Fishery Management Report No. 13-32

Frazer Lake Fish Pass: 2012 Season and Historical Review

by

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Alaska Department of Fish and Game Divisions of Sport Fish and Commercial Fisheries

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_{2,}$ etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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ABSTRACT

Frazer Lake is located on the southwestern side of Kodiak Island, about 113 km from Kodiak city, and empties into Dog Salmon Creek. The Frazer Lake system did not historically support runs of anadromous fish due to a 10 m barrier falls that prevented access to spawning habitat. In an effort to enhance the Alitak District commercial salmon fishery, the federally controlled Alaska Territorial Fishery Service created a sockeye salmon *Oncorhynchus nerka* run to Frazer Lake. From 1951 to 1971, sockeye salmon were planted in the Frazer Lake system and in 1962, a fish pass was constructed for adult salmon to bypass the falls and access Frazer Lake.

The Alaska Department of Fish and Game has been responsible for the operation and maintenance of the fish pass since 1962. These responsibilities include the enumeration and biological sampling of sockeye salmon adults and smolt. In addition to collecting biological data from sockeye salmon, limnological data has been collected at various stations on Frazer Lake since 1985.

The sockeye salmon escapement through Dog Salmon weir was 154,416 in 2012; of which 148,884 were counted at the Frazer Fish Pass. The total estimated commercial harvest was 217,631, which was above the five and ten-year averages (189,220; 197,004), with a total run of 372,049 sockeye salmon. The adult sockeye salmon run was comprised mostly of age-2.2 (54%) and 2.3 (26%) fish. In 2012, an estimated 5,566,177 sockeye salmon smolt outmigrated from Frazer Lake, of which 96% were age-2 sockeye salmon smolt.

In 2012, Frazer Lake had a mean total nitrogen to total phosphorus ratio of 102.7:1, a mean chlorophyll *a* concentration of 1.36 µg/L, a mean density of 270,325 no/m^2, and a mean biomass of 368.9 mg/m^2.

Key words: Frazer Lake, Olga Bay, Dog Salmon Creek, Kodiak Management Area, *Oncorhynchus nerka*, sockeye salmon, fish pass, limnology, zooplankton

INTRODUCTION

BACKGROUND

A 10 m barrier falls blocked anadromous fish access to Frazer Lake, prompting Alaska Territorial Fishery Service biologists to investigate the Frazer Lake drainage and determine the feasibility of an engineered fish pass to allow access to Frazer Lake (Ziemer 1962; Figures 1 and 2). Sockeye salmon (*Oncorhynchus nerka)* were introduced into Frazer Lake beginning in 1951 using donor stocks from three lakes (Blackett 1979; Appendix A1). In 1962 an engineered fish pass was completed providing anadromous fish access into Frazer Lake (Ziemer 1962; Figure 3).

The run is now an important contributor to the Kodiak Island's commercial fishery with an estimated sockeye salmon run size ranging from approximately 110,000 to 712,000 fish during the most recent 10-year period (2002-2011; Table 1; Appendix C7). The Alaska Department of Fish and Game (ADF&G) has established an escapement goal of 75,000 to 170,000 sockeye salmon (Nemeth et al. 2010; Appendix A2).

In addition to being an important species to the commercial fishery, sockeye salmon are an important food source for the Kodiak brown bear (*Ursus arctos middendorfii*) and other wildlife. The creation of a sockeye salmon run at Frazer Lake has dramatically increased brown bear densities in the Frazer Lake area by providing a stable protein food (Barnes 1990). As a result, the Kodiak National Wildlife Refuge initiated public bear-viewing at Frazer Fish Pass.

Presently, the fish pass is operated each year from May through August to count salmon and ensure fish are moving through it efficiently. Other studies are done according to need and funding availability, and may include limnological sampling in the lake, estimating the abundance of sockeye salmon smolt outmigrating from the lake in the spring, renovating the fish pass structure, and counting other species of adult salmon that ascend the fish pass.

Notable Frazer Lake publications are by Blackett (1979) for establishment of the sockeye salmon run, Blackett (1987) for the history of the fish pass infrastructure, Kyle et al. (1988) for trophic level responses, Sagalkin (1999) for the last comprehensive report, Burger et al. (2000) for the genetic heritage of fish in the lake, Sagalkin (2003) for infrastructure improvements, Duesterloh and Watchers (2007) for the last smolt report, and Finkle and Ruhl (2012b) for lake limnology.

The intent of this report is to describe investigations in 2012, and to document adult fish passage, smolt monitoring, and infrastructure work in the years since each was last reported. Historical data are included in appendices.

STUDY AREA

Frazer Lake (57°12'13.03"N latitude, 154°03'29.30"W longitude) is at an elevation of 108 m and is located approximately 113 km southwest of the City of Kodiak, within the Kodiak National Wildlife Refuge (Figure 1). The lake is the second largest on Kodiak Island at 14.2 km long and 1.6 km wide, and has a surface area of 16.1 km^2. Frazer Lake has a mean depth of 37.5 m, a maximum depth of 63.4 m and holds a volume of 527 km^3 (Figure 2; Finkle and Ruhl 2012b). The lake drains into Dog Salmon Creek, which is approximately 16.0 km long and empties into Olga Bay. A 10 m barrier waterfall is located approximately 1.0 km downstream of Frazer Lake on Dog Salmon Creek (Figure 3). Additionally, in 1983, a weir was installed on Dog Salmon Creek 0.7 km upstream from Olga Bay to provide timely salmon escapement counts for more effective management of the commercial fishery in Olga Bay (Figure 1).

HISTORY OF SALMON POPULATIONS IN FRAZER LAKE

Frazer Lake was barren of sockeye salmon until 1951, when the first eggs were transplanted from Karluk Lake sockeye salmon. Sockeye salmon were introduced into Frazer Lake from three different donor stocks (Karluk and Red lakes on Kodiak Island, and Hidden Lake draining into Becharof Lake on the Alaska Peninsula) and continued to be transplanted into the lake through 1971 (Blackett 1984; Burger et al. 2000; Appendix A1). The run was fully established by the late 1970s, and is now managed for harvest and escapement in the Kodiak Management Area. All three donor stocks had detectable genetic contributions to the sockeye salmon populations present in the lake in 1995 but the contribution from Hidden Lake was minimal (Burger et al. 2000).

Chinook salmon (*O. tshawytscha*) fry were also transplanted into Dog Salmon Creek from 1966 through 1969, using Karluk River spawners as the donor stock (Appendix A1). This stock is small with a 10-year average of 126 adult Chinook salmon ascending the fish pass (2002-2011; Appendices C1 and C6) as compared to that reported in the late 1970s (70; Blackett 1979) and the 1980s (100; Barrett 1988).

Steelhead (*O. mykiss*), pink (*O. gorbushca*), and chum salmon (*O. keta*) are naturally present in the river below the falls (Blackett 1979). Steelhead have only ascended the fish pass in 1995 (1 fish) and 2012 (6 fish; Appendix C1). Pink salmon have slowly colonized upstream spawning habitat. For the recent 10-year period from 2002 through 2011, an average of 1,706 pink salmon have been counted ascending the fish pass each year, although most years are lower than the average (Appendix C1). The average number of pink salmon passing Dog Salmon during the same 10-years was 149,105 fish (Jackson et al. 2012). The number of chum salmon ascending the fish pass has decreased over time, averaging 1 fish in the last 10 years (Appendix C1).

The only known resident fish in Frazer Lake are rainbow trout *O. mykiss*, Dolly Varden char *Salvenlinus malma*, threespine stickleback *Gasterosteus aculeatus*, and freshwater sculpin *Cottus aleuticus* (Blackett 1979).

HISTORY OF THE FISH PASS

Adult sockeye salmon began returning to the base of the waterfall in 1956 and were backpacked around the falls and into the lake. Counts before 1962 only represent the number of sockeye salmon backpacked around the falls, and not the total number that may have returned. This practice continued until 1962, when a pair of 64 m long fish passes were constructed (Blackett 1987; Figures 3 and 4). Another pair of passes were added in 1979 to increase fish passage. In the early 1970s, the entrance to the fish passes was realigned to face downstream because returning adults appeared to have difficulties finding it, as it faced upstream towards the base of the falls. In addition to the entrance realignment, a fish diversion weir was installed to guide salmon towards the entrance.

Concerns over increasing adult fish passage at Frazer Fish Pass have led to various redesigns of the fish pass and entrance structures (Blackett 1987; Barrett 1988; Sagalkin 2003). Barrett (1988), citing design deficiencies in the new passes, only operated the older fish passes. Although both pairs of passes are still standing, only the original pair, from 1962, has been used to pass fish in recent years.

By 2002 the fish diversion weir, entrance chute, upper sampling deck, and fish pass covers had aged and were in poor condition. In 2003 a permanent steel walkway was installed, an aluminum entrance chute was added, concrete repairs were made, rotten wood structures were rebuilt, and wooden fish pass covers were replaced with aluminum covers **(**Sagalkin 2003).

Although necessary to pass fish into the lake, the fish pass was located far enough upriver from the ocean to be only marginally useful for inseason management of the newly-developed commercial sockeye salmon fishery. The fish pass was not useful at all for any chum or pink salmon inseason management because most of these populations spawned downstream of the pass. To improve inseason salmon management, a weir was installed near the mouth of Dog Salmon Creek in 1983, only 0.7 km upstream from Lower Olga Bay. The weir has been operated annually since then, with travel time of sockeye salmon from the weir through the top of the fish pass estimated at approximately 7 days (Barrett 1988).

The first year the Dog Salmon weir was installed; there was a discrepancy between the final Dog Salmon count and the Frazer Fish Pass count. These count differences have been the subject of extensive speculation, and have been variously attributed to fish spawning in the intervening space, predation by Kodiak brown bears, and a simple inability to ascend the ladder. These concerns have in turn led to various redesigns of the entrance to the fish pass, as described by Sagalkin (2003). The pass infrastructure currently consists of a diversion weir at the bottom of the falls that shunts returning spawners to one side the river, where they encounter an aluminum chute at the bottom of the fish pass. Both the weir and the chute are effective at guiding fish to the pass, but are also places of high fish congestion and subsequent exploitation by bears. Notably, as many as 105,602 (2004) sockeye salmon have been counted through Dog Salmon weir but did not ascend the fish pass (Appendix C7).

Because salmon entry and passage rates through the fish pass are dependent on the volume of water flowing through or next to the fish pass (Blackett 1987), a small water diversion weir

(4 feet in length) was installed perpendicular to the fish diversion weir to increase flow near the fish pass entrance in 2006 (Figure 4). In 2012, the length of the small water diversion weir was extended to 16 feet (Figure 5). Increasing the length of the extension appears to have increased fish passage and helped reduce the number of sockeye salmon left remaining in Dog Salmon Creek (Appendix C7).

ESCAPEMENT GOALS

The Frazer Lake sockeye salmon escapement goal has been modified several times and gone through several reviews since the 1950s (ADF&G 1999; Nemeth et. al 2010; Appendix A2). The addition of Dog Salmon Weir counts created some confusion about which count (Dog Salmon Weir or Frazer Fish Pass) to use for the escapement goal. Although inconsistently applied when first established, the sockeye salmon count through Frazer Fish Pass was accepted as the Frazer Lake escapement (ADF&G 1999). Consequently, counts through the Dog Salmon Weir have been utilized for management purposes only (determining fishing periods).

The current sockeye salmon escapement goal for Frazer Lake was established in 2007 and is a BEG of 75,000–170,000 fish (biological escapement goal; Nemeth et. al 2010; Appendix A2). The Frazer Lake BEG includes jacks as part of the escapement number. The S_{msy} (maximum sustainable yield) is estimated at 117,000 sockeye salmon while S_{eq} (carrying capacity) is estimated at 321,000 sockeye salmon.

FERTILIZATION

Colonizing Frazer Lake with sockeye salmon resulted in substantial changes in the plankton community (Kyle et al. 1988). In an effort to maintain and increase the survivability of sockeye salmon smolt by enhancing the productivity of the zooplankton community, a lake nutrient enhancement project was implemented between 1988 and 1992 (Schrof et al. 2000; Schrof and Honnold 2003). From mid-June to mid-August during these five years, an average of 7.6 tons/week of nitrogen-phosphorous fertilizer was aerially deposited over a 10 km^2 area of the lake. The phosphorous added was in the form of inorganic phosphate and the nitrogen was a mixture of ammonium, nitrate, and urea (Kyle 1994).

2012 SEASON

The overall project goal is to optimize natural sockeye salmon production by providing unobstructed and timely adult fish passage to Frazer Lake, and to collect adult, smolt, and limnological data relevant to generating accurate preseason run forecasts, escapement goal evaluations, and monitor the health of the system.

To achieve the project objective, ADF&G research personnel collected data to:

<u>Smolt</u>

1. Estimate the abundance (N) of outmigrating sockeye salmon smolt within 30% (relative error) of the true value with 95% confidence;
2. Estimate the age composition of outmigrating sockeye salmon smolt within d=0.05 (size of the effect) of the true proportion (for each major age group within each stratum) with 95% confidence;
3. Estimate the average length (mm) and weight (g) by smolt age group and stratum;

Adult salmon

4. Enumerate the escapement of adult sockeye salmon returns through the fish pass while providing unobstructed and timely adult fish passage to Frazer Lake;
5. Estimate the age and sex composition of adult sockeye salmon returns where estimates are within d=0.07 of the true proportion (for each age group within each stratum) with 95% confidence;
6. Estimate the average length (mm) by age and sex; and

Limnology

7. Evaluate water chemistry, nutrients, phytoplankton, and zooplankton in Frazer Lake.

METHODS

Smolt Assessment

Trap Deployment and Assembly

A single inclined plane trap (Todd 1994; Figure 6) was operated 3 m upstream of the falls in the thalweg from May 8 through June 28, 2012. A catch box was attached to the cod-end of the trap, and the entire trapping system was connected to cables attached to each stream bank by come-alongs. The trap was secured to an aluminum pipe frame, which allowed the trap to be adjusted horizontally in response to water level fluctuations. In contrast to recent years when the trap was fished only three days a week, in 2012 the trap fished continuously throughout the smolt outmigration. The trapping system was removed when smolt counts diminished to less than 100 smolt for three consecutive days to avoid obstruction of adult fish passage. Detailed methods of trap installation are described in the 2012 Frazer Operational Plan (Foster et al. 2012a).

Smolt Capture, Handling, and Sampling

Smolt were captured in the inclined plane trap 24 hours a day, where a sampling day extends from noon of the first day to noon the following day and the date will correspond with the first day. Smolt were collected throughout the migration and held in the catch box until they were counted or selected for sampling. During the night (2200 to 0800 hours), the live box was checked every 1 to 2 hours, depending on smolt abundance. During the day (0801 to 2159 hours), the live box was checked every 3 to 4 hours. All smolt were removed from the live box with a dip net, counted, and either released downstream of the trap or transferred to an in stream holding box for sampling and marking. All outmigrating fish were visually identified and enumerated using a tally denominator, except when catch rates exceeded the crew's ability to hand tally, in which case smolt numbers were estimated using a catch-weight method (Sagalkin 1999). Species identification was made by visual examination of external characteristics (Pollard et al. 1997). All data, including mortality counts, were entered on a reporting form each time the trap was checked. All fish were visually inspected for marks during mark-recapture events including those encountered during catch-weight estimates.

For catch weight estimates, the crew first recorded the weight of an empty perforated 5-gallon bucket. Smolt were then transferred to the bucket using a dip net. After excess water had drained from the bucket, the weight of the apparatus was recorded, and then all fish within the bucket were identified, enumerated and released. This served as the reference measure. Subsequent nets of fish were weighed, but not counted, before release. Every ten catch weights, the bucket with smolt was weighed and all fish again identified and enumerated before release to establish new reference weights and species compositions.

On five days each week, 40 fish per day were randomly selected from the catch box, held in an in stream live box, and sampled for age, weight, and length (AWL) data. Smolt were anesthetized using tricaine methanesulfonate (MS-222) prior to being sampled. Fork length was measured to the nearest 1 mm, and each smolt weighed to the nearest 0.1 g. Scales were removed from the preferred area (INPFC 1963) and mounted on a microscope slide for age determination. After sampling, smolt were held in aerated buckets of water until they recovered from the anesthetic, then were released downstream from the trap.

Additionally, the overall health or condition factor (Bagenal and Tesch 1978), which is a quantitative measure of the isometric growth of a fish and a relative index of fish health, was determined for each smolt sampled using

$$K = \frac{W}{L^3} 10^5$$

Detailed methods for smolt capture, handling, and sampling are provided in Foster et al. (2012b).

Trap Efficiency and Mark-Recapture Abundance Estimation

Total smolt abundance was estimated using single-site mark-recapture procedures (Carlson et al. 1998). Trap efficiency was estimated using mark-recapture trials within specific recapture periods (strata), generally weekly, when smolt numbers were sufficient. Trap efficiencies were adjusted to reflect delayed mortality testing data, described below, and then used to estimate the number of smolt outmigrating during each stratum from the watershed.

Releases of sockeye salmon smolt marked with Bismarck Brown Y dye were made once per stratum, as well as when changes were made to the trapping system. Based on prior smolt studies at Frazer Lake, an effort was made to achieve a trap efficiency of 5%. To estimate total smolt abundance each week with a 5% probability of exceeding a relative error (r) of 30%, 450 (10% trap efficiency) to 900 (5% trap efficiency) smolt would need to be marked and released for each experiment (Carlson et al. 1998; Robson and Regier 1964).

To estimate any mortality associated with the marking process 100 marked fish were retained and monitored for four days. Trap efficiency was adjusted using the marked mortality tests, subtracting marked mortality, reducing the number of smolt released to reflect marking mortality. Therefore, a sample size of 1000 was set as the goal for each experiment to account for any marking mortality. Actual numbers of fish marked, released, and retained for mortality testing varied by release event (Tables 2 and 3). Past mark retention and delayed mortality experiments on other smolt enumeration projects indicated that most of the captured smolt mortalities occurred within the first three days of capture (Bouwens and Newland 2003). Smolt utilized for the dye release were captured in the trap, transported to the release site 1.2 km upstream, and released at 2200 hours to coincide with the natural outmigration.

All smolt data collected were categorized into strata and statistical week to help recreate the smolt run. The statistical week is a perennial tool and is defined by a span of 7 days that is numbered consistently and used as an index. The stratum was defined as the period of time between dye-release tests. Additional methods for trap efficiency and mark-recapture abundance estimation are provided in Foster et al. (2012a).

Trap efficiency E_h for stratum h was calculated as

$$E_h = \frac{m_h + 1}{M_h + 1}, \tag{1}$$

where

m_h = number of marked smolt recaptured in stratum h

A modification of the stratified Petersen estimator (Carlson et al. 1998) was used to estimate the number of unmarked smolt U_h emigrating within each stratum h as

$$\hat{U}_h = \frac{u_h (M_h + 1)}{m_h + 1}, \tag{2}$$

where

u_h = number of unmarked smolt recaptured in stratum h.

Variance of the smolt abundance estimate was estimated as

$$\hat{\text{var}}\left(\hat{U}_h\right) = \frac{(M_h + 1)(u_h + m_h + 1)(M_h - m_h)u_h}{(m_h + 1)^2 (m_h + 2)}. \tag{3}$$

Total abundance of U of unmarked smolt over all strata was estimated by

$$\hat{U} = \sum_{h=1}^{L} \hat{U}_h, \tag{4}$$

where L is the number of strata. Variance for $\hat{U}$ was estimated by

$$\hat{\text{var}}\left(\hat{U}\right) = \sum_{h=1}^{L} v\left(\hat{U}_h\right), \tag{5}$$

and 95% confidence intervals were estimated using

$$\hat{U} \pm 1.96\sqrt{v\left(\hat{U}\right)}, \tag{6}$$

which assumes that $\hat{U}$ is approximately normally distributed.

Within each stratum h, the total population size by age class j was estimated as,

$$\hat{U}_{jh} = \hat{U}_h \hat{\theta}_{jh}, \tag{7}$$

where $\hat{\theta}_{jh}$ is the observed proportion of age class j in stratum h. Variance of $\hat{\theta}_{jh}$ was estimated using the standard variance estimate of a population proportion (Thompson 1987). The variance of $\hat{U}_{jh}$ was then estimated by

$$\hat{\text{var}}\left(\hat{U}_{jh}\right) = \hat{U}_h^{\,2} v\left(\hat{\theta}_{jh}\right) + \hat{U}_h v\left(\hat{\theta}_{jh}\right)^2. \tag{8}$$

The total number of emigrating smolt within each age class was estimated by summing the individual strata estimates where the following assumptions were not violated (Carlson et al. 1998):

- The population was unchanging (i.e., a closed population with no immigration or emigration),
- all smolt had the same probability of being marked. (i.e., trap is not selective and strata are consistent),
- all smolt had the same probability of capture. (i.e., marking fish does not affect their behavior or ability to be captured),
- all marked smolt released can be recovered. (i.e., marking mortality was accurate),
- all marked smolt were identifiable. (i.e., crew well trained and strata are discrete),
- and marks were not lost after marking. (i.e., effectively stained).

Adult Assessment

Fish Pass Operation and Adult Enumeration

The fish pass was operated continuously from May 27 through August 20. Many major components of the fish pass are permanently assembled and require minimal assembly (Figure 3). Major assembled components include two steeppasses, a cement entrance and exit (counting tank) structure, the cement portion of the upper water diversion above the falls, and the framework and walkway of the fish diversion weir (Figure 4). Major components needing assembly include panels and boards on the fish diversion weir and upper water diversion and a secondary lower water diversion assembly (Figure 3). Detailed methods of fish pass installation, operation, and maintenance is described in the 2012 Frazer Operational Plan (Foster et al. 2012a) and Blackett (1987).

Fish freely moved up the steeppass into a counting tank at the top of the fish pass, upstream of the falls, where they remained until a gate was opened by personnel. Adult salmon were enumerated by personnel with tally denominators while exiting the counting tank. Counting frequency was dependent on the rate of fish passage.

Salmon entry and passage rates through the fish pass are dependent on the volume of water flowing through the fish pass (Blackett 1987). Water flow through the fish pass was adjusted by adding or taking away stop logs placed in the upper water diversion.

In an effort to further expedite fish passage into the lake, water flow was redirected from the falls to the fish pass entrance by using a lower flow diversion placed perpendicular to the fish diversion weir (Figures 4 and 5). The lower flow diversion was tested with eight feet and 16 feet lengths in 2011 (Figure 5). The longer flow diversion appears to have worked more efficiently and was used in 2012.

Adult ASL Sampling

Adult sockeye salmon were captured and randomly sampled as they exited through the counting gate throughout the season. Eighty sockeye salmon per day were sampled for ASL data three times per week for a total of 240 fish per week. Detailed adult sampling methods are described in the 2012 Frazer Operational Plan (Foster et al. 2012b).

Scales were collected from the preferred area of each fish (INPFC 1963) and mounted on scale "gum" cards (Clutter and Whitesel 1956). Ages were assigned by criteria established by Mosher (1968). Ages were recorded using European notation (Koo 1962), sex was determined from external morphological characteristics, and length measurements were from mid-eye to tail fork to nearest 1 mm.

Limnological Assessment

In 2012, limnological assessment of Frazer Lake was conducted at two stations at approximately four week intervals from May to October. Parameters measured include: temperature, dissolved oxygen, light attenuation, water clarity, pH, alkalinity, total phosphorus (TP), total filterable phosphorus (TFP), filterable reactive phosphorus (FRP), nitrate + nitrite (NO_3^- + NO_2^-; N+N), ammonia (NH_4^+; TA), total Kjeldahl nitrogen (TKN), chlorophyll-*a* (chl-*a*), pheophytin-*a*, phytoplankton density, biomass, and size, by phylum, and zooplankton density, biomass, and size, to lowest possible taxonomic level. A temperature data logger was also positioned in the lake all season at limnology Station 3 (Figure 2). Detailed methods for sample collection are provided in Foster et al. (2012c) and detailed sample processing methods are provided in Ruhl (2013).

RESULTS

Smolt Assessment

Smolt Capture

Trapping took place for a total of 52 days beginning on May 8 and ended on June 28. Due to late ice-out conditions, few smolt were observed until May 20 when 3,940 smolt were captured. Peak capture occurred in the last week of May, with 78% (250,325 fish) of the captured fish leaving Frazer Lake between May 25 and June 2 (Tables 2 and 3; Figure 7). The trap was removed after three consecutive daily sockeye salmon smolt counts under 100 were observed. A total of 319,738 (319,237 live; 0.2% mortality) sockeye salmon smolt were captured by the trap in 2012.

Trap Efficiency and Mark-Recapture Abundance Estimation

Mark-recapture experiments were conducted on five occasions throughout the 2012 season (Tables 2 and 3). Small daily catches of smolt in the beginning of the emigration delayed completion of a mark-recapture test until 24 May. As a result, the first strata encompassed the largest time frame, 8 May to 30 May. Adjusted for mortality, a total of 3,282 sockeye salmon smolt were marked and released for the season. One hundred-sixty-five smolt were recaptured and the majority of marked smolt were recaptured within two days of being released. Trap efficiency estimates per stratum ranged between 4.0% and 7.3%. Mean estimated trap efficiency for the total emigration was 5.6%. An estimated 5,566,771 (95% CI 3,657,351–7,476,191) sockeye salmon smolt outmigrated from Frazer Lake during 2012 based upon mark-recapture estimates and trap counts.

Smolt AWL and Condition Factor

Age-2 sockeye salmon composed 96% of the total population, followed by age-1 sockeye salmon which comprised 4% of the total outmigration (Table 4). No age-0 or freshwater-age-4 smolt were captured in 2012.

The five-year (2007–2011) average age composition of sampled sockeye salmon smolt was composed of 18.1% freshwater-age-1, 73.3% freshwater-age-2, and 7.9% freshwater-age-3 smolt (Appendix B1).

In 2012, the average condition factor (K) was 0.74 for both age-1 and age-2 sockeye salmon smolt, while age-3 smolt averaged 0.80 (Table 5). Sampled age-1 smolt had a mean weight of 4.0 g and a mean length of 80.6 mm. Sampled age-2 smolt had a mean weight of 6.3 g and a mean length of 94.7 mm. Sampled age-3 smolt had a mean weight of 17.7 g and a mean length of 129.0 mm. The five year (2007–2011) average K was 0.73 for age-1 smolt, 0.70 for age-2 smolt, and 0.69 for age-3 smolt. (Appendices B1 and B2). The five year (2007–2011) mean weight was 4.4 g for age-1 smolt, 6.6 g for age-2 smolt, and 8.0 g for age-3 smolt.

Adult Assessment

Fish Pass Enumeration

In 2012, the Frazer Fish Pass was operated from June 7 through August 20. Sockeye salmon began ascending the fish pass on Jun 11 and the last count through the fish pass occurred on August 20. The largest sockeye salmon count occurred on July 13 (18,150). A total of 148,884 adult sockeye salmon were counted through the fish pass in 2012 (Table 6; Figures 8 and 9). The 5-year (2007–2011) average escapement for sockeye salmon entering Frazer Lake was 111,343 fish.

A total of 6 steelhead, 39 Chinook and 2 pink salmon were counted through the fish pass (Table 6). Notably, this was the second year in which steelhead have used the fish pass. The five- and ten-year averages for Chinook salmon are 37 fish, and 126 fish, while the five- and ten-year averages for pink salmon are 2,349 fish and 1,706 fish (Appendices C5 and C6; Jackson et al. 2012).

Dog Salmon Escapement

A total of 154,416 adult sockeye salmon were counted through Dog Salmon weir between June 01 and August 19, 2012 (Table 1; Appendix C4). The 5-year (2007–2011) average total escapement was 151,317.

In 2012, the run timing for Dog Salmon weir sockeye salmon escapement was slightly earlier than average when compared to the last ten years (Figure 10; Appendix C4).

Number of Sockeye Salmon Remaining in Dog Salmon Creek

In 2012, only 3.6% (5,532) of the sockeye salmon passing through Dog Salmon weir did not ascend Frazer fish pass and remained in Dog Salmon Creek (Table 1; Figure 11). This was the fewest sockeye salmon left in Dog Salmon Creek below the fish pass since 1989. Throughout the season an average of 21,851 sockeye salmon were in Dog Salmon Creek between Dog Salmon weir and Frazer fish pass.

The average number of sockeye salmon left in Dog Salmon River from 1985 to 2011 was 29,859 (15.6%; Table 1; Figures 11; Appendix C7). Considering Dog Salmon and Frazer Fish Pass count data prior to 2002, the average number of sockeye salmon left in Dog Salmon River (1985 to 2001) was 22,598 (10.0%; Table 1; Figure 11; Appendix C7). After 2001, the average number of sockeye salmon left in Dog Salmon River (2002 to 2011) was 42,203 (24.9%).

Jack Percentage

In 2012, jack (ocean-age-1) sockeye salmon made up 1.9% of the total escapement into Frazer Lake (Table 7 and Figure 12). This jack percentage was less than the 5–year average of 33.8%.

Adult ASL

Of the 2,247 adult sockeye salmon scales samples collected at Frazer Fish Pass in 2012, 1,985 were readable and 65% of the fish sampled were female (Table 8). The range of lengths measured for male fish was wider than for females (285-619 mm and 408-611 mm, respectively). Mean length for females was 505 mm and 494 mm for males. Mean length for jacks was 342 mm.

The age composition of sockeye salmon escapement into Frazer Lake was calculated by interpolating the weekly age composition of sampled (Table 9) to weekly escapement counts. When applied to the entire escapement, age-2.2 fish composed 54% of the total population, followed by age-2.3 fish which comprised 26% of the total escapement. In each week, age-2.2 fish were the predominant age class. Age-2.3 fish were the second most common age class, except in mid-August (stat. week 33) when age-1.2 fish were also common (Table 4). Since 2002, age-2.2 fish have composed an average of 30% of the total annual escapement and age-2.3 and age-2.1 composed 22%, and 19% respectively (Appendix C2).

Run Reconstruction and Exploitation

Harvest estimates of sockeye salmon bound for Frazer Lake were based on catches within the Alitak and Humpy-Deadman districts. Detailed methods for calculating the catch estimate for Frazer Lake are given in Foster et al. (2012b). In 2012, the total commercial harvest apportioned for Frazer Lake sockeye salmon was estimated at 217,631. This harvest was above the five-year average of 189,220 (Table 1). The total run for Frazer Lake sockeye salmon in 2012 was estimated at 372,049, which was above the 5-year average of 340,337 and the 10-year average of 358,191.

