

2006 Kodiak Smolt Projects Summary

by

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and

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March 2007

Alaska Department of Fish and Game

Division of Commercial Fisheries



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Weights and measures (metric)		General		Measures (fisheries)	
centimeter	cm	Alaska Administrative Code	AAC	fork length	FL
deciliter	dL			mid-eye-to-fork	MEF
gram	g	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	mid-eye-to-tail-fork	METF
hectare	ha			standard length	SL
kilogram	kg	all commonly accepted		total length	TL
kilometer	km				
liter	L	professional titles	e.g., Dr., Ph.D., R.N., etc.		
meter	m			Mathematics, statistics	
milliliter	mL	at	@	<i>all standard mathematical signs, symbols and abbreviations</i>	
millimeter	mm	compass directions:		alternate hypothesis	H _A
		east	E	base of natural logarithm	<i>e</i>
		north	N	catch per unit effort	CPUE
Weights and measures (English)		south	S	coefficient of variation	CV
cubic feet per second	ft ³ /s	west	W	common test statistics	(F, t, χ^2 , etc.)
foot	ft	copyright	©	confidence interval	CI
gallon	gal	corporate suffixes:		correlation coefficient (multiple)	R
inch	in	Company	Co.	correlation coefficient (simple)	r
mile	mi	Corporation	Corp.	covariance	cov
nautical mile	nmi	Incorporated	Inc.	degree (angular)	°
ounce	oz	Limited	Ltd.	degrees of freedom	df
pound	lb	District of Columbia	D.C.	expected value	<i>E</i>
quart	qt	et alii (and others)	et al.	greater than	>
yard	yd	et cetera (and so forth)	etc.	greater than or equal to	≥
		exempli gratia	e.g.	harvest per unit effort	HPUE
Time and temperature		(for example)		less than	<
day	d	Federal Information Code	FIC	less than or equal to	≤
degrees Celsius	°C	id est (that is)	i.e.	logarithm (natural)	ln
degrees Fahrenheit	°F	latitude or longitude	lat. or long.	logarithm (base 10)	log
degrees kelvin	K	monetary symbols		logarithm (specify base)	log ₂ , etc.
hour	h	(U.S.)	\$, ¢	minute (angular)	'
minute	min	months (tables and figures): first three letters	Jan,...,Dec	not significant	NS
second	s	registered trademark	®	null hypothesis	H ₀
		trademark	™	percent	%
Physics and chemistry		United States (adjective)	U.S.	probability	P
all atomic symbols		United States of America (noun)	USA	probability of a type I error (rejection of the null hypothesis when true)	α
alternating current	AC	U.S.C.	United States Code	probability of a type II error (acceptance of the null hypothesis when false)	β
ampere	A	U.S. state	use two-letter abbreviations (e.g., AK, WA)	second (angular)	"
calorie	cal			standard deviation	SD
direct current	DC			standard error	SE
hertz	Hz			variance	
horsepower	hp			population	Var
hydrogen ion activity (negative log of)	pH			sample	var
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

REGIONAL INFORMATION REPORT NO. 4K07-2

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The Regional Information Report Series was established in 1987 and was redefined in 2006 to meet the Division of Commercial Fisheries regional need for publishing and archiving information such as project operational plans, area management plans, budgetary information, staff comments and opinions to Board of Fisheries proposals, interim or preliminary data and grant agency reports, special meeting or minor workshop results and other regional information not generally reported elsewhere. Reports in this series may contain raw data and preliminary results. Reports in this series receive varying degrees of regional, biometric and editorial review; information in this series may be subsequently finalized and published in a different department reporting series or in the formal literature. Please contact the author or the Division of Commercial Fisheries if in doubt of the level of review or preliminary nature of the data reported. Regional Information Reports are available through the Alaska State Library and on the Internet at: <http://www.sf.adfg.ak.us/statewide/divreprots/html/intersearch.cfm>.

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This document should be cited as:

Duesterloh S. and G. M. Watchers. 2007. 2006 Kodiak smolt projects summary. Alaska Department of Fish and Game, Regional Information Report No. 4K07-2, Kodiak.

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ABSTRACT

The Alaska Department of Fish and Game (ADF&G) operated sockeye salmon *Oncorhynchus nerka* smolt enumeration and biological sampling projects within the Kodiak Management Area at Afognak Lake, Frazer Lake, Karluk Lake, and Spiridon Lake in 2006. From early May to early July, Canadian fan and incline plane traps were used to capture smolt. Mark-recapture methods were used to determine the trap efficiency and estimate total smolt emigration at all systems except at Spiridon Lake, where a smolt weir and trapping system provided 100% capture. This report provides 2006 daily and cumulative smolt emigration estimates for each site and comparisons with previous seasons. Smolt emigration estimates for 2006 were below average for all systems and lower than the 2005 average for all systems except Frazer Lake. In addition, biometric and age composition data of emigrating smolt are reported and a brief outlook for 2007 is included for each system.

Key words: smolt, smolt trap, sockeye salmon, *Oncorhynchus nerka*, Kodiak Island, Afognak Lake, Frazer Lake, Karluk Lake, Spiridon Lake

INTRODUCTION

In 2006, the Alaska Department of Fish and Game (ADF&G) operated sockeye salmon *Oncorhynchus nerka* smolt enumeration projects at four locations on the Kodiak Archipelago: Afognak Lake, Frazer Lake, Karluk Lake, and Spiridon Lake (Figure 1). Data collected from each project included daily emigration estimates and timing by age class, as well as size-at-age data. These data provide insight into the natural variability of each system's juvenile production, including estimates of freshwater survival. This information, particularly when combined with limnology data, assists with evaluating system productivity, forecasting runs, assessing escapement goals, and planning stocking objectives.

The purpose of this report is to present and summarize the 2006 smolt estimates and emigration timing and to compare these to previous years' estimates. A brief outlook for the 2007 smolt season is included for each project. Each project was described and results summarized by the project biologists: Robert Baer for Afognak Lake, Greg Watchers for Spiridon Lake, Switgard Duesterloh for Frazer and Karluk Lakes. The authors of this report compiled the data, added a general discussion, and formatted the report.

METHODS

An incline plane or Canadian fan trap was installed in each river between 1.5 and 3 km downstream from each lake outlet. All of the projects, with the exception of the Spiridon Lake project, used mark-recapture methods to estimate trap efficiency and calculate the total smolt emigration. Smolt were captured, marked with Bismarck Brown dye, and released upstream of the trap. The proportion of released to recaptured smolt was used to estimate the efficiency of the trap (Carlson et al. 1998). Trap efficiencies, along with the daily smolt counts from the trap, were then used to estimate the total smolt emigration. Smolt were counted individually if possible, unless, during peak migration, a count- by-weight system was used. At the Spiridon Lake project smolt were counted individually until high smolt abundance required the use of a timed count system for a portion of each half-hour (1-8 minutes depending on smolt density). These timed counts were expanded and summed with the individual counts to estimate the total emigration.

Five times each week 40 smolt were collected, briefly anesthetized, measured to the nearest mm, and weighed to the nearest gram. Then a few scales were removed carefully and transferred onto microscope slides for later age determination.

More detailed descriptions of the methods are available in the Salmon Research Operational Plans for the Kodiak Area, 2006 (Foster et al. 2006).

