Paint Lakes
Sockeye Salmon Enhancement
Progress Report
2003

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This year's operation of the Paint Lake Sockeye Salmon Enhancement Project was made possible through enhancement taxes paid by the commercial fishermen in Area H, Cook Inlet and associated waters, through the harvest and sale of surplus fish and by a grant from the U.S. Fish and Wildlife Service.

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DISCLAIMER

The Cook Inlet Aquaculture Association conducts salmon enhancement and restoration projects in area H, Cook Inlet and associated waters. As an integral part of these projects a variety of monitoring and evaluation studies are conducted. The following progress report is a synopsis of the monitoring and evaluation studies conducted for the Paint Lake sockeye salmon enhancement project.

The purpose of the progress report is to provide a vehicle to distribute the information produced by the monitoring and evaluation studies. Data collected each year are presented with a summary of the information previously collected for comparative purposes. These reports are intended to provide a general description of project activity and are not an exhaustive evaluation of any restoration or enhancement project. The information presented in this report has not undergone an extensive review. As reviews are completed, the information may be updated and presented in later progress reports.

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ACKNOWLEDGEMENTS

Many individuals contributed to the successful 2003 field season at the Paint Lake Salmon Enhancement Project. Appreciation is extended to Cook Inlet Aquaculture Association seasonal employees, Tyler Staples and Craig King, and full time staff, Gary Fandrei and Ronald Carlson, who endured many long hours in the field. The Cook Inlet Aquaculture Association Board of Directors and the Alaska Department of Fish and Game for the support they have provided to the Paint Lakes Sockeye Salmon Enhancement Project. Finally, thank you to the U.S. Fish and Wildlife Service and Senator Ted Stevens for providing the funding that allowed us to increase our evaluation of this important salmon resource.

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ABSTRACT

Upper and Lower Paint Lakes are located in the McNeil River State Game Refuge approximately 178 kilometers southwest of Homer, Alaska. The main tributary of the system is Upper paint Creek; the outlet, from the lower lake is the Paint River, which flows approximately 16 km to Akjemguiga Cove of Kamishak Bay of Cook Inlet. Initial salmon enhancement activities were conducted by ADF&G. The Cook Inlet Aquaculture Association (CIAA) began enhancement at the Paint Lakes in 1991 after the completion of the Paint River Fish Ladder.

Between 14 October and 11 November 2002, an estimated .508 million sockeye salmon (*Oncorhynchus nerka*) pre-smolt were released into Upper Paint Lake. All .508 million fry were otolith marked. There were no sockeye salmon fry or presmolt released to Upper or Lower Paint Lake in 2003

During 2003, smolt migration monitoring began on 20 May and continued daily until 11 July. During this time a total of 6,865 sockeye salmon smolts migrated from the lake.

Based on otolith marks, 100% of the migrating sockeye smolts were enhanced and all smolts were age 1 . The average length and weight of the sockeye smolts was 95 mm (±1.5 mm) and 7.9 g (±0.46 g).

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INTRODUCTION AND PURPOSE

Sockeye salmon is the only species that has been stocked on a production scale within the Paint River system. Paint River Lakes were stocked with hatchery sockeye fry on a near annual basis from 1986 through 1996. However, extremely low returns of 200 to 1,800 fish per year were documented. Currently, there are no definite explanations for the poor survivals from the Paint River system. Other nearby lakes in the Kamishak District, stocked with the same size fry at the same basic time period, have produced fair to excellent returns of adult sockeye salmon. Unfortunately, little evaluation work has been conducted to date to attempt to answer these possible reasons for poor sockeye production from the Paint River system.

In 1991, CIAA constructed a $2.5 million fish pass on the Paint River. The purpose of the fish pass was to provide anadromous fish access to spawning and rearing habitats available in the Paint River system. The Paint River fish pass, however, has never been operated because adult returns from the initial enhancement efforts were too small to warrant the operation of the pass and CIAA redirected its financial resources to maintain enhancement efforts initiated by the State (excerpt Trail Lakes Annual Management Plan 2002, Amendment A).

CIAA, the State and the Federal government have all invested in the development of a Paint River fishery and CIAA is currently seeking additional funds to complete the Paint River fish pass. The scope of this evaluation was to assess the success of the October presmolt release by monitoring smolt migration, zooplankton density, and other limnological parameters.