Limnological Assessment

Lake Temperature and Physical Parameters

Mean 1 m temperatures for Frazer Lake increased from 2.8°C in May to 11.8° C in August before slowly cooling to 7.9° C in October (Table 10; Figure 13). In all months except June, 1 m temperatures in 2012 were cooler than the most recent 5-year average temperature (2007–2011; Appendix D2).

Mean 1 m dissolved oxygen for Frazer Lake was the highest in May and June (13.1 mg/L) and then decreased in July through September (11.6 mg/L in September; Table 10). For each month, 1 m dissolved oxygen measurements in 2012 were greater than the 5-year average (2007-2011; Appendix D2).

Frazer Lake was well mixed in May of 2012 and began stratifying in June (Figure 13), with the greatest stratification occurring in August. By October the lake was again well mixed.

General Lake Chemistry and Nutrients

Frazer Lake, stations 1 and 3 averaged, pH (7.6), alkalinity (14.0), chlorophyll *a* (1.36 μg/L), and TKN (271.2 μg/L) were above the 5-year average as measured at the epilimnion (Appendices D4 and D5). All phosphorus values, stations 1 and 3 averaged, TP (3.0 μg/L), TFP (1.7 μg/L), and FRP (0.8 μg/L) and TA (4.7 μg/L) were below the 5-year average as measured at the epilimnion (Appendices D4 and D5). The N+N (36.4 μg/L) measurement was similar to the 5-year average at the epilimnion.

Zooplankton

All zooplankton identified were crustaceans commonly referred to as either cladocerans (*Order* Anomopoda and Ctenopoda) or copepods (*Order* Calanoida, Cyclopoida, and Harpacticoida). Copepods were more abundant (60.9% of mean density) than cladocerans (39.1%; Tables 11–14). The two most abundant groups of copepods were the *Cyclops*, an important component of the zooplankton community in sockeye salmon rearing lakes, (47.4%) and the pooled category of "other copepods" (13.2%) which was made up mostly of the genus *Harpaticus* and various unidentified nauplii (larvae). The other copepod genera included *Diaptomus* (0.2%) and *Epischura* (0.1%). Among the cladocerans, the most abundant groups was *Bosmina* (30.6%). A pooled category of "other cladocerans" (7.6%), consisted of various unidentified immature cladocerans (stations 1 and 3 averaged; Tables 11-14). Other observed cladoceran genera were *Daphnia* (0.5%) and *Holopedium* (0.4%).

Mean total zooplankton biomass was 370.2 mg m^{-2}, and was mostly comprised (74.5% of mean total biomass) of copepods (Tables 11-14). The copepod genus *Cyclops* (73.3%) represented most of the biomass, followed by the cladoceran genus *Bosmina* (24.0%). The remaining biomass was composed of *Daphnia* (0.5%), *Diaptomus* (1.0%), *Epischura* (0.2%), *Holopedium* (0.9%).

The copepod *Diaptomus* was the largest zooplankton measured, with a weighted mean length of 1.22 mm (Table 14; Appendix D8). Weighted mean lengths of the remaining zooplankton measured, in decreasing size, were 0.89 mm for the copepod *Epishura*, 0.78 mm for *Cyclops*, 0.57 mm for the cladoceran *Holopedium*, 0.56 mm for *Daphnia*, and 0.34 mm for *Bosmina*.

Phytoplankton

Phytoplankton samples were collected from stations 1 and 3 in 2011 and 2012. Mean seasonal phytoplankton biomass was 854.5 (mg/m^3) in 2011 and 1,587.5 (mg/m^3) in 2012 (Tables 15-16; Appendix D11). The overall mean biomass was 1,219.98 (mg/m^3; 2011–2012; Appendix D11). Mean seasonal biomass was consistent between stations (1 and 3).

In both years, phytoplankton biomass was predominately composed of Bacillariophyta, Cyanobacteria, and Pyrrhophyta (overall - 65, 15, and 10% respectively; Appendix D11). The biomass of both Bacillariophyta (Diatoms) and Cyanobacteria (Blue-green algae) varied between years.

DISCUSSION

SMOLT ASSESSMENT

The Frazer Lake sockeye salmon smolt outmigration typically begins in early May, peaks in late May, and ends around mid-July. A variety of smolt capture methods have been utilized since the sockeye salmon enhancement program began in Frazer Lake (Barrett 1988, 1989; Blackett 1984; Coggins 1997; Duesterloh and Watchers 2007; Eaton 1967, 1968; Eaton and Meehan 1966a, 1966b; Gwartney 1969; Russell 1972; Sagalkin 1999; Swanton et al. 1996; Appendix A3). Smolt abundance and/or age composition was estimated from 1965 through 1971 using a smolt weir at the outlet of the lake. Between 1972 and 1984, smolt abundance or age composition was indexed each year, using a variety of methods and sampling sites between the lake outlet and below the waterfall. Between 1985 and 1993, smolt abundance or age composition was estimated using an incline plane trap placed below the falls. Since 1994, smolt abundance or age composition was estimated using an incline plane trap placed above the falls (Appendix A3). Throughout the years, captured sockeye salmon smolt have been randomly selected and sampled for AWL data.

The last published sockeye salmon smolt outmigration estimate was published by Duesterloh and Watchers (2007). Between 2007 and 2011, an incline plane trap was fished several days a week above the falls to estimate smolt age composition.

This was the first year since 2006, in which the sockeye salmon smolt outmigration was estimated at Frazer Lake (Appendix B3). The low mortality associated with transporting sockeye salmon smolt to the release site for mark-recapture tests allowed the use of single-site mark-recapture methods. The average trap efficiency of 5.6% (range, 4.0% to 7.3%) was above the goal of 5.0% and was achieved without installing wings to increase the trap capture area.

The estimated sockeye salmon smolt outmigration in 2012 (5,566,771; Table 2) was greater than the 7-year average of 3,414,675 (data from 2000 to 2006) and the 15-year average of 4,356,633 (data from 1991 to 1997 and 1999 to 2006). Estimates prior to 1970 were excluded because the run was just beginning, and not yet established. Estimates from 1987 through 1990 were excluded when calculating means based on recommendations from Coggins (1997; page 2).

Considering the consistency in trap efficiency and the small variance (coefficient of variation = 0.11; Table 2), confidence in the population estimate is high.

ADULT ASSESSMENT

As previously mentioned comparison between Dog Salmon Weir and Frazer Fish Pass counts lead to concerns over the number of adult sockeye salmon left remaining in Dog Salmon Creek (not ascending Frazer Fish Pass), indicating further modifications to the fish pass were needed to improve fish passage and reduce the number of sockeye salmon left in Dog Salmon Creek.

In view of findings by Blackett (1987), additional modifications were made to the entrance in 2011 to increase attractant water flow. Water flow was redirected from the falls to the fish pass entrance by using a secondary diversion weir placed perpendicular to the fish diversion weir (Figures 5 and 6). In 2011, the secondary diversion weir was eight feet long and appeared to work moderately well. In 2012, the secondary diversion weir was increased to sixteen feet long and appears to have improved fish passage, decreasing the build-up of fish below the pass and reducing the number of sockeye salmon left in Dog Salmon River to the lowest since 1989 (5,532; 3.6%). Comparison between daily and cumulative sockeye salmon escapement counts at Dog Salmon Weir and Frazer Fish Pass in 2004 and 2012 illustrates the effect water flow on fish movement and timing (Figure 14). For example, in 2004, the time it took sockeye salmon to move from Dog Salmon Weir through Frazer Fish Pass was delayed when compared to 2012 (Figure 14). Additionally, in 2004, sockeye salmon passage through Frazer Fish Pass was more compressed than 2012, indicating increased fish build-up below the fish pass in 2004.

Concerns over recent trends in the number of jacks (one-ocean sockeye salmon) escaping into Frazer Lake have been voiced by members of the public. Overall, the number of jacks averaged 20.5% from 1986 to 2011 (Appendices C9 and C10). In the last 10 years (2002–2011), the percentage of jacks has increased to 31.5%, as compared to previous years (13.7%; 1986–2001 averaged).

Since 2000, the frequency of jacks in the Frazer Lake escapement has fluctuated, with two high years followed by two low years (Appendices C9 and C10). The prevalence of jacks was the highest in 2003, with 70.2% of the sockeye salmon escapement composed of jacks. This recent cyclic nature from 2000 through 2012 is comprised by years of low jack abundance (2000, 2001, 2004, 2005, 2008, 2009, and 2012) and years of high jack abundance (2002, 2003, 2006, 2007, 2010, and 2011). This cyclic nature suggests the frequency of jacks in the Frazer Lake may be driven by genetics.

Adult sockeye salmon escapement has consistently met the escapement goal since 1987 (Appendix C7; BEG 75,000–170,000; Nemeth et. al 2010). The five-year average sockeye salmon escapement is 111,343 and the ten-year average escapement is 119,084; on average reaching the S_{msy} of 117,000.

LIMNOLOGICAL ASSESSMENT

Frazer Lake has been sampled for limnological data by ADF&G since 1985 (with the exception of 1997–2000; Appendix D1), chiefly as part of a standard suite of lakes sampled each year. Limnological descriptions have been intermittently reported as part of salmon escapement reports, and, more recently, in specific limnology reports by Finkle and Ruhl (2011, 2012a, 2012b; data from 2009–2011).

Seasonal means of lake physical properties (temperature, DO, light, and water clarity) in 2012 were consistent with measurements taken in recent years in Frazer Lake (Appendix D2). Temperatures in the lake were below the 19-year average (1989–2011; Appendices D9 and D10).

Seasonal measurements of mean nutrient and algal pigment concentrations generally showed little variation over the sampling season, with the exception of nitrogen components (Tables 17–19). From a historical perspective, pH and alkalinity were above average (Appendix D4), phosphorus components were below average (Appendix D3), nitrogen components were average, except TKN, which was roughly twice the historical average and the highest value ever observed (possibly due to increased terrestrial input from near record snow pack runoff; Heather Finkle, ADF&G, personal communication), and algal components were above average. The decreased phosphorus concentration, coupled with increased chl-*a* (primary production), suggests adequate rates of photosynthesis, thus increased uptake of nutrients.

Typically, phytoplankton communities are dominated by either diatoms or flagellates (Officer and Ryther 1980). Diatoms are the preferred phytoplankton prey for zooplankton in northern lakes and tend to dominate in oligotrophic systems with sufficient silicon concentration (Officer and Ryther 1980). Low phosphorus levels of oligotrophic lakes favor some diatom species because they can store phosphorous (Wehr and Sheath 2003). Several of the larger lakes in Kodiak, such as Spiridon Lake, are pre-dominated by diatoms (Thomsen 2011). Considering available data, it appears that Frazer Lake is also dominated by diatoms (Appendix D11).

Mean phytoplankton biomass in Frazer Lake has increased in the two years of data collection with the 2012 biomass nearly double that of 2011 (Appendix D11). Likewise, mean nitrogen (TKN) concentration has increased immensely in the last two years, ranging from 148.3 in 2011 to 271.4 in 2012.

The seasonal mean zooplankton density and biomass estimates were average in Frazer Lake over the sampling season and typical for the recent 5-year and 10-year averages (Appendices D5, D6, and D7). Data from the two predominate zooplankton taxa, the cladoceran *Bosmina* and the copepod *Cyclops*, suggest that juvenile sockeye salmon may affect these key taxa. *Cyclops* had the greatest density and biomass in 2012, comprising 47.4% of total average zooplankton density and 73.3% of total average zooplankton biomass (Table 14). *Bosmina* were small, and their mean length of 0.34 mm was similar to historic averages (1985–2012 average of 0.36 mm; Appendix D8); and below the juvenile sockeye salmon minimum elective feeding threshold of 0.40 mm (Kyle 1992).

HISTORICAL SPAWNING, HABITAT USE, AND AERIAL SURVEYS

Through 1986, foot surveys were frequently conducted on Frazer Lake and its tributaries to learn more about the ecology and life history of the newly-established sockeye salmon run. From 1965 through 1986, as much as 74% of the run spawned in four tributary streams and the lake's shoreline. Pinnell Creek, and the upper end of the lake, accounted for the majority of the spawners. Barrett (1988) noted a gradual increase in the proportion of lake shore spawners and suggested the run was still colonizing and adapting to local habitat, with potential ramifications for future run timing and sub-population composition. Burger et al. (2000) agreed with this assessment 14 years later, stating that Frazer Lake sockeye salmon population likely had not reached a demographic or genetic equilibrium and noting substantial changes in run timing, age structure, and spawning site use over the past 20 years. Burger (2000) found that reproductive adaptations from the donor stocks was preserved in Frazer Lake with donors from the shoreline (Karluk Lake) spawning on the shoreline, donors from tributaries (Red Lake) spawning in tributaries, and donors utilizing the outlet (Hidden Lake) spawning in the outlet.

In the mid-1980s, Kyle et al. (1988**)** conducted extensive studies in Frazer Lake to assess trophic responses to the salmon population and to assess the rearing habitat capacity for juvenile sockeye salmon. The authors found strong density dependent effects of large spawning escapements (e.g., > 400,000 fish), with large escapements correlated with lower zooplankton densities, smaller *Bosmina* body size, a decrease in the ratio of copepods to cladocerans, and a reduced body length of freshwater-age-1 smolts. Based on this, the authors concluded sockeye salmon production in Frazer Lake was limited by rearing habitat, and recommended escapements be kept below the estimated spawning habitat capacity of 400,000 fish (Kyle et al. 1988).

Other studies of the lake and its tributaries include a thorough listing of spawning streams and stream classifications by Meehan et al. (1965), and estimates that bear predation removed 5% of the fish spawning each year in Pinnell Creek, the largest single spawning aggregate (Barrett 1988).

The counting sites at the Dog Salmon weir and the Frazer Lake fish pass eliminate the need for routine aerial surveys of salmon abundance in the Dog Salmon River, though surveys are sometimes flown to address other questions, such as spawning site use in Frazer Lake. Prior to 1990, aerial surveys were generally flown between early June and the end of August, with greater frequency during the peak of the sockeye salmon runs. Since 1990, any aerial surveys flown on the watershed have tended to be focused on estimating the early and late season sockeye salmon numbers, with aerial surveys flown in early June and in August.

OUTLOOK FOR 2013

Project activities at Frazer Lake in 2013 will be similar to the 2012 field season for adult and smolt monitoring. Extensive fish pass renovations will likely begin in the fall of 2013 or spring of 2014. Single-site mark-recapture methods will again be utilized to estimate smolt outmigration numbers in 2013. Testing of the 100% smolt capture trapping system will be continued in 2013; with operation beginning once testing is complete.

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TABLES AND FIGURES

Table 1.–Frazer Fish Pass and Dog Salmon Weir (DS) sockeye salmon counts, total run, commercial harvest, and sockeye salmon remaining in DS Creek, 2000–2012.

Year	Dog Salmon (DS) Weir Count	Commercial Harvest	Total Run	Frazer Fish Pass Count	Sockeye Remaining in DS River no.	%
2000	173,340	221,366	394,706	158,044	15,296	8.8
2001	163,455	239,937	403,391	154,349	9,106	5.6
2002	105,989	4,237	110,226	85,317	20,672	19.5
2003	262,731	51,183	313,914	201,679	61,052	23.2
2004	226,266	485,985	712,251	120,664	105,602	46.7
2005	152,959	472,978	625,937	136,948	16,011	10.5
2006	108,343	9,557	117,900	89,516	18,827	17.4
2007	139,808	28,763	168,571	120,186	19,622	14.0
2008	153,276	367,327	520,603	105,363	47,913	31.3
2009	147,798	327,178	474,976	101,845	45,953	31.1
2010	135,100	30,012	165,112	94,680	40,420	29.9
2011	180,603	192,820	372,423	134,642	45,961	25.4
2012	154,416	217,631	372,049	148,884	5,532	3.6
Average (2007-2011)	151,317	189,220	340,337	111,343	39,974	26.4
Average (2002-2011)	161,287	197,004	358,191	119,084	42,203	24.9

Table 2.–Estimated abundance of sockeye salmon smolt outmigrating from Frazer Lake, 2012.

Stratum (h)	Beginning Date	Ending Date	Unmarked (u_h)	Released (M_h)	Recovered (m_h)	Estimate (U_h)	Variance (U_h)	95% C. I. lower	95% C. I. upper
1	5/8	5/30	190,941	440	31	2,633,196	194,909,469,215	1,767,884	3,498,507
2	5/31	6/6	92,529	596	25	2,125,889	160,144,956,123	1,341,534	2,910,244
3	6/7	6/13	29,392	801	33	693,133	13,159,780,663	468,289	917,976
4	6/14	6/20	4,538	771	50	68,694	85,704,413	50,549	86,839
5	6/21	6/28	1,837	673	26	45,860	73,162,124	29,095	62,625
			319,237	3,282	165	5,566,771	368,373,072,538	3,657,351	7,476,191
						SE= 606,937			

Note: The parameters h, u_h, M_h, m_h, U_h, and U_h are used to calculate the outmigration estimate and are defined on page 7.

Table 3.–Daily and cumulative sockeye salmon trap catch, AWL samples, mark-recapture, trap efficiencies, outmigration estimates, and age composition estimates for Frazer Lake, 2012.

Date	Daily Catch	AWL Samples	Marked Releases	Marked Recoveries	Trap Efficiency	Outmigration Estimate Daily	Outmigration Estimate Cumulative	Freshwater Age: Age 1	Age 2	Age 3
Stratum 1										
8-May	10	10	0	0	7.3%	138	138	0	138	0
9-May	8	8	0	0	7.3%	110	248	14	234	0
10-May	12	12	0	0	7.3%	165	414	14	400	0
11-May	3	3	0	0	7.3%	41	455	28	428	0
12-May	12	12	0	0	7.3%	165	621	41	579	0
13-May	15	15	0	0	7.3%	207	827	55	772	0
14-May	84	84	0	0	7.3%	1,158	1,986	55	1,931	0
15-May	73	40	0	0	7.3%	1,007	2,993	105	2,862	25
16-May	43	40	0	0	7.3%	593	3,586	121	3,440	25
17-May	33	33	0	0	7.3%	455	4,041	148	3,867	25
18-May	38	38	0	0	7.3%	524	4,565	148	4,391	25
19-May	276	50	0	0	7.3%	3,806	8,371	301	8,045	25
20-May	3,940	80	0	0	7.3%	54,335	62,706	3,052	59,629	25
21-May	5,664	40	0	0	7.3%	78,110	140,816	5,004	135,786	25
22-May	709	40	0	0	7.3%	9,778	150,594	5,738	144,831	25
23-May	1,975	40	0	0	7.3%	27,236	177,830	5,738	172,067	25
24-May	6,335	40	595	7	7.3%	87,364	265,194	7,922	257,247	25
25-May	21,662	40	0	15	7.3%	298,733	563,926	15,390	548,511	25
26-May	63,233	40	0	7	7.3%	872,023	1,435,949	37,191	1,398,733	25
27-May	1,659	0	0	0	7.3%	22,879	1,458,827	38,373	1,420,402	52
28-May	189	0	0	0	7.3%	2,606	1,461,434	38,508	1,422,871	56
29-May	39,871	40	0	1	7.3%	549,846	2,011,280	52,254	1,958,971	56
30-May	45,097	40	0	1	7.3%	621,916	2,633,196	83,350	2,549,791	56
Total Stratum 1	190,941	745	595	31		2,633,196				
Stratum 2										
31-May	45,849	40	877	14	4.4%	1,053,398	3,686,594	83,350	3,603,189	56
1-Jun	21,553	40	0	3	4.4%	495,188	4,181,783	108,109	4,073,618	56
2-Jun	10,851	40	0	5	4.4%	249,306	4,431,089	120,574	4,310,459	56
3-Jun	1,621	0	0	3	4.4%	37,243	4,468,332	121,692	4,346,584	56
4-Jun	718	0	0	0	4.4%	16,496	4,484,828	122,187	4,362,586	56
5-Jun	8,399	40	0	0	4.4%	192,970	4,677,798	127,011	4,550,732	56
6-Jun	3,538	40	0	0	4.4%	81,287	4,759,085	129,043	4,629,987	56
Total Stratum 2	92,529	200	877	25		2,125,889				
Stratum 3										
7-Jun	5,638	40	880	29	4.2%	132,957	4,892,042	132,367	4,759,620	56
8-Jun	4,652	40	0	4	4.2%	109,705	5,001,748	132,367	4,869,325	56
9-Jun	10,532	40	0	0	4.2%	248,369	5,250,117	150,995	5,099,067	56
10-Jun	4,359	0	0	0	4.2%	102,795	5,352,912	160,246	5,192,097	569
11-Jun	2,042	0	0	0	4.2%	48,155	5,401,067	164,580	5,235,677	810
12-Jun	1,537	40	0	0	4.2%	36,246	5,437,314	170,017	5,265,580	1,716
13-Jun	632	40	0	0	4.2%	14,904	5,452,218	172,998	5,277,503	1,716
Total Stratum 3	29,392	200	880	33		693,133				
Stratum 4										
14-Jun	277	40	898	36	6.6%	4,193	5,456,411	174,046	5,280,648	1,716
15-Jun	1,129	40	0	14	6.6%	17,090	5,473,501	177,891	5,293,893	1,716
16-Jun	439	40	0	0	6.6%	6,645	5,480,146	178,722	5,299,708	1,716
17-Jun	378	0	0	0	6.6%	5,722	5,485,868	179,809	5,304,342	1,716
18-Jun	1,111	0	0	0	6.6%	16,818	5,502,686	183,005	5,317,965	1,716
19-Jun	548	40	0	0	6.6%	8,295	5,510,981	183,834	5,325,431	1,716
20-Jun	656	40	0	0	6.6%	9,930	5,520,911	186,317	5,332,878	1,716
Total Stratum 4	4,538	200	898	50		68,694				

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Table 3.–Page 2 of 2.

Date	Daily Catch	AWL Samples	Marked Releases	Marked Recoveries	Trap Efficiency	Outmigration Estimate Daily	Outmigration Estimate Cumulative	Freshwater Age Age 1	Freshwater Age Age 2	Freshwater Age Age 3
					Stratum 5					
21-Jun	1,081	40	716	22	4.0%	26,987	5,547,898	197,111	5,349,070	1,716
22-Jun	124	38	0	1	4.0%	3,096	5,550,994	198,007	5,351,270	1,716
23-Jun	85	42	0	3	4.0%	2,122	5,553,116	198,210	5,353,190	1,716
24-Jun	272	0	0	0	4.0%	6,790	5,559,906	199,698	5,358,491	1,716
25-Jun	106	0	0	0	4.0%	2,646	5,562,552	200,278	5,360,557	1,716
26-Jun	64	40	0	0	4.0%	1,598	5,564,150	200,478	5,361,955	1,716
27-Jun	65	40	0	0	4.0%	1,623	5,565,772	200,762	5,363,294	1,716
28-Jun	40	39	0	0	4.0%	999	5,566,771	200,993	5,364,062	1,716
Total Stratum 5	1,837	239	716	26		45,860				
					Total					
	319,237	1,584	3,966	165		5,566,771		200,993	5,364,062	1,716

Table 4.–Age composition of Frazer Fish Pass sockeye salmon interpolated to escapement, 2012.

			Age										
Stat Week	Sample Size		0.2	1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.2	3.3	Total Fish
24	0	Percent	0.0	1.0	4.0	5.1	0.0	48.5	40.4	0.0	1.0	0.0	100.0
		Numbers	0	0	1	1	0	12	10	0	0	0	24
25	99	Percent	0.0	0.9	4.4	5.0	0.0	48.8	39.9	0.0	0.9	0.0	100.0
		Numbers	0	5	26	26	0	259	207	0	5	0	528
26	227	Percent	0.0	0.2	9.2	3.7	0.5	52.3	33.5	0.0	0.2	0.3	100.0
		Numbers	0	0	1,478	456	127	7,507	4,456	0	0	47	14,071
27	213	Percent	0.0	0.0	12.0	2.6	1.7	52.5	30.8	0.0	0.3	0.0	100.0
		Numbers	0	0	4,574	1,060	747	21,585	12,695	0	70	25	40,755
28	251	Percent	0.0	0.0	16.9	2.9	0.3	50.0	28.1	0.1	1.9	0.0	100.0
		Numbers	0	0	4,792	817	78	14,090	7,950	18	517	0	28,264
29	242	Percent	0.0	0.0	13.6	2.1	0.9	54.4	25.2	0.3	3.4	0.0	100.0
		Numbers	0	0	4,230	670	291	16,493	7,590	86	1,008	20	30,387
30	248	Percent	0.1	0.0	14.5	3.1	2.1	58.7	18.0	0.1	3.1	0.3	100.0
		Numbers	22	0	2,304	446	322	9,292	2,736	8	448	36	15,616
31	213	Percent	0.4	0.0	15.4	1.9	3.1	61.7	15.5	0.0	2.0	0.0	100.0
		Numbers	27	0	959	123	209	3,860	990	0	127	3	6,297
32	213	Percent	0.4	0.1	14.6	1.4	7.3	57.0	17.4	0.0	1.7	0.0	100.0
		Numbers	29	2	893	91	539	3,677	1,206	0	120	0	6,556
33	207	Percent	0.0	0.3	18.6	1.4	6.6	55.9	15.6	0.0	1.5	0.0	100.0
		Numbers	0	18	939	65	303	2,738	720	0	65	0	4,849
34	72	Percent	0.0	0.0	12.8	2.7	9.6	48.9	23.2	0.0	2.7	0.0	100.0
		Numbers	0	0	197	42	147	752	357	0	42	0	1,537
Totals	1985	Percent	0.1	0.0	13.7	2.5	1.9	53.9	26.1	0.1	1.6	0.1	100.0
		Numbers	79	25	20,393	3,795	2,763	80,265	38,918	113	2,402	130	148,884

Table 5.–Length, weight, and condition coefficient of Frazer Lake sockeye salmon samples, by freshwater age and statistical week, 2012.

Stat	Sample	Length (mm)		Weight (g)		Condition	
			Std		Std		Std
Week	Size	Mean	Error	Mean	Error	Mean	Error
Freshwater-Age-1							
19	1	73.0	0.00	2.4	0.00	0.62	0.00
20	6	70.3	2.04	2.6	0.20	0.74	0.02
21	12	73.5	2.56	2.9	0.32	0.70	0.02
22	6	80.7	3.46	3.6	0.26	0.70	0.06
23	6	75.0	4.79	3.2	0.50	0.73	0.06
24	18	81.9	0.99	4.1	0.18	0.73	0.01
25	38	80.8	1.24	4.1	0.20	0.75	0.01
26	43	82.0	1.30	4.3	0.21	0.74	0.01
27	10	90.1	2.01	5.7	0.52	0.76	0.02
Totals	140	80.6	0.73	4.0	0.12	0.74	0.01
Freshwater-Age-2							
19	17	96.2	1.61	6.1	0.34	0.68	0.01
20	196	99.5	0.46	7.0	0.10	0.70	0.00
21	308	96.7	0.34	6.6	0.07	0.72	0.00
22	194	94.9	0.37	6.2	0.08	0.72	0.00
23	194	92.2	0.32	5.8	0.08	0.73	0.00
24	181	90.9	0.35	5.7	0.08	0.75	0.00
25	162	92.6	0.68	6.3	0.17	0.77	0.00
26	157	93.8	0.44	6.6	0.11	0.79	0.00
27	29	95.4	0.74	7.2	0.17	0.83	0.01
Totals	1,438	94.7	0.17	6.3	0.04	0.74	0.00
Freshwater-Age-3							
20	1	121.0	0.00	13.5	0.00	0.76	0.00
24	1	137.0	0.00	21.8	0.00	0.85	0.00
Totals	2	129.0	8.00	17.7	4.15	0.80	0.04

Table 6.–Frazer Fish Pass daily escapement counts, by species, 2012.

Date	Sockeye	Chinook	Pink	Steelhead Down	Steelhead Up
9-Jun	0	0	0	0	2
10-Jun	0	0	0	0	0
11-Jun	19	0	0	0	0
12-Jun	5	0	0	0	0
13-Jun	0	0	0	0	0
14-Jun	0	0	0	0	0
15-Jun	0	0	0	0	0
16-Jun	30	0	0	0	3
17-Jun	137	0	0	0	0
18-Jun	2	0	0	0	0
19-Jun	245	2	0	0	0
20-Jun	114	0	0	0	0
21-Jun	6	0	0	0	0
22-Jun	8	0	0	0	0
23-Jun	39	0	0	0	0
24-Jun	1	0	0	0	0
25-Jun	4,887	1	0	0	0
26-Jun	1,149	1	0	0	0
27-Jun	7,981	0	0	0	0
28-Jun	11,802	1	0	0	0
29-Jun	4,427	6	0	0	0
30-Jun	2,134	0	0	0	0
1-Jul	14,976	6	0	0	1
2-Jul	6,544	0	0	0	0
3-Jul	832	1	0	0	0
4-Jul	40	0	0	0	0
5-Jul	138	0	0	0	0
6-Jul	12,056	2	0	0	0
7-Jul	4,289	0	0	0	0
8-Jul	227	0	0	0	0
9-Jul	169	0	0	0	0
10-Jul	10,307	2	0	0	0
11-Jul	1,078	1	0	0	0
12-Jul	90	0	0	0	0
13-Jul	18,150	3	0	0	0
14-Jul	288	0	0	0	0
15-Jul	182	0	0	0	0
16-Jul	196	0	0	0	0
17-Jul	432	0	0	0	0

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Table 6.–Page 2 of 2.

Date	Sockeye	Chinook	Pink	Steelhead Down	Steelhead Up
18-Jul	11,049	0	0	0	0
19-Jul	4,159	1	0	0	0
20-Jul	54	0	0	0	0
21-Jul	467	2	0	0	0
22-Jul	621	1	0	0	0
23-Jul	903	0	0	0	0
24-Jul	424	0	0	0	0
25-Jul	8,988	1	0	0	0
26-Jul	1,773	0	0	0	0
27-Jul	213	0	0	0	0
28-Jul	551	1	0	0	0
29-Jul	281	0	0	0	0
30-Jul	94	0	0	0	0
31-Jul	3,336	0	0	0	0
1-Aug	49	0	0	0	0
2-Aug	57	0	0	0	0
3-Aug	134	0	0	0	0
4-Aug	16	0	0	0	0
5-Aug	5,194	0	0	0	0
6-Aug	554	0	0	0	0
7-Aug	144	1	0	0	0
8-Aug	457	3	0	0	0
9-Aug	169	0	0	0	0
10-Aug	263	0	0	0	0
11-Aug	146	0	0	0	0
12-Aug	3,349	2	0	0	0
13-Aug	650	0	0	0	0
14-Aug	36	0	0	0	0
15-Aug	236	0	0	0	0
16-Aug	320	0	0	0	0
17-Aug	468	1	2	0	0
18-Aug	454	0	0	0	0
19-Aug	73	0	0	0	0
20-Aug	222	0	0	0	0
Total	148,884	39	2	0	6

Table 7.–Number and percentage of sockeye salmon escapement into Frazer Lake, by year, and ocean age, 2000–2012.