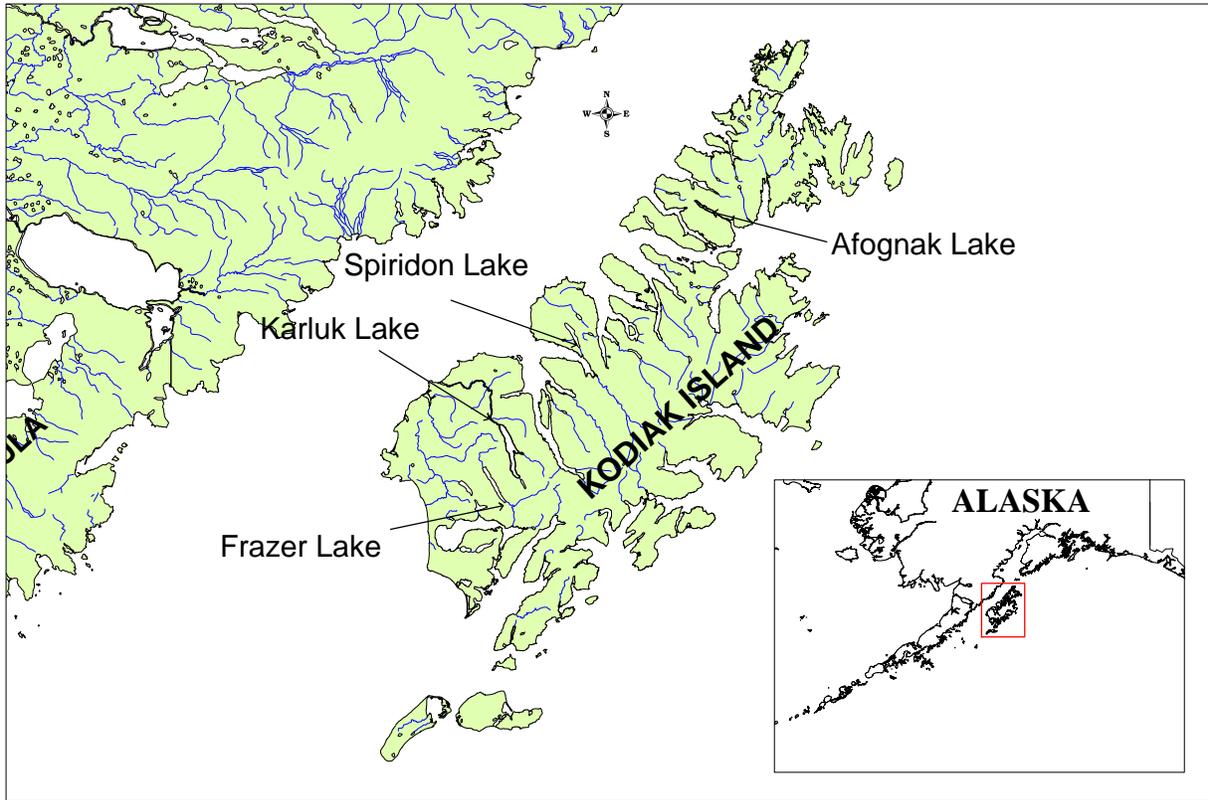


Figure 1.-Smolt enumeration and biological sampling project locations within the Kodiak Archipelago, 2006.

RESULTS

AFOGNAK LAKE

The Afognak Lake (58° 07' N. lat., 152° 55' W. long.) watershed is located on the southeast side of Afognak Island within lands owned by the Afognak Native Corporation (Figure 1). Afognak Lake drains in a southeasterly direction via the 3.2 km Afognak River, emptying into Afognak Bay, which is part of the Alaska Maritime National Wildlife Refuge. The lake has a mean depth of 8.6 m and a maximum depth of 23.0 m (Schrof and Honnold 2003).

Background

The ADF&G has operated a counting weir on the Afognak River annually, since 1978. Weir counts along with catch data (commercial, subsistence, and sport) have provided managers with an estimate of adult sockeye salmon production, but little information on juvenile production has been collected prior to 2003. In 2003, the ADF&G conducted a feasibility study to estimate the number and condition of sockeye salmon smolt emigrating from Afognak Lake. This study was followed by a 3-year project (2004-2006) funded through the U.S. Fish and Wildlife Service Office of Subsistence Management.

2006 Season Summary

The smolt trap was operated for a total of 45 days from May 16 to June 29 (Appendix A1). During the trapping period, 43,824 sockeye salmon smolt were captured in the trap at Afognak River (Figure 2). The largest count was on May 29, when 7,144 sockeye salmon smolt were

captured. A second large count of 4,121 smolt occurred on June 2. The timing of the emigration occurred later than in the previous 3 years of data collection.

Population Estimate

The sockeye salmon smolt emigration estimate in 2006 from the Afognak Lake drainage was 205,153 (95% C.I. 180,952 – 229,353; Appendix A2). Four mark-recapture tests were performed and trap efficiency varied from 15.4% to 23.6% (Appendix A1). The smolt estimate (205,153) in 2006 was the lowest estimate recorded since smolt trap operations were initiated in 2003 (Figure 3; Appendix A2). The majority of smolt were age 1 (71.4%) and the remainder were age 2 (28.6%; Table 1).

Table 1.-Afognak Lake average sockeye salmon smolt length, weight and condition factor by age, and estimated age composition of the 2006 emigration.

Afognak Lake smolt	Age				
	0	1	2	3	4
sample size n	0	765	202	0	0
Avg. length (mm)	-	70.8	79.6	-	-
Avg. weight (g)	-	3	3.8	-	-
condition	-	0.83	0.75	-	-
% in pop.	0.0	71.4	28.6	0.0	0.0

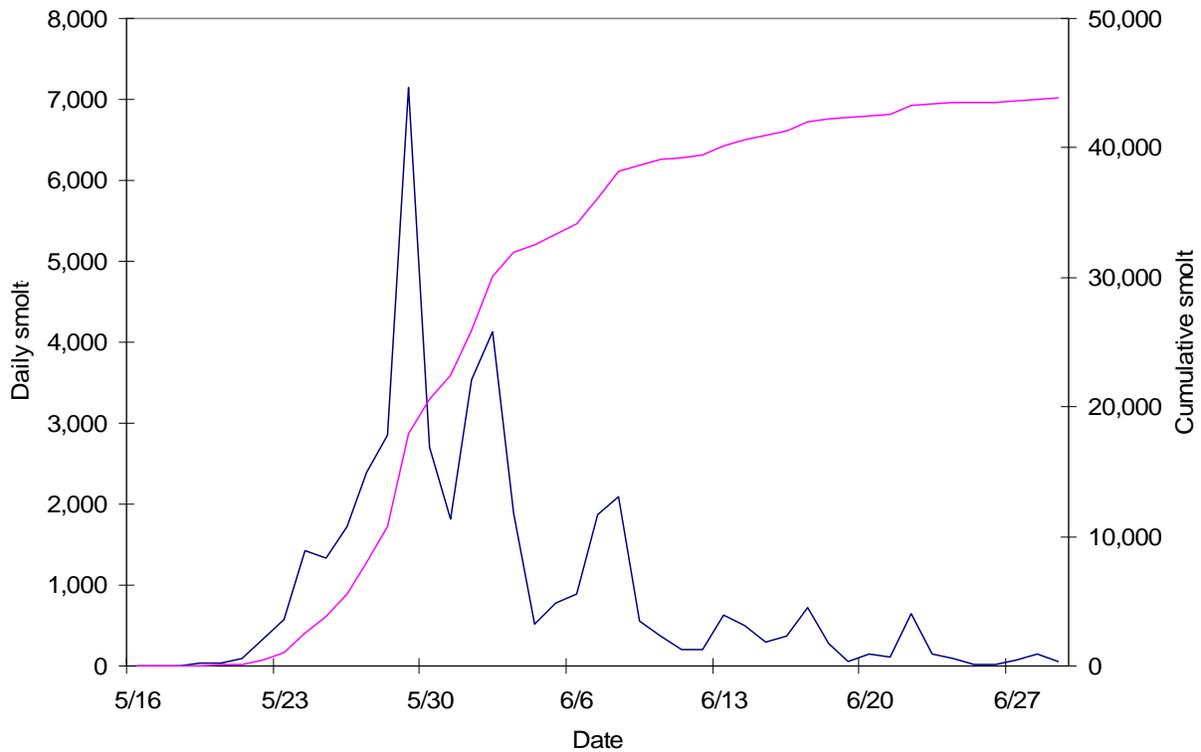


Figure 2.-Afognak Lake daily and cumulative sockeye salmon smolt counts, 2006.

Outlook

This was the third of a 3-year sockeye salmon smolt emigration study at Afognak Lake. Funding for this project was provided through the Office of Subsistence Management (OSM), Fisheries Resource Monitoring Program. In 2006, a proposal for continuation of the project for another 3 years was approved by the OSM and is awaiting approval by the Federal Subsistence Board.