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PROJECT AREA

Upper and Lower Paint Lakes are located in the McNeil River State Game Refuge approximately 178 kilometers southwest of Homer, Alaska. The two lakes are connected by a small creek. The main tributary of the system is Upper Paint Creek; the outlet, at the lower lake forms a falls to the Paint River, which flows approximately 16 km to Akjemguiga Cove of Kamishak Bay of Cook Inlet.

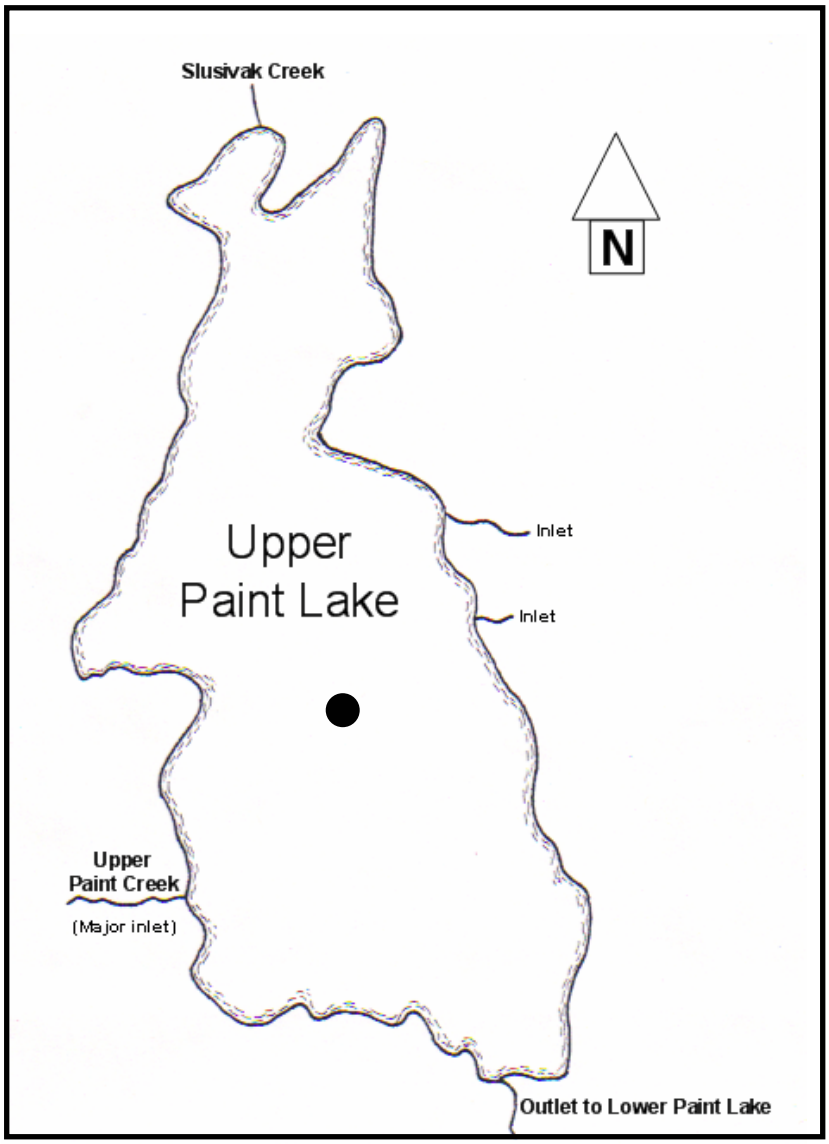

Figure 1. Area Map of Upper Paint Lake.