	Ocean Age								
Year	1	%	2	%	3	%	4	%	Total Fish
2000	24,529	15.5	83,051	52.5	50,416	31.9	48	0.0	158,044
2001	1,969	1.3	16,642	10.8	135,726	87.9	12	0.0	154,349
2002	21,907	25.7	11,738	13.8	49,832	58.4	1,840	2.2	85,317
2003	141,449	70.1	54,369	27.0	5,589	2.8	272	0.1	201,679
2004	8,366	6.9	104,679	86.8	7,619	6.3	0	0.0	120,664
2005	624	0.5	56,535	41.3	79,663	58.2	125	0.1	136,948
2006	33,650	37.6	5,694	6.4	49,441	55.2	730	0.8	89,516
2007	70,482	58.6	42,359	35.2	7,036	5.9	309	0.3	120,186
2008	11,376	10.8	71,889	68.2	22,036	20.9	61	0.1	105,363
2009	4,636	4.6	51,035	50.1	45,853	45.0	321	0.3	101,845
2010	49,546	52.3	16,852	17.8	28,012	29.6	184	0.2	94,680
2011	57,177	42.5	67,498	50.1	9,806	7.3	184	0.1	134,642
2012	2,789	1.9	103,139	69.3	42,843	28.8	184	0.1	148,884
Average (2007-2011)	38,644	33.8	49,926	44.3	22,549	21.7	212	0.2	
Average (2000-2011)	35,476	27.2	48,528	38.3	40,919	34.1	341	0.3	
Average[a] (00,01,04,05,08,09,12)	7,756	5.9	69,567	54.1	54,880	39.9	107	0.1	
Average[a] (02,03,06,07,010,11)	53,459	41.0	28,359	21.5	21,388	22.7	503	0.5	

[a] Averages grouped to better reflect cyclic ocean-age-1 patterns.

Table 8.–Length composition of Frazer Lake sockeye salmon escapement samples by age and sex, 2012.

	Age										
	0.2	1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.2	3.3	Total
Females											
Mean Length	493	0	490	533	0	493	539	529	489	522	505
Standard Error	17.50	0	1.83	6.07	0	0.95	1.44	0	4.70	4.00	1.75
Range	475-510		408-570	451-588		415-598	438-611	529-529	448-545	518-526	408-611
Sample Size	2	0	177	33	0	735	314	1	22	2	1286
Males											
Mean Length	0	291	488	557	344	490	557	0	493	0	494
Standard Error	0	5.50	3.60	3.47	3.47	1.86	2.34	0	10.87	0	2.37
Range		285-296	400-564	519-578	308-407	403-590	456-619		431-535		285-619
Sample Size	0	2	101	17	54	357	156	0	12	0	699
All											
Mean Length	493	291	489	541	344	492	545	529	490	522	501
Standard Error	17.50	5.50	1.75	4.45	3.47	0.88	1.29	0	4.81	4.00	1.03
Range	475-510	285-296	400-570	451-588	308-407	403-598	438-619	529-529	431-545	518-526	285-619
Sample Size	2	2	278	50	54	1092	470	1	34	2	1985
Percent											
Females	0.2%	0.0%	13.8%	2.6%	0.0%	57.2%	24.4%	0.1%	1.7%	0.2%	64.8%
Males	0.0%	0.3%	14.4%	2.4%	7.7%	51.1%	22.3%	0.0%	1.7%	0.0%	35.2%
All	0.1%	0.1%	14.0%	2.5%	2.7%	55.0%	23.7%	0.1%	1.7%	0.1%	100.0%

Table 9.–Age composition of sampled sockeye salmon smolt outmigrating from Frazer Lake by statistical week, 2012.

Stat	Sample	Freshwater Age					
Week	Size	1	%	2	%	3	%
19	18	1	0.06	17	0.94	0	0.00
20	203	6	0.03	196	0.97	1	0.00
21	320	12	0.04	308	0.96	0	0.00
22	200	6	0.03	194	0.97	0	0.00
23	200	6	0.03	194	0.97	0	0.00
24	200	18	0.09	181	0.91	1	0.01
25	200	38	0.19	162	0.81	0	0.00
26	200	43	0.22	157	0.79	0	0.00
27	39	10	0.26	29	0.74	0	0.00
Total	1,580	140	0.09	1,438	0.91	2	0.00

Note: Four of the 1,580 samples were not ageable.

Table 10.–Monthly and seasonal averages of 1 m temperature, dissolved oxygen, light, and Secchi measurements from Frazer Lake, 2012.

		Month						Seasonal
Station		May	June	July	August	September	October	Average
Station 1								
	1-m Temperature (°C)	2.8	8.4	9.9	11.7	10.1	7.8	8.4
	1-m Dissolved oxygen (mg/L)	13.1	13.0	12.1	11.7	11.7	11.9	12.2
	Light (Par)	300.0	215.0	128.0	72.0	76.2	67.1	143.1
	Secchi depth (m)	5.8	4.5	6.5	6.0	7.5	6.8	6.2
Station 3								
	1-m Temperature (°C)	2.7	8.2	9.8	12.0	10.1	8.0	8.5
	1-m Dissolved oxygen (mg/L)	13.2	13.1	12.0	11.7	11.6	11.8	12.2
	Light (Par)	234.0	235.0	95.0	407.0	–	75.7	209.3
	Secchi depth (m)	6.5	5.0	7.8	5.8	7.0	6.8	6.5
Stations 1 and 3 (Mean)								
	1-m Temperature (°C)	2.8	8.3	9.9	11.8	10.1	7.9	8.5
	1-m Dissolved oxygen (mg/L)	13.1	13.1	12.0	11.7	11.6	11.8	12.2
	Light (Par)	267.0	225.0	111.5	239.5	76.2	71.4	165.1
	Secchi depth (m)	6.1	4.8	7.1	5.9	7.3	6.8	6.3

Table 11.–Monthly and seasonal averages of zooplankton abundance (number/m^2) for Frazer Lake, station 1, 2012.

Taxon		May	June	July	August	Sept	Oct	Seasonal Mean
Copepods	*Epischura*	-	-	1,592	1,062	796	-	575
	Ovig Epischura	-	-	-	-	-	-	-
	Diaptomus	-	-	-	-	-	-	-
	Ovig Diaptomus	-	-	-	-	-	-	-
	Cyclops	117,834	245,223	251,592	117,834	20,701	7,431	126,769
	Ovig. *Cyclops*	-	-	1,592	26,539	796	-	4,821
	Harpaticus	-	-	-	-	796	-	133
	Nauplii	157,113	25,478	4,777	1,062	3,981	27,601	36,668
Total Copepods		274,947	270,701	259,554	146,497	27,070	35,032	168,967
	Bosmina	1,062	1,062	6,369	41,401	111,465	231,423	65,464
	Ovig. *Bosmina*	-	1,062	6,369	13,800	24,682	37,155	13,845
	Daphnia L.	1,062	-	3,185	-	1,592	1,062	1,150
	Ovig Daphnia L.	-	-	-	-	796	-	133
	Holopedium	-	-	-	1,062	1,592	2,123	796
	Ovig Holopedium	-	-	-	-	-	-	-
	Chydorinae	-	-	-	-	-	-	-
	Eurytemora	-	-	-	-	-	-	-
	Immature Cladocera	-	-	7,962	19,108	21,497	29,724	13,048
Total Cladocerans		2,123	2,123	23,885	75,372	161,624	301,486	94,436
Total Copepods + Cladocerans		277,070	272,824	283,440	221,868	188,694	336,518	263,402

Table 12.–Monthly and seasonal averages of zooplankton abundance (number/m^2) for Frazer Lake, station 3, 2012.

Taxon		May	June	July	August	Sept	Oct	Seasonal Mean
Copepods	*Epischura*	-	-	-	-	-	-	-
	Ovig Epischura	-	-	-	-	-	-	-
	Diaptomus	796	-	3,981	-	1,062	-	973
	Ovig Diaptomus	-	-	-	-	-	-	-
	Cyclops	151,274	250,531	184,448	54,140	30,786	11,943	113,854
	Ovig. *Cyclops*	-	-	10,616	36,093	6,369	11,943	10,837
	Harpaticus	-	-	-	1,062	-	-	177
	Nauplii	128,185	27,601	1,327	1,062	2,123	46,444	34,457
Total Copepods		280,255	278,132	200,372	92,357	40,340	70,329	160,297
	Bosmina	-	-	2,654	38,217	153,928	205,679	66,746
	Ovig. *Bosmina*	-	1,062	2,654	19,108	35,032	58,386	19,374
	Daphnia L.	-	-	-	-	3,185	5,308	1,415
	Ovig Daphnia L.	-	-	-	-	1,062	-	177
	Holopedium	-	-	-	2,123	6,369	-	1,415
	Ovig Holopedium	-	-	-	-	-	-	-
	Chydorinae	-	-	-	-	-	2,654	442
	Eurytemora	-	1,062	-	-	-	-	177
	Immature Cladocera	-	2,123	3,981	36,093	41,401	79,618	27,203
Total Cladocerans		-	4,246	9,289	95,541	240,977	351,645	116,950
Total Copepods + Cladocerans		280,255	282,378	209,660	187,898	281,316	421,975	277,247

Table 13.–Monthly and seasonal averages of zooplankton abundance (number/m^2) for Frazer Lake, stations 1 and 3 averaged, 2012.

Taxon		May	June	July	August	Sept	Oct	Seasonal Mean
Copepods	*Epischura*	-	-	796	531	398	-	288
	Ovig Epischura	-	-	-	-	-	-	-
	Diaptomus	398	-	1,990	-	531	-	487
	Ovig Diaptomus	-	-	-	-	-	-	-
	Cyclops	134,554	247,877	218,020	85,987	25,743	9,687	120,311
	Ovig. *Cyclops*	-	-	6,104	31,316	3,583	5,971	7,829
	Harpaticus	-	-	-	531	398	-	155
	Nauplii	142,649	26,539	3,052	1,062	3,052	37,022	35,563
Total Copepods		277,601	274,416	229,963	119,427	33,705	52,680	164,632
	Bosmina	531	531	4,512	39,809	132,696	218,551	66,105
	Ovig. *Bosmina*	-	1,062	4,512	16,454	29,857	47,771	16,609
	Daphnia L.	531	-	1,592	-	2,389	3,185	1,283
	Ovig Daphnia L.	-	-	-	-	929	-	155
	Holopedium	-	-	-	1,592	3,981	1,062	1,106
	Ovig Holopedium	-	-	-	-	-	-	-
	Chydorinae	-	-	-	-	-	1,327	221
	Eurytemora	-	531	-	-	-	-	88
	Immature Cladocera	-	1,062	5,971	27,601	31,449	54,671	20,126
Total Cladocerans		1,062	3,185	16,587	85,456	201,300	326,566	105,693
Total Copepods + Cladocerans		278,662	277,601	246,550	204,883	235,005	379,246	270,325

Table 14.–Seasonal weighted mean zooplankton density, biomass, and size by individual station from Frazer Lake, 2012.

Station	*n*		*Epischura*	*Diaptomus*	*Cyclops*	Other Copepods	*Bosmina*	*Daphnia*	*Holopedium*	Other Cladocerans	Total Copepods	Total Cladocerans	Total all zooplankton
1	5	density (no. m^2)	575	0	131,591	36,801	79,308	1,283	796	13,048	168,967	94,436	263,402
		%	0.2	0.0	50.0	14.0	30.1	0.5	0.3	5.0	64.1	35.9	100.0
		biomass (mg m^2)	1.9	0.0	276.4	–[a]	81.3	1.6	1.9	–[a]	278.2	84.7	362.9
		%	0.5%	0.0%	76.1%	–[a]	22.4%	0.4%	0.5%	–[a]	76.7%	23.3%	100.0%
		size (mm)	0.89	–	0.75	–[a]	0.34	0.52	0.52	–[a]			
3	5	density (no. m^2)	0	973	124,690	34,634	86,120	1,592	1,415	27,822	160,297	116,950	277,247
		%	0.0	0.4	45.0	12.5	31.1	0.6	0.5	10.0	57.8	42.2	100.0
		biomass (mg m^2)	0.0	7.4	266.3	–[a]	96.5	2.4	4.8	–[a]	273.6	103.8	377.4
		%	0.0%	2.0%	70.5%	–[a]	25.6%	0.6%	1.3%	–[a]	72.5%	27.5%	100.0%
		size (mm)	–	1.22	0.81	–[a]	0.34	0.59	0.61	–[a]			
All Data		density (no. m^2)	288	487	128,140	35,717	82,714	1,438	1,106	20,435	164,632	105,693	270,325
		%	0.1	0.2	47.4	13.2	30.6	0.5	0.4	7.6	60.9	39.1	100.0
		biomass (mg m^2)	0.9	3.7	271.3	–[a]	88.9	2.0	3.3	–[a]	275.9	94.3	370.2
		%	0.2%	1.0%	73.3%	–[a]	24.0%	0.5%	0.9%	–[a]	74.5%	25.5%	100.0%
		size (mm)	0.89	1.22	0.78	–[a]	0.34	0.56	0.57	–[a]			

[a] Other copepods and cladocerans are composed of immature species that are too small to measure and generate a biomass estimate.

Table 15.–Summary of Frazer Lake phytoplankton biomass, by sample date and phylum, 2011.

		Phylum						
		Chlorophyta (Green Algae)	Chrysophyta (Golden-brown Algae)	Bacillariophyta (Diatoms)	Cryptophyta (crytomonads)	Pyrrhophyta (Dinoflagellate)	Cyanobacteria (Blue-green Algae)	Total
Date	Station	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)
13-May	1	90.74	26.00	222.58	0.76	103.25	0.00	444.33
13-May	3	26.09	24.12	369.70	4.58	96.11	0.69	524.30
16-Jun	1	25.01	43.73	67.03	130.06	130.71	2,150.74	2,548.27
16-Jun	3	21.59	90.44	105.22	59.58	217.18	948.44	1,445.46
16-Jul	1	36.05	121.66	94.22	83.60	100.35	0.00	436.89
16-Jul	3	10.91	96.62	98.88	46.45	11.14	2.29	269.29
17-Aug	1	15.67	58.41	47.89	14.00	34.58	0.27	171.83
17-Aug	3	6.70	61.35	80.92	61.20	20.41	0.00	233.59
15-Sep	1	8.08	78.16	293.11	48.63	98.82	0.00	527.80
15-Sep	3	6.60	67.28	362.79	37.94	23.92	0.00	501.53
13-Oct	1	2.60	31.25	1,154.96	17.18	2.69	0.00	1,209.68
13-Oct	3	1.27	65.32	1,853.93	13.75	3.71	0.00	1,940.97
Average	1	29.69	59.87	313.30	49.04	78.40	358.50	889.80
Average	3	12.19	67.52	478.57	37.25	62.08	158.57	819.19
Average	1 and 3	20.94	63.70	395.94	43.15	70.24	258.54	854.49

Table 16.–Summary of Frazer Lake phytoplankton biomass, by sample date and phylum, 2012.

		Phylum						
		Chlorophyta (Green Algae)	Chrysophyta (Golden-brown Algae)	Bacillariophyta (Diatoms)	Cryptophyta (crytomonads)	Pyrrhophyta (Dinoflagellate)	Cyanobacteria (Blue-green Algae)	Total
Date	Station	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)
5/16/2012	1	0.00	0.00	3,111.22	55.95	129.85	0.00	3,297.02
5/16/2012	3	0.00	0.00	2,444.95	62.14	0.00	14.00	2,521.09
6/13/2012	1	13.16	0.00	1,426.13	72.49	18.02	0.01	1,529.81
6/13/2012	3	0.38	102.56	1,137.74	28.59	112.66	0.00	1,381.94
7/17/2012	1	1.03	0.00	568.07	71.69	168.65	0.73	810.18
7/17/2012	3	24.49	0.00	847.16	6.16	237.16	10.67	1,125.63
8/15/2012	1	0.00	25.56	1,004.25	10.79	329.41	7.06	1,377.08
8/15/2012	3	1.64	0.00	640.01	154.35	134.56	0.03	930.60
9/11/2012	1	2.25	0.00	1,263.17	82.86	163.13	0.00	1,511.41
9/11/2012	3	0.00	0.00	1,337.66	49.24	495.18	3.85	1,885.93
10/17/2012	1	0.00	0.00	889.82	29.02	230.25	1.79	1,150.88
10/17/2012	3	0.00	0.00	1,069.50	313.82	144.85	0.00	1,528.16
Average	1	2.74	4.26	1,377.11	53.80	173.22	1.60	1,612.73
Average	3	4.42	17.09	1,246.17	102.38	187.40	4.76	1,562.22
Average	1 and 3	3.58	10.68	1,311.64	78.09	180.31	3.18	1,587.48

Table 17.–Monthly and seasonal averages of water chemistry components, photosynthetic pigment concentrations, and nutrient concentrations for Frazer Lake, station 1, 2012.

Depth	Sample type	May	June	July	August	September	October	Seasonal Average	Std Error
1 meter									
	pH	7.4	7.6	7.8	7.8	7.4	7.7	7.6	0.03
	Alkalinity (mg/L $CaCO_3$)	14.0	13.0	15.0	14.0	13.5	15.0	14.1	0.13
	Total phosphorous (μg/L P)	2.3	2.5	3.0	4.0	5.1	5.9	3.8	0.24
	Total filterable phosphorous (μg/L P)	1.5	1.7	1.3	1.9	1.6	1.6	1.60	0.03
	Filterable reactive phosphorous (μg/L P)	0.4	0.8	0.8	1.2	0.4	1.0	0.8	0.05
	Total Kjeldahl nitrogen (μg/L N)	245.2	281.0	267.6	279.4	286.6	268.8	271.4	2.47
	Ammonia (μg/L N)	5.6	1.2	2.0	1.7	10.0	–	4.1	0.75
	Nitrate + nitrite (μg/L N)	62.6	33.3	17.2	14.4	24.8	–	30.5	3.88
	Organic silicon (μg/L)	2,542.0	2,634.0	2,688.6	2,580.9	3,010.0	2,274.4	2621.6	39.72
	Chlorophyll *a* (μg/L)	0.48	1.28	1.2	1.92	1.44	1.28	1.27	0.08
	Phaeophytin *a* (μg/L)	0.53	0.06	0.2	0.54	0.58	0.29	0.37	0.04
30 meters									
	pH	7.3	7.6	7.6	7.7	7.2	7.7	7.5	0.03
	Alkalinity (mg/L $CaCO_3$)	14.0	13.5	15.3	14.0	14.0	14.5	14.2	0.10
	Total phosphorous (μg/L P)	3.7	3.9	3.6	3.4	5.0	–	3.9	0.13
	Total filterable phosphorous (μg/L P)	1.4	2.3	1.2	1.9	1.7	1.6	1.7	0.09
	Filterable reactive phosphorous (μg/L P)	0.4	1.4	1.1	1.5	0.7	0.7	1.0	0.07
	Total Kjeldahl nitrogen (μg/L N)	233.7	247.8	314.8	281.8	323.4	358.8	293.4	10.16
	Ammonia (μg/L N)	2.0	2.8	13.9	16.4	26.5	8.1	11.6	1.55
	Nitrate + nitrite (μg/L N)	61.8	48.2	38.2	37.8	37.6	51.4	45.8	1.64
	Organic silicon (μg/L)	2,509.6	2,508.1	1,509.5	1,792.2	3,056.9	2,296.0	2,278.7	92.50
	Chlorophyll *a* (μg/L)	0.64	1.92	1.0	0.8	0.8	1.12	1.05	0.08
	Phaeophytin *a* (μg/L)	0.48	0.1	0.26	0.1	0.21	0.45	0.27	0.03

Table 18.–Monthly and seasonal averages of water chemistry components, photosynthetic pigment concentrations, and nutrient concentrations for Frazer Lake, station 3, 2012.

Depth	Sample type	May	June	July	August	September	October	Seasonal Average	Std Error
1 meter									
	pH	7.4	7.6	7.7	7.9	7.5	7.5	7.6	0.03
	Alkalinity (mg/L $CaCO_3$)	14.5	13.5	15.0	13.8	13.5	14.8	14.2	0.11
	Total phosphorous (µg/L P)	1.7	2.0	2.2	2.7	2.4	2.7	2.3	0.07
	Total filterable phosphorous (µg/L P)	1.7	1.8	1.6	1.8	1.7	1.9	1.8	0.02
	Filterable reactive phosphorous (µg/L P)	0.4	0.9	0.6	1.7	0.7	1.0	0.9	0.08
	Total Kjeldahl nitrogen (µg/L N)	291.7	280.2	272.9	204.7	333.4	242.4	270.9	9.30
	Ammonia (µg/L N)	1.4	1.2	1.7	1.4	11.2	9.6	4.4	0.78
	Nitrate + nitrite (µg/L N)	57.1	34.8	18.8	13.2	23.8	68.1	36.0	3.68
	Organic silicon (µg/L)	2,635.7	2,456.0	2,216.9	2,571.6	2,727.1	2,424.1	2,505.2	30.1
	Chlorophyll *a* (µg/L)	0.96	1.28	1.40	2.24	1.76	1.12	1.46	0.08
	Phaeophytin *a* (µg/L)	0.16	0.06	0.14	0.45	0.03	0.34	0.20	0.03
50 meters									
	pH	7.3	7.5	7.7	7.9	7.3	7.5	7.5	0.04
	Alkalinity (mg/L $CaCO_3$)	14.3	13.5	15.0	14.0	13.8	14.5	14.2	0.09
	Total phosphorous (µg/L P)	4.0	3.5	3.6	3.6	3.5	–	3.6	0.04
	Total filterable phosphorous (µg/L P)	1.7	1.2	1.9	1.9	1.6	1.6	1.7	0.06
	Filterable reactive phosphorous (µg/L P)	0.4	0.6	0.6	0.9	1	1.2	0.8	0.05
	Total Kjeldahl nitrogen (µg/L N)	225.9	240.9	278.8	245.7	320.5	342.4	275.7	7.56
	Ammonia (µg/L N)	0.7	7.5	13.4	17.6	27.7	8.9	12.6	1.55
	Nitrate + nitrite (µg/L N)	57.6	49.2	46.7	42.1	43.6	67.3	51.1	1.61
	Organic silicon (µg/L)	2,217.0	1,777.8	2,139.7	2,586.6	2,537.9	2,409.1	2,278.0	50.2
	Chlorophyll *a* (µg/L)	0.96	0.96	0.96	0.64	0.80	1.28	0.93	0.04
	Phaeophytin *a* (µg/L)	0.38	0.16	0.16	0.03	0.10	0.06	0.15	0.02

Table 19.–Monthly and seasonal averages of water chemistry components, photosynthetic pigment concentrations, and nutrient concentrations for Frazer Lake, stations 1 and 3 averaged, 2012.

Depth	Sample type	May	June	July	August	September	October	Seasonal Average	Std Error
1 meter									
	pH	7.4	7.6	7.8	7.8	7.5	7.6	7.6	0.03
	Alkalinity (mg/L $CaCO_3$)	14.3	13.3	15.0	13.9	13.5	14.9	14.1	0.12
	Total phosphorous (µg/L P)	2.0	2.3	2.6	3.4	3.8	4.3	3.0	0.15
	Total filterable phosphorous (µg/L P)	1.6	1.8	1.5	1.9	1.7	1.8	1.7	0.02
	Filterable reactive phosphorous (µg/L P)	0.4	0.9	0.7	1.5	0.6	1.0	0.8	0.06
	Total Kjeldahl nitrogen (µg/L N)	268.5	280.6	270.3	242.1	310.0	255.6	271.2	3.87
	Ammonia (µg/L N)	3.5	1.2	1.9	1.6	10.6	9.6	4.7	0.71
	Nitrate + nitrite (µg/L N)	59.9	34.1	18.0	13.8	24.3	68.1	36.4	3.77
	Organic silicon (µg/L)	2,588.8	2,545.0	2,452.8	2,576.3	2,868.5	2,349.3	2,563.4	29.09
	Chlorophyll *a* (µg/L)	0.72	1.28	1.3	2.08	1.60	1.2	1.36	0.08
	Phaeophytin *a* (µg/L)	0.35	0.06	0.17	0.50	0.31	0.32	0.28	0.03
Hypolimnion (st 1-30 m, st 3-50 m)									
	pH	7.3	7.5	7.7	7.8	7.3	7.6	7.5	0.03
	Alkalinity (mg/L $CaCO_3$)	14.2	13.5	15.2	14.0	13.9	14.5	14.2	0.09
	Total phosphorous (µg/L P)	3.9	3.7	3.6	3.5	4.3	–	3.8	0.06
	Total filterable phosphorous (µg/L P)	1.6	1.8	1.6	1.9	1.7	1.6	1.7	0.02
	Filterable reactive phosphorous (µg/L P)	0.4	1.0	0.9	1.2	0.9	1.0	0.9	0.04
	Total Kjeldahl nitrogen (µg/L N)	229.8	244.4	296.8	263.8	322.0	350.6	284.5	7.80
	Ammonia (µg/L N)	1.4	5.2	13.7	17.0	27.1	8.5	12.1	1.54
	Nitrate + nitrite (µg/L N)	59.7	48.7	42.5	40.0	40.6	59.4	48.5	1.52
	Organic silicon (µg/L)	2,363.3	2,143.0	1,824.6	2,189.4	2,797.4	2,352.6	2,278.4	53.45
	Chlorophyll *a* (µg/L)	0.80	1.44	0.98	0.72	0.80	1.20	0.99	0.05
	Phaeophytin *a* (µg/L)	0.43	0.13	0.21	0.07	0.16	0.26	0.21	0.02

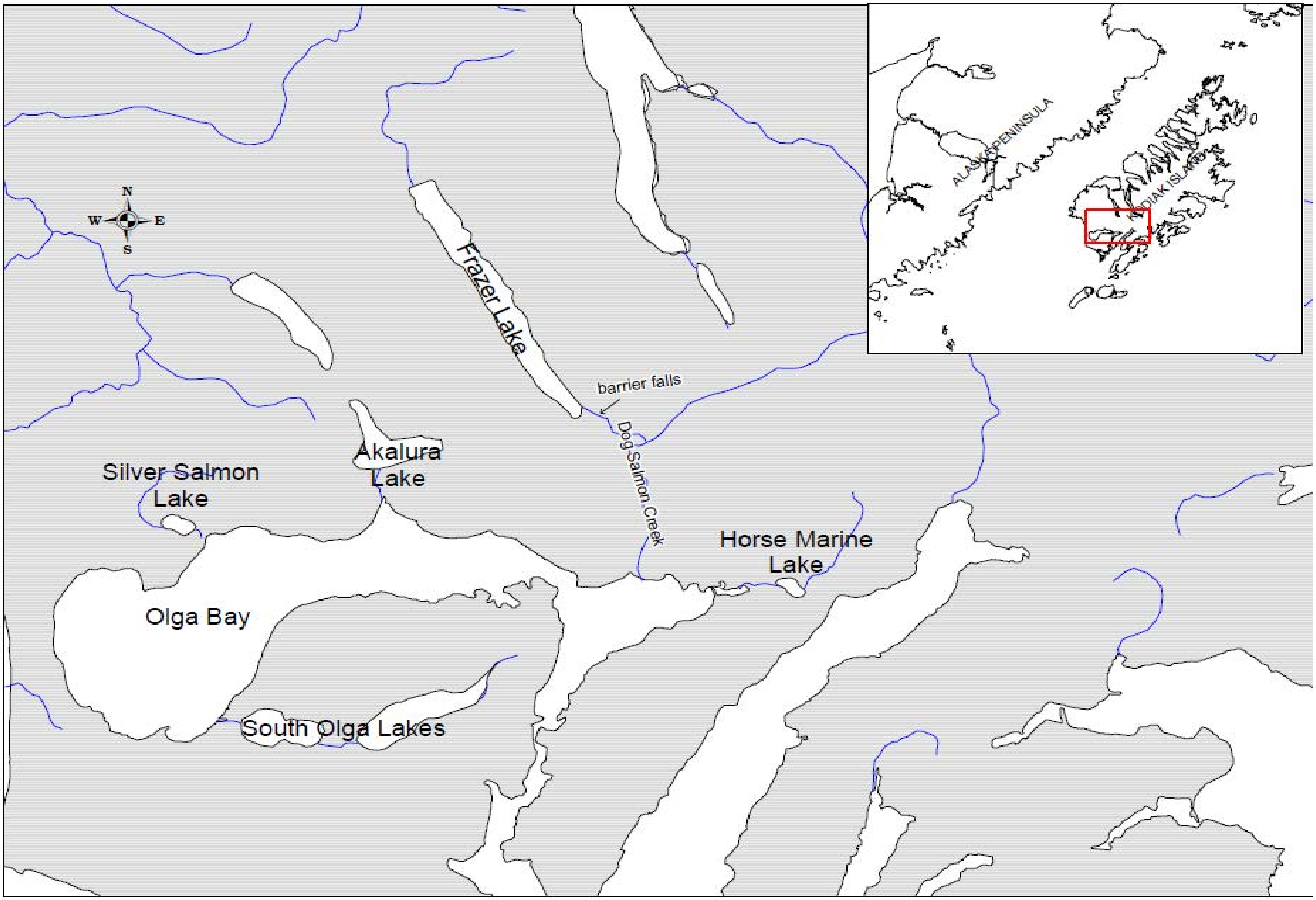

Figure 1.–Locations of Frazer Lake, Dog Salmon Creek, barrier falls, and Olga Bay on Kodiak Island.