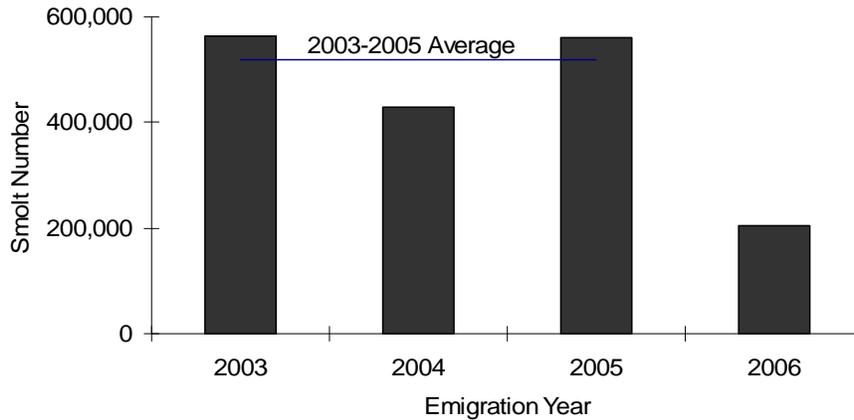


Figure 3.-Afognak Lake sockeye salmon smolt population estimates, 2003-2006.

FRAZER LAKE

Frazer Lake (57° 15' N. lat., 154° 08' W. long.) is located on the south end of Kodiak Island within the Kodiak National Wildlife Refuge (KNWR; Figure 1). Frazer Lake drains in a southwesterly direction via the 16 km Dog Salmon Creek, which empties into Olga Bay. The lake has a mean depth of 33.2 m and a maximum depth of 58.9 m (Schrof and Honnold 2003).

Background

Prior to the first stocking of sockeye salmon in 1951 and the installation of a fish pass in 1962, Frazer Lake was void of sockeye salmon because a 10-m barrier fall prevented anadromous fish from entering the lake (Russell 1972). The Frazer Lake sockeye salmon stock is now considered of major importance to the island-wide salmon fishery.

Smolt age, weight, and length (AWL) data have been collected since 1966, and the total emigrating population has been estimated since 1991 (Duesterloh and Watchers 2005).

From 1991 to 2005, an incline plane smolt trap (Todd 1994) was used just upstream of the fish pass and barrier falls, approximately 1.2 km downstream from the lake. This trap was installed adjacent to a small island approximately 75 m upstream from the barrier falls. In 2006, a Canadian fan trap was installed about 150 m upstream of the barrier falls and placed in the middle of the river.

Funding for the operation of the Frazer smolt project and fish pass has in recent years been provided by the Kodiak Regional Aquaculture Association (KRAA).

2006 Season Summary

In 2006, Kodiak Island experienced a late and cold spring and a late ice-out. On May 13, the incline plane smolt trap was installed in the same place as in previous years. At this time Frazer Lake still had 90% ice cover and the river water level was high. Only 3 smolt were trapped during the first night. Smolt numbers remained low for 9 nights, then started to increase. A

further rise in the water level combined with the occurrence of the diatom *Didymosphenium*, which caused problems with the trap drainage, soon made the incline trap inoperable. The incline smolt trap was taken out on May 24, and a Canadian fan trap was installed about 50 m upstream in the middle of the river on May 28 and operated for 40 days until July 7 (Appendix B1). During the trapping period, 196,114 sockeye salmon smolt were counted. An estimated adjustment of 8,865 smolt was made for the 4 missed counting periods between May 24 and May 28 for a total of 205,066 (Figure 4). The highest count occurred on June 2 (42,205 smolt). Five mark-recapture experiments were conducted and trap efficiency varied from 4.9% to 13.8% (Appendix B1). A total of 1,356 smolt were sampled for length, weight and condition and scales were analyzed for age composition.

Population Estimate

The total smolt emigration estimate from Frazer Lake in 2006 was 2,421,826 (95% C.I. 1,869,420-2,974,232). This was higher than the 2005 estimate of 1,572,049, but lower than the 1991-2005 average of 4,494,833 and the 1999-2005 average of 3,419,123 smolt (Figure 5, Appendix B2). An adjustment to the total emigration estimate was made to account for the 4 nights when no counts were made because of changing traps: A steady slope was assumed between the last count with the incline plane trap (204) and the first count with the Canadian fan trap (12,733). A factor of 2.25 was applied to each daily count, resulting in a total adjustment of 8,865. During the first 10 days, when the old trap was used, and during the 4 days when emigration was estimated, an estimated trap efficiency of 5% was applied based on the assumption that the flow problems in the trap resulted in low efficiency. However, because of the low smolt numbers during this time, the estimate does not contribute a significant proportion of the total season estimate.

The majority of smolt were age 1 (58.9 %), 22.6 % were age 2 and 14.1 % age 3 and there were 4.3% age 4 (Table 2).

Table 2.-Frazer Lake average sockeye salmon smolt length, weight and condition factor by age, and estimated age composition of the 2006 emigration.

Frazer Lake smolt	Age				
	0	1	2	3	4
sample size n	12	967	206	127	44
Avg. length (mm)	80	96.8	104.1	109.6	112.1
Avg. weight (g)	3.4	7.1	8.7	10.1	10.8
condition	0.66	0.78	0.76	0.76	0.76
% in pop.	0.1	58.9	22.6	14.1	4.3

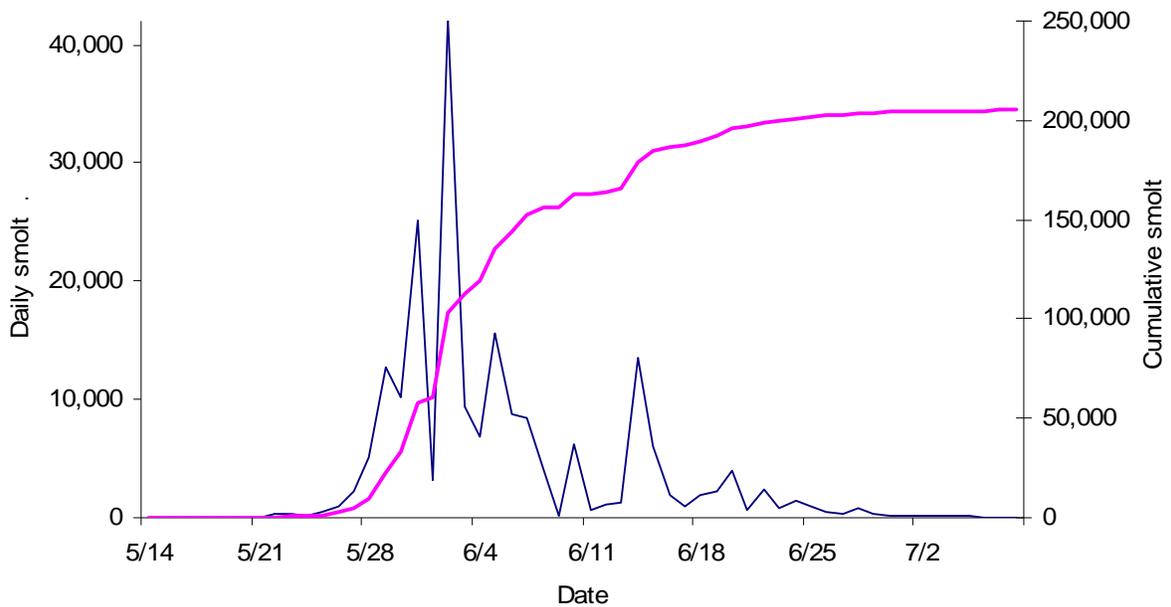


Figure 4.-Frazer Lake daily and cumulative sockeye salmon smolt counts, 2006.

Outlook

Smolt emigration estimates from Frazer Lake have been collected since 1991 and age, weight and length data since 1996, providing a valuable long-term database for comparative studies. The ADF&G plans to continue to collect smolt data and estimate the total emigration in 2007.