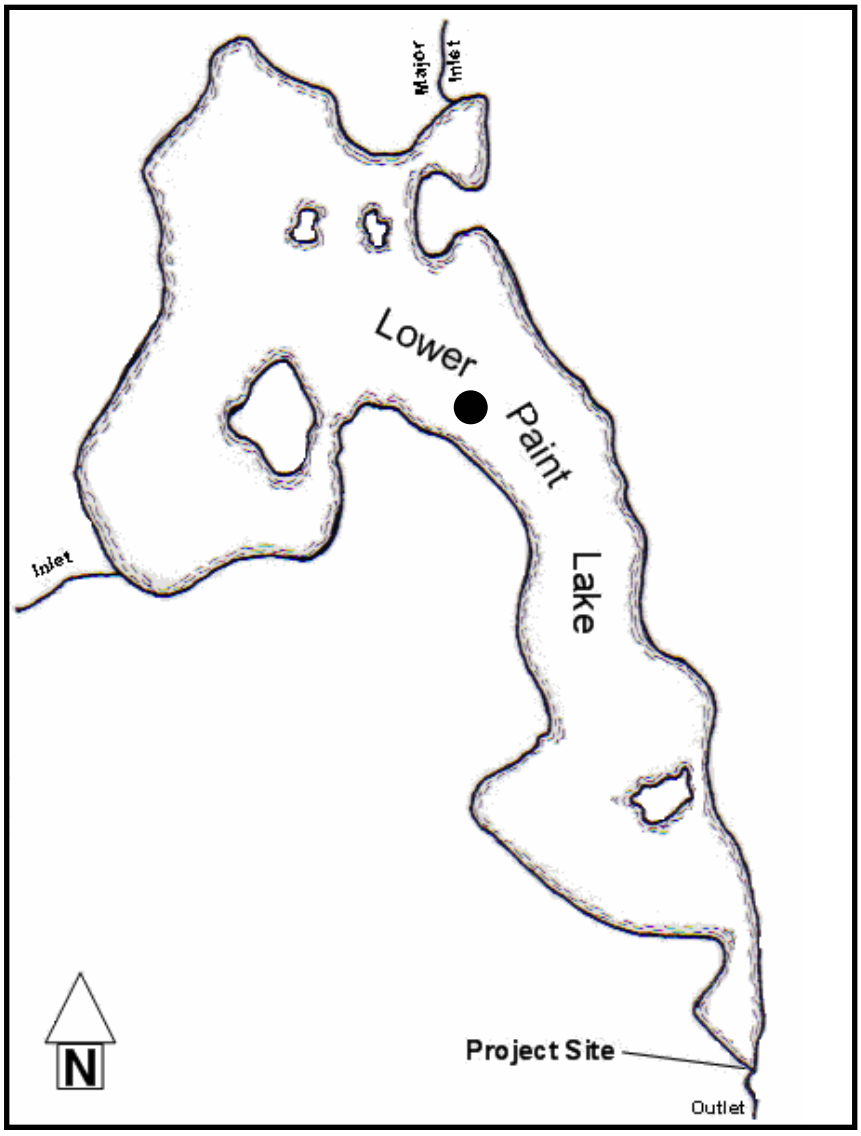

Figure 2. Area Map of Lower Paint Lake.

Fish present in the Paint Lakes watershed include lake trout (*Salvelinus namaycush)* and arctic grayling *(Thymallus arcticus*), and round white fish (Prosopium cylindraceum).

METHODS

In general, sockeye salmon egg takes hatchery incubation, fry rearing, and smolt enumeration monitoring follow procedures recommended by ADF&G.

Limnological Sampling and Environmental Conditions

During 2003, assessments of water quality were conducted three times during the open water season from May to August. Two sites, one on each lake (See Figures 1 and 2, black circles), were sampled for dissolved oxygen, temperature and light transmission profiles, Secchi disk transparency, and zooplankton densities. Samples for analysis of phosphorous, carbon, chlorophyll a, phaeophytin a, nitrogen, calcium, magnesium, iron, conductivity, pH, alkalinity, turbidity, and color were also collected with a Kemmerer sampler one meter below the surface and from the midhypolimnion.

Water samples were collected by CIAA and water analysis completed by ADF&G. Sample collection and analysis procedures are described by Koenings, et al. (1986).

Percent cloud cover was estimated, precipitation measured to the nearest millimeter and lake water and air temperatures were recorded at 5:00 PM each day by CIAA as part of the smolt enumeration activities. Standard CIAA procedures were followed for collecting these measurements.

Smolt Enumeration

To enumerate the smolt migration, a smolt trap was temporarily placed at the outlet of Lower Paint Lake. The smolt trap consisted of a modified fyke net with nylon mesh leads extended with Vexar® netting and a double compartment live-box. The leads and fyke net funneled migrating

smolts into the live-box. A swing gate controlled by the trap operators directed smolts into one of two live-box compartments where they were counted and released downstream, momentarily held for a sub-sample count, or passed through the trap system uncounted.