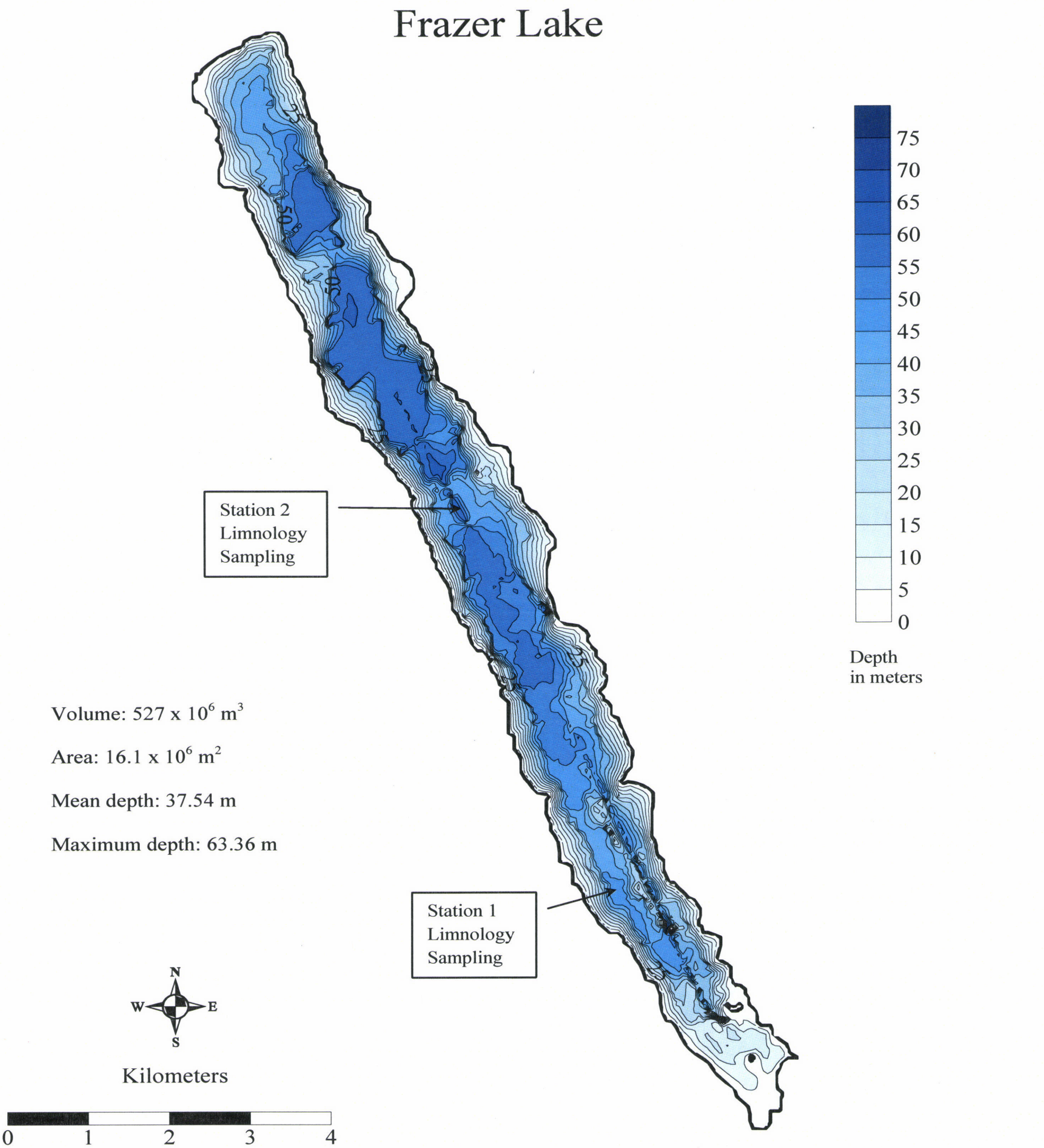

Figure 2.–Morphometric map showing the location of limnology sampling stations on Frazer Lake.

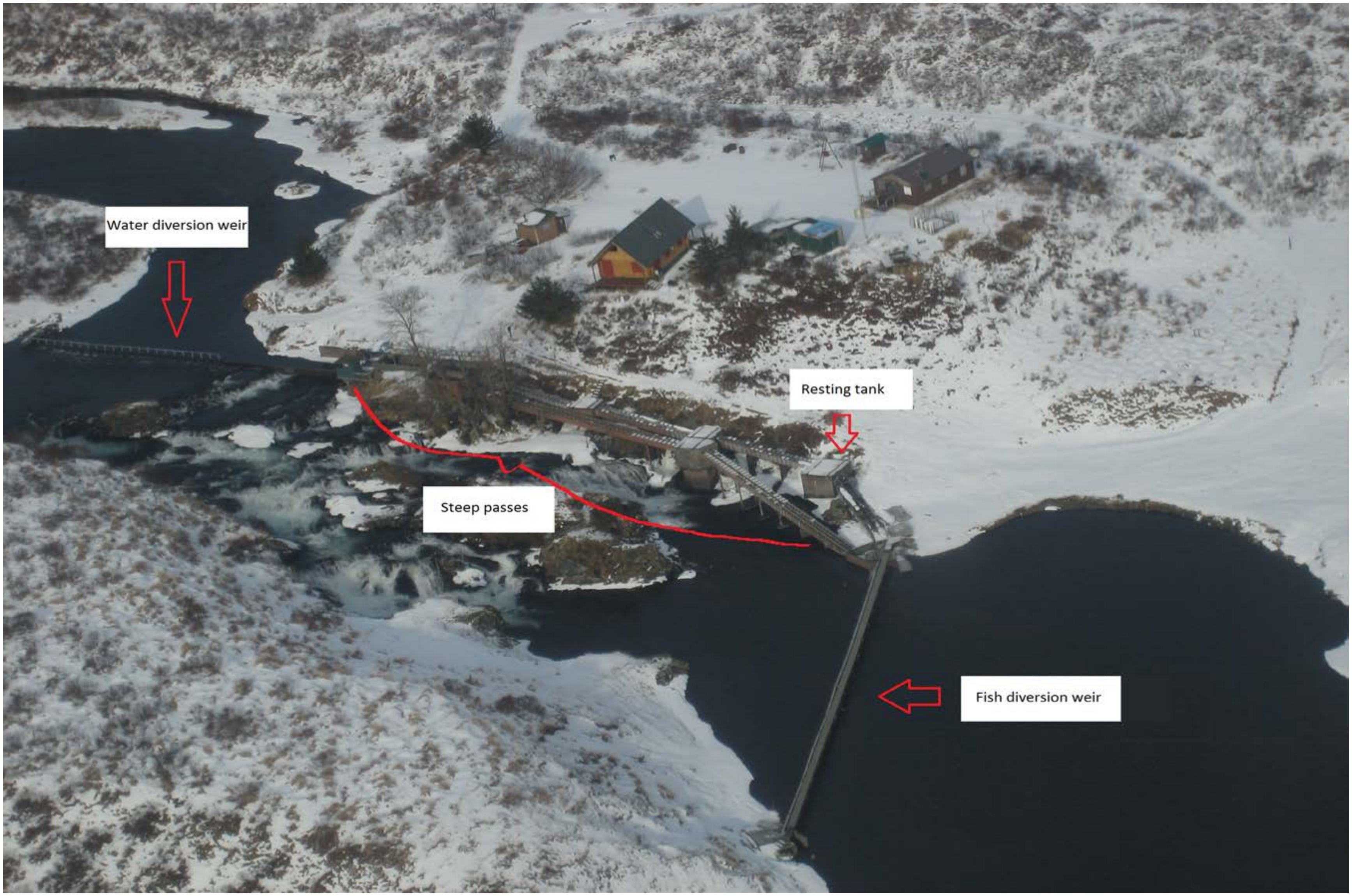

Figure 3.–Aerial view of Frazer Fish Pass, 2012.

Figure 4.–Secondary water flow diversion at Frazer Fish Pass entrance, 2006.

Figure 5.–Secondary water flow diversion at Frazer Fish Pass entrance, 2012.

Figure 6.–Dog Salmon Creek smolt trapping system, 2012.

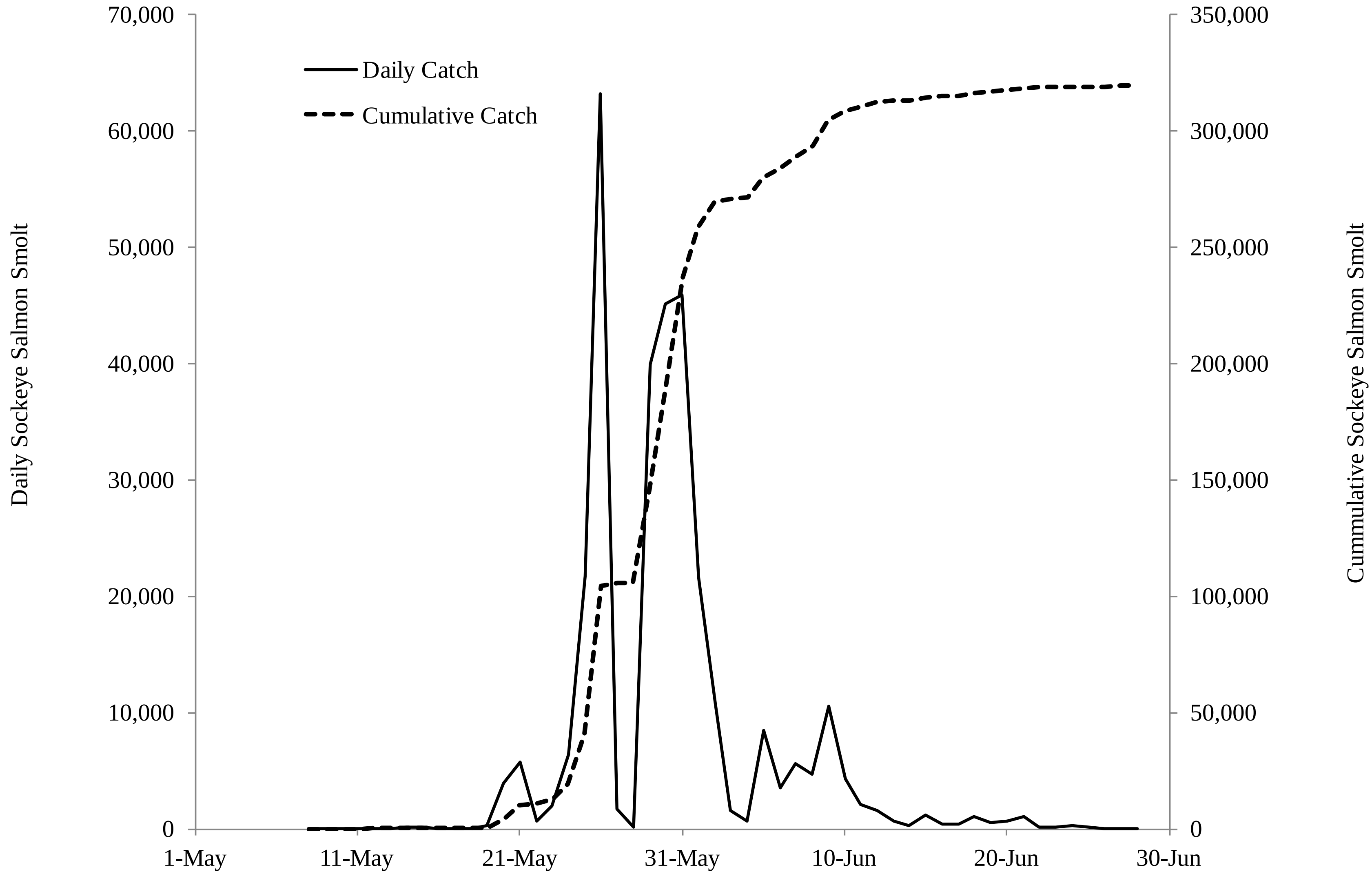

Figure 7.–Daily and cumulative sockeye salmon smolt catch, Frazer Lake, 2012.

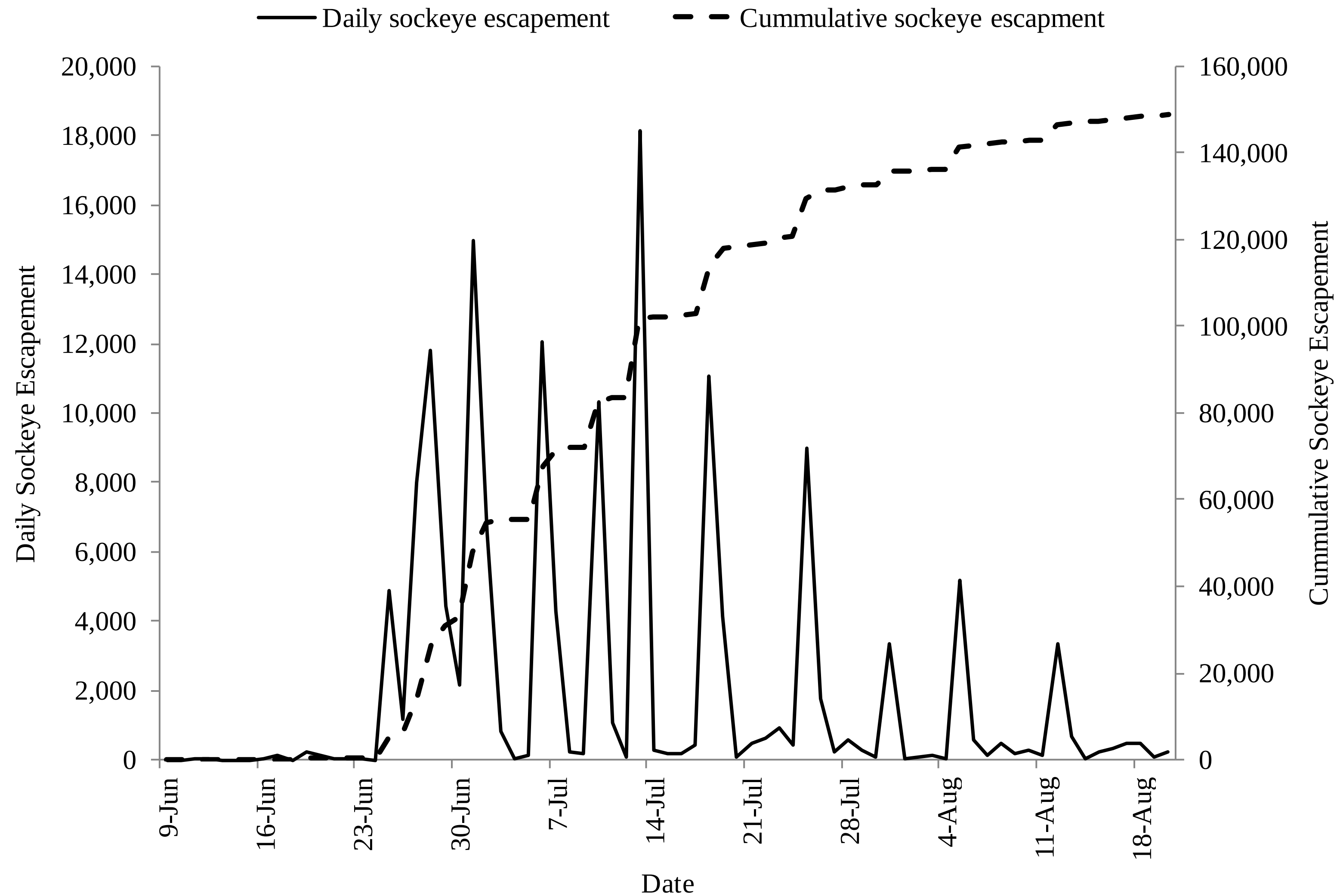

Figure 8.–Daily and cumulative sockeye salmon escapement, Frazer Lake, 2012.

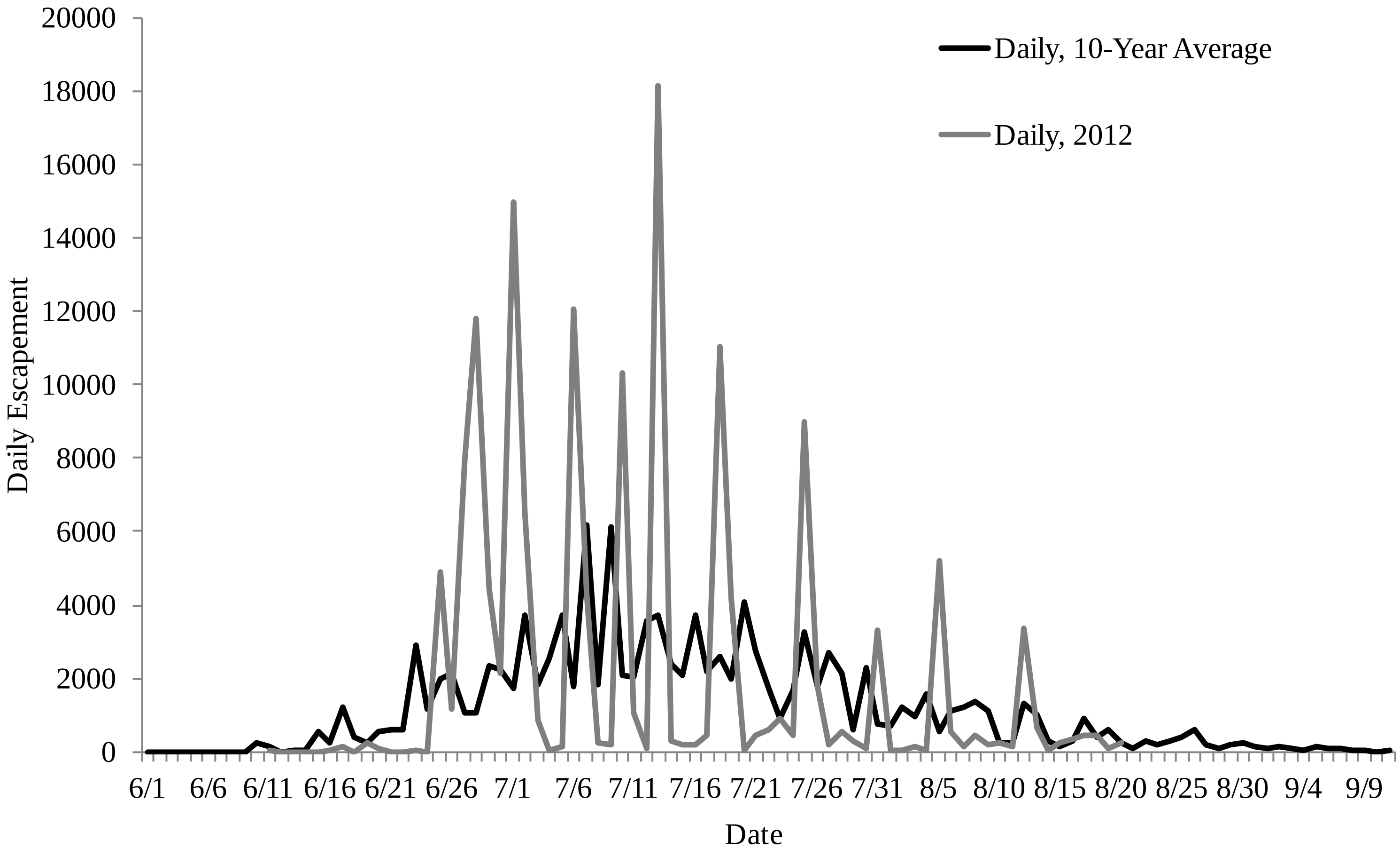

Figure 9.– Daily and 10-year average sockeye salmon escapement, Frazer Fish Pass, 2012.

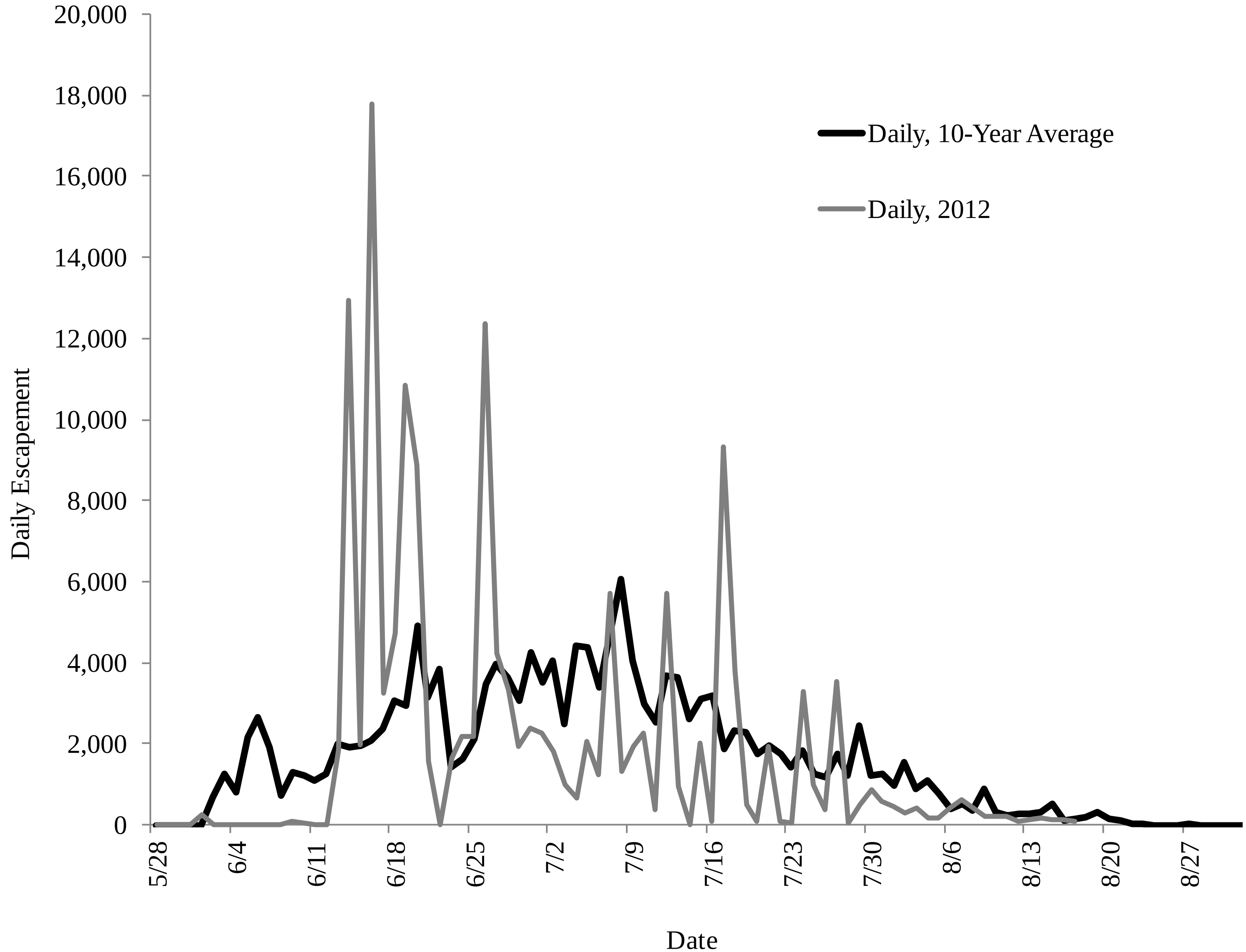

Figure 10.–Daily and 10-year average sockeye salmon escapement, Dog Salmon weir, 2012.

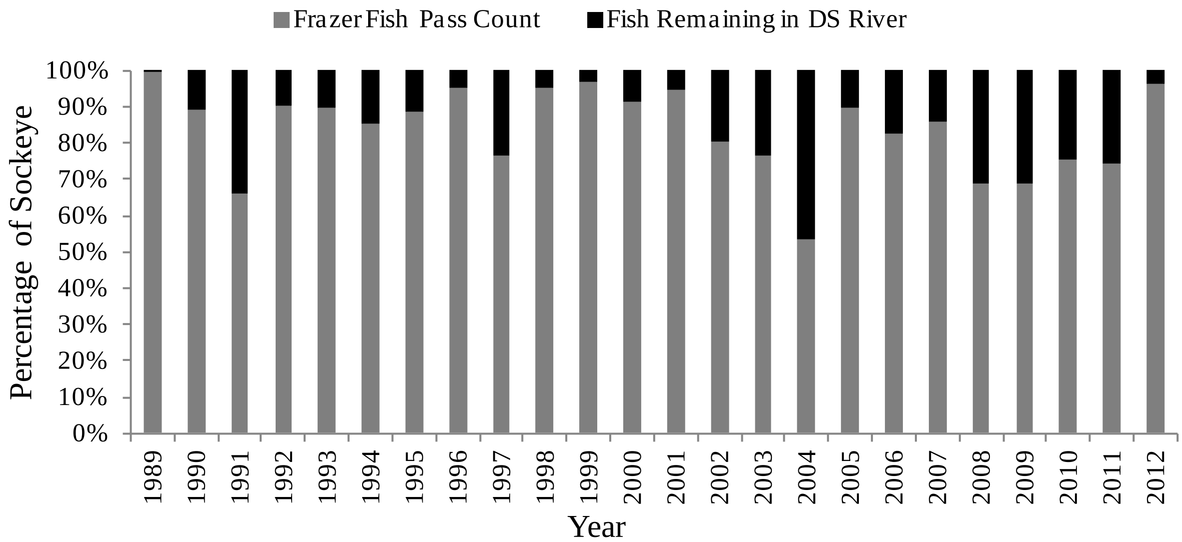

Figure 11.–Percentage of sockeye salmon remaining in Dog Salmon Creek, 1989-2012.

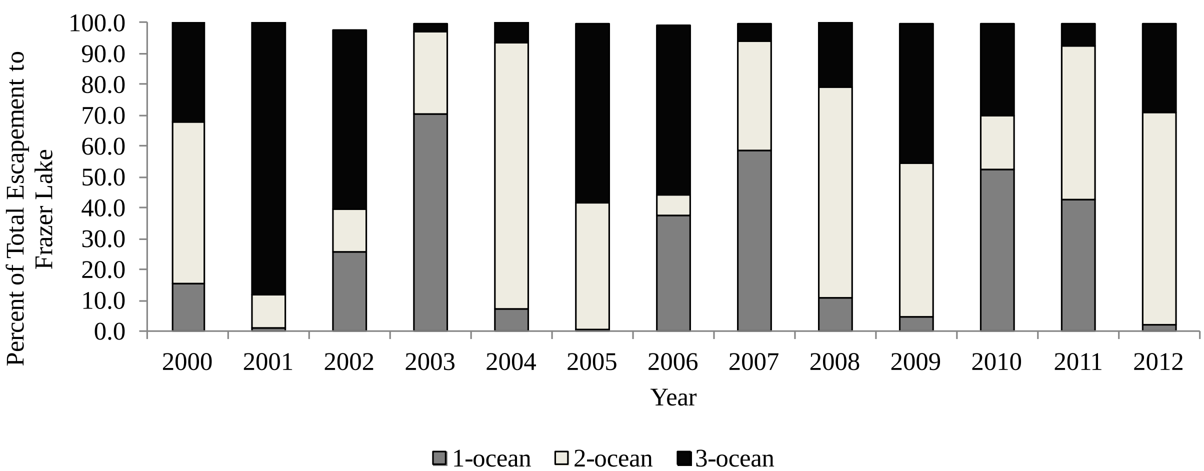

Figure 12.–Percentage of sockeye salmon escapement into Frazer Lake, by ocean age and year, 2000-2012.

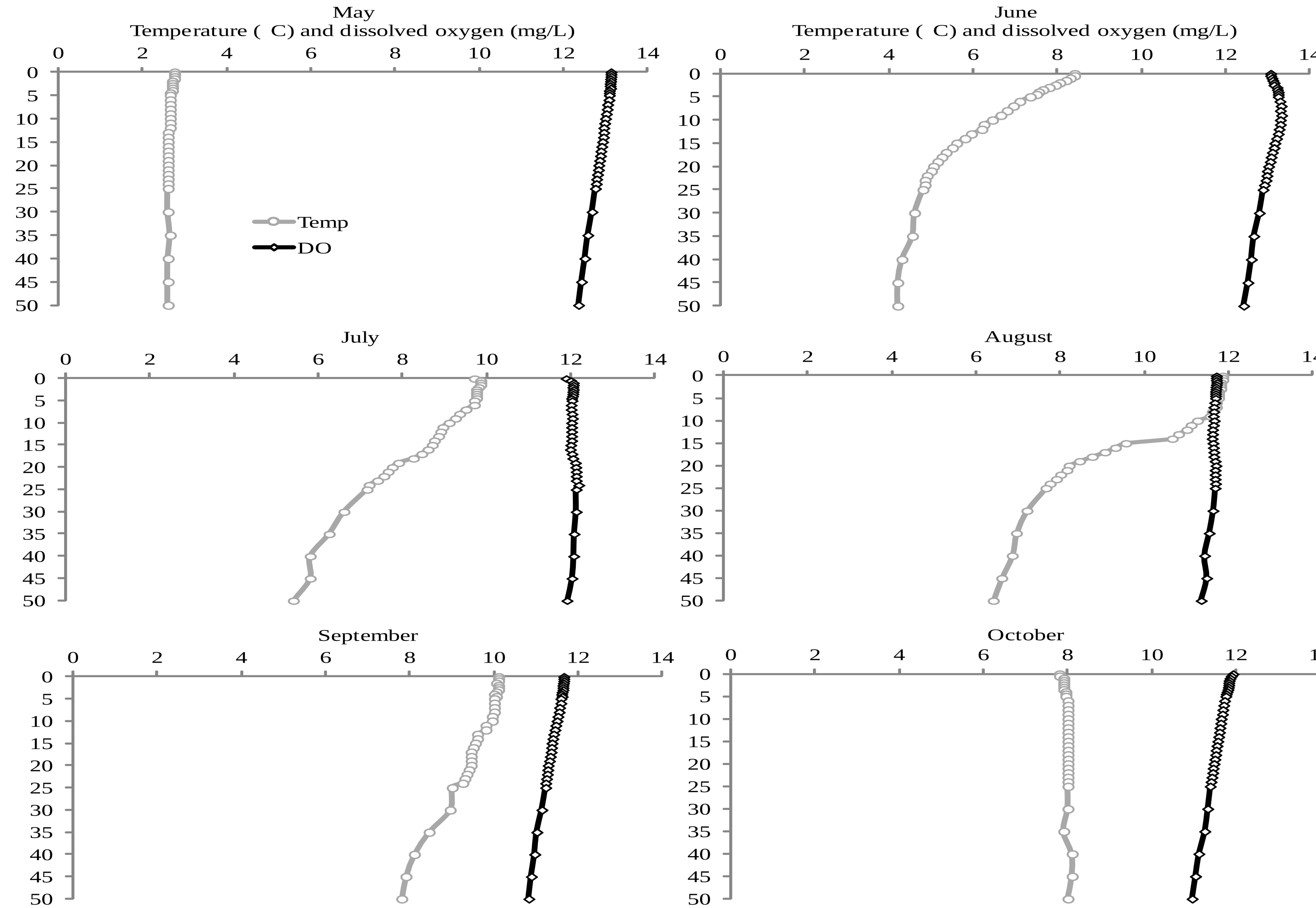

Figure 13.–Temperature and dissolved oxygen depth profiles by month from Frazer Lake, 2012.