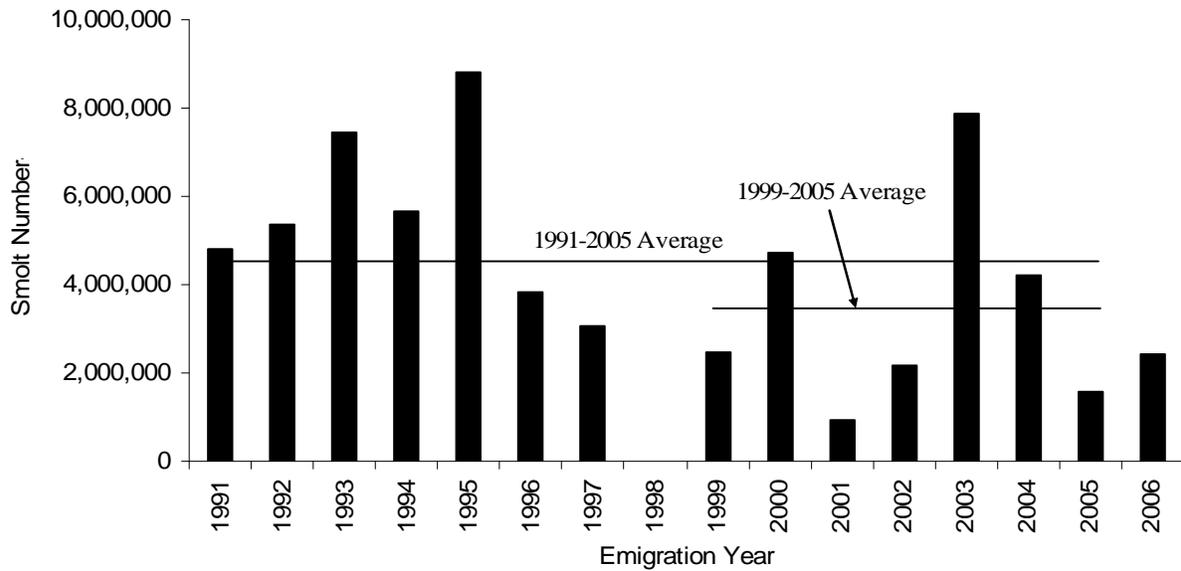


Figure 5.-Frazer Lake smolt population estimates, 1991-2006. No estimate was generated in 1998 because the trap was inoperable due to high water after June 1.

KARLUK LAKE

Karluk Lake (57° 21' N. lat., 154° 02' W. long.) is located on the south end of Kodiak Island in the Kodiak National Wildlife Refuge (KNWR). Karluk Lake drains in a northeasterly direction via the 35 km Karluk River, emptying into Shelikof Strait (Figure 1). The lake has a mean depth of 48.6 m, and a maximum depth of 126 m (Schrof and Honnold 2003).

Background

Karluk Lake is considered one of the largest sockeye salmon producing systems in the Kodiak Archipelago. Some of the earliest recorded commercial harvests (dating from the late 1800s; Roppel 1986) of sockeye salmon are from the Karluk system. Karluk Lake sockeye salmon production severely declined in the 1940s, and did not significantly increase until the late 1970s (Koenings and Burkett, 1987).

Two runs of sockeye salmon have been recognized in Karluk Lake: an early run passing the weir through July 21 and a late run passing the weir after July 21 (Koenings and Burkett, 1987). Early-run fish are generally tributary spawners and late-run fish generally spawn in Lower Thumb River, the shoals of Karluk Lake, and the main-stem of Karluk River.

A Canadian fan trap was used to capture emigrating sockeye salmon smolt 2 km downstream from the lake outlet. From 1999 to 2003, the smolt project was funded by the KRAA. The smolt project was continued from 2004 to 2006 as part of a larger project funded by the Gulf of Alaska Ecosystem Monitoring (GEM) program. Previous smolt projects were conducted in the 1960s, in the early 1980s, in 1991 and 1992.

Funding from the GEM project was acquired to initiate a collaborative study with the University of Alaska to study the role of marine derived nutrients in the Karluk watershed. The 2006 season was the last of 3 years, in which the smolt project was conducted under the GEM program funding.

2006 Season Summary

In 2006, Kodiak Island experienced a cold spring and the ice cover on Karluk Lake lasted until May 13. The smolt trap was installed shortly after ice-out on May 16 and was removed on June 25, after 41 days of fishing (Appendix C1). During the trapping period, 68,227 sockeye salmon smolt were counted through the trap on the Karluk River (Figure 6). Very small numbers of sockeye salmon smolt were caught during the first days of trap operation. After one week, the trap was moved to slightly deeper water and daily counts increased. The peak count occurred on May 27 (15,118 smolt), and was more than four times as high as the peak count in 2005 (3,287; Figure 6; Appendix C1; Watchers and Duesterloh, 2005). Four mark-recapture experiments were conducted and trap efficiencies were from 3.6% to 7.1%. The low trap efficiency of 3.6% coincided with a one-week period from June 1 to June 8, where one of the trap wings had to be removed because it could not withstand the high water velocity at that time (Appendix C1). When the water level dropped in the following week, the wing was reinstalled and trap efficiency increased to 7.1%. High mortality occurred in each of the four dye tests. This was most likely caused by excessive stress during the handling and transport of smolt, and suboptimal conditions in the holding boxes. A delayed mortality test was conducted with 100 smolt from each dye test and mortalities monitored over four consecutive days were high (25-50%). Trap efficiency was calculated without mortality adjustment. However, the weak condition of the marked smolt may indicate that fewer smolt were available for recapture at the trap site. If this was the case, trap efficiency would be underestimated and the total emigration estimate would be overestimated.

Length, weight and scale samples were taken from a total of 1,014 sockeye smolt (Table 3). The 2006 smolt age composition in the total emigration was 33.5% age 2 and 65.9% age 3. This represents an unusually high percentage of age 3 smolt and might be a reflection of poor zooplankton biomass in Karluk Lake, in 2005.

Table 3.-Karluk Lake average sockeye salmon smolt length, weight and condition factor by age, and estimated age composition of the 2006 emigration.

Karluk Lake smolt	Age				
	0	1	2	3	4
2006	0	3	439	565	6
sample size n	0	3	439	565	6
Avg. length (mm)	-	76.7	92.6	101.8	103.8
Avg. weight (g)	-	3.6	6.3	7.9	8.1
condition	-	0.8	0.79	0.74	0.72
% in pop.	0.0	0.0	33.5	65.9	0.5

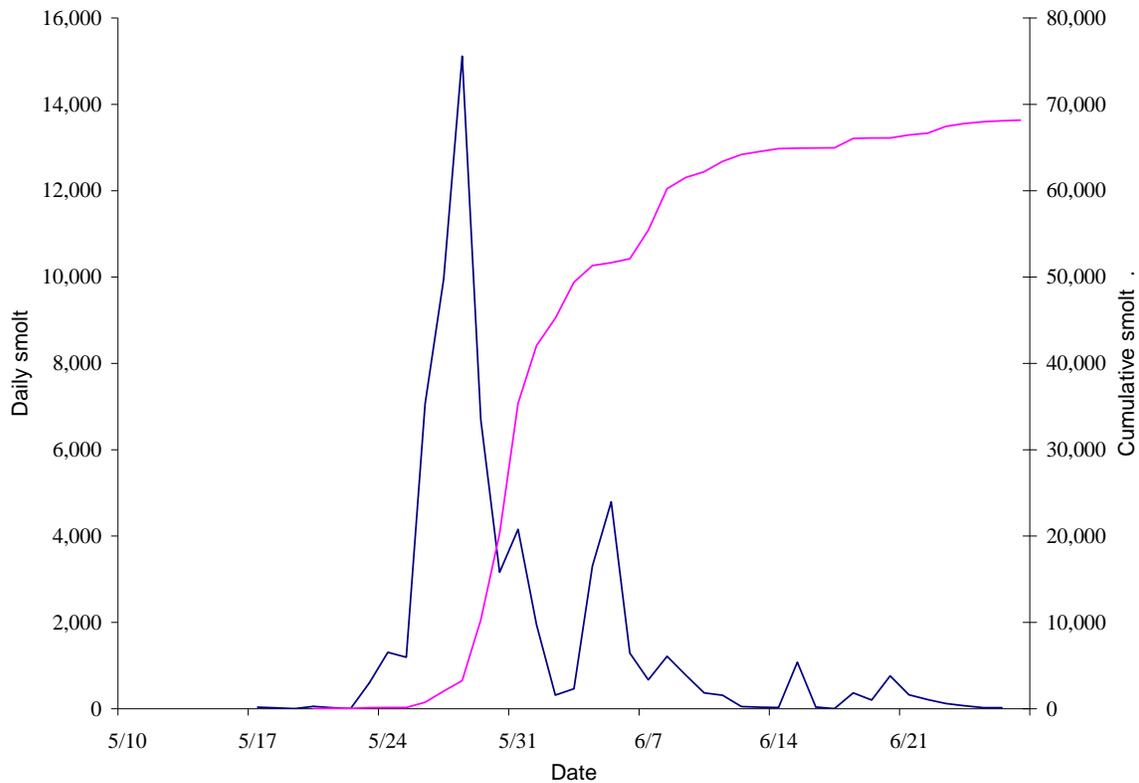


Figure 6.-Karluk Lake daily and cumulative sockeye salmon smolt counts, 2006.