Total counts of smolts migrating from the Paint Lakes were made until the migration of fish exceeded 1,000 to 2,000 fish per hour. At migrations rates greater than 2,000 fish per hour, fish densities in the trap become too great and the fish become stressed. To avoid stressing the fish during periods of peak migration, a 10% sub-sampling procedure was used to enumerate the fish.

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

Assuming the two-minute sub-sampling intervals were randomly distributed throughout sub-sampling[1] and smolts moved through the weir randomly, the total smolt migration was estimated as follows:

If:

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

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

$\hat{T}$ = the total smolt migration,

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

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

N = the number of possible two minute sub-sampling intervals,

Then, the total smolt migration ($\hat{T}$) is:

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

with a variance of:

1 Predetermined randomly selected 2-minute sub-sampling intervals assured random distribution within each 20-minute period.

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

and 95% confidence limits of:

$$\hat{T}_s \pm 2\sqrt{v\left(\hat{T}_s\right)}.$$

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

In 2003, migrating smolts were enumerated from 20 May through 11 July. The 10% sub-sampling procedure was not used in 2003. A detailed description of smolt enumeration procedures is available in any of CIAA's Enhancement Project Procedure Manual (CIAA, 2002).

Smolt Characteristics and Enhanced Contribution

CIAA has released sockeye salmon fry to Upper and Lower Paint Lakes in 1995 and 1996. However, this is the first year the smolt migration was enumerated by CIAA. The smolt characteristics and enhanced contribution were assessed by collecting a sample of the migrating sockeye and coho smolts to collect an otolith and determine the smolts' age, weight, and length characteristics.

In 2002, CIAA marked the otolith of all salmon fry released to the Paint Lakes with a thermal mark[2]. The purpose of this mark is to determine the contribution of released fish to the smolt population. In 2003, the otoliths of sockeye smolts collected for age, weight and length measurements were removed and checked for a thermal mark.

In 2003, smolts collected for measurement and otolith removal were sampled in proportion to the daily smolt migration. This was attempted by collecting every 450th sockeye smolt. The numbering sequence began when the first fish passed through the trap and continued consecutively until the smolt migration was complete. However, due to the unexpected low

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

number of migrating smolts, the method was changed to collect 5 samples every day. Age, weight and length measurements were made on and otoliths removed from 58 sockeye smolts.

Each smolt collected for evaluation was first measured to the nearest millimeter for fork length[3] and then weighed to the nearest 0.1 gram. Several scales were also removed from the primary growth area[4] and mounted on a glass slide for subsequent age determination. The otoliths were then removed and placed in a labeled one-dram vial. Ethanol was added to the vial to cover the otoliths.

After the smolt migration was complete, the otoliths were shipped to Trail Lakes Hatchery. Staff at Trail Lakes Hatchery processed the otoliths and checked each for a hatchery mark following procedures described by Glick and Shields (1993). Of the 58 pairs of sockeye otoliths collected, 58 were readable.

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

If:

N = total number of migrating smolts,

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

n = total number of smolts sampled,

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

a = total number of enhanced smolts sampled,

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

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

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

c_i = number of age $= i$ smolts sampled,

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

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

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

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

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

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

$y =$ the weight or length of the smolt.

Then, the proportion of enhanced smolts, $\hat{P}$, is:

$$\hat{P} = a / n;$$

with a variance of:

$$v\left(\hat{P}\right) = \left(1 - f\right)(1/n)\sum W_h p_h q_h;$$

which, under proportional allocation, is like the usual simple random sample estimate. And, the total number of enhanced smolts, $\hat{A}$, is:

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

with a variance of:

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

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

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

with relative errors of:

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

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

$$\hat{L}_i = c_i / n;$$

with a variance of:

4 The primary growth area is located above the lateral line on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin.

$$v(\hat{L}_i) = (1 - f)\frac{1}{n}\sum_h W_h l_{hi} m_{hi};$$

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

$$\hat{C}_i = N(\hat{L}_i);$$

with a variance of:

$$v(\hat{C}_i) = N^2 v(\hat{L}_i).$$

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

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

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

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

with an approximate variance estimate of:

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

and 95% confidence interval estimates of:

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

Adult Return and Escapement

Adult salmon returning to Paint River Falls is enumerated annually by ADF&G aerial surveys. Currently, the Paint River Fish Ladder is not operating and there is no escapement of sockeye salmon (or any other species of salmon) into the Paint Lake system.