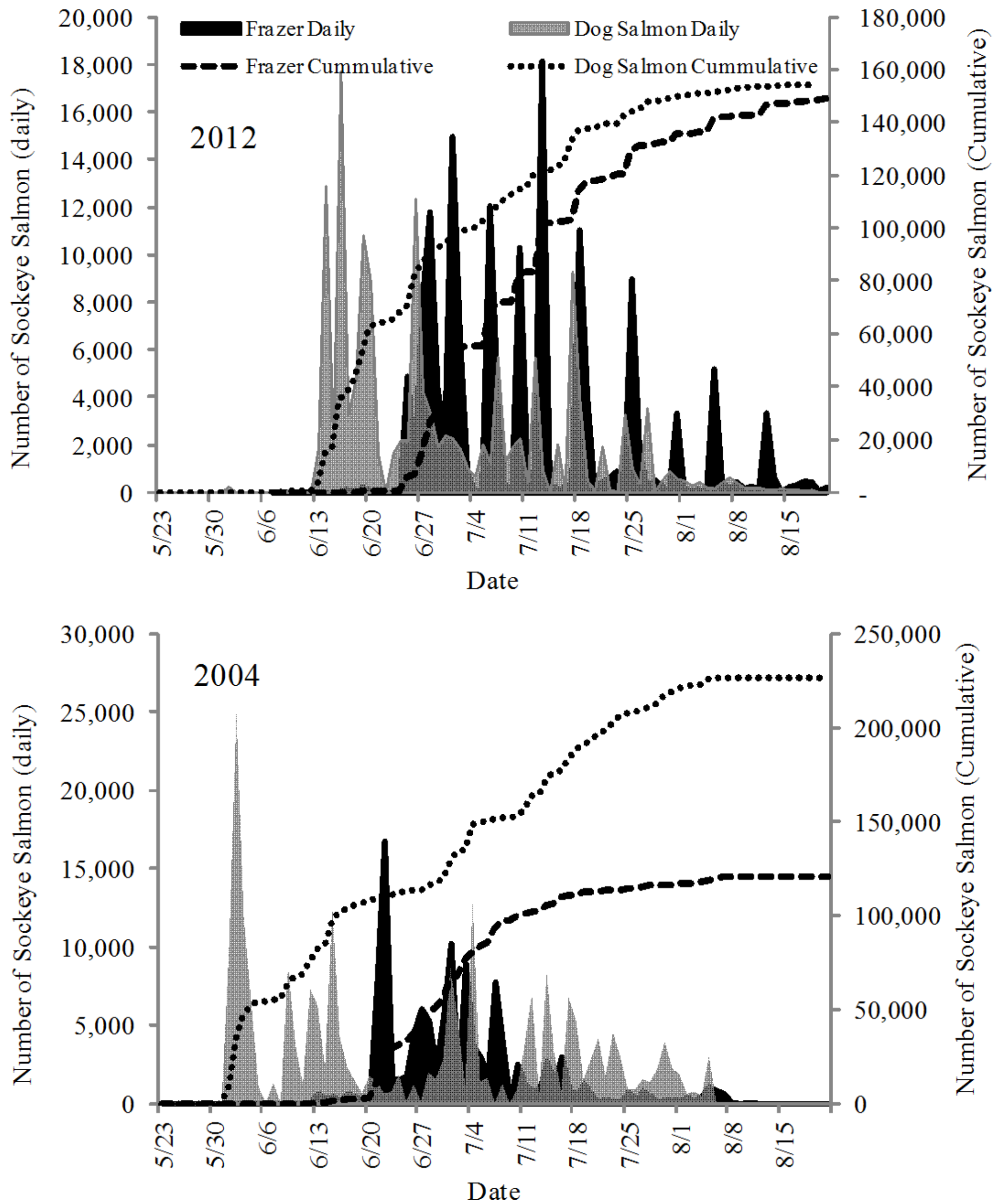

Figure 14.–Daily and cumulative adult sockeye salmon escapement counts for Frazer Fish Pass and Dog Salmon Weir, 2012 and 2004.

APPENDIX A. HISTORICAL STOCKING, ESCAPEMENT GOALS, AND SMOLT SAMPLING METHODS AND LOCATIONS

Appendix A1.–Salmon stocking in Frazer Lake by species, life stages, donor source and location of planting events, 1951-1971.

Year	Species	Lifestage			Donor source	Location of planting in Frazer Lake
		Adults	Fry	Eggs		
1951	O. nerka			200,000	Karluk Lake	Stumble Creek
1952	O. nerka			313,000	Karluk Lake	Linda Creek
1953	O. nerka			1,092,000	Karluk Lake	Pinnell, Westside, Linda, Midway Creeks
1954	O. nerka			541,000	Karluk Lake	Linda Creek
1955	O. nerka			320,000	Karluk Lake	Linda and Stumble Creeks
1956	O. nerka			504,000	Red Lake	Linda and Stumble Creeks
1958	O. nerka	42			Red Lake	Midway Creek
1961	O. nerka	600	87,000		Red Lake	Lake
1962	O. nerka	1,839			Red Lake	Lake
1963	O. nerka	9,500			Red Lake	Lake
1964	O. nerka	1,800			Red Lake	Lake
1965	O. nerka	4,000		830,000	Red Lake	Lake (adults); tributaries (eggs)
1966	O. nerka	4,728	504,300	600,000	Red Lake	Lake (adults, fry); Stumble Creek (eggs)
1966	O. tshawytscha		42,000		Karluk Lake	Lower lake outlet below Frazer falls
1967	O. nerka	7,334		1,190,000	Red Lake	Lake (adults); Midway, Pinnell, and Linda creeks (eggs)
1967	O. tshawytscha		56,000		Karluk Lake	Lower lake outlet below Frazer falls
1968	O. nerka	30	311,000	3,387,000	Red Lake	Lake (adults, fry); Midway, Pinnell, and Linda creeks (eggs)
1968	O. tshawytscha		46,000		Karluk Lake	Lower lake outlet below Frazer falls
1969	O. nerka	60			Red Lake	Lake
1969	O. nerka		599,760	1,963,000	Ruth Lake (Becharof Lake)	Lake (fry); Midway and Linda Creeks (eggs)
1969	O. tshawytscha		16,000		Karluk Lake	Lower lake outlet below Frazer falls
1970	O. nerka		945,000		Red Lake	Pinnell Creek
1971	O. nerka		527,000		Red Lake	Pinnell Creek
Totals	O. nerka	29,933	2,974,060	7,970,000		
	O. tshawytscha	0	160,000	0		

Appendix A2.–Frazer Lake Escapement Goals (1950–2012).

Escapement Goal (Range)	Type	SMSY	SEQ	Reference	Dates of Use
75,000 – 170,000	BEG	117,000	321,000	Nemeth et al. 2010	Current
75,000 – 170,000	BEG	118,000		Honnold et al. 2007	
70,000 – 150,000	BEG	105,000		Nelson et al. 2005	
140,000 – 200,000	BEG			Nelson and Lloyd 2001	
Lake goal 124,000 – 181,000	BEG			Malloy and Prokopowich 1992	
200,000 – 275,000					1986-1988
350,000 – 400,000					1981-1985
175,000					1950's to 1970's

Appendix A3.–Frazer Lake/Dog Salmon Creek smolt capture locations and methods, 1965–2012.

Year	Smolt Sampling Method	Location
1965-1971	Smolt weir	1/4 mile below lake outlet
1972-1974	Index netting	Varied
1975-1978	Seining	Below Frazer falls
1985-1993	Incline plane and concrete trap	Incline plane trap: between unipod 6 and 8 of lower adult salmon weir. Concrete trap: north bank of lower adult salmon weir
1994-1998	Incline plane trap	76 meters upriver from upper diversion weir adjacent to small island.
2001-2004	Incline plane trap	75 meters upriver from upper diversion weir adjacent to small island.
2005	Incline plane trap	Above falls, 30 feet downstream of tip of second island
2006-2007	Floating smolt and incline plane trap	Fan trap: Above falls, 30 feet downstream of tip of second island. Floating trap: above falls upriver of second island.
2008-2012	Incline plane Trap	Upstream of waterfall and concrete water diversion weir

APPENDIX B. HISTORICAL SMOLT DATA

Appendix B1.–Mean length, weight, and condition coefficient by year and age (freshwater-age-1, 2, & 3) of sockeye smolt outmigrating from Frazer Lake, 1965–2012.

		Freshwater-Age-1					Freshwater-Age-2					Freshwater-Age-3				
Year	Total smolt sampled	N	Age composition (%)	Length (mm)	Weight (g)	Condition Coefficient (K)	N	Age composition (%)	Length (mm)	Weight (g)	Condition Coefficient (K)	N	Age composition (%)	Length (mm)	Weight (g)	Condition Coefficient (K)
1965	1,057	698	66.0	146	27.2	0.91	346	32.7	174	48.0	0.89	13	1.2	-	-	
1966	1,916	542	28.3	163	31.0	0.93	1,358	70.9	180	53.1	0.91	15	0.8	-	-	
1967	1,938	1,196	61.7	147	28.8	0.90	680	35.1	177	53.2	0.97	62	3.2	-	-	
1968	1,789	1,517	84.8	154	36.3	0.92	265	14.8	185	62.0	0.94	7	0.4	-	-	
1969	0	0		-	-		0		-	-		0		-	-	
1970	2,537	1,878	74.0	149	30.9	0.93	649	25.6	180	54.0	0.93	10	0.4	-	-	
1971	470	130	27.7	130	20.5	0.93	334	71.1	173	44.5	0.86	6	1.3	-	-	
1972	474	452	95.4	120	15.8	0.91	22	4.6	151	31.7	0.92	0	0.0	-	-	
1973	120	46	38.3	126	18.2	0.91	74	61.7	142	25.6	0.88	0	0.0	-	-	
1974	875	227	24.9	124	18.0	0.95	573	66.3	151	29.9	0.89	75	8.8	-	-	
1975	1,304	328	27.7	132	22.4	0.97	972	71.9	149	29.5	0.89	4	0.3	-	-	
1976	924	479	52.5	130	19.3	0.88	418	44.6	157	34.0	0.87	27	2.9	-	-	
1977	788	385	48.9	130	20.7	0.95	403	51.1	154	32.0	0.88	0	0.0	-	-	
1978	330	107	32.4	126	17.2	0.87	223	67.6	145	26.0	0.86	0	0.0	-	-	
1979	831	460	55.4	113	11.9	0.83	371	44.6	143	23.4	0.80	0	0.0	-	-	
1980	439	349	79.5	107	9.1	0.75	90	20.5	109	9.8	0.75	0	0.0	-	-	
1981	318	250	78.6	90	5.8	0.78	68	21.4	108	10.2	0.79	0	0.0	-	-	
1982	327	64	19.6	80	4.1	0.77	248	75.8	95	7.0	0.78	15	4.6	-	-	
1983	519	23	4.4	84	5.0	0.82	495	95.4	95	6.9	0.81	1	0.2	-	-	
1984	1,261	1,189	94.3	76	2.9	0.64	50	4.0	99	7.1	0.68	3	0.2	-	-	
1985	2,555	2,389	93.5	70	2.6	0.73	51	2.0	84	4.7	0.80	0	0.0	-	-	
1986	1,525	85	5.6	90	5.5	0.76	1,438	94.3	98	7.4	0.79	2	0.1	-	-	
1987	1,164	196	16.8	81	4	0.74	761	65.4	104	8.2	0.73	207	17.8	-	-	
1988	0	0		-	-		0	-	-	-		0		-	-	
1989	644	22	3.4	87	5.5	0.84	622	96.6	101	8.0	0.78	0		-	-	
1990	1,172	574	49.0	84	4.5	0.74	554	47.3	104	9.0	0.79	44	3.8	112	11.7	0.82
1991	2,096	747	35.6	90	5.4	0.74	1,345	64.2	90	5.6	0.77	4	0.2	121	15.7	0.85
1992	3,205	49	1.5	86	6.1	0.94	2,961	92.4	84	5.4	0.91	195	6.1	89.2	7.1	0.91
1993	1,612	8	0.5	90	6.1	0.83	685	42.5	100	8.3	0.82	916	56.8	103.8	9.0	0.81
1994	2,472	713	28.8	86	5.2	0.81	1,457	58.9	103	8.1	0.75	302	12.2	112.8	10.7	0.74
1995	2,213	39	1.8	87	5.3	0.74	2,154	97.3	91	5.6	0.73	20	0.9	115.2	13.6	0.79

-continued-

Year	Total smolt sampled	Freshwater-Age-1 N	Freshwater-Age-1 Age composition (%)	Freshwater-Age-1 Length (mm)	Freshwater-Age-1 Weight (g)	Freshwater-Age-1 Condition Coefficient (K)	Freshwater-Age-2 N	Freshwater-Age-2 Age composition (%)	Freshwater-Age-2 Length (mm)	Freshwater-Age-2 Weight (g)	Freshwater-Age-2 Condition Coefficient (K)	Freshwater-Age-3 N	Freshwater-Age-3 Age composition (%)	Freshwater-Age-3 Length (mm)	Freshwater-Age-3 Weight (g)	Freshwater-Age-3 Condition Coefficient (K)
1996	1,915	42	2.2	91	6.2	0.78	1,747	91.2	86	5.1	0.76	126	6.6	95	9.0	0.74
1997	2,652	599	22.6	89	5.5	0.78	1,395	52.6	93	6.4	0.77	638	24.1	106	9.5	0.79
1998	1,841	618	33.6	98	8.1	0.86	1,205	65.5	110	10.4	0.79	18	1.0	114	11.8	0.78
1999	2,345	1,357	57.9	89	5.5	0.78	793	33.8	121	13.7	0.77	196	8.4	126	15.3	0.77
2000	3,517	29	0.8	52	1.3	1.07	3,385	96.2	86	4.3	0.67	90	2.6	113	11.7	0.80
2001	2,604	77	3.0	70	3.4	0.86	2,444	93.9	77	3.8	0.82	79	3.0	109	11.4	0.84
2002	2,183	961	44.0	85	5.4	0.89	937	42.9	95	7.5	0.87	279	12.8	100	8.7	0.87
2003	749	7	0.9	65	2.6	0.87	740	98.8	86	4.8	0.77	2	0.3	134	20.9	0.86
2004	912	2	0.2	59	1.7	0.82	909	99.7	75	3.2	0.76	1	0.1	129	18.0	0.84
2005	1,083	30	2.8	87	5.3	0.81	277	25.6	90	5.8	0.79	776	71.7	93	6.1	0.75
2006	1,356	967	71.3	97	7.1	0.78	206	15.2	104	8.7	0.76	127	9.4	110	10.1	0.76
2007	920	273	29.7	91	6.1	0.80	572	62.2	108	9.2	0.74	75	8.2	109	9.3	0.71
2008	580	6	1.0	81	3.5	0.61	573	98.8	88	4.1	0.60	1	0.2	100	5.6	0.56
2009	487	43	8.8	84	4.4	0.73	354	72.7	94	6.3	0.75	90	18.5	94	6.4	0.76
2010	891	431	48.4	87	5.4	0.78	361	40.5	98	7.2	0.74	98	11.0	104	8.5	0.75
2011	1,487	38	2.6	71	2.8	0.73	1,376	92.5	96	6.1	0.69	26	1.7	114	10.4	0.68
2012	1,580	140	8.9	81	4.0	0.74	1,438	91.0	95	6.3	0.74	2	0.1	129	17.7	0.80
Average (2007-2011)	873	158	18.1	83	4.4	0.73	647	73.3	97	6.6	0.70	58	7.9	104	8.0	0.69
Average (1992-2011)	1,751	314	18.1	82	4.9	0.81	1,227	68.7	94	6.7	0.76	203	12.8	109	10.7	0.78

Appendix B2.–Mean length, weight, and condition coefficient by year and age (freshwater-age-0, 4) of sockeye smolt outmigrating from Frazer Lake, 1992–2012.

	Freshwater-Age-0					Freshwater-Age-4				
Year	N	Age compostion (%)	Length (mm)	Weight (g)	Condition Coefficient (K)	N	Age compostion (%)	Length (mm)	Weight (g)	Condition Coefficient (K)
1992	0	0.0	–	–	–	0	0.0	–	–	–
1993	0	0.0	–	–	–	3	0.2	121.33	11.8	0.57
1994	0	0.0	–	–	–	0	0.0	–	–	–
1995	0	0.0	–	–	–	0	0.0	–	–	–
1996	0	0.0	–	–	–	0	0.0	–	–	–
1997	0	0.0	–	–	–	9	0.3	112.56	11.9	0.81
1998	0	0.0	–	–	–	0	0.0	–	–	–
1999	0	0.0	–	–	–	0	0.0	–	–	–
2000	0	0.0	–	–	–	13	0.4	138.3	24.3	0.90
2001	3	0.1	52.7	1.4	0.93	1	0.0	155.0	33.5	0.90
2002	0	0.0	–	–	–	6	0.3	99.5	9.2	0.93
2003	0	0.0	–	–	–	0	0.0	–	–	–
2004	0	0.0	–	–	–	0	0.0	–	–	–
2005	0	0.0	–	–	–	0	0.0	–	–	–
2006	12	0.9	80.0	3.4	0.66	44	3.2	112.0	10.8	0.8
2007	0	0.0	–	–	–	0	0.0	–	–	–
2008	0	0.0	–	–	–	0	0.0	–	–	–
2009	0	0.0	–	–	–	0	0.0	–	–	–
2010	0	0.0	–	–	–	1	0.1	140.0	22.1	0.81
2011	0	0.0	–	–	–	0	0.0	–	–	–
2012	0	0.0	–	–	–	0	0.0	–	–	–
Average (1992-2011)	1	0.1	66.3	2.4	0.80	4	0.2	125.5	17.7	0.81
Average (2007-2011)	0	0.0	–	–	–	0	0.0	140.0	22.1	0.81

Appendix B3.–Estimated sockeye salmon smolt outmigration by age class and year for Frazer Lake, 1965–2012.

Year	Estimated Outmigration	Sample Total	Freshwater Age 0 no.	0 %	Freshwater Age 1 no.	1 %	Freshwater Age 2 no.	2 %	Freshwater Age 3 no.	3 %	Freshwater Age 4 no.	4 %
1965	26,945	1,057	0	0	698	66	346	33	13	1	0	0
1966	157,291	1,916	0	0	542	28	1,358	71	15	1	0	0
1967	134,123	1,938	0	0	1,196	62	680	35	62	3	0	0
1968	93,793	1,789	0	0	1,517	85	265	15	7	0	0	0
1969	[b]	0	-		-		-		-		-	
1970	44,808	2,537	0	0	1,878	74	649	26	10	0	0	0
1971	[b]	470	0	0	130	28	334	71	6	1	0	0
1972	[b]	474	0	0	452	95	22	5	0	0	0	0
1973	[b]	120	0	0	46	38	74	62	0	0	0	0
1974	[b]	875	0	0	227	26	573	65	75	9	0	0
1975	[b]	1,304	0	0	328	25	972	75	4	0	0	0
1976	[b]	924	0	0	479	52	418	45	27	3	0	0
1977	[b]	788	0	0	385	49	403	51	0	0	0	0
1978	[b]	330	0	0	107	32	223	68	0	0	0	0
1979	[b]	831	0	0	460	55	371	45	0	0	0	0
1980	[b]	439	0	0	349	79	90	21	0	0	0	0
1981	[b]	318	0	0	250	79	68	21	0	0	0	0
1982	[b]	327	0	0	64	20	248	76	15	5	0	0
1983	[b]	519	0	0	23	4	495	95	1	0	0	0
1984	[b]	1,261	19	2	1,189	94	50	4	3	0	0	0
1985	[b]	2,555	117	5	2,389	94	51	2	0	0	0	0
1986	[b]	1,525	1	0	85	6	1,438	94	2	0	0	0
1987	3,786 [a]	1,164	0	0	196	17	761	65	207	18	0	0
1988	4,335,622 [a]	0	-		-		-		-		-	
1989	12,979,068 [a]	644	0	0	22	3	622	97	0	0	0	0
1990	5,186,355 [a]	1,172	0	0	574	49	554	47	44	4	0	0
1991	4,818,501	2,096	0	0	747	36	1,345	64	4	0	0	0
1992	5,365,777	3,205	0	0	49	2	2,961	92	195	6	0	0
1993	7,434,298	1,612	0	0	8	0	685	42	916	57	3	0
1994	5,661,489	2,472	0	0	713	29	1,457	59	302	12	0	0
1995	8,823,777	2,213	0	0	39	2	2,154	97	20	1	0	0
1996	3,820,604	1,915	0	0	42	2	1,747	91	126	7	0	0
1997	3,069,352	2,652	11	0	599	23	1,395	53	638	24	9	0
1998	[b]	1,841	0	0	618	34	1,205	65	18	1	0	0
1999	2,452,962	2,345	0	0	1,357	58	793	34	196	8	0	0

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Year	Estimated Outmigration	Sample Total	Freshwater Age 0 no.	0 %	1 no.	1 %	2 no.	2 %	3 no.	3 %	4 no.	4 %
2000	4,734,647	3,517	0	0	29	1	3,385	96	90	3	13	0
2001	941,578	2,604	3	0	77	3	2,444	94	79	3	1	0
2002	2,168,537	2,183	0	0	961	44	937	43	279	13	6	0
2003	7,869,881	749	0	0	7	1	740	99	2	0	0	0
2004	4,194,210	912	0	0	2	0	909	100	1	0	0	0
2005	1,572,049	1,083	0	0	30	3	277	26	776	72	0	0
2006	2,421,826	1,356	12	1	967	71	206	15	127	9	44	3
2007	[b]	920	0	0	273	30	572	62	75	8	0	0
2008	[b]	580	0	0	6	1	573	99	1	0	0	0
2009	[b]	487	0	0	43	9	354	73	90	18	0	0
2010	[b]	891	0	0	431	48	361	41	98	11	1	0
2011	[b]	1,487	47	3	38	3	1,376	93	26	2	0	0
2012	5,566,771	1,580	0	0	140	9	1,438	91	2	0	0	0
Mean (1991-2011)	4,356,633	1,751	4	0	314	18	1,227	69	203	13	4	0
Mean (2000-2011)	3,414,675	1,397	5	0	239	18	1,011	70	137	12	5	0

[a] Outmigration estimates shown are from Barrett and not reliable; per Coggins 1997 (4K97-50 pg. 2).

[b] Outmigration estimates not available.

APPENDIX C. HISTORICAL ADULT DATA

Appendix C1.–Frazer Fish Pass cumulative escapement counts by year and species, 1964–2012.

Year	Sockeye	Chinook	Pink	Chum	Steelhead Down	Steelhead Up	All Species
1964	1,351	0	0	18	0	0	1,369
1965	5,074	0	1,698	9	0	0	6,781
1966	11,728	0	0	243	0	0	11,971
1967	14,500	0	0	0	0	0	14,500
1968	16,708	0	3	499	0	0	17,210
1969	13,981	0	2,390	4	0	0	16,375
1970	24,081	2	1	117	0	0	24,201
1971	55,366	22	2,788	116	0	0	58,292
1972	65,844	111	1	216	0	0	66,172
1973	56,255	35	1,607	206	0	0	58,103
1974	82,709	12	0	55	0	0	82,776
1975	64,199	7	3,508	126	0	0	67,840
1976	119,321	28	3	89	0	0	119,441
1977	139,475	205	11,061	87	0	0	150,828
1978	142,281	131	2	33	0	0	142,447
1979	126,742	53	10,178	60	0	0	137,033
1980	405,535	66	6	28	0	0	405,635
1981	377,716	22	11,124	85	0	0	388,947
1982	437,772	47	0	56	0	0	437,875
1983	158,340	86	1,414	63	0	0	159,903
1984	53,524	85	1	79	0	0	53,689
1985	485,835	165	641	25	0	0	486,666
1986	126,529	127	0	9	0	0	126,665
1987	40,544	94	285	5	0	0	40,928
1988	246,704	212	0	6	0	0	246,922
1989	360,373	85	516	0	0	0	360,974
1990	226,960	183	0	5	0	0	227,148
1991	190,358	127	0	0	0	0	190,485
1992	185,825	128	0	510	0	0	186,463
1993	178,391	211	14	1	0	0	178,617
1994	206,071	189	0	3	0	0	206,263
1995	196,362	296	156	0	1	0	196,815
1996	198,695	485	3	0	0	0	199,183
1997	205,264	454	0	0	0	0	205,718
1998	233,755	147	0	0	0	0	233,902
1999	216,565	126	0	0	0	0	216,691

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Year	Sockeye	Chinook	Pink	Chum	Steelhead Down	Steelhead Up	All Species
2000	158,044	121	0	0	0	0	158,165
2001	154,349	166	0	0	0	0	154,515
2002	85,317	211	1	0	0	0	85,529
2003	201,679	443	1	0	0	0	202,123
2004	120,664	204	4,869	0	0	0	125,737
2005	136,948	156	2	0	0	0	137,106
2006	89,516	59	447	0	0	0	90,022
2007	120,186	57	0	5	0	0	120,248
2008	105,363	19	283	0	0	0	105,665
2009	101,845	42	2	0	0	0	101,889
2010	94,680	41	11,451	2	0	0	106,174
2011	134,642	27	7	0	0	0	134,676
2012	148,884	39	2	0	0	6	148,937
5-yr Average (2007-2011)	111,343	37	2,349	1	0	0	113,730
10-yr Average (2002-2011)	119,084	126	1,706	1	0	0	120,917
20-yr Average (1992-2011)	156,208	179	862	26	0	0	157,275

Appendix C2.–Frazer Lake interpolated adult sockeye salmon escapement age composition, 1986–2012.

		Age										
	No. Fish	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	Total
Year	Sampled	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.	Fish
1986	967	10	17,231	1,639	0	282	5,545	99,724	0	465	1,632	126,529
	%	0.0	13.6	1.3	0.0	0.2	4.4	78.8	0.0	0.4	1.3	
1987	868	752	5,023	19,852	53	7,501	2,959	4,098	69	0	89	40,544
	%	1.9	12.4	49.0	0.1	18.5	7.3	10.1	0.2	0.0	0.2	
1988	1,098	124	3,189	6,540	374	20,765	202,514	6,081	1,164	5,494	461	246,704
	%	0.1	1.3	2.7	0.2	8.4	82.1	2.5	0.5	2.2	0.2	
1989	1,335	9,359	5,611	3,477	0	601	91,433	249,645	0	0	0	360,373
	%	2.6	1.6	1.0	0.0	0.2	25.4	69.3	0.0	0.0	0.0	
1990	1,727	505	168,915	11,212	0	10,071	12,251	15,187	36	473	8,310	226,960
	%	0.2	74.4	4.9	0.0	4.4	5.4	6.7	0.0	0.2	3.7	
1991	1,077	934	312	32,436	0	15,628	139,818	245	0	984	0	190,358
	%	0.5	0.2	17.0	0.0	8.2	73.5	0.1	0.0	0.5	0.0	
1992	1,412	16,072	10,029	1,941	0	8,171	76,358	67,784	0	3,869	930	185,825
	%	8.6	5.4	1.0	0.0	4.4	41.1	36.5	0.0	2.1	0.5	
1993	1,908	1,154	83,475	5,940	0	15,622	45,741	24,979	190	23	1,073	178,391
	%	0.6	46.8	3.3	0.0	8.8	25.6	14.0	0.1	0.0	0.6	
1994	1,674	530	5,492	45,993	0	11,160	112,302	19,239	4,910	6,125	273	206,071
	%	0.3	2.7	22.3	0.0	5.4	54.5	9.3	2.4	3.0	0.1	
1995	2,082	2,714	905	1,393	0	37,690	70,972	58,993	918	22,273	482	196,362
	%	1.4	0.5	0.7	0.0	19.2	36.1	30.0	0.5	11.3	0.2	
1996	2,258	1,153	1,683	220	0	74,652	69,315	28,224	441	5,279	17,728	198,695
	%	0.6	0.8	0.1	0.0	37.6	34.9	14.2	0.2	2.7	8.9	
1997	1,440	1,765	4,233	7,636	0	22,593	114,771	47,149	2,409	133	4,220	205,264
	%	0.9	2.1	3.7	0.0	11.0	55.9	23.0	1.2	0.1	2.1	
1998	1,377	16,080	10,707	5,274	0	20,213	130,299	48,125	2,074	984	0	233,755
	%	6.9	4.6	2.3	0.0	8.6	55.7	20.6	0.9	0.4	0.0	
1999	1,136	27,954	36,827	15,299	0	39,374	65,894	23,996	991	6,197	33	216,565
	%	12.9	17.0	7.1	0.0	18.2	30.4	11.1	0.5	2.9	0.0	
2000	1,259	907	18,479	21,565	0	22,402	57,850	23,990	1,220	6,722	4,862	158,044
	%	0.6	11.7	13.6	0.0	14.2	36.6	15.2	0.8	4.3	3.1	
2001	1,487	454	1,218	28,871	0	1,468	11,475	100,474	36	3,948	6,382	154,349
	%	0.3	0.8	18.7	0.0	1.0	7.4	65.1	0.0	2.6	4.1	

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		Age										
	No. Fish	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	Total
Year	Sampled	no.	no.	no.	no.	no.	no.	no.	no.	no.	no.	Fish
2002	1,453	954	797	6,486	1,182	20,784	10,865	39,145	169	75	4,201	85,317
	%	1.1	0.9	7.6	1.4	24.4	12.7	45.9	0.2	0.1	4.9	
2003	1,443	27,029	331	237	248	102,817	54,037	5,352	11,603	0	0	201,679
	%	13.4	0.2	0.1	0.1	51.0	26.8	2.7	5.8	0.0	0.0	
2004	635	399	20,391	41	0	7,967	72,333	7,578	0	11,955	0	120,664
	%	0.3	16.9	0.0	0.0	6.6	59.9	6.3	0.0	9.9	0.0	
2005	942	251	6,037	28,913	0	373	50,427	46,170	0	71	4,581	136,948
	%	0.2	4.4	21.1	0.0	0.3	36.8	33.7	0.0	0.1	3.3	
2006	1,293	2,736	2,448	3,109	415	11,382	3,023	45,301	19,532	223	1,031	89,516
	%	3.1	2.7	3.5	0.5	12.7	3.4	50.6	21.8	0.2	1.2	
2007	1,907	12,714	3,953	460	264	49,654	13,483	6,481	7,933	24,887	95	120,186
	%	10.6	3.3	0.4	0.2	41.3	11.2	5.4	6.6	20.7	0.1	
2008	1,688	1,051	29,190	614	0	8,782	36,516	7,474	1,544	5,870	13,792	105,363
	%	1.0	27.7	0.6	0.0	8.3	34.7	7.1	1.5	5.6	13.1	
2009	1,953	78	9,125	18,862	0	4,559	33,932	20,144	0	7,978	6,707	101,845
	%	0.1	9.0	18.5	0.0	4.5	33.3	19.8	0.0	7.8	6.6	
2010	1,975	3,784	2,841	17,666	95	39,988	13,990	9,889	5,774	21	457	94,680
	%	4.0	3.0	18.7	0.1	42.2	14.8	10.4	6.1	0.0	0.5	
2011	2,251	3,371	3,604	2,183	123	48,300	62,700	7,623	5,442	1,194	0	134,642
	%	2.5	2.7	1.6	0.1	35.9	46.6	5.7	4.0	0.9	0.0	
2012	1,985	25	20,393	3,795	0	2,763	80,265	38,918	0	2,402	130	148,884
	%	0.0	13.7	2.5	0.0	1.9	53.9	26.1	0.0	1.6	0.1	
Average	(1986-2011)	5,109	17,386	11,071	106	23,185	60,031	38,965	2,556	4,432	2,975	
%		2.9	10.3	8.5	0.1	15.2	32.9	22.8	2.0	3.0	2.1	
Average	(2002-2011)	5,237	7,872	7,857	233	29,461	35,131	19,516	5,200	5,227	3,086	
%		3.6	7.1	7.2	0.2	22.7	28.0	18.8	4.6	4.5	3.0	
Average	(2007-2011)	4,199	9,742	7,957	96	30,257	32,124	10,322	4,138	7,990	4,210	
%		3.6	9.1	8.0	0.1	26.4	28.1	9.7	3.6	7.0	4.0	

Appendix C3.–Cummulative and average sockeye salmon escapement counts, Frazer Fish Pass, 2000–2012.