Population Estimate

The total smolt emigration estimate from Karluk Lake for 2006 was 1,173,252 (95% C.I. 965,308-1,381,196) sockeye salmon smolt (Figure 7; Appendix C2). Because of the mortality problems with the dye-released smolt, the estimate could be slightly high. The 2006 estimate was lower than the 2005 estimate (1,494,818), and lower than the 1999-2005 average estimate of 1,972,020 smolt (Figure 7; Appendix C2).

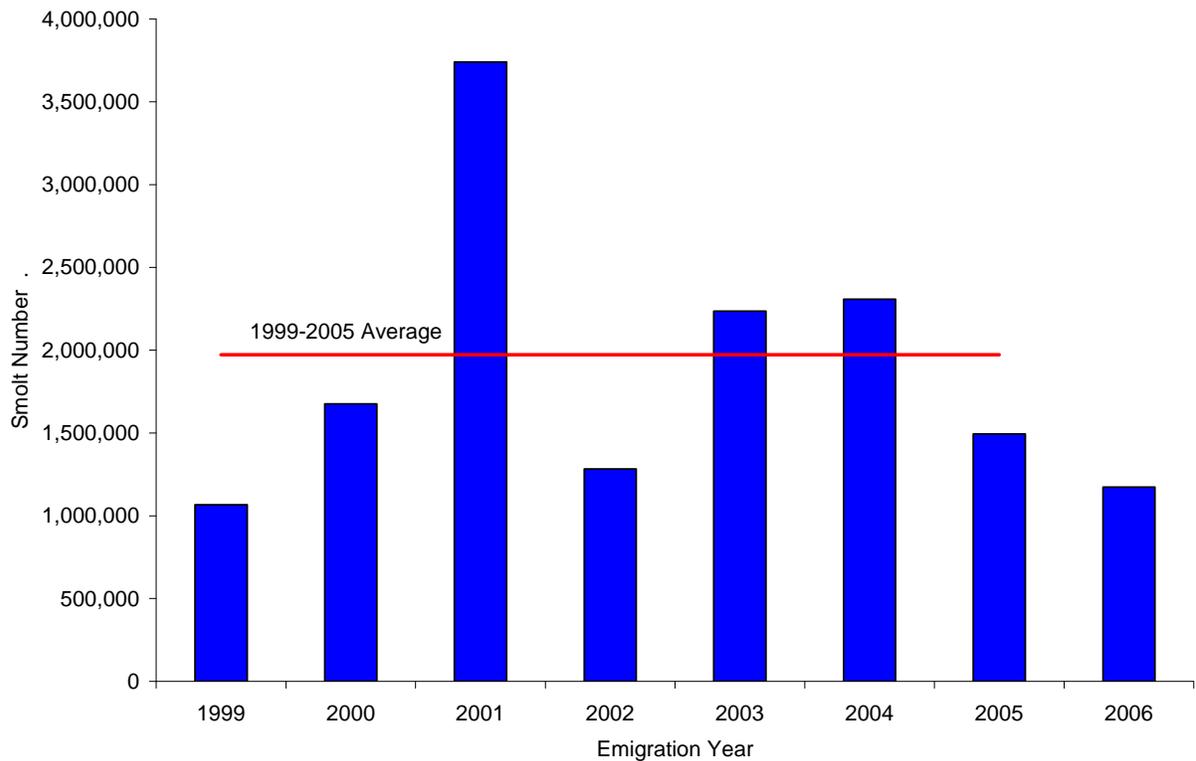


Figure 7.-Karluk Lake sockeye salmon smolt population estimates, 1999-2006.

Outlook

In 2006, the smolt emigration project was conducted with GEM funding for the last season of a 3-year funding cycle. The ADF&G is presently seeking funding to continue smolt monitoring in the Karluk River. If no funding is secured, the project will be discontinued in 2007.

SPIRIDON LAKE

Spiridon Lake (57° 40'N. lat., 153° 39'W. long.) is located on the west side of Kodiak Island, within the KNWR. Spiridon Lake drains in a southerly direction into Telrod Cove by way of Telrod Creek (Figure 1). Impassable water falls in Telrod Creek prevent anadromous fish from reaching the lake. The lake has a mean depth of 34.7 m, and a maximum depth of 82.0 m (Schrof and Honnold 2003).

Background

Spiridon Lake was first stocked with a small number (<300,000) of sockeye salmon fry by the ADF&G and the KRAA in 1990 (Honnold 1997). From 1991 to 2006, the system was stocked with sockeye salmon fry and pre-smolt and the returning salmon have supported the commercial fishery, particularly in Telrod Cove. Since 1992, a waterfall bypass system has been used to move emigrating sockeye salmon smolt around the upper falls of Telrod Creek and deposit them into the creek below the falls for their continued migration to the ocean. The bypass system consists of a smolt weir, two Canadian fan traps, two de-watering tanks, a tank for enumeration and sampling, and a pipeline. All smolt are individually counted when passing through the system, except during times of high smolt passage, when a timed count method is applied.

2006 Season Summary

The bypass system was operated for a total of 45 days from May 20 to July 3 (Figure 8; Appendix D1). During the period of operation, an estimated 564,959 live sockeye salmon smolt were enumerated through the bypass system (Figure 8). The peak count occurred on June 3 (89,771).

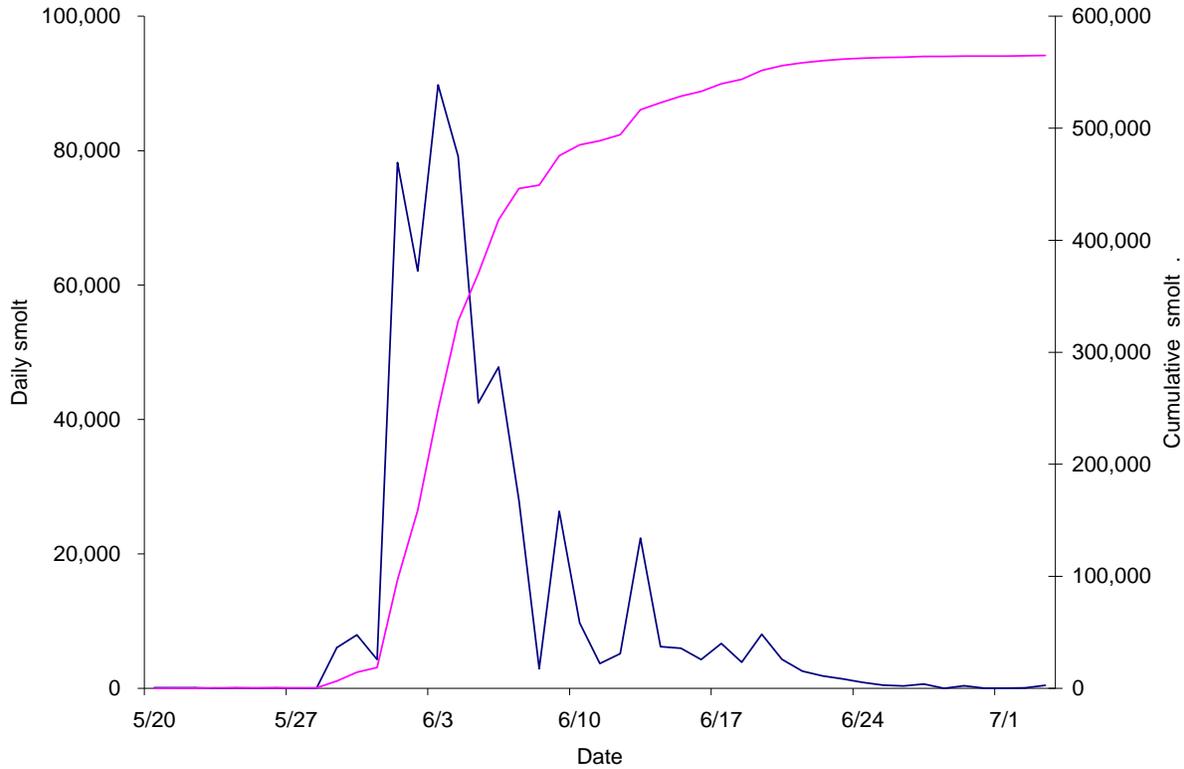


Figure 8.-Spiridon Lake daily and cumulative sockeye salmon smolt counts, 2006.

