6	10	746	4647
15	7	10	596	5243
16	8	10	1431	6674
17	9	10	123	6797
18	10	11	397	7194
19	11	10	669	7863
20	12	11	535	8398
21	13	10	1369	9767
22	14	10	1106	10873
23	15	10	1400	12273
24	16	10	788	13061
25	17	10	472	13533
26	18	10	1363	14896
27	19	10	wash Out	
28	20	11	wash Out	--
29	21	12	wash Out	--
30	22	11	wash Out	14896
31	23	11	418	15314
32	24	11	120	15434
33	25	11	131	15565
34	26		115	15680
35	27		72	15752
36	28		53	15805
37	29		148	15953
38	30		103	16056
39	July 1		52	16108
40	2		171	16279
41	3		102	16381
42	4		68	16449
43	5		39	16488
44	6		23	16511
45	7		72	16521
46	8		23	16544
47	9		10	16554
48	10		12	16566
49	11	13	17	16583
50	12	13	7	16590
51	13	14	4	16594
52	14	14	3	16597

Appendix 7. Daily smolt log, English Bay river, 1992.

Day	Date	Rain (mm)	Temp (C)	Sockeye Daily Total	Sockeye Cumulative Total	Coho	Pink	Daily Warden
1	April 11		3	0	0	0	*	0
2	12		1	0	0	19	*	0
3	13		1	0	0	26	*	0
4	14	14	1	0	0	30	*	0
5	15	6	1	0	0	17	*	2
6	16	10	1	3	3	43	*	0
7	17	2	1	2	5	52	*	0
8	18		3	0	5	10	*	2
9	19		4	4	9	51	*	3
10	20		3	1	10	66	*	13
11	21		2	0	10	0	*	0
12	22		3	40	50	20	*	22
13	23		4	0	50	51	*	21
14	24		4	2	52	40	*	16
15	25		3	0	52	33	*	98
16	26		4	2	54	82	*	6
17	27		3	1	55	49	*	30
18	28		1	0	55	13	*	4
19	29*			-	--	--	-	--
20	30			-	--	--	-	--
21	May 1			-	--	--	-	--
22	2			-	--	--	-	--
23	3			-	--	--	-	--
24	4			-	--	--	-	--
25	5			-	--	--	-	--
26	6			-	--	--	-	--
27	7			-	--	--	-	--
28	8			-	--	--	-	--
29	9			-	--	--	-	--
30	10			-	--	--	-	--
31	11			-	--	--	-	--
32	12			-	--	--	-	--
33	13		6	7	62	24	*	108
34	14		6	7	69	40	*	443
35	15		6	4	73	21	*	524
36	16		6	5	78	59	*	882
37	17		6	26	104	126	*	871
38	18		8	37	141	90	*	1951
39	19		8	29	170	56	*	667
40	20		9	57	227	156	*	2180
41	21		13	164	391	110	*	1434
42	22		13	871	1262	446	*	1411
43	23*		15	65	----	---	-	----
44	24		-	---	----	---	-	----
45	25		10	474	1736	117	*	119
46	26		10	999	2735	157		96
47	27		-	7886	10621	459		137
48	28		-	1283	11904	271		140
49	29		-	2118	14022	152		133
50	30		-	1788	15810	55		3

Appendix 7. continued.

Day	Date	Rain (mm)	Temp (C)	Sockeye Daily Total	Sockeye Cumulative Total	Coho	Dolly Varden Pink
51	31		10	2409	18219	187	2
52	June 1		10	2757	20976	222	51
53	2		13	2233	23209	65	31
54	3		9	2832	26041	68	6
55	4	2	10	985	27026	80	10
56	5	2	11	2009	29035	133	7
57	6		10	1122	30157	121	3
58	7		11	1034	31191	70	0
59	8		12	856	32047	59	3
60	9		12	613	32660	42	0
61	10		13	451	33111	21	0
62	11		13	1049	34160	45	1
63	12		12	803	34963	61	0
64	13		12	547	35510	54	1
65	14	2	12	854	36364	225	0
66	15	1	12	463	36827	75	0
67	16		12	535	37362	61	0
68	17		12	378	37740	37	0
69	18	12	12	859	38599	173	0
70	19		12	605	39204	73	0
71	20		13	535	39739	37	0
72	21	3	13	502	40241	40	0
73	22		12	244	40485	34	0
74	23		13	202	40687	7	0
75	24		12	221	40908	11	0
76	25		13	151	41059	13	0
77	26	10	13	193	41252	35	0
78	27	20	13	482	41734	64	0
79	28		--	--	41734	--	-
80	29		--	40	41774	7	0
81	30		13	353	42127	93	0
82	July 1		13	162	42289	59	0
83	2		14	148	42437	10	0
84	3		14	195	42632	20	0
85	4		15	76	42708	8	0
86	5		15	203	42911	28	0
87	6		14	136	43047	32	0
88	7	2	14	138	43185	18	0
89	8	2	14	38	43223	59	0
90	9	1	14	29	43252	53	0
91	10	2	14	8	43260	9	0
92	11		14	10	43270	18	0
93	12		14	17	43287	19	0
94	13		14	6	43293	25	0
95	14	2	14	18	43311	35	0
96	15	2	14	33	43344	43	0
			Total	43409		5590	10981

Appendix 7. continued.

* = Pink smolt were not enumerated. Asterisk represents timing of their migrati
appears as if DV keyed in on Pink smolt.

** = Trap was pulled due to mortality of pink smolt in trap.
It was reinstalled May 15

@= Trap washed out. Reinstalled on 5/25. Leads were shortened to 40 feet
due to high flows. Trap capturing 80-90% of the flow.
Pink smolt abundance dropped, so has number of Dolly Varden

~ High water washed the trap out 5AM 6/28
' Only fishing with the fyke net on June 29. Trap leads reinstalled to
40' lengths on 5/25

Appendix 8. Adult sockeye salmon escapement, English Bay River weir, 1992

Date		Water Temp (C)	Daily Count	Cumulative Count	
June	8	12	120	120	estimate before weir installed
	9	12	6	126	
	10	13	46	172	
	11	13	26	198	
	12	12	32	230	
	13	12	27	257	
	14	12	35	292	
	15	12	50	342	
	16	12	99	441	
	17	12	149	590	
	18	12	86	676	
	19	12	199	875	
	20	13	392	1267	
	21	13	112	1379	
	22	12	191	1570	
	23	13	149	1719	
	24	12	251	1970	
	25	13	327	2297	
	26	13	153	2450	
	27	13	215	2665	
	28		20	2685	est. weir washed out
	29		30	2715	est. weir washed out
	30	13	43	2758	
July	1	13	121	2879	
	2	14	167	3046	
	3	14	108	3154	
	4	15	421	3575	
	5	15	311	3886	
	6	14	153	4039	
	7	14	113	4152	
	8	14	132	4284	
	9	14	143	4427	
	10	14	157	4584	
	11	14	254	4838	
	12	14	273	5111	
	13	14	321	5432	
	14	14	217	5649	
	15	14	144	5793	
	16	14	53	5846	
	17	14	66	5912	
	18	14	120	6032	
	19	14	130	6162	
	20	14	145	6307	
	21	14	29	6336	
	22	14	57	6393	
	23	13	0	6393	
	24	14	7	6400	