	Year													Average	
Date	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	5 Year (2007-2011)	10 Year (2002-2011)
31-May	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-
1-Jun	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-
2-Jun	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-
3-Jun	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-
4-Jun	-	24	-	-	-	28	-	-	-	-	-	-	-	-	3
5-Jun	-	37	-	-	-	28	-	-	-	-	-	-	-	-	3
6-Jun	-	53	-	-	-	29	-	-	-	-	-	-	-	-	3
7-Jun	-	101	-	-	-	29	-	-	-	-	-	-	-	-	3
8-Jun	-	305	-	-	2	29	-	-	-	-	-	-	-	-	3
9-Jun	-	369	-	-	2	35	-	-	-	-	-	-	-	-	4
10-Jun	-	427	-	-	2	2,301	-	-	-	-	-	-	-	-	230
11-Jun	1	1,234	-	-	2	3,676	-	-	-	31	-	-	19	6	371
12-Jun	6	2,629	-	-	2	3,678	-	-	-	42	-	-	24	8	372
13-Jun	7	5,479	43	-	3	3,758	-	-	1	54	-	1	24	11	386
14-Jun	14	25,026	178	1	3	4,103	-	-	2	54	-	1	24	11	434
15-Jun	19	45,385	1,179	79	12	8,678	-	-	24	80	-	8	24	22	1,006
16-Jun	51	62,128	3,272	109	104	8,907	-	2	28	106	-	8	54	29	1,254
17-Jun	526	63,772	13,101	535	740	9,912	26	3	33	107	-	8	191	30	2,447
18-Jun	3,105	65,691	14,546	1,174	1,044	11,682	28	4	37	111	-	9	193	32	2,864
19-Jun	5,167	72,708	16,118	1,535	1,511	11,742	60	19	37	120	-	49	438	45	3,119
20-Jun	10,445	103,240	20,529	1,632	1,695	11,748	60	48	37	172	438	105	552	160	3,646
21-Jun	14,382	119,709	21,897	5,223	2,346	11,769	60	50	37	209	583	221	558	220	4,240
22-Jun	20,149	123,540	23,381	5,385	2,831	11,845	115	1,770	85	1,751	671	510	566	957	4,834
23-Jun	25,411	124,833	26,591	9,966	2,904	31,960	135	2,383	130	1,841	689	929	605	1,194	7,753
24-Jun	30,809	125,639	29,786	10,376	3,154	35,755	135	2,572	147	2,858	2,914	1,335	606	1,965	8,903
25-Jun	45,969	126,577	32,173	10,644	10,945	35,809	135	2,716	148	11,918	2,990	1,406	5,493	3,836	10,888
26-Jun	56,068	130,331	32,691	11,331	27,761	36,768	147	3,944	148	12,158	3,017	2,146	6,642	4,283	13,011
27-Jun	64,316	131,408	35,884	12,965	29,301	37,935	149	4,126	540	14,263	3,470	2,245	14,623	4,929	14,088
28-Jun	69,769	132,246	39,682	14,265	30,868	38,349	155	4,509	915	15,412	4,790	2,485	26,425	5,622	15,143
29-Jun	80,126	133,388	40,440	14,565	32,669	38,852	155	4,623	1,309	28,826	4,820	8,718	30,852	9,659	17,498
30-Jun	88,164	133,666	42,462	17,899	37,254	39,135	156	4,698	1,404	29,608	4,887	20,062	32,986	12,132	19,757

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Date	Year													Average	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	5 Year (2007-2011)	10 Year (2002-2011)
1-Jul	90,790	133,707	43,326	19,465	43,342	43,124	156	4,994	1,445	31,686	4,887	22,584	47,962	13,119	21,501
2-Jul	93,614	134,478	44,056	37,256	48,642	44,415	174	10,897	1,478	32,689	4,952	27,530	54,506	15,509	25,209
3-Jul	95,320	134,624	48,850	42,845	50,966	44,450	224	13,161	2,973	33,284	5,198	28,511	55,338	16,625	27,046
4-Jul	96,497	134,676	52,588	42,978	56,544	44,738	232	14,280	8,674	33,445	9,064	33,340	55,378	19,761	29,588
5-Jul	96,564	138,700	54,668	43,065	66,816	45,974	319	20,830	10,430	40,392	10,218	40,253	55,516	24,425	33,297
6-Jul	97,320	138,706	55,717	43,934	68,055	50,246	358	23,143	12,422	45,103	10,293	41,594	67,572	26,511	35,087
7-Jul	100,381	139,205	56,329	59,388	77,015	68,684	672	38,183	14,512	45,333	10,293	41,961	71,861	30,056	41,237
8-Jul	101,100	141,546	57,173	61,844	80,718	77,871	682	39,210	14,793	45,573	10,392	42,588	72,088	30,511	43,084
9-Jul	101,643	142,443	57,998	80,801	83,726	79,361	6,364	40,437	17,902	45,663	18,348	61,697	72,257	36,809	49,230
10-Jul	102,811	143,964	58,373	86,121	85,489	86,880	7,876	41,802	18,883	46,007	18,563	62,975	82,564	37,646	51,297
11-Jul	104,286	144,295	58,657	87,115	93,293	95,013	7,928	42,382	18,954	48,009	18,963	63,188	83,642	38,299	53,350
12-Jul	107,741	144,461	59,337	97,556	97,163	96,690	8,296	44,556	32,410	48,476	19,654	65,153	83,732	42,050	56,929
13-Jul	113,563	144,976	59,411	107,373	97,213	103,774	11,200	45,266	36,444	48,847	20,134	76,757	101,882	45,490	60,642
14-Jul	113,846	145,328	60,246	117,366	99,739	105,193	11,775	45,413	36,598	49,245	20,421	84,353	102,170	47,206	63,035
15-Jul	114,017	145,706	61,881	125,207	101,020	105,606	12,396	45,650	38,646	52,421	22,354	85,976	102,352	49,009	65,116
16-Jul	116,698	145,901	62,539	140,002	101,828	106,117	14,346	46,379	38,694	68,457	22,495	87,557	102,548	52,716	68,841
17-Jul	120,775	147,079	63,375	141,202	102,696	106,499	14,633	57,409	38,734	69,821	23,771	91,991	102,980	56,345	71,013
18-Jul	122,048	147,235	65,510	141,587	105,422	106,735	14,669	60,967	54,028	70,500	23,785	92,891	114,029	60,434	73,609
19-Jul	126,964	147,436	65,760	151,806	106,687	107,128	14,869	61,350	58,499	70,840	25,001	93,883	118,188	61,915	75,582
20-Jul	130,849	149,188	65,904	158,463	109,705	107,168	24,727	61,862	58,829	71,725	28,047	110,076	118,242	66,108	79,651
21-Jul	131,444	149,528	66,331	167,199	110,625	107,350	26,187	64,390	59,777	71,860	38,495	111,811	118,709	69,267	82,403
22-Jul	136,589	149,666	67,540	171,667	111,181	107,571	26,624	65,172	60,238	72,092	45,545	113,512	119,330	71,312	84,114
23-Jul	148,663	149,763	70,995	173,039	112,496	107,691	27,224	65,677	60,501	72,511	46,060	114,024	120,233	71,755	85,022
24-Jul	149,386	149,813	74,123	175,837	113,082	107,769	29,365	65,778	61,431	79,429	46,222	114,090	120,657	73,390	86,713
25-Jul	150,254	150,045	74,362	182,046	113,097	108,204	36,625	81,228	61,612	81,856	46,248	114,363	129,645	77,061	89,964
26-Jul	150,873	150,233	74,648	183,430	113,442	115,480	36,842	88,877	62,080	82,034	46,255	114,541	131,418	78,757	91,763
27-Jul	153,770	150,801	76,171	185,976	113,554	118,119	37,501	89,443	68,249	82,071	58,202	115,262	131,631	82,645	94,455
28-Jul	154,081	150,882	78,230	187,155	113,646	119,502	37,848	90,510	77,624	82,288	63,287	115,629	132,182	85,868	96,572
29-Jul	154,596	151,009	79,015	188,064	114,435	119,581	38,972	91,566	78,331	82,370	63,289	115,871	132,463	86,285	97,149
30-Jul	154,927	151,341	81,643	191,858	114,641	122,779	39,609	94,183	79,096	90,651	63,454	116,413	132,557	88,759	99,433
31-Jul	155,234	151,723	82,064	193,117	115,449	125,224	39,884	94,371	79,826	91,490	63,812	116,777	135,893	89,255	100,201

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Appendix C3.–Page 3 of 3.

Date	Year													Average	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	5 Year (2007-2011)	10 Year (2002-2011)
1-Aug	155,500	152,320	82,074	193,908	115,926	126,149	41,023	94,438	82,820	91,525	64,262	116,867	135,942	89,982	100,899
2-Aug	155,528	152,768	82,341	194,507	116,089	127,424	48,975	94,581	83,099	91,586	65,181	117,173	135,999	90,324	102,096
3-Aug	155,966	152,974	82,632	196,454	116,332	128,376	53,909	94,825	83,338	91,685	65,395	117,760	136,133	90,601	103,071
4-Aug	156,017	152,991	82,878	198,184	116,630	128,674	54,452	97,851	83,826	98,734	66,830	118,377	136,149	93,124	104,644
5-Aug	156,081	153,182	83,138	199,344	116,787	129,086	55,246	98,453	84,709	99,531	67,199	118,678	141,343	93,714	105,217
6-Aug	156,155	153,291	83,505	200,175	117,245	131,135	56,643	99,235	89,444	99,564	67,725	118,795	141,897	94,953	106,347
7-Aug	157,622	153,495	83,681	200,946	117,369	131,633	58,268	100,236	96,532	99,820	68,091	118,885	142,041	96,713	107,546
8-Aug	157,823	153,764	83,941	201,584	117,897	135,262	62,311	102,576	97,589	99,983	68,826	118,978	142,498	97,590	108,895
9-Aug	157,902	153,941	84,361	201,679	118,971	136,810	62,624	106,908	98,309	100,126	70,635	119,629	142,667	99,121	110,005
10-Aug	157,968	154,063	84,434	201,679	119,812	136,899	62,869	107,289	98,779	100,230	70,840	119,763	142,930	99,380	110,259
11-Aug	158,007	154,152	84,620	201,679	120,455	136,948	62,986	107,518	99,228	100,312	71,471	119,907	143,076	99,687	110,512
12-Aug	158,044	154,223	84,844	201,679	120,535	136,948	72,139	109,229	99,463	100,824	72,311	120,237	146,425	100,413	111,821
13-Aug	158,044	154,277	85,131	201,679	120,561	136,948	77,557	111,581	100,026	100,888	73,474	120,639	147,075	101,322	112,848
14-Aug	158,044	154,349	85,257	201,679	120,596	136,948	77,569	112,148	100,725	100,902	74,446	121,078	147,111	101,860	113,135
15-Aug	158,044	154,349	85,317	201,679	120,664	136,948	77,628	112,714	100,872	100,919	74,471	121,345	147,347	102,064	113,256
16-Aug	158,044	154,349	85,317	201,679	120,664	136,948	77,977	114,109	101,066	100,991	74,702	121,905	147,667	102,555	113,536
17-Aug	158,044	154,349	85,317	201,679	120,664	136,948	81,103	115,482	101,126	101,175	78,639	122,452	148,135	103,775	114,459
18-Aug	158,044	154,349	85,317	201,679	120,664	136,948	82,310	115,626	101,167	101,395	81,060	122,620	148,589	104,374	114,879
19-Aug	158,044	154,349	85,317	201,679	120,664	136,948	82,519	115,825	101,332	101,501	82,273	126,520	148,662	105,490	115,458
20-Aug	158,044	154,349	85,317	201,679	120,664	136,948	82,611	115,929	101,469	101,845	82,337	128,278	148,884	105,972	115,708
21-Aug	158,044	154,349	85,317	201,679	120,664	136,948	82,616	116,038	101,778	101,845	82,612	128,596	148,884	106,174	115,809
22-Aug	158,044	154,349	85,317	201,679	120,664	136,948	84,293	116,078	101,962	101,845	83,450	128,746	148,884	106,416	116,098
23-Aug	158,044	154,349	85,317	201,679	120,664	136,948	84,387	117,295	102,139	101,845	83,610	128,842	148,884	106,746	116,273
24-Aug	158,044	154,349	85,317	201,679	120,664	136,948	85,058	118,422	102,895	101,845	83,672	128,947	148,884	107,156	116,545
27-Aug	158,044	154,349	85,317	201,679	120,664	136,948	88,922	119,415	105,363	101,845	86,483	130,414	148,884	108,704	117,705
28-Aug	158,044	154,349	85,317	201,679	120,664	136,948	89,084	119,499	105,363	101,845	86,793	130,620	148,884	108,824	117,781
29-Aug	158,044	154,349	85,317	201,679	120,664	136,948	89,427	120,116	105,363	101,845	87,443	130,943	148,884	109,142	117,975
30-Aug	158,044	154,349	85,317	201,679	120,664	136,948	89,516	120,186	105,363	101,845	88,378	132,401	148,884	109,635	118,230
31-Aug	158,044	154,349	85,317	201,679	120,664	136,948	89,516	120,186	105,363	101,845	89,486	132,698	148,884	109,916	118,370
1-Sep	158,044	154,349	85,317	201,679	120,664	136,948	89,516	120,186	105,363	101,845	90,169	132,774	148,884	110,067	118,446
2-Sep	158,044	154,349	85,317	201,679	120,664	136,948	89,516	120,186	105,363	101,845	91,174	133,226	148,884	110,359	118,592
3-Sep	158,044	154,349	85,317	201,679	120,664	136,948	89,516	120,186	105,363	101,845	92,001	133,498	148,884	110,579	118,702
4-Sep	158,044	154,349	85,317	201,679	120,664	136,948	89,516	120,186	105,363	101,845	92,211	133,627	148,884	110,646	118,736
5-Sep	158,044	154,349	85,317	201,679	120,664	136,948	89,516	120,186	105,363	101,845	92,949	134,058	148,884	110,880	118,853
6-Sep	158,044	154,349	85,317	201,679	120,664	136,948	89,516	120,186	105,363	101,845	93,508	134,469	148,884	111,074	118,950
7-Sep	158,044	154,349	85,317	201,679	120,664	136,948	89,516	120,186	105,363	101,845	94,114	134,565	148,884	111,215	119,020
8-Sep	158,044	154,349	85,317	201,679	120,664	136,948	89,516	120,186	105,363	101,845	94,313	134,642	148,884	111,270	119,047
9-Sep	158,044	154,349	85,317	201,679	120,664	136,948	89,516	120,186	105,363	101,845	94,680	134,642	148,884	111,343	119,084

Appendix C4.–Cummulative and average sockeye salmon escapement counts, Dog Salmon Weir, 2000–2012.

	Year													Average	
Date	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	5 Year (2007-2011)	10 Year (2002-2011)
28-May	-	2,500	-	-	-	-	-	-	-	-	-	-	-	-	-
29-May	-	4,037	-	-	-	-	-	-	-	-	-	-	-	-	-
30-May	-	13,601	-	-	-	-	-	-	-	-	-	-	-	-	-
31-May	-	14,499	-	-	1	-	-	-	-	-	-	3	-	1	0
1-Jun	-	15,413	-	-	1	-	-	-	-	-	12	4	234	3	2
2-Jun	-	26,062	-	-	1	6,969	-	-	-	-	12	17	234	6	700
3-Jun	-	29,163	-	-	1	19,656	-	-	-	-	12	17	235	6	1,969
4-Jun	-	40,222	-	-	1	27,850	-	-	-	-	12	20	235	6	2,788
5-Jun	-	44,094	5,060	-	9,816	34,406	-	-	-	-	13	21	235	7	4,932
6-Jun	-	47,906	6,858	-	34,677	34,406	-	-	1	2	13	22	244	8	7,598
7-Jun	-	63,511	7,364	-	46,535	41,160	-	7	1	4	13	22	244	9	9,511
8-Jun	144	71,241	8,019	-	53,026	41,193	-	8	5	6	15	32	244	13	10,230
9-Jun	144	80,258	12,519	143	54,081	41,577	-	14	141	2,744	15	4,245	317	1,432	11,548
10-Jun	177	88,362	14,019	144	54,085	41,790	-	36	766	11,196	15	5,809	355	3,564	12,786
11-Jun	189	91,332	17,579	144	55,391	42,666	-	38	766	13,364	15	6,589	364	4,154	13,655
12-Jun	280	95,581	22,100	2,451	55,406	42,730	680	56	766	18,895	15	7,388	388	5,424	15,049
13-Jun	3,909	110,398	26,148	3,502	64,142	47,417	721	60	766	20,275	15	8,470	2,242	5,917	17,152
14-Jun	14,015	120,891	27,374	3,681	67,894	50,812	721	60	10,412	20,536	53	9,164	15,178	8,045	19,071
15-Jun	37,912	126,609	29,612	3,690	69,093	51,356	721	97	15,032	22,235	1,346	11,937	17,170	10,129	20,512
16-Jun	61,926	126,742	32,501	8,699	76,389	53,198	721	149	17,151	24,109	1,347	12,288	34,947	11,009	22,655
17-Jun	71,934	127,136	34,521	13,050	82,661	54,227	721	184	17,420	29,483	6,694	15,477	38,214	13,852	25,444
18-Jun	79,624	127,338	36,342	13,272	84,909	57,504	721	7,294	17,846	38,748	9,030	15,921	42,949	17,768	28,159
19-Jun	81,826	127,635	37,817	16,982	97,345	58,695	721	9,593	19,587	43,033	10,637	19,080	53,800	20,386	31,349
20-Jun	85,041	127,886	39,738	18,085	101,602	62,017	8,760	12,299	29,061	43,794	14,083	25,312	62,659	24,910	35,475
21-Jun	90,491	128,002	42,790	27,008	103,924	69,115	10,012	13,066	36,274	43,794	15,216	29,071	64,234	27,484	39,027
22-Jun	90,820	128,103	45,364	31,987	105,380	71,912	10,266	13,785	48,448	43,799	25,369	35,542	64,250	33,389	43,185
23-Jun	91,273	129,535	46,138	33,711	106,048	74,802	11,923	13,785	50,131	45,227	25,631	36,829	65,892	34,321	44,423
24-Jun	93,401	131,897	47,740	37,458	107,771	75,403	12,122	14,217	51,795	52,038	26,442	37,435	68,077	36,385	46,242
25-Jun	98,163	134,272	49,989	39,349	109,235	76,233	15,353	16,120	56,454	53,359	28,453	38,473	70,273	38,572	48,302
26-Jun	104,070	134,494	52,385	41,924	109,855	77,398	17,032	20,901	57,085	55,570	36,972	47,910	82,659	43,688	51,703
27-Jun	104,661	136,651	53,628	45,106	110,610	78,385	17,448	24,106	60,724	66,929	41,536	47,998	86,899	48,259	54,647
28-Jun	105,984	136,817	56,282	58,458	112,470	78,922	20,900	26,395	60,950	79,199	43,695	49,409	90,233	51,930	58,668
29-Jun	106,765	137,108	56,791	68,089	112,596	80,037	21,137	27,391	63,195	80,528	46,392	54,478	92,158	54,397	61,063
30-Jun	106,968	137,169	58,553	84,344	113,802	82,091	21,627	36,592	73,989	83,923	53,739	56,968	94,561	61,042	66,563

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Date	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average 5 Year (2007-2011)	Average 10 Year (2002-2011)
1-Jul	107,231	138,456	61,537	88,095	113,926	88,435	26,015	39,938	76,471	85,767	53,739	63,580	96,833	63,899	69,750
2-Jul	108,795	138,762	63,972	95,188	115,899	90,572	28,075	47,129	76,509	85,890	55,494	77,500	98,653	68,504	73,623
3-Jul	109,374	138,891	66,215	103,988	117,484	90,861	29,636	52,995	82,832	88,016	58,059	79,908	99,659	72,362	76,999
4-Jul	111,681	140,867	68,006	104,051	120,235	93,169	34,658	56,425	86,005	90,662	58,270	86,910	100,333	75,654	79,839
5-Jul	113,559	145,638	68,857	119,780	128,926	93,468	36,897	58,294	86,144	92,919	59,565	103,126	102,377	80,010	84,798
6-Jul	117,088	147,399	69,486	129,701	134,157	96,392	38,643	68,373	89,466	93,517	60,408	107,479	103,599	83,849	88,762
7-Jul	117,889	148,080	72,755	133,883	135,262	99,417	41,130	71,686	96,101	98,882	65,833	107,649	109,308	88,030	92,260
8-Jul	117,908	148,609	74,868	149,402	148,101	112,401	43,368	73,754	104,357	99,133	71,388	109,757	110,619	91,678	98,653
9-Jul	119,105	148,955	75,504	161,475	149,484	113,925	45,787	77,394	119,773	99,685	72,312	113,924	112,558	96,618	102,926
10-Jul	120,405	149,083	78,431	171,503	151,103	115,936	45,916	86,173	120,660	100,865	77,512	114,535	114,833	99,949	106,263
11-Jul	128,418	149,649	79,326	177,801	151,154	116,482	48,524	88,930	120,713	103,918	80,493	119,077	115,213	102,626	108,642
12-Jul	136,637	150,178	82,786	185,574	152,408	119,008	49,515	93,600	121,670	104,280	88,435	123,329	120,911	106,263	112,061
13-Jul	145,148	150,390	82,802	196,019	152,412	123,295	53,846	96,062	125,144	107,599	94,074	129,734	121,874	110,523	116,099
14-Jul	152,315	152,520	84,110	202,384	153,313	124,237	54,358	100,321	126,978	108,646	95,481	134,936	121,892	113,272	118,476
15-Jul	152,640	153,679	84,775	210,938	156,942	125,686	56,553	102,019	128,593	111,068	102,264	137,157	123,930	116,220	121,600
16-Jul	153,603	155,464	85,556	219,325	163,932	128,598	58,982	104,826	129,921	111,924	108,808	141,638	124,004	119,423	125,351
17-Jul	154,128	156,254	87,342	221,909	164,421	128,987	59,227	107,573	132,381	114,079	111,035	145,202	133,343	122,054	127,216
18-Jul	155,227	156,336	89,025	224,461	172,734	129,267	59,523	112,402	132,586	114,567	111,451	147,916	137,137	123,784	129,393
19-Jul	158,542	156,336	89,402	228,577	176,004	130,974	62,180	117,165	133,726	116,057	114,231	149,080	137,618	126,052	131,740
20-Jul	159,955	156,531	90,228	231,922	176,779	131,455	63,334	122,152	135,381	116,059	115,064	152,334	137,727	128,198	133,471
21-Jul	161,829	156,792	90,941	235,464	183,523	132,020	63,470	122,644	136,491	118,978	117,029	153,352	139,651	129,699	135,391
22-Jul	162,204	157,149	91,942	239,252	188,795	132,473	64,287	124,319	136,884	119,221	118,555	154,772	139,733	130,750	137,050
23-Jul	162,322	157,539	92,327	244,117	190,320	133,680	65,787	125,148	139,416	119,241	118,795	158,098	139,781	132,140	138,693
24-Jul	162,578	157,991	93,180	246,693	193,117	134,071	74,449	125,248	141,314	119,635	120,423	159,277	143,070	133,179	140,741
25-Jul	163,140	158,338	93,449	247,268	197,250	135,992	74,600	126,779	141,910	121,411	120,752	160,449	144,070	134,260	141,986
26-Jul	164,254	158,480	93,600	247,882	199,006	136,448	75,646	127,048	142,961	124,104	122,489	160,748	144,434	135,470	142,993
27-Jul	165,608	158,891	95,087	250,174	203,537	136,742	76,181	127,262	143,524	129,325	123,513	162,317	147,982	137,188	144,766
28-Jul	166,098	159,275	96,064	252,092	206,489	137,168	77,686	127,843	144,568	130,281	125,144	163,142	148,028	138,196	146,048
29-Jul	166,559	160,097	97,176	253,292	207,421	137,577	78,636	131,080	146,017	141,762	125,595	166,383	148,538	142,167	148,494
30-Jul	166,969	160,671	97,876	254,389	208,296	138,005	78,653	133,369	146,527	144,530	128,916	167,035	149,426	144,075	149,760
31-Jul	167,235	161,345	98,545	255,056	209,839	138,114	83,607	134,072	147,842	144,711	129,156	168,586	149,999	144,873	150,953

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Appendix C4.–Page 3 of 3.

	Year													Average	
Date	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	5 Year (2007-2011)	10 Year (2002-2011)
1-Aug	167,947	161,418	99,158	256,468	211,193	139,572	87,210	134,219	148,520	144,723	129,628	168,831	150,475	145,184	151,952
2-Aug	168,385	161,500	99,607	257,619	213,376	141,730	92,565	136,735	148,685	145,166	130,285	169,522	150,759	146,079	153,529
3-Aug	168,675	161,564	100,500	258,319	217,310	142,419	93,126	136,842	149,235	145,185	130,629	170,250	151,194	146,428	154,382
4-Aug	168,988	161,632	101,201	259,287	219,567	142,424	98,523	136,859	149,626	145,487	131,514	170,661	151,384	146,829	155,515
5-Aug	169,193	161,729	101,967	259,843	221,401	143,350	98,870	136,905	150,268	145,612	131,769	172,451	151,561	147,401	156,244
6-Aug	169,392	161,867	102,315	260,948	222,014	143,538	99,069	137,246	151,222	145,639	132,490	172,685	151,986	147,856	156,717
7-Aug	169,754	162,008	102,936	261,408	222,759	144,472	99,507	137,338	151,591	145,799	132,742	174,055	152,621	148,305	157,261
8-Aug	169,851	162,054	103,538	261,535	223,266	145,256	100,056	137,489	151,878	145,839	133,269	174,186	153,019	148,532	157,631
9-Aug	170,312	162,215	103,934	261,613	226,266	147,760	100,869	138,276	151,952	145,990	133,591	174,478	153,217	148,857	158,473
10-Aug	170,575	162,305	104,236	262,237	226,266	148,971	101,683	138,340	152,113	145,992	133,775	174,730	153,423	148,990	158,834
11-Aug	170,947	162,330	104,412	262,564	226,266	149,029	102,362	138,459	152,160	146,172	134,060	175,198	153,621	149,210	159,068
12-Aug	171,158	162,411	104,582	262,731	226,266	149,708	102,513	138,602	152,165	146,313	135,100	175,708	153,727	149,578	159,369
13-Aug	171,486	162,462	104,705	262,731	226,266	149,866	103,363	139,074	152,221	146,566	135,100	176,191	153,846	149,830	159,608
14-Aug	171,602	162,501	104,931	262,731	226,266	150,298	104,114	139,227	152,245	146,648	135,100	177,211	154,005	150,086	159,877
15-Aug	171,664	162,527	105,057	262,731	226,266	151,215	105,076	139,391	152,433	147,798	135,100	178,215	154,118	150,587	160,328
16-Aug	171,844	162,682	105,130	262,731	226,266	151,450	105,448	139,391	152,707	147,798	135,100	178,363	154,231	150,672	160,438
17-Aug	172,160	162,803	105,215	262,731	226,266	151,605	106,110	139,673	152,774	147,798	135,100	178,499	154,310	150,769	160,577
18-Aug	172,348	162,844	105,367	262,731	226,266	152,066	106,993	139,684	152,794	147,798	135,100	178,594	154,416	150,794	160,739
19-Aug	172,463	162,879	105,487	262,731	226,266	152,278	108,193	139,706	153,026	147,798	135,100	179,480	154,416	151,022	161,007
20-Aug	172,542	162,950	105,550	262,731	226,266	152,907	108,343	139,724	153,276	147,798	135,100	179,603	154,416	151,100	161,130
21-Aug	172,675	162,961	105,579	262,731	226,266	152,959	108,343	139,729	153,276	147,798	135,100	180,553	154,416	151,291	161,233
22-Aug	172,758	162,992	105,664	262,731	226,266	152,959	108,343	139,808	153,276	147,798	135,100	180,603	154,416	151,317	161,255
23-Aug	172,808	163,002	105,725	262,731	226,266	152,959	108,343	139,808	153,276	147,798	135,100	180,603	154,416	151,317	161,261
24-Aug	172,859	163,009	105,770	262,731	226,266	152,959	108,343	139,808	153,276	147,798	135,100	180,603	154,416	151,317	161,265
25-Aug	172,903	163,309	105,824	262,731	226,266	152,959	108,343	139,808	153,276	147,798	135,100	180,603	154,416	151,317	161,271
26-Aug	172,912	163,309	105,838	262,731	226,266	152,959	108,343	139,808	153,276	147,798	135,100	180,603	154,416	151,317	161,272
27-Aug	172,943	163,309	105,988	262,731	226,266	152,959	108,343	139,808	153,276	147,798	135,100	180,603	154,416	151,317	161,287
28-Aug	173,343	163,309	105,988	262,731	226,266	152,959	108,343	139,808	153,276	147,798	135,100	180,603	154,416	151,317	161,287
29-Aug	173,343	163,309	105,988	262,731	226,266	152,959	108,343	139,808	153,276	147,798	135,100	180,603	154,416	151,317	161,287
30-Aug	173,343	163,309	105,988	262,731	226,266	152,959	108,343	139,808	153,276	147,798	135,100	180,603	154,416	151,317	161,287
31-Aug	173,343	163,309	105,988	262,731	226,266	152,959	108,343	139,808	153,276	147,798	135,100	180,603	154,416	151,317	161,287

Appendix C5.–Cummulative and average pink salmon escapement counts, Frazer Fish Pass, 2002–2012.