Population Estimate

A total of 566,173 sockeye salmon smolt emigrated from Spiridon Lake in 2006 (Figures 8 and 9; Appendix D2). Of these, 564,959 smolt were passed through the bypass system. Smolt mortality through the bypass system was 1,214 (0.2%), with most of the mortality occurring on the trap wings (Appendix D1). The 2006 sockeye salmon smolt estimate was one of the lowest in the history of the project (Figure 9; Appendix D2). The low smolt count in 2006 was due to a decrease in the stocking levels. Length, age and weight samples were collected from 989 smolt (Table 4).

Table 4.-Spiridon Lake average sockeye salmon smolt length, weight and condition factor by age, and estimated age composition of the 2006 emigration.

Spiridon Lake smolt	Age				
	0	1	2	3	4
	0	871	118	0	0
Avg. length (mm)	-	106.7	157.7	-	-
Avg. weight (g)	-	9.7	32.6	-	-
condition	-	0.75	0.82	-	-
% in pop.	0.0	88.1	11.9	0.0	0.0

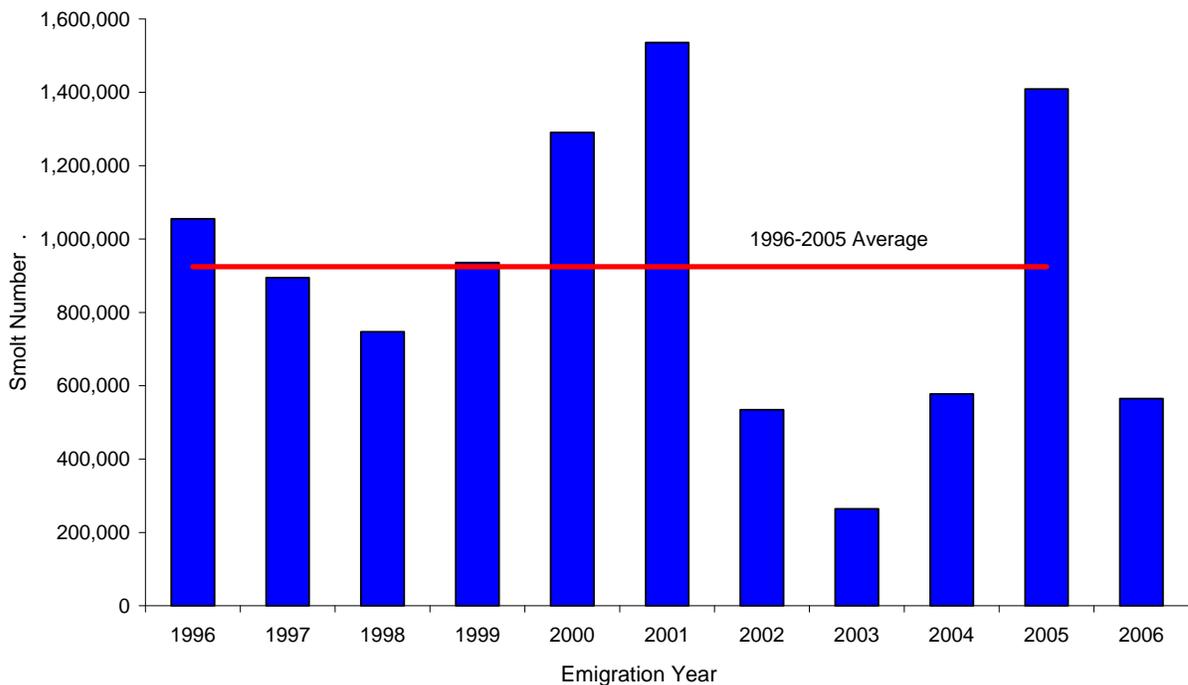


Figure 9.-Spiridon Lake sockeye salmon smolt population estimates, 1996-2006.

Outlook

Spiridon Lake has a continual stocking program. The KRAA will continue funding the Spiridon smolt stocking and enumeration in 2007.

CONCLUSIONS

Smolt emigration from Afognak, Karluk and Spiridon lakes in 2006 was less than in 2005 (Table 5). While in Afognak and Karluk Lakes rearing conditions may have contributed to the decline in smolt numbers, Spiridon Lake was stocked with fewer juvenile sockeye in 2005 than in previous years (Schrof and Byrne 2006). Frazer Lake had a larger smolt emigration in 2006 than in 2005 (Table 5). Details about each system’s production and limnology will be provided in separate ADF&G reports.

Table 5.-Summary of recent smolt emigration estimates from current smolt projects and their relative productivity, 2001-2006.

System	Surface Area (km ²)	Population Estimate					2005	2006 Average 2001-2005		
		2001	2002	2003	2004	2005	2006	smolt/km ²	smolt/km ²	smolt/km ²
Afognak Lake ^a	5.3			564,793	430,004	633,795	205,153	119,584	38,708	102,427
Frazer Lake	16.6	941,578	2,168,537	7,869,881	4,194,210	1,572,049	2,421,826	94,702	145,893	201,762
Karluk Lake	39.4	3,740,255	1,281,971	2,235,498	2,080,339	1,494,818	1,173,252	37,940	29,778	54,989
Spiridon Lake ^b	9.2	1,528,916	521,925	262,847	577,655	1,409,374	564,959	153,193	61,409	93,494

^a The Afognak Lake project began in 2003.

^b The population estimate for Spiridon Lake is the number of live smolt (not total smolt).

ACKNOWLEDGMENTS

In addition to the people and funding sources mentioned throughout, we would like to extend our thanks to the numerous technicians who worked hard, often in cold and wet hours of the night, to collect the data presented in this report. Thanks are also extended to Steve Honnold and Steve Schrof from the ADF&G for supervision of the projects and review of the manuscript.

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APPENDIX A. AFOGNAK LAKE

Appendix A1.-Afognak Lake daily and cumulative sockeye salmon catches and corresponding mark-recapture data, 2006.

Date	Catch Daily	Catch Cumulative	Dye Test Period Cumulative	AWL Sample Cumulative	Number Marked Releases	Marked Recoveries Cumulative	Trap Efficiency (%)
16-May	1	1					
17-May	8	9					
18-May	4	13					
19-May	42	55		20			
20-May	28	83					
21-May	88	171					
22-May	342	513		60			
23-May	580	1,093		100			
24-May	1,420	2,513		140			
25-May	1,332	3,845		180	312	56	
26-May	1,720	5,565		220		73	
27-May	2,396	7,961				73	
28-May	2,844	10,805				73	
29-May	7,144	17,949				73	
30-May	2,695	20,644		260		73	
31-May	1,808	22,452		300		73	
1-Jun	3,531	25,983	25,983	340		73	23.6%
2-Jun	4,121	30,104		380	515	82	
3-Jun	1,892	31,996				97	
4-Jun	523	32,519				97	
5-Jun	775	33,294		420		98	
6-Jun	888	34,182	8,199	460		98	19.2%
7-Jun	1,879	36,061		500	485	16	
8-Jun	2,095	38,156		523		50	
9-Jun	556	38,712		563		83	
10-Jun	375	39,087				89	
11-Jun	203	39,290				92	
12-Jun	205	39,495		603		93	
13-Jun	634	40,129		643		95	
14-Jun	497	40,626		683		95	
15-Jun	289	40,915		723		95	
16-Jun	375	41,290	7,108	763		95	19.8%
17-Jun	725	42,015			492	40	
18-Jun	269	42,284				69	
19-Jun	62	42,346		783		72	
20-Jun	154	42,500		823		73	
21-Jun	107	42,607		847		74	

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Appendix A1.-Page 2 of 2.

Date	Catch Daily	Catch Cumulative	Dye Test Period Cumulative	AWL Sample Cumulative	Number Marked Releases	Marked Recoveries Cumulative	Trap Efficiency (%)
22-Jun	655	43,262		887		75	
23-Jun	148	43,410		927		75	
24-Jun	94	43,504				75	
25-Jun	26	43,530				75	
26-Jun	15	43,545				75	
27-Jun	80	43,625		967		75	
28-Jun	141	43,766				75	
29-Jun	58	43,824	2,534			75	15.4%
30-Jun	Trap Pulled				Average Trap Efficiency		19.5%

Appendix A2.-Estimated number of sockeye salmon smolt emigrating from Afognak Lake by year and age class, 2003-2006.