Gamete Collection, Incubation and Rearing

Gamete collecting activities for the Paint Lake System are not active. However, in 2002, Trail Lakes Hatchery experienced a surplus of Tustumena Lake sockeye salmon fry. These fry were reared at the hatchery to the presmolt stage for release to the Paint Lake System.

Fish Transport and Stocking

A Total of .508 million sockeye salmon presmolt produced from gametes collected from Tustumena Lake in 2001 were released to Upper Paint Lake on 14, 16, 17 October and 8 November 2002 (Table 1). The presmolt were transported by truck in oxygenated tanks from Trail Lakes Hatchery to the Soldotna Airport and gravity fed via tubing into an agriculture airplane. They were then flown to Upper Paint Lake and dropped from 100ft into the water. None of the released fry were externally marked or tagged; however, the otoliths of all the released fry were marked with thermal bands [Rbr 1:1.3,2.3]. Otoliths samples were processed to document the marks and are on file at Trail Lakes Hatchery.

Table 1. Summary of sockeye salmon releases at the Paint Lakes, 1994 - 2003.

Release		Fry		Pre-smolt				
Year	Release Site	Number	Size(g)	Number	Size(g)	BY	Broodstock	Hatchery
1986	Upper Paint Lake	500,000	0.20	0		1985	Glacier Flats	Crooked Creek
	Lower Paint Lake	320,000	0.20	0		1985	Glacier Flats	Crooked Creek
1987			No Stocking					
1988	Upper Paint Lake	1,100,000	0.20	0		1987	Glacier Flats	Crooked Creek
	Lower Paint Lake	552,000	0.20	0		1987	Glacier Flats	Crooked Creek
	Elusivak Creek	521,000	0.20	0		1987	Glacier Flats	Crooked Creek
1989	Upper Paint Lake	1,000,000	0.19	0		1988	Glacier Flats	Crooked Creek
	Lower Paint Lake	500,000	0.19	0		1988	Glacier Flats	Crooked Creek
	Elusivak Creek	500,000	0.19	0		1988	Glacier Flats	Crooked Creek
1990	Upper Paint Lake	1,000,000	0.21	0		1989	Glacier Flats	Crooked Creek
	Lower Paint Lake	500,000	0.21	0		1989	Glacier Flats	Crooked Creek
	Elusivak Creek	500,000	0.21	0		1989	Glacier Flats	Crooked Creek
1991	Upper Paint Lake	500,000	0.22	0		1990	Bear Creek	Crooked Creek
	Lower Paint Lake	250,000	0.22	0		1990	Glacier Flats	Crooked Creek
1992	Upper Paint Lake	500,000	0.22	0		1991	Bear Creek	Crooked Creek
	Lower Paint Lake	250,000	0.22	0		1991	Bear Creek	Crooked Creek
1993	Upper Paint Lake	500,000	0.21	0		1992	Bear Creek	Crooked Creek
	Lower Paint Lake	500,000	0.21	0		1992	Bear Creek	Crooked Creek
1994			No Stocking					
1995	Upper Paint Lake	337,000	0.18	0		1994	Bear Creek	Crooked Creek
	Lower Paint Lake	251,000	0.22	0		1994	Bear Creek	Crooked Creek
1996	Upper Paint Lake	500,000	0.28	0		1995	Bear Creek	Crooked Creek
1997			No Stocking					
1998			No Stocking					
1999			No Stocking					
2000			No Stocking					
2001			No Stocking					
2002	Upper Paint Lake	0		509,000	3.6	2001	Bear Creek	Trail Lakes
2003			No Stocking					
Total		10,581,000		509,000				
Average		529,050	0.21	509,000	3.6			

RESULTS AND DISCUSSION

Limnology and Environmental Conditions

Water Chemistry and zooplankton data from 2003 are presented in Appendix 1. Historical zooplankton densities presented as seasonal means are presented in Table 2.

Environmental conditions during the Paint Lake smolt migration were monitored from 21 May to 11 June 2003. Stream stage measurements averaged 0.55 feet and ranged from 0.19 to 1.11 feet. During the period of smolt migration, stream temperatures averaged 12.7°C and ranged from 9 to 19°C. Air temperatures averaged 21.8°C and ranged from 7 to 28°C. Twelve percent of the