	Year											Average	
Date	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	5 Year (2007-2011)	10 Year (2002-2011)
9-Jul	0	1	0	0	0	0	0	0	0	0	0	0	0
10-Jul	0	1	0	0	0	0	0	0	0	0	0	0	0
11-Jul	0	1	0	0	0	0	0	0	0	0	0	0	0
12-Jul	0	1	0	0	0	0	0	0	0	0	0	0	0
13-Jul	0	1	0	0	0	0	0	0	0	0	0	0	0
14-Jul	0	1	0	0	0	0	0	0	0	0	0	0	0
15-Jul	0	1	0	0	0	0	1	0	0	0	0	0	0
16-Jul	0	1	0	0	0	0	1	0	0	0	0	0	0
17-Jul	0	1	0	0	0	0	1	0	0	0	0	0	0
18-Jul	0	1	0	0	0	0	1	0	0	0	0	0	0
19-Jul	0	1	0	0	0	0	1	0	0	0	0	0	0
20-Jul	0	1	0	0	2	0	1	0	0	0	0	0	0
21-Jul	0	1	0	0	2	0	1	0	0	0	0	0	0
22-Jul	0	1	0	0	2	0	1	0	0	0	0	0	0
23-Jul	0	1	0	0	2	0	1	0	0	0	0	0	0
24-Jul	0	1	0	0	2	0	1	0	0	0	0	0	0
25-Jul	0	1	0	0	2	0	1	0	0	0	0	0	0
26-Jul	0	1	0	0	2	0	1	0	0	0	0	0	0
27-Jul	0	1	0	0	2	0	1	0	0	0	0	0	0
28-Jul	0	1	0	0	2	0	1	0	0	0	0	0	0
29-Jul	0	1	0	0	2	0	1	0	0	0	0	0	0
30-Jul	0	1	0	0	2	0	1	0	0	0	0	0	0
31-Jul	0	1	0	0	2	0	1	1	0	0	0	0	1
1-Aug	0	1	0	0	2	0	1	1	0	0	0	0	1
2-Aug	0	1	0	0	2	0	1	1	0	0	0	0	1
3-Aug	0	1	0	0	2	0	1	1	0	0	0	0	1
4-Aug	0	1	0	0	2	0	1	2	0	0	0	1	1
5-Aug	0	1	0	0	2	0	1	2	0	0	0	1	1
6-Aug	0	1	0	0	2	0	1	2	0	0	0	1	1
7-Aug	0	1	0	0	2	0	3	2	0	0	0	1	1
8-Aug	0	1	0	2	2	0	3	2	0	0	0	1	1
9-Aug	0	1	3,058	2	2	0	3	2	0	0	0	1	307
10-Aug	0	1	4,420	2	2	0	3	2	0	0	0	1	443

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	Year											Average	
Date	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	5 Year (2007-2011)	10 Year (2002-2011)
11-Aug	0	1	4,701	2	2	0	3	2	0	0	0	1	471
12-Aug	0	1	4,782	2	2	0	3	2	0	0	0	1	479
13-Aug	0	1	4,825	2	2	0	3	2	0	0	0	1	484
14-Aug	0	1	4,855	2	2	0	3	2	0	0	0	1	487
15-Aug	1	1	4,869	2	2	0	3	2	0	0	0	1	488
16-Aug	1	1	4,869	2	2	0	3	2	0	0	0	1	488
17-Aug	1	1	4,869	2	2	0	3	2	0	0	2	1	488
18-Aug	1	1	4,869	2	2	0	3	2	0	0	2	1	488
19-Aug	1	1	4,869	2	2	0	3	2	0	0	2	1	488
20-Aug	1	1	4,869	2	2	0	3	2	0	0	2	1	488
21-Aug	1	1	4,869	2	2	0	3	2	0	0	2	1	488
22-Aug	1	1	4,869	2	2	0	3	2	0	2	2	1	488
23-Aug	1	1	4,869	2	2	0	3	2	0	5	2	2	489
24-Aug	1	1	4,869	2	2	0	12	2	0	5	2	4	489
25-Aug	1	1	4,869	2	2	0	35	2	0	5	2	8	492
26-Aug	1	1	4,869	2	2	0	249	2	106	7	2	73	524
27-Aug	1	1	4,869	2	5	0	283	2	230	7	2	104	540
28-Aug	1	1	4,869	2	43	0	283	2	362	7	2	131	557
29-Aug	1	1	4,869	2	338	0	283	2	571	7	2	173	607
30-Aug	1	1	4,869	2	447	0	283	2	984	7	2	255	660
31-Aug	1	1	4,869	2	447	0	283	2	1,636	7	2	386	725
1-Sep	1	1	4,869	2	447	0	283	2	2,167	7	2	492	778
2-Sep	1	1	4,869	2	447	0	283	2	3,621	7	2	783	923
3-Sep	1	1	4,869	2	447	0	283	2	5,290	7	2	1,116	1,090
4-Sep	1	1	4,869	2	447	0	283	2	6,175	7	2	1,293	1,179
5-Sep	1	1	4,869	2	447	0	283	2	7,394	7	2	1,537	1,301
6-Sep	1	1	4,869	2	447	0	283	2	8,407	7	2	1,740	1,402
7-Sep	1	1	4,869	2	447	0	283	2	9,760	7	2	2,010	1,537
8-Sep	1	1	4,869	2	447	0	283	2	10,442	7	2	2,147	1,605
9-Sep	1	1	4,869	2	447	0	283	2	10,863	7	2	2,231	1,648
10-Sep	1	1	4,869	2	447	0	283	2	11,288	7	2	2,316	1,690
11-Sep	1	1	4,869	2	447	0	283	2	11,451	7	2	2,349	1,706
12-Sep	1	1	4,869	2	447	0	283	2	11,451	7	2	2,349	1,706

Appendix C6.–Daily and average Chinook salmon escapement counts, Frazer Fish Pass, 2002–2012.

	Year											Average	
Date	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	5 Year (2007-2011)	10 Year (2002-2011)
10-Jun	0	0	0	1	0	0	0	0	0	0	0	0	0
11-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Jun	1	0	1	0	0	0	0	0	0	0	0	0	0
15-Jun	2	2	0	2	0	0	0	0	0	0	0	0	1
16-Jun	1	0	1	0	0	0	1	0	0	0	0	0	0
17-Jun	1	2	0	0	0	0	0	0	1	0	0	0	0
18-Jun	2	17	1	0	0	0	0	0	0	0	0	0	2
19-Jun	5	4	0	0	0	0	0	0	2	0	2	0	1
20-Jun	5	0	0	0	0	0	0	1	0	0	0	0	1
21-Jun	4	7	1	1	0	0	0	1	2	1	0	1	2
22-Jun	1	4	0	0	0	5	0	1	6	0	0	2	2
23-Jun	13	22	0	11	4	4	0	0	2	0	0	1	6
24-Jun	8	1	0	12	0	0	0	0	0	0	1	0	2
25-Jun	11	4	18	0	0	0	0	3	0	0	1	1	4
26-Jun	7	13	62	2	0	1	0	0	0	0	0	0	9
27-Jun	4	23	8	4	1	0	0	1	0	0	1	0	4
28-Jun	9	8	4	4	0	0	0	0	1	0	6	0	3
29-Jun	10	12	4	3	4	0	0	6	0	3	0	2	4
30-Jun	12	15	9	5	1	0	0	3	0	5	6	2	5
1-Jul	4	8	8	8	0	0	0	2	0	1	0	1	3
2-Jul	9	71	17	1	0	4	0	0	0	1	1	1	10
3-Jul	15	34	6	1	6	0	1	0	0	0	0	0	6
4-Jul	10	3	8	4	0	0	1	1	0	0	0	0	3
5-Jul	15	6	7	4	2	11	0	6	0	2	2	4	5
6-Jul	5	7	3	3	1	5	0	3	0	0	0	2	3
7-Jul	2	33	3	9	2	2	0	0	0	0	0	0	5
8-Jul	4	18	0	11	0	3	0	2	0	0	0	1	4
9-Jul	2	24	3	5	1	2	2	1	0	2	2	1	4
10-Jul	0	8	2	10	0	1	2	2	0	0	1	1	3

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	Year											Average	
Date	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	5 Year (2007-2011)	10 Year (2002-2011)
11-Jul	2	4	1	3	0	0	0	1	0	0	0	0	1
12-Jul	12	3	2	8	0	0	0	0	0	0	3	0	3
13-Jul	0	8	0	5	0	0	1	0	0	0	0	0	1
14-Jul	2	5	3	4	3	0	0	1	1	3	0	1	2
15-Jul	4	5	2	0	1	0	0	0	1	0	0	0	1
16-Jul	3	7	1	0	5	0	0	2	0	0	0	0	2
17-Jul	1	3	2	0	0	0	0	0	0	0	0	0	1
18-Jul	3	0	2	0	0	4	1	0	1	1	1	1	1
19-Jul	0	1	2	1	1	0	5	0	1	0	0	1	1
20-Jul	1	4	0	4	0	0	0	0	0	1	2	0	1
21-Jul	0	7	0	2	1	0	1	0	0	0	1	0	1
22-Jul	0	8	3	9	0	0	0	0	2	3	0	1	3
23-Jul	1	0	3	0	0	0	0	0	1	2	0	1	1
24-Jul	3	1	0	0	2	0	0	0	0	0	1	0	1
25-Jul	0	2	1	2	1	1	0	0	0	0	0	0	1
26-Jul	0	0	0	0	0	1	0	0	9	0	0	2	1
27-Jul	2	3	0	3	0	0	0	0	2	0	1	0	1
28-Jul	0	1	0	1	0	1	2	0	1	0	0	1	1
29-Jul	1	1	0	0	1	0	0	0	3	0	0	1	1
30-Jul	1	3	0	0	1	3	0	2	1	0	0	1	1
31-Jul	0	16	2	4	0	0	0	0	1	0	0	0	2
1-Aug	0	2	2	0	0	0	0	0	0	0	0	0	0
2-Aug	0	1	0	2	3	0	0	0	0	0	0	0	1
3-Aug	1	5	1	2	6	0	0	0	0	0	0	0	2
4-Aug	1	5	0	0	0	0	0	2	0	0	0	0	1
5-Aug	0	0	1	2	1	0	0	0	1	0	0	0	1
6-Aug	0	0	1	0	0	0	0	0	0	0	1	0	0
7-Aug	0	2	1	0	0	0	2	0	1	0	3	1	1
8-Aug	2	0	0	3	0	0	0	0	1	0	0	0	1
9-Aug	1	0	4	0	0	1	0	0	0	0	0	0	1
10-Aug	0	0	2	0	0	0	0	0	0	0	0	0	0

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	Year											Average	
Date	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	5 Year (2007-2011)	10 Year (2002-2011)
11-Aug	0	0	2	0	1	0	0	0	0	1	2	0	0
12-Aug	1	0	0	0	0	1	0	0	0	0	0	0	0
13-Aug	3	0	0	0	0	0	0	0	0	0	0	0	0
14-Aug	4	0	0	0	0	0	0	0	0	0	0	0	0
15-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Aug	0	0	0	0	0	0	0	0	0	0	1	0	0
17-Aug	0	0	0	0	1	0	0	0	0	0	0	0	0
18-Aug	0	0	0	0	2	0	0	0	0	0	0	0	0
19-Aug	0	0	0	0	1	0	0	0	0	0	0	0	0
20-Aug	0	0	0	0	0	0	0	1	0	0	0	0	0
21-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Aug	0	0	0	0	1	0	0	0	0	0	0	0	0
23-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Aug	0	0	0	0	2	0	0	0	0	0	0	0	0
25-Aug	0	0	0	0	1	0	0	0	0	0	0	0	0
26-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Aug	0	0	0	0	1	1	0	0	0	0	0	0	0
28-Aug	0	0	0	0	0	3	0	0	0	0	0	1	0
29-Aug	0	0	0	0	1	3	0	0	0	0	0	1	0
30-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Sep	0	0	0	0	0	0	0	0	0	1	0	0	0
2-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	211	443	204	156	59	57	19	42	41	27	39	37	126

Appendix C7.–Dog Salmon Weir and Frazer Fish Pass escapement, commercial harvest, total run, and remainder of sockeye salmon in Dog Salmon River, 1985–2012.

Year	Dog Salmon (DS) Weir Count	Commercial Harvest	Total Run	Frazer Fish Pass Count	Sockeye Remaining in DS River no.	%
1985	506,336	131,535	637,871	485,835	20,501	4.0
1986	136,553	41,652	178,205	126,529	10,024	7.3
1987	48,956	8,626	57,582	40,544	8,412	17.2
1988	248,055	210,406	458,461	246,704	1,351	0.5
1989	362,007	708,864	1,070,871	360,373	1,634	0.5
1990	254,540	725,293	979,833	226,707	27,833	10.9
1991	288,013	980,132	1,268,145	190,358	97,655	33.9
1992	206,406	212,367	418,773	185,825	20,581	10.0
1993	198,412	552,993	751,405	178,391	20,021	10.1
1994	240,913	409,132	650,045	206,071	34,842	14.5
1995	222,170	730,207	952,377	196,323	25,847	11.6
1996	208,638	492,275	700,913	198,695	9,943	4.8
1997	268,328	148,091	416,419	205,264	63,064	23.5
1998	245,409	360,949	606,358	233,755	11,654	4.7
1999	222,964	134,115	357,079	216,565	6,399	2.9
2000	173,340	221,366	394,706	158,044	15,296	8.8
2001	163,455	239,937	403,391	154,349	9,106	5.6
2002	105,989	4,237	110,226	85,317	20,672	19.5
2003	262,731	51,183	313,914	201,679	61,052	23.2
2004	226,266	485,985	712,251	120,664	105,602	46.7
2005	152,959	472,978	625,937	136,948	16,011	10.5
2006	108,343	9,557	117,900	89,516	18,827	17.4
2007	139,808	28,763	168,571	120,186	19,622	14.0
2008	153,276	367,327	520,603	105,363	47,913	31.3
2009	147,798	327,178	474,976	101,845	45,953	31.1
2010	135,100	30,012	165,112	94,680	40,420	29.9
2011	180,603	192,820	372,423	134,642	45,961	25.4
2012	154,416	217,631	372,049	148,884	5,532	3.6
Average (2007-2011)	151,317	189,220	340,337	111,343	39,974	26.4
Average (2002-2011)	161,287	197,004	358,191	119,084	42,203	24.9
Average (1985-2001)	234,970	371,055	606,026	212,372	22,598	10.0

Appendix C8.–Frazer Lake sockeye salmon brood table showing estimated returns from parent escapement by age class, 1966–2012.

Brood		Age																Total	Return/
Year	Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	4.1	2.4	4.2	3.3	other	Return	Spawner
1966	16,456	0	0	0	11,820	1,732	7,580	16,149	0	0	2,629	0	0	0	0	0	0	39,910	2.4
1967	21,834	0	1,118	0	38,626	395	38,395	11,553	0	0	5,114	0	0	0	0	0	0	95,202	4.4
1968	16,738	0	461	0	15,565	899	15,228	14,998	0	0	10,757	0	0	0	0	0	0	57,910	3.5
1969	14,041	0	138	0	14,654	5,229	9,306	30,137	0	0	6,007	0	0	0	0	512	0	65,984	4.7
1970	24,039	0	2,241	0	17,672	16,989	1,687	51,299	0	0	9,351	3,074	0	0	0	1,691	0	104,005	4.3
1971	55,366	0	512	0	1,417	6,345	769	92,226	0	0	20,151	0	0	0	0	0	0	121,419	2.2
1972	66,419	0	742	0	10,888	11,016	8,032	91,876	0	0	71,167	345	0	0	0	0	0	194,066	2.9
1973	56,255	0	256	0	2,677	5,637	4,825	31,706	345	0	15,969	0	0	0	0	0	0	61,415	1.1
1974	82,609	0	10,850	0	53,591	9,305	28,713	75,084	154	461	30,407	461	0	0	0	0	0	209,026	2.5
1975	64,199	0	1,034	0	22,571	8,906	20,732	173,687	0	0	72,701	0	0	0	0	0	0	299,631	4.7
1976	119,321	0	2,150	0	223,444	8,753	73,677	257,625	0	0	143,383	0	0	0	0	393	0	709,424	5.9
1977	139,548	0	2,764	0	73,189	2,928	92,211	107,917	0	0	146,064	393	0	0	0	0	0	425,466	3.0
1978	141,981	0	7,807	0	162,130	507	24,148	22,970	0	0	16,844	0	0	0	0	638	0	235,043	1.7
1979	126,742	0	507	0	1,374	982	2,965	24,323	0	0	26,791	0	0	0	0	2,165	0	59,106	0.5
1980	405,535	0	0	0	6,064	16,305	7,654	589,393	0	0	141,065	684	0	46	0	52	0	761,264	1.9
1981	377,716	0	876	0	12,120	0	2,455	7,748	0	172	5,239	0	0	0	0	862	0	29,471	0.1
1982	430,423	0	1,276	0	23,647	431	28,624	3,735	24	754	10,870	10,812	0	0	0	0	0	80,172	0.2
1983	158,340	0	10	26	8,935	9,729	13,438	380,531	1,604	0	586,833	0	0	0	0	36,986	0	1,038,092	6.6
1984	53,524	0	1,001	0	5,771	33,628	7,437	386,832	0	0	67,142	2,046	0	0	0	0	0	503,856	9.4
1985	485,835	0	192	0	16,502	4,399	49,290	53,978	151	0	22,578	9,032	0	1,595	0	2,694	0	160,412	0.3
1986	126,529	1,393	67,475	0	727,658	40,794	230,893	972,290	0	0	168,815	9,129	0	0	0	8,584	0	2,227,031	17.6
1987	40,544	0	1,787	1,851	3,019	26,596	3,902	187,581	0	0	159,822	104	0	156	0	882	0	385,701	9.5
1988	246,704	0	1,886	0	21,073	7,793	30,096	210,586	133	0	64,565	20,510	0	16	0	7,994	0	364,652	1.5
1989	360,373	0	16,191	208	327,929	12,847	153,078	373,277	5,752	0	300,182	145,325	0	0	0	40,754	0	1,375,543	3.8
1990	226,707	0	1,096	0	18,217	12,986	33,393	400,750	1,678	0	210,744	15,341	0	455	0	9,340	0	704,000	3.1
1991	190,358	0	621	0	2,031	57,463	1,728	330,834	302	0	105,361	630	0	0	0	0	0	498,970	2.6
1992	185,825	0	3,545	0	20,513	78,168	27,471	211,959	4,666	0	185,148	18,141	0	0	0	2,209	0	551,819	3.0
1993	178,391	0	2,529	45	12,677	41,759	56,178	291,218	4,831	0	64,155	17,867	0	256	0	5,830	0	497,344	2.8
1994	206,071	0	2,056	0	23,034	17,688	39,741	112,849	1,048	0	77,546	15,427	0	187	0	15,733	0	305,309	1.5
1995	196,323	0	10,106	0	59,574	39,574	77,223	152,287	1,251	0	251,356	11,284	0	815	0	5,387	0	608,857	3.1
1996	198,695	0	20,062	0	41,983	22,276	81,667	32,786	26	1,641	50,325	101	0	191	0	201	0	251,259	1.3
1997	205,264	0	626	0	8,327	1,639	9,831	14,560	231	630	15,665	2,251	0	0	0	0	77	53,837	0.3
1998	233,755	0	367	0	1,374	24,808	14,710	87,861	16,454	0	57,957	88,617	0	366	0	33,880	0	326,394	1.4
1999	216,565	0	1,152	0	3,507	136,968	77	481,220	0	0	241,075	1,299	0	496	0	2,090	97	867,981	4.0

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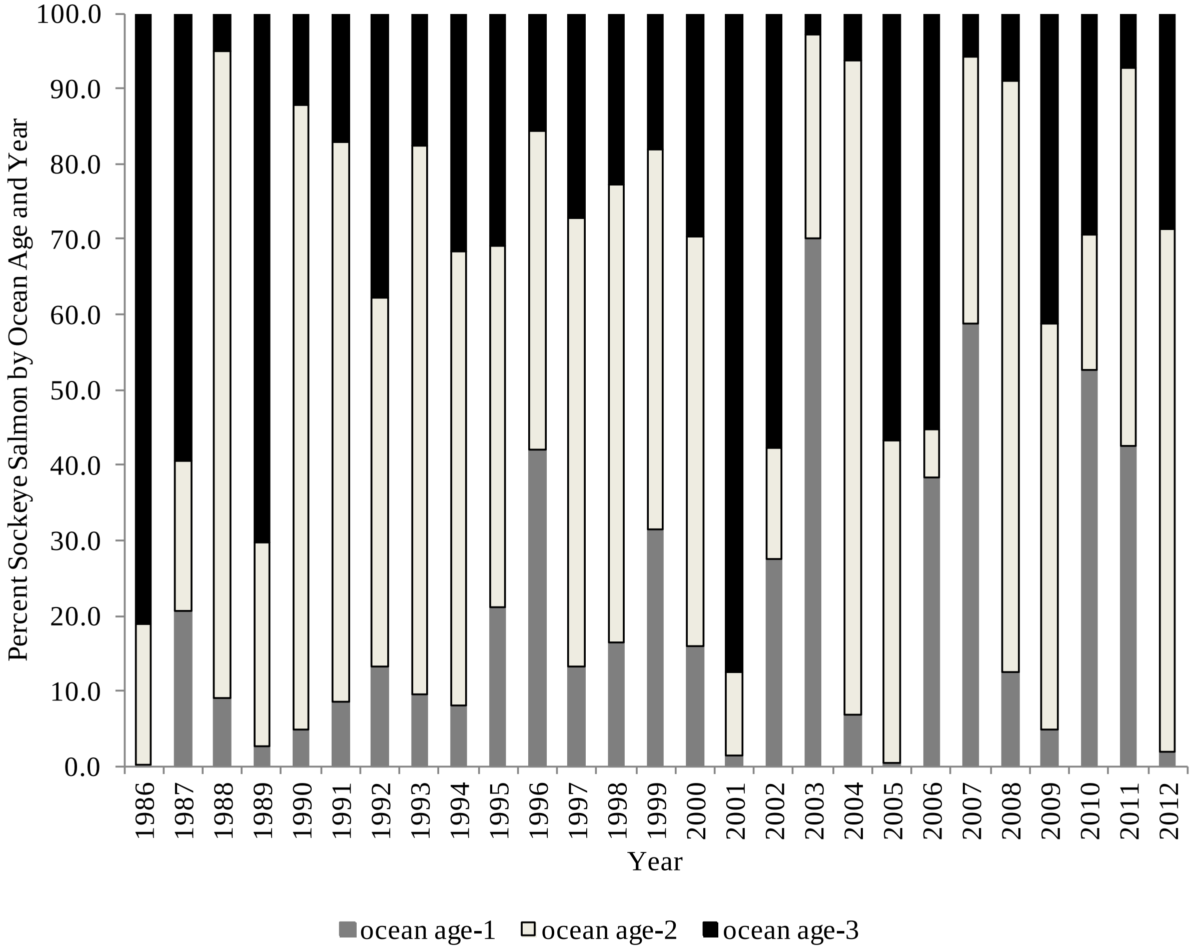
Brood		Age																Total	Return/
Year	Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	4.1	2.4	4.2	3.3	other	Return	Spawner
2000	158,044	0	35,476	0	68,494	15,072	219,630	107,018	0	521	58,178	330	0	547	233	289	521	506,309	3.2
2001	154,349	0	814	0	21,700	557	5,639	3,657	23,842	131	11,476	29,633	293	776	718	81,003	1,501	181,739	1.2
2002	85,317	0	335	0	5,659	14,124	5,844	27,492	11,173	0	44,559	35,868	0	415	0	29,071	153	174,694	2.0
2003	201,679	0	3,365	0	8,565	58,042	16,372	170,743	2,948	0	81,058	31,271	0	162	0	1,004	0	373,528	1.9
2004	120,664	0	14,757	0	148,241	16,861	90,953	197,458	0	250	20,896	233	0	175	0	0	0	489,822	4.1
2005	136,949	0	1,993	0	34,005	9,131	34,164	29,710	8,606	434	36,619	3,204	90	344	0	506		158,806	1.2
2006	89,516	0	113	224	5,281	58,888	21,506	216,074	7,610	0	118,641	5,882	0						
2007	120,185	0	5,543	660	13,247	68,111	21,217	174,630	0										
2008	105,363	0	4,692	0	46,539	3,757													
2009	101,845	499	34																
2010	94,680																		
2011	134,565																		
2012	148,884																		
10-Year Average (1994-2003):		Number	6,760	0	22,020	30,068	42,794	108,225	5,180	266	88,920	19,644	27	360	87	15,333	235	364,991	
10-Year Average (1994-2003):		Percent	1.9	0.0	6.0	8.2	11.7	29.7	1.4	0.1	24.4	5.4	0.0	0.1	0.0	4.2	0.1	100.0	2.0

Appendix C9.–Frazer Lake sockeye salmon escapement by ocean age and year, 1986–2012.

	Ocean Age					
Year	1	%	2	%	3	%
1986	293	0.2	23,242	18.6	101,363	81.2
1987	8,322	20.7	7,982	19.8	23,950	59.5
1988	22,052	9.0	211,196	85.9	12,621	5.1
1989	9,960	2.8	97,044	26.9	253,122	70.3
1990	10,612	4.9	181,639	83.1	26,399	12.1
1991	16,562	8.7	141,114	74.1	32,681	17.2
1992	24,243	13.2	90,256	49.0	69,725	37.8
1993	16,967	9.6	129,240	73.0	30,919	17.5
1994	16,601	8.1	123,919	60.2	65,231	31.7
1995	41,321	21.1	94,149	48.1	60,386	30.8
1996	76,246	42.1	76,277	42.1	28,444	15.7
1997	26,768	13.3	119,137	59.4	54,785	27.3
1998	38,366	16.4	141,990	60.7	53,399	22.8
1999	68,320	31.6	108,918	50.3	39,294	18.1
2000	24,529	16.0	83,051	54.2	45,555	29.7
2001	1,959	1.3	16,642	11.2	129,345	87.4
2002	21,907	27.6	11,738	14.8	45,690	57.6
2003	141,449	70.2	54,369	27.0	5,589	2.8
2004	8,366	6.9	104,679	86.8	7,619	6.3
2005	624	0.5	56,535	42.8	75,082	56.8
2006	33,650	38.3	5,694	6.5	48,415	55.2
2007	70,300	58.8	42,323	35.4	6,941	5.8
2008	11,376	12.5	71,576	78.6	8,088	8.9
2009	4,636	4.9	51,035	53.9	39,005	41.2
2010	49,546	52.7	16,852	17.9	27,555	29.3
2011	57,113	42.5	67,498	50.2	9,806	7.3
2012	2,789	1.9	103,061	69.4	42,713	28.8
Average (1986-2011)	30,850	20.5	81,850	47.3	50,039	32.1
Average (1986-2001)	25,195	13.7	102,862	51.0	64,201	35.3
Average (2002-2011)	39,897	31.5	48,230	41.4	27,379	27.1

Appendix C10.–Percentage of Frazer Lake sockeye salmon escapement by ocean age and year, 1986–2012.



APPENDIX D. HISTORICAL LIMNOLOGICAL DATA

Appendix D1.–The number of limnological sampling stations and samples collected from Frazer Lake, 1985–1996, 2009–2012.

Year	Sampling Station	Total Samples
1985	1, 3	20
1986	1, 3	28
1987	1, 3	32
1988	1, 3	27
1989	1, 3	24
1990	1, 3	36
1991	1	14
1992	1, 3	26
1993	1	10
1994	1, 2, 3, 4	24
1995	1, 2, 3, 4	24
1996	1, 2, 3, 4	22
2009	1	5
2010	1, 3	20
2011	1, 3	24
2012	1, 3	20

Note: Map locations for stations 2 and 4 are available in Sagalkin (1999).

Appendix D2.–Yearly seasonal averages of 1-m temperature, dissolved oxygen, and light measurements from Frazer Lake, 2001–2012.

		Year												Average	
Month		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	5-yr	10-yr
May															
	Temp (°C)		2.8		10.5	4.2	3.0	3.8	3.8	3.4	2.8	4.1	2.8	3.6	4.1
	DO (mg/l)		13.0		10.5	12.6	12.7	12.6	12.8	13.2	13.3	13.3	13.1	13.0	12.7
	Light (Klux)		2,600		1,140	465	470	405	660	2,400	2,200	998	267	1,333	1,160
June															
	Temp (°C)				10.7	10.7	9.3	9.0	9.2	8.5	6.9	6.6	8.3	8.0	8.8
	DO (mg/l)				10.0	10.5	10.3	10.3	12.8	14.8	9.2	12.7	13.1	11.9	11.5
	Light (Klux)					475	1,950	390	11	1,831	207	331	225	554	677
July															
	Temp (°C)							12.4	10.1	14.7	11.2	10.2	9.9	11.7	11.4
	DO (mg/l)							9.8	11.5	10.0	10.8	11.9	12.0	10.8	11.0
	Light (Klux)							1,800	19	3,094	205	433	112	1,110	944
August															
	Temp (°C)					13.9	11.2	13.5	12.2	12.6	11.0	13.1	11.8	12.5	12.4
	DO (mg/l)					9.8	9.9	9.2	11.3	10.2	10.9	11.2	11.7	10.5	10.5
	Light (Klux)					525	285	300	3	3,781	642	129	240	971	738
September															
	Temp (°C)	11.2		13.0		12.6	10.1	10.5	10.2	10.8		10.4	10.1	10.5	11.0
	DO (mg/l)	10.4		10.3		9.9	10.9	10.9	10.7	10.9		11.0	11.6	10.9	10.8
	Light (Klux)	400		725		255	775	240	525	355		151	76	318	388
October															
	Temp (°C)		8.5	10.3							9.7	8.9	7.9	9.3	9.0
	DO (mg/l)		10.5	11.3							11.2	11.1	11.8	11.2	11.2
	Light (Klux)		1,050	1,950							115	10	71	62	639

Appendix D3.–Summary of seasonal mean epilimnion (1 meter), nutrient concentrations by station for Frazer Lake: 1985–1996, and 2009–2012.