Smolt Emigration Year	Number and Relative Percent of Smolt by Age Class			Total Population Estimate	SE	95% CI	
	1.	2.	3.			Lower	Upper
2003	373,513 66.1%	191,279 33.9%	0 0.0%	564,793	51,047	374,814	754,772
2004	387,584 90.1%	42,420 9.9%	0 0.0%	430,004	29,643	371,905	488,104
2005	521,025 93.0%	39,205 7.0%	0 0.0%	560,230	37,590	486,554	633,906
2006	146,527 71.4%	58,626 28.6%	0 0.0%	205,153	12,347	180,952	229,353
2003-2005 Average				518,342		411,091	625,594

APPENDIX B. FRAZER LAKE

Appendix B1.-Frazer Lake daily and cumulative sockeye salmon catches and corresponding mark-recapture data, 2006.

Date ^a	Catch		Mark-Recapture			Trap Efficiency	Trap comments
	Daily	Cumulative	Number Released	Daily Recaptures	Cumulative Recaptures		
13-May							
14-May	3	3					
15-May	6	9					
16-May	3	12					
17-May	3	15					*estimated 5% trap efficiency for the old trap
18-May	5	20					
19-May	15	35					
20-May	21	56					
21-May	33	89					
22-May	354	443					water flow in trap strong
23-May	262	705					
24-May	204	909					trap sunk, removed
25-May	450	1,359					trap out
26-May	1,012	2,371					no trap
27-May	2,278	4,649					no trap
28-May	5,125	9,774					no trap
29-May	12,733	22,507					new trap fish tight 21:00
30-May	10,186	32,693	863	71	71	8.2	
31-May	25,077	57,770		3	74	8.6	
1-Jun	3,196	60,966					
2-Jun	42,205	103,171					
3-Jun	9,432	112,603					
4-Jun	6,875	119,478					
5-Jun	15,573	135,051	945	129	129	13.7	
6-Jun	8,704	143,755		1	130	13.8	
7-Jun	8,376	152,131					
8-Jun	3,981	156,112					
9-Jun	182	156,294					
10-Jun	6,166	162,460					
11-Jun	664	163,124					
12-Jun	1,047	164,171					
13-Jun	1,196	165,367					
14-Jun	13,475	178,842	964	55	55	5.7	
15-Jun	6,058	184,900		5	60	6.2	
16-Jun	1,958	186,858					first adults passed
17-Jun	1,013	187,871					
18-Jun	1,890	189,761					
19-Jun	2,219	191,980					
20-Jun	3,968	195,948					

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Appendix B1.-Page 2 of 2.

Date ^a	Catch		Mark-Recapture			Trap Efficiency	comments
	Daily	Cumulative	Number Released	Daily Recaptures	Cumulative Recaptures		
21-Jun	562	196,510	919	44	44	4.8	
22-Jun	2,453	198,963		1	45	4.9	
23-Jun	828	199,791					
24-Jun	1,385	201,176					
25-Jun	886	202,062					
26-Jun	469	202,531					
27-Jun	390	202,921					
28-Jun	809	203,730	637	50	50	7.8	
29-Jun	301	204,031		3	53	8.3	
30-Jun	111	204,142					
1-Jul	147	204,289					
2-Jul	87	204,376					
3-Jul	209	204,585					
4-Jul	217	204,802					
5-Jul	137	204,939					
6-Jul	63	205,002					
7-Jul	50	205,052					
8-Jul	14	205,066					

^a Dates are 24 hr. periods from noon to noon.

Appendix B2.-Estimated number of sockeye salmon smolt emigrating from Frazer Lake by year and age class, 1991-2006.

Smolt Emigration Year	Number and Relative Percent of Smolt by Age Class					Total Population Estimate	SE	95% CI	
	0.	1.	2.	3.	4.			Lower	Upper
1991	0 0.0%	1,940,906 40.3%	2,870,690 59.6%	6,905 0.1%	0 0.0%	4,818,501	1,077,978	2,705,664	6,931,337
1992	0 0.0%	82,415 1.5%	4,978,109 92.8%	305,253 5.7%	0 0.0%	5,365,777	624,657	4,141,448	6,590,106
1993	0 0.0%	22,221 0.3%	4,046,434 54.4%	3,364,676 45.3%	966 0.0%	7,434,298	1,397,839	4,694,534	10,174,062
1994	0 0.0%	673,765 11.9%	4,450,246 78.6%	537,478 9.5%	0 0.0%	5,661,489	344,992	4,985,306	6,337,672
1995	0 0.0%	53,410 0.6%	8,684,874 98.4%	85,492 1.0%	0 0.0%	8,823,777	551,775	7,742,298	9,905,256
1996	0 0.0%	57,487 1.5%	3,480,272 91.1%	282,845 7.4%	0 0.0%	3,820,604	268,297	3,294,742	4,346,466
1997	0 0.0%	244,298 8.0%	2,196,609 71.6%	628,446 20.5%	0 0.0%	3,069,352	295,134	2,490,891	3,647,814
1998	Due to high water, smolt emigration estimates are not available								
1999	0 0.0%	744,710 30.4%	1,274,565 52.0%	433,687 17.7%	0 0.0%	2,452,962	219,262	2,023,209	2,882,715
2000	0 0.0%	10,105 0.8%	4,659,190 96.2%	55,939 2.6%	9,413 0.4%	4,734,647	227,527	4,289,578	5,181,484
2001	19 0.0%	10,536 1.1%	901,579 95.8%	29,243 3.1%	201 0.0%	941,578	38,386	866,342	1,016,814
2002	0 0.0%	583,159 26.9%	1,156,770 53.3%	370,756 17.1%	57,852 2.7%	2,168,537	140,236	1,893,674	2,443,400
2003	12,572 0.2%	7,393,216 93.9%	446,597 5.7%	17,496 0.2%	0 0.0%	7,869,881	1,012,546	5,885,292	9,854,471
2004	0 0.0%	0 0.0%	4,190,016 99.9%	4,194 0.1%	0 0.0%	4,194,210	748,399	2,727,348	5,661,072
2005	0 0.0%	11,004 0.7%	286,113 18.2%	1,274,932 81.1%	0 0.0%	1,572,049	314,203	956,211	2,187,886
2006	2,217 0.1%	1,426,654 58.9%	547,604 22.6%	341,938 14.1%	103,413 4.3%	2,421,826	281,840	1,869,420	2,974,232
1991-2005 Average						4,494,833		3,478,324	5,511,468

APPENDIX C. KARLUK LAKE

Appendix C1.-Karluk Lake daily and cumulative sockeye salmon catches and corresponding mark-recapture data, 2006.

Date	Daily	Cumulative	Released	Recovered	Trap Eff.	Comments
16-May	35	35				* applied same trap efficiency as
17-May	21	56				at new trap location
18-May	6	62				(-> low estimate)
19-May	58	120				
20-May	24	144				
21-May	4	148				
22-May	600	748				
23-May	1,306	2,054				
24-May	1,191	3,245				
25-May	7,060	10,305	979	62	6.3	moved trap and water gauge
26-May	9,962	20,267		2	6.5	
27-May	15,118	35,385				
28-May	6,692	42,077				
29-May	3,162	45,239				
30-May	4,157	49,396				
31-May	1,945	51,341				
1-Jun	317	51,658	777	18	2.3	
2-Jun	467	52,125		8	3.3	reduced wings due to fast flow
3-Jun	3,309	55,434		0		
4-Jun	4,792	60,226		2	3.6	
5-Jun	1,287	61,513				
6-Jun	673	62,186				
7-Jun	1,216	63,402				
8-Jun	783	64,185				
9-Jun	368	64,553	949	67	7.1	reinstalled wings
10-Jun	313	64,866		0		
11-Jun	48	64,914				
12-Jun	37	64,951				
13-Jun	30	64,981				
14-Jun	1,080	66,061				some holes under wings
15-Jun	38	66,099	745	29	3.9	
16-Jun	7	66,106		7	4.8	fixed holes, increased wing area
17-Jun	370	66,476		3	5.2	
18-Jun	202	66,678		2	5.5	
19-Jun	763	67,441				
20-Jun	325	67,766				
21-Jun	214	67,980				
22-Jun	120	68,100				
23-Jun	73	68,173				
24-Jun	27	68,200				
25-Jun	27	68,227				

Appendix C2.-Estimated number of sockeye salmon smolt emigrating from Karluk Lake by year and age class, 1999-2006.