		Depth	Total-P		Total filterable-P		Filterable reactive-P		Total Kjeldahl nitrogen		Ammonia		Nitrate+ nitrite		Chlorophyll α	
Year	Station	(m)	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD
1985	1	1	6.2	1.5	2.1	1.1	2.0	0.6	85.7	13.1	8.2	5.1	46.7	8.7	1.1	0.3
	3	1	6.0	1.0	2.2	0.7	2.1	0.9	87.9	15.7	14.8	19.3	49.7	12.5	1.2	0.5
1986	1	1	5.2	0.7	2.7	0.7	2.2	0.9	79.7	9.7	11.5	3.4	61.0	14.7	0.6	0.2
	3	1	5.2	0.9	3.0	0.8	2.0	0.7	78.9	7.4	11.1	4.2	58.7	19.4	0.6	0.2
1987	1	1	5.5	1.1	4.2	2.4	3.0	1.9	98.7	12.5	13.1	9.1	88.2	21.1	1.0	0.5
	3	1	6.2	0.9	3.7	0.8	2.0	0.7	98.3	6.9	10.8	8.5	80.7	21.7	0.9	0.5
1988	1	1	6.5	1.6	5.5	5.0	4.1	4.8	86.5	27.6	11.2	6.2	81.2	20.8	0.6	0.2
	3	1	7.2	4.0	3.3	1.1	2.0	0.5	92.3	35.7	11.1	7.6	83.4	19.7	0.6	0.4
1989	1	1	8.0	3.0	4.4	1.9	2.0	0.3	111.1	20.8	5.3	3.1	64.1	16.1	1.2	0.8
	3	1	8.3	6.8	4.1	1.3	2.7	1.0	107.9	26.6	5.9	4.5	70.1	17.0	1.0	0.8
1990	1	1	5.6	1.5	2.8	0.4	1.2	0.5	66.3	18.6	6.4	3.8	47.1	22.0	1.8	1.1
	3	1	5.9	1.7	2.9	0.5	1.3	0.5	69.7	24.9	9.4	9.9	44.8	18.2	1.7	1.5
1991	1	1	5.4	1.0	3.5	0.7	2.2	0.8	99.1	27.2	6.9	10.6	45.1	23.1	1.5	0.7
1992	1	1	5.4	2.7	2.7	1.2	1.4	0.6	106.4	32.5	7.6	6.3	69.4	22.1	1.3	0.8
	3	1	4.9	3.2	2.6	1.2	1.3	0.5	102.7	40.3	9.6	6.5	71.0	20.9	1.1	0.6
1993	1	1	5.2	0.8	3.4	1.1	2.1	0.6	100.7	16.1	6.3	1.3	56.8	28.8	1.7	0.5
1994	1	1	5.1	2.2	1.9	0.3	1.4	0.3	93.4	7.0	6.7	7.1	66.2	14.3	0.7	0.2
	3	1	6.4	3.8	2.1	0.7	1.5	0.5	103.2	16.5	9.8	10.8	68.2	19.5	0.6	0.2
1995	1	1	4.6	0.8	2.0	0.4	1.5	0.3	87.4	13.4	8.0	6.1	82.8	19.8	1.9	0.7
	3	1	4.9	0.8	2.0	0.3	1.4	0.3	87.9	14.6	7.2	6.1	88.1	22.6	1.6	0.9
1996	1	1	5.1	1.9	2.1	0.8	1.7	0.9	109.3	18.2	6.8	5.7	44.7	23.4	0.5	0.2
	3	1	4.8	0.9	2.0	0.9	1.5	0.8	108.0	19.4	6.3	6.6	49.1	28.2	0.5	0.2
2009	1	1	5.0	0.8	1.4	1.4	2.1	0.7	ND	ND	5.4	1.5	29.2	22.1	0.9	0.2
2010	1	1	3.8	0.6	1.9	0.4	1.3	0.3	97.0	71.0	6.1	4.6	36.9	16.6	0.7	0.2
	3	1	3.6	0.3	1.7	0.3	1.1	0.2	ND	ND	8.2	7.9	38.1	16.3	0.6	0.3
2011	1	1	5.2	0.7	2.2	0.6	0.8	0.4	148.3	15.6	5.1	3.0	25.8	17.4	1.3	0.6
	3	1	4.9	1.2	1.9	0.3	0.4	0.1	142.0	33.7	4.3	2.1	22.9	17.3	1.1	0.6
2012	1	1	3.8	0.2	1.6	0.0	0.8	0.1	271.4	2.5	4.1	0.8	30.5	3.9	1.3	0.1
	3	1	2.3	0.1	1.8	0.0	0.9	0.1	270.9	9.3	4.4	0.78	36.0	3.7	1.5	0.1
Mean St1 (1985–2011)			5.5	1.4	2.9	1.2	1.9	0.9	97.8	21.7	7.6	5.1	56.3	19.4	1.1	0.5
Mean St1 (2009–2011)			4.7	0.7	1.8	0.8	1.4	0.5	122.7	43.3	5.5	3.0	30.6	18.7	0.9	0.3

Appendix D4.–Summary of seasonal mean epilimnion (1 meter), water chemistry parameters by station and depth for Frazer Lake, 1985–1992, 1994–1996, and 2009–2012.

		Conductance		pH		Alkalinity		Turbidity		Color		Calcium		Magnesium		Iron	
Year	Station	(µmhos/cm)	SD		SD	(µ g L)	SD	(NTU)	SD	units)	SD	(µ g L)	SD	(µ g L)	SD	(µ g L)	SD
1985	1	48.2	2.7	6.8	0.2	13.0	1.0	0.9	0.2	8.2	2.2	4.8	0.2	0.6	0.5	14.6	9.2
	3	47.4	3.1	6.9	0.1	13.8	0.4	1.2	0.6	8.6	1.6	4.5	0.4	0.9	0.3	22.0	13.0
1986	1	48.0	1.5	6.9	0.2	13.6	2.2	0.5	0.2	9.0	1.3	4.7	0.3	1.1	0.6	11.2	7.6
	3	47.9	1.5	7.0	0.1	13.1	1.6	0.5	0.2	7.9	1.7	4.6	0.4	1.1	0.6	13.2	6.2
1987	1	46.9	1.6	6.7	0.2	13.4	2.7	0.4	0.1	13.8	5.4	N/A	N/A	N/A	N/A	16.8	8.2
	3	47.0	1.7	6.9	0.3	13.9	2.4	0.5	0.1	8.0	3.6	N/A	N/A	N/A	N/A	24.1	11.4
1988	1	46.6	1.3	6.9	0.2	12.1	2.0	0.6	0.3	9.6	7.6	N/A	N/A	N/A	N/A	20.0	13.0
	3	47.1	0.4	6.9	0.2	12.3	1.4	0.8	0.3	6.7	1.0	N/A	N/A	N/A	N/A	24.9	7.1
1989	1	50.7	1.2	7.1	0.3	13.8	0.8	0.9	0.7	6.8	2.2	5.3	0.3	1.4	N/A	15.3	8.7
	3	50.6	1.7	7.0	0.2	13.0	0.7	0.4	0.1	7.9	3.7	5.3	0.6	0.3	N/A	16.3	7.0
1990	1	50.6	0.9	7.1	0.2	13.9	1.2	0.8	0.3	6.0	2.4	4.4	1.2	0.9	0.3	31.0	23.7
	3	50.7	0.9	7.1	0.1	14.3	0.8	0.8	0.3	4.7	0.9	4.4	0.7	0.8	0.4	47.8	76.4
1992	1	52.9	6.0	7.0	0.1	12.9	1.0	0.6	0.2	6.1	2.5	5.1	0.4	1.2	0.6	17.0	5.3
	3	51.7	0.8	7.1	0.2	13.3	0.4	0.8	0.3	6.5	1.8	5.0	0.7	1.4	0.9	19.8	5.0
1994	1	55.5	1.3	7.0	0.4	14.0	1.2	0.6	0.5	5.3	1.0	4.9	0.1	1.3	0.1	8.8	4.2
	3	55.0	0.8	6.8	0.2	13.1	0.6	0.6	0.3	5.5	1.9	4.9	0.1	1.3	0.1	15.5	14.2
1995	1	50.0	2.6	6.8	0.2	12.9	0.9	1.3	0.8	7.8	2.1	4.5	0.2	1.0	0.4	28.0	21.8
	3	50.8	3.2	6.6	0.3	13.8	1.1	1.1	0.5	6.8	2.2	4.5	0.2	1.0	0.4	21.8	11.3
1996	1	53.3	1.5	6.8	0.2	13.9	0.4	0.5	0.1	7.0	2.4	4.6	0.1	0.7	0.3	13.0	10.4
	3	53.7	1.2	6.9	0.2	14.0	0.3	0.5	0.1	6.3	1.3	4.6	0.1	0.7	0.3	17.7	9.6
2009	1	N/A	N/A	7.0	0.2	14.3	0.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	N/A	N/A	ND	N/A	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2010	1	N/A	N/A	7.0	0.1	13.0	0.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	N/A	N/A	7.1	0.2	13.3	0.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2011	1	N/A	N/A	7.5	0.1	14.9	0.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	N/A	N/A	7.5	0.1	15.8	0.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2012	1	N/A	N/A	7.6	0.2	14.0	0.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	N/A	N/A	7.6	0.2	14.2	0.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mean St 1 (1985-1990)		48.5		6.9		13.3		0.7		8.9		4.8		1.0		18.1	
Mean St 1 (1985-1996)		50.3		7.0		13.4		0.7		8.0		4.8		1.0		17.6	
Mean St 1 (1985-2011)		N/A		7.0		13.6		N/A		N/A		N/A		N/A		N/A	

Appendix D5.–Frazer Lake weighted mean zooplankton density and biomass, station 1, by species, 1985–2012.

		Diaptomus			Cyclops			Bosmina			Daphnia			TOTALS	
	Samples	Density	Biomass	Biomass	Density	Biomass	Biomass	Density	Biomass	Biomass	Density	Biomass	Biomass	Density	Biomass
Year	(n)	(no/m^2)	(mg/m^2)	%	(no/m^2)	(mg/m^2)	%	(no/m^2)	(mg/m^2)	%	(no/m^2)	(mg/m^2)	%	(no/m^2)	(mg/m^2)
1985	5	0	0.0	0.0	716	1.0	0.5	124,735	147.0	79.9	24,655	36.0	19.6	150,106	184.0
1986	7	38	0.0	0.0	1,441	2.0	2.6	48,491	54.0	71.1	15,127	20.0	26.3	65,097	76.0
1987	8	38	1.0	1.4	7,620	13.0	18.6	33,326	43.0	61.4	8,568	13.0	18.6	49,552	70.0
1988	7	0	0.0	0.0	2,540	4.0	2.1	104,261	120.0	63.2	48,485	66.0	34.7	155,286	190.0
1989	6	0	0.0	0.0	7,475	13.0	9.2	78,291	99.0	70.2	23,332	29.0	20.6	109,098	141.0
1990	9	139	1.0	1.3	34,936	51.0	68.0	20,973	22.0	29.3	567	1.0	1.3	56,615	75.0
1991	7	417	1.0	0.8	17,440	23.0	17.7	107,787	101.0	77.7	3,586	5.0	3.8	129,230	130.0
1992	7	15	1.0	0.4	49,651	107.0	45.9	94,359	106.0	45.5	9,539	19.0	8.2	153,564	233.0
1993	5	0	0.0	0.0	58,057	90.0	34.4	170,435	160.0	61.1	8,482	12.0	4.6	236,974	262.0
1994	4	186	1.0	0.7	17,277	30.0	21.7	61,440	72.0	52.2	19,904	35.0	25.4	98,807	138.0
1995	4	0	0.0	0.0	62,128	91.0	61.9	49,125	46.0	31.3	6,422	10.0	6.8	117,675	147.0
1996	4	0	0.0	0.0	50,186	112.5	41.1	100,344	115.6	42.2	31,396	45.6	16.6	181,926	273.7
1997	4	0	0.0	0.0	89,358	298.8	46.1	204,379	263.4	40.6	61,147	86.5	13.3	354,884	648.7
1998	3	302	0.3	0.0	319,083	685.7	62.9	246,200	363.2	33.3	20,059	41.8	3.8	585,643	1,090.9
1999	4	0	0.0	0.0	226,991	394.4	92.1	28,026	31.3	7.3	1,062	2.3	0.5	256,078	428.1
2000	4	0	0.0	0.0	46,129	63.8	63.6	33,838	35.5	35.3	597	1.1	1.1	49,686	100.4
2001	5	0	0.0	0.0	26,575	26.3	8.1	83,921	116.3	35.9	58,235	181.5	56.0	168,731	324.1
2002	5	55	0.1	0.0	26,342	29.7	6.1	110,100	114.3	23.3	146,272	346.7	70.6	282,769	490.8
2003	4	955	3.3	1.0	105,626	113.7	34.7	168,100	175.3	53.4	29,538	35.8	10.9	304,219	328.0
2004	4	0	0.0	0.0	28,981	37.5	25.8	43,127	31.2	21.5	50,876	76.7	52.7	122,984	145.5
2005	4	0	0.0	0.0	37,421	49.1	21.8	124,337	144.5	64.2	19,705	31.4	14.0	181,463	225.0
2006	4	332	0.4	0.1	300,889	538.0	76.8	110,019	149.9	21.4	10,284	12.4	1.8	421,524	700.8
2007	5	318	0.7	0.2	163,142	280.9	80.0	47,941	48.0	13.7	16,178	21.7	6.2	227,579	351.4
2008	5	0	0.0	0.0	18,230	20.7	22.9	54,589	62.4	69.2	6,096	7.1	7.9	78,915	90.2
2009	5	0	0.0	0.0	52,675	144.1	60.4	31,407	38.7	16.2	49,371	55.6	23.3	133,453	238.4
2010	5	467	3.1	0.9	102,463	175.8	48.1	117,134	123.5	33.7	64,968	63.4	17.3	285,032	366.2
2011	6	708	2.2	0.4	194,201	405.8	80.0	43,900	50.9	10.0	38,482	48.4	9.5	277,291	507.2
2012	6	0	0.0	0.0	131,591	276.4	76.9	79,308	81.3	22.6	1,283	1.6	0.4	212,182	359.2
Mean (1985–2011)	5.2	147	0.6	0.3	75,836	140.8	39.0	90,392	105.0	43.1	28,627	48.3	17.6	193,859	294.6

Appendix D6.–Frazer Lake weighted mean zooplankton density and biomass, station 3, by species, 1985–1997, and 2001–2012.

		Diaptomus			Cyclops			Bosmina			Daphnia			TOTALS	
	Samples	Density	Biomass	Biomass	Density	Biomass	Biomass	Density	Biomass	Biomass	Density	Biomass	Biomass	Density	Biomass
Year	(n)	(no/m²)	(mg/m²)	%	(no/m²)	(mg/m²)	%	(no/m²)	(mg/m²)	%	(no/m²)	(mg/m²)	%	(no/m²)	(mg/m²)
1985	5	79	<1	0.0	2,308	5.0	2.1	118,756	142.0	58.9	59,855	94.0	39.0	180,998	241.0
1986	7	38	<1	0.0	5,421	11.0	5.9	85,040	112.0	59.9	39,904	64.0	34.2	130,403	187.0
1987	8	152	<1	0.0	18,729	32.0	18.7	62,026	90.0	52.6	27,487	49.0	28.7	108,394	171.0
1988	7			0.0	8,910	33.0	12.4	80,300	116.0	43.4	70,026	118.0	44.2	159,236	267.0
1989	6		<1	0.0	23,987	66.0	20.8	111,125	156.0	49.2	60,952	95.0	30.0	196,064	317.0
1990	9	9		0.0	66,576	161.0	52.1	96,200	141.0	45.6	3,704	7.0	2.3	166,489	309.0
1991	7	38		0.0	92,584	201.0	60.5	115,408	126.0	38.0	2,351	5.0	1.5	210,381	332.0
1992	7			0.0	217,445	683.0	66.9	139,729	231.0	22.6	47,815	107.0	10.5	404,989	1021.0
1993	5	425	2.0	0.3	182,532	393.0	67.0	152,866	168.0	28.6	16,826	24.0	4.1	352,649	587.0
1994	4			0.0	82,325	158.0	35.0	167,359	240.0	53.1	36,386	54.0	11.9	286,070	452.0
1995	4			0.0	56,051	78.0	57.8	30,521	35.0	25.9	14,385	22.0	16.3	100,956	135.0
1996	4	20,966	60.9	13.3	156,783	187.2	40.8	136,092	149.5	32.6	35,974	60.7	13.3	349,815	458.4
1997	4	0	0.0	0.0	82,935	231.3	42.1	154,777	243.7	44.4	55,892	74.4	13.5	293,604	549.5
2001	5	64	0.6	0.2	38,413	52.2	15.5	138,317	230.9	68.7	39,225	52.3	15.6	216,019	335.9
2002	5	0	0.0	0.0	45,886	65.0	20.6	142,038	140.5	44.4	92,118	110.8	35.0	280,042	316.4
2003	4	0	0.0	0.0	52,362	58.3	19.5	170,435	179.7	60.3	51,858	60.2	20.2	274,655	298.2
2004	2	0	0.0	0.0	61,837	66.3	87.4	5,308	5.7	7.5	1,593	3.8	5.0	68,738	75.9
2005	4	0	0.0	0.0	83,201	148.9	46.6	124,472	139.1	43.5	23,819	31.6	9.9	231,492	319.6
2006	4	796	1.1	0.0	294,520	462.6	74.0	113,058	151.0	24.2	8,360	10.1	1.6	416,734	624.8
2007	5	425	3.0	0.6	318,684	449.8	83.5	57,113	62.1	11.5	16,348	24.0	4.4	392,570	538.8
2008	5	318	0.8	0.5	41,858	72.4	47.6	56,119	71.8	47.3	4,892	7.0	4.6	103,187	151.9
2009	5	106	0.0	0.0	55,361	133.5	64.9	22,187	28.4	13.8	34,395	43.8	21.3	112,049	205.7
2010	5	648	3.1	0.6	178,790	315.2	62.3	102,675	141.2	27.9	42,941	46.3	9.2	325,054	505.8
2011	6	354	2.0	0.5	121,798	247.0	56.7	68,046	85.2	19.6	71,320	101.6	23.3	261,518	435.9
2012	6	973	7.4	2.0	124,690	266.3	71.5	86,120	96.5	25.9	1,592	2.4	0.6	213,375	372.6
Mean (1985–2011)	5	1,285	5.2	0.7	95,387	179.6	44.2	102,082	132.7	38.5	35,768	52.7	16.6	234,254	368.1

Appendix D7.–Frazer Lake weighted mean zooplankton density and biomass, stations 1 and 3 averaged, by species, 1985–2012.

		Diaptomus			Cyclops			Bosmina			Daphnia			TOTALS	
	Samples	Density	Biomass	Biomass	Density	Biomass	Biomass	Density	Biomass	Biomass	Density	Biomass	Biomass	Density	Biomass
Year	(n)	(no/m^2)	(mg/m^2)	%	(no/m^2)	(mg/m^2)	%	(no/m^2)	(mg/m^2)	%	(no/m^2)	(mg/m^2)	%	(no/m^2)	(mg/m^2)
1985	5	40	0.5	0.2	1,512	3.0	1.4	121,746	144.5	67.9	42,255	65.0	30.5	165,552	213.0
1986	7	38	0.5	0.3	3,431	6.5	4.9	66,766	83.0	62.9	27,516	42.0	31.8	97,750	132.0
1987	8	95	0.9	0.7	13,175	22.5	18.6	47,676	66.5	55.0	18,028	31.0	25.6	78,973	120.9
1988	7	0	0.0	0.0	5,725	18.5	8.1	92,281	118.0	51.6	59,256	92.0	40.3	157,261	228.5
1989	6	0	0.5	0.2	15,731	39.5	17.2	94,708	127.5	55.6	42,142	62.0	27.0	152,581	229.5
1990	9	74	0.5	0.2	50,756	106.0	55.2	58,587	81.5	42.5	2,136	4.0	2.1	111,552	192.0
1991	7	228	0.5	0.2	55,012	112.0	48.5	111,598	113.5	49.1	2,969	5.0	2.2	169,806	231.0
1992	7	8	0.5	0.1	133,548	395.0	63.0	117,044	168.5	26.9	28,677	63.0	10.0	279,277	627.0
1993	5	213	1.0	0.2	120,295	241.5	56.9	161,651	164.0	38.6	12,654	18.0	4.2	294,812	424.5
1994	4	93	0.5	0.2	49,801	94.0	31.9	114,400	156.0	52.9	28,145	44.5	15.1	192,439	295.0
1995	4	0	0.0	0.0	59,089	84.5	59.9	39,823	40.5	28.7	10,403	16.0	11.3	109,315	141.0
1996	4	10,483	30.4	8.3	103,485	149.9	40.9	118,218	132.6	36.2	33,685	53.2	14.5	265,870	366.0
1997	4	0	0.0	0.0	86,146	265.0	44.2	179,578	253.6	42.3	58,519	80.5	13.4	324,244	599.1
2001	5	32	0.3	0.1	32,494	39.3	11.9	111,119	173.6	52.6	48,730	116.9	35.4	192,375	330.0
2002	5	28	0.0	0.0	36,114	47.4	11.7	126,069	127.4	31.6	119,195	228.7	56.7	281,406	403.6
2003	4	478	1.6	0.5	78,994	86.0	27.5	169,268	177.5	56.7	40,698	48.0	15.3	289,437	313.1
2004	4	0	0.0	0.0	45,409	51.9	46.9	24,218	18.5	16.7	26,235	40.3	36.4	95,861	110.7
2005	4	0	0.0	0.0	60,311	99.0	36.3	124,405	141.8	52.1	21,762	31.5	11.6	206,478	272.3
2006	4	564	0.8	0.1	297,705	500.3	75.5	111,539	150.5	22.7	9,322	11.3	1.7	419,129	662.8
2007	4	372	1.8	0.4	240,913	365.4	82.1	52,527	55.1	12.4	16,263	22.8	5.1	310,075	445.1
2008	5	159	0.4	0.3	30,044	46.5	38.4	55,354	67.1	55.4	5,494	7.0	5.8	91,051	121.1
2009	5	53	0.0	0.0	54,018	138.8	62.5	26,797	33.5	15.1	41,883	49.7	22.4	122,751	222.1
2010	5	558	3.1	0.7	140,627	245.5	56.3	109,905	132.4	30.4	53,955	54.8	12.6	305,043	436.0
2011	6	531	2.1	0.4	158,000	326.4	69.2	55,973	68.0	14.4	54,901	75.0	15.9	269,405	471.5
2012	6	487	3.7	1.0	128,140	271.3	74.1	82,714	88.9	24.3	1,437	2.0	0.5	212,778	365.9
Mean (1985–2011)		716	2.9	0.5	85,612	160.2	41.6	96,237	118.9	40.8	32,197	50.5	17.1	214,056	331.4
Mean (2002–2011)		274	1.0	0.3	114,213	190.7	50.7	85,605	97.2	30.7	38,971	56.9	18.3	239,063	345.8
Mean (2007–2011)		334	1.5	0.4	124,720	224.5	61.7	60,111	71.2	25.5	34,499	41.9	12.4	219,665	339.1

Appendix D8.–Seasonal weighted lengths (mm) of zooplankton in Frazer Lake, average of stations 1 and 3, 1985–2012.

Year	*Diaptomus*	*Epishura*	*Cyclops*	*Bosmina*	*Daphnia*	*Holopedium*
1985	0.70	-	0.78	0.36	0.60	-
1986	-	-	0.73	0.37	0.60	-
1987	0.96	-	0.70	0.39	0.64	-
1988	-	-	0.94	0.37	0.61	-
1989	-	-	0.84	0.38	0.59	-
1990	0.82	0.93	0.77	0.39	0.65	-
1991	0.64	-	0.76	0.34	0.62	-
1992	1.24	0.64	0.91	0.39	0.71	-
1993	0.95	-	0.76	0.33	0.59	-
1994	1.04	-	0.73	0.38	0.61	-
1995	-	-	0.65	0.34	0.60	-
1996	0.87	-	0.64	0.35	0.61	-
1997	-	-	0.93	0.39	0.56	-
1998	-	-	0.78	0.40	0.69	-
1999	-	-	0.71	0.35	0.70	-
2000	-	-	0.64	0.34	0.66	-
2001	-	-	0.60	0.41	0.57	0.59
2002	0.70	0.68	0.62	0.33	0.52	0.42
2003	0.92	0.73	0.57	0.34	0.53	-
2004	-	1.21	0.59	0.26	0.59	-
2005	-	0.83	0.69	0.35	0.58	0.46
2006	0.65	0.92	0.69	0.38	0.54	0.35
2007	0.99	0.92	0.67	0.34	0.58	0.45
2008	0.82	1.08	0.67	0.36	0.55	0.30
2009	0.91	0.78	0.85	0.37	0.52	0.51
2010	1.11	0.98	0.72	0.36	0.50	0.52
2011	1.00	1.04	0.77	0.35	0.57	0.54
2012	1.22	0.89	0.78	0.34	0.56	0.57
Mean (1985–2011)	0.90	0.90	0.73	0.36	0.60	0.46

Appendix D9.–Temperatures (°C) measured at the 1 and 50 meter strata in the Spring (May–June), Summer (July–August), and Fall (September–October) for Frazer Lake, 1989–2012.

	Spring		Summer		Fall	
Year	Surface	Bottom	Surface	Bottom	Surface	Bottom
1989	—	—	—	—	11.5	—
1990	8.4	—	14.8	—	11.9	—
1991	5.5	3.8	12.1	6.1	10.1	—
1992	5.8	4.9	12.3	5.3	10.2	7.3
1993	10.4	—	17.6	—	13.5	—
1994	7.3	4.2	11.5	6.0	8.6	8.4
1995	5.0	3.9	11.9	9.3	10.8	12.6
1996	5.7	4.8	12.4	6.3	9.3	7.5
1997	5.3	4.5	14.6	5.4	10.8	6.5
1998	—	—	—	—	—	—
1999	—	—	—	—	—	—
2000	—	—	—	—	—	—
2001	—	—	—	—	11.2	6.7
2002	2.8	2.4	—	—	8.5	6.6
2003	—	—	—	—	11.6	8.2
2004	—	—	—	—	—	—
2005	7.4	4.6	13.9	6.3	12.6	6.8
2006	6.2	4.3	11.2	6.3	10.1	7.6
2007	6.4	4.4	12.9	5.9	10.5	—
2008	6.5	4.1	11.1	6.0	10.2	7.2
2009	5.9	4.4	13.7	6.1	10.8	7.9
2010	4.8	3.8	11.1	7.1	9.7	8.4
2011	5.3	4.5	11.6	6.5	10.4	8.4
2012	5.5	3.4	10.9	5.9	9.0	7.9
Average	6.1	3.9	12.7	6.3	10.6	7.9

Note: Spring temperature corresponds to the average of May and June temperatures, summer temperature corresponds to the average of July and August temperatures, and fall temperature corresponds to the average of September and October measurements, if available.

Appendix D10.–Temperatures (°C) measured at the 1 and 50 meter strata by month, for Frazer Lake, 1989–2012.

	May		June		July		August		September		October	
Year	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
1989	—	—	—	—	—	—	—	—	11.5	—	—	—
1990	5.0	—	11.8	—	14.3	—	15.3	—	14.7	—	9.0	—
1991	3.5	3.0	7.6	4.5	11.8	6.0	12.4	6.3	10.1	—	—	—
1992	3.7	—	7.9	4.9	11.3	5.5	13.3	5.0	10.2	7.3	—	—
1993	8.0	—	12.9	—	17.3	—	18.0	—	13.5	—	—	—
1994	—	—	7.3	4.2	11.0	5.5	12.0	6.5	—	—	8.6	8.4
1995	5.0	3.9	—	—	12.2	6.0	11.7	12.5	10.8	12.6	—	—
1996	5.7	4.8	—	—	11.9	5.4	13.0	7.2	9.3	7.5	—	—
1997	5.3	4.5	—	—	14.7	5.0	14.4	5.8	10.8	6.5	—	—
2001	—	—	—	—	—	—	—	—	11.2	6.7	—	—
2002	2.8	2.4	—	—	—	—	—	—	—	—	8.5	6.6
2003	—	—	—	—	—	—	—	—	13.0	7.5	10.3	8.8
2005	4.2	3.7	10.7	5.5	—	—	13.9	6.3	12.6	6.8	—	—
2006	3.0	3.0	9.3	5.5	—	—	11.2	6.3	10.1	7.6	—	—
2007	3.8	3.5	9.0	5.3	12.4	5.9	13.5	—	10.5	—	—	—
2008	3.8	3.5	9.2	4.7	10.1	5.5	12.2	6.4	10.2	7.2	—	—
2009	3.4	3.0	8.5	5.7	14.7	5.7	12.6	6.4	10.8	7.9	—	—
2010	2.8	2.5	6.9	5.0	11.2	6.5	11.0	7.6	—	—	9.7	8.4
2011	4.1	3.6	6.6	5.4	10.2	6.0	13.1	6.9	10.4	8.4	8.9	8.8
2012	2.8	2.6	8.3	4.2	9.9	5.4	11.8	6.4	10.1	7.8	7.9	8.0
Mean (1989–2011)	4.3	3.5	8.9	5.1	12.5	5.7	13.2	6.9	11.2	7.8	9.1	8.2

Appendix D11.–Summary of Frazer Lake phytoplankton mean biomass, by phylum and year.

		Phylum												
		Chlorophyta (Green Algae)		Chrysophyta (Golden-brown Algae)		Bacillariophyta (Diatoms)		Cryptophyta (crytomonads)		Pyrrhophyta (Dinoflagellate)		Cyanobacteria (Blue-green Algae)		Total
Date	Station	Biomass (mg/m^3)	%	Biomass (mg/m^3)	%	Biomass (mg/m^3)	%	Biomass (mg/m^3)	%	Biomass (mg/m^3)	%	Biomass (mg/m^3)	%	Biomass (mg/m^3)
2011	1	29.69	0.03	59.87	0.07	313.30	0.35	49.04	0.06	78.40	0.09	358.50	0.40	888.80
2011	3	12.19	0.01	67.52	0.08	478.57	0.59	37.25	0.05	62.08	0.08	158.57	0.19	816.18
2012	1	2.74	0.00	4.26	0.00	1,377.11	0.85	53.80	0.03	173.22	0.11	1.60	0.00	1,612.73
2012	3	4.42	0.00	17.09	0.01	1,246.17	0.80	102.38	0.07	187.40	0.12	4.76	0.00	1,562.22
Mean (2011)		20.94	0.02	63.70	0.08	395.94	0.47	43.15	0.05	70.24	0.08	258.54	0.30	852.49
Mean (2012)		3.58	0.00	10.68	0.01	1,311.64	0.83	78.09	0.05	180.31	0.11	3.18	0.00	1,587.48
Mean (2011 and 2012)		12.26	0.01	37.19	0.04	853.79	0.65	60.62	0.05	125.28	0.10	130.86	0.15	1,219.98