Smolt Emigration Year	Number and Relative Percent of Smolt by Age Class					Total Population Estimate	SE	95% CI	
	0	1.	2.	3.	4.			Lower	Upper
1999	0 0.0%	15,381 1.4%	404,730 37.9%	620,832 58.2%	25,591 2.4%	1,066,534	178,256	717,152	1,415,915
2000	0 0.0%	9,441 0.6%	1,263,785 75.4%	402,919 24.0%	0.0 0.0%	1,676,502	177,577	1,328,451	2,024,553
2001	2,838 0.1%	238,271 6.4%	3,062,597 81.9%	436,469 11.7%	80 0.0%	3,740,255	308,090	3,136,398	4,344,111
2002	791 0.1%	11,482 0.9%	1,072,906 83.7%	195,323 15.2%	1,468 0.1%	1,281,971	77,168	1,130,721	1,433,221
2003	0 0.0%	16,445 0.7%	1,712,968 76.6%	501,816 22.4%	4,205 0.2%	2,235,435	286,498	1,673,898	2,796,972
2004	533 0.0%	26,479 1.3%	1,420,076 68.3%	633,039 30.4%	186 0.0%	2,308,625	161,283	1,764,223	2,396,454
2005	0 0.0%	478 3.2%	12,272 82.1%	2,182 14.6%	23 0.1%	1,494,818	392,276	725,956	2,263,680
2006	0 0.0%	0 0.0%	3,930 33.5%	7,732 65.9%	59 0.5%	1,173,252	106,094	965,308	1,381,196
1999-2005 Average						1,972,020		1,496,686	2,382,130

APPENDIX D. SPIRIDON LAKE

Appendix D1.-Spiridon Lake Sockeye salmon daily and cumulative smolt counts, corresponding mortality and resulting total live counts, 2006.

Date	Daily	Cumulative	Daily Mortality	Cumulative Mortality	Daily Live	Cumulative Live
20-May	87	87	0	0	87	87
21-May	104	191	1	1	103	190
22-May	88	279	1	2	87	277
23-May	18	297	3	5	15	292
24-May	56	353	2	7	54	346
25-May	39	392	0	7	39	385
26-May	79	471	0	7	79	464
27-May	1	472	0	7	1	465
28-May	0	472	0	7	0	465
29-May	6,121	6,593	57	64	6,064	6,529
30-May	7,935	14,528	2	66	7,933	14,462
31-May	4,302	18,830	17	83	4,285	18,747
1-Jun	78,336	97,166	103	186	78,233	96,980
2-Jun	62,156	159,322	63	249	62,093	159,073
3-Jun	89,990	249,312	219	468	89,771	248,844
4-Jun	79,396	328,708	240	708	79,156	328,000
5-Jun	42,509	371,217	38	746	42,471	370,471
6-Jun	47,903	419,120	77	823	47,826	418,297
7-Jun	27,974	447,094	56	879	27,918	446,215
8-Jun	2,984	450,078	58	937	2,926	449,141
9-Jun	26,392	476,470	50	987	26,342	475,483
10-Jun	9,804	486,274	47	1,034	9,757	485,240
11-Jun	3,721	489,995	26	1,060	3,695	488,935
12-Jun	5,161	495,156	2	1,062	5,159	494,094
13-Jun	22,364	517,520	5	1,067	22,359	516,453
14-Jun	6,201	523,721	8	1,075	6,193	522,646
15-Jun	5,973	529,694	10	1,085	5,963	528,609
16-Jun	4,292	533,986	0	1,085	4,292	532,901
17-Jun	6,718	540,704	38	1,123	6,680	539,581
18-Jun	3,893	544,597	8	1,131	3,885	543,466
19-Jun	8,047	552,644	5	1,136	8,042	551,508
20-Jun	4,329	556,973	1	1,137	4,328	555,836
21-Jun	2,580	559,553	24	1,161	2,556	558,392
22-Jun	1,853	561,406	19	1,180	1,834	560,226
23-Jun	1,390	562,796	0	1,180	1,390	561,616
24-Jun	900	563,696	10	1,190	890	562,506
25-Jun	477	564,173	6	1,196	471	562,977

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Appendix D.1.-Page 2 of 2.

Date	Daily	Cumulative	Daily Mortality	Cumulative Mortality	Daily Live	Cumulative Live
26-Jun	375	564,548	2	1,198	373	563,350
27-Jun	662	565,210	11	1,209	651	564,001
28-Jun	0	565,210	0	1,209	0	564,001
29-Jun	378	565,588	4	1,213	374	564,375
30-Jun	20	565,608	0	1,213	20	564,395
1-Jul	41	565,649	1	1,214	40	564,435
2-Jul	61	565,710	0	1,214	61	564,496
3-Jul	463	566,173	0	1,214	463	564,959

Appendix D2.-Spiridon Lake sockeye salmon total and live smolt estimates by year and age class, 1992-2006.

Smolt Outmigration Year	Number and Relative Proportions of Smolt by Age Class			Total Smolt	Total Mortality	Number and Relative Proportions of Live Smolt by Age Class			Total Live Smolt
	1.	2.	3.			1.	2.	3.	
1992	1,466,995 98.8%	17,826 1.2%	0 0.0%	1,484,821 100.0%	87,169 5.9%	1,380,321 98.8%	17,331 1.2%	0 0.0%	1,397,652 100.0%
1993	260,115 75.3%	85,443 24.7%	0 0.0%	345,558 100.0%	15,433 4.5%	249,784 75.7%	80,341 24.3%	0 0.0%	330,125 100.0%
1994	599,717 70.5%	244,360 28.7%	6,271 0.7%	850,348 100.0%	3,123 0.4%	597,502 70.5%	243,464 28.7%	6,259 0.7%	847,225 100.0%
1995	314,604 51.2%	299,556 48.7%	831 0.1%	614,992 100.0%	21,030 3.4%	304,326 51.2%	288,822 48.6%	813 0.1%	593,961 100.0%
1996	918,540 87.1%	135,414 12.8%	1,232 0.1%	1,055,186 100.0%	23,120 2.2%	897,762 87.0%	133,097 12.9%	1,207 0.1%	1,032,066 100.0%
1997	654,293 73.1%	237,492 26.5%	2,934 0.3%	894,719 100.0%	25,551 2.9%	635,650 73.1%	230,685 26.5%	2,833 0.3%	869,168 100.0%
1998	529,726 70.9%	216,923 29.0%	301 0.0%	746,950 100.0%	21,321 2.9%	514,606 70.9%	210,731 29.0%	292 0.0%	725,629 100.0%
1999	812,267 86.8%	123,458 13.2%	373 0.0%	936,118 100.0%	37,331 4.0%	779,875 86.8%	118,534 13.2%	358 0.0%	898,787 100.0%
2000	792,029 61.4%	493,529 38.2%	5,133 0.4%	1,290,692 100.0%	4,384 0.3%	788,909 61.3%	492,275 38.3%	5,122 0.4%	1,286,306 100.0%
2001	1,093,246 71.2%	442,975 28.8%	0 0.0%	1,536,221 100.0%	7,305 0.5%	1,087,695 71.1%	441,221 28.9%	0 0.0%	1,528,916 100.0%
2002	441,964 82.7%	92,484 17.3%	0 0.0%	534,448 100.0%	12,523 2.3%	431,542 82.7%	90,384 17.3%	0 0.0%	521,925 100.0%
2003	228,857 86.5%	34,854 13.2%	914 0.3%	264,624 100.0%	1,777 0.7%	227,376 86.5%	34,698 13.2%	789 30.0%	262,847 100.0%
2004	540,748 93.4%	36,882 6.4%	1,274 0.2%	578,904 100%	1,249 0.2%	539,582 93.4%	36,804 6.4%	1,269 0.2%	577,655 100%
2005	1,368,763 96.3%	48,326 3.4%	4,264 0.3%	1,421,353 100%	11,979 0.8%	1,357,702 96.3%	47,636 3.4%	4,036 0.3%	1,409,374 100%
2006	498,798 88.1%	67,375 11.9%	0 0.0%	566,173 100%	1,214 0.2%	497,729 88.2%	67,230 16.8%	0 0.0%	564,959 100%
Average 1992-2006	712,851	181,430	1,589	874,740 100.0%	18,301 2.1%	696,484	178,318	1,551	877,260 100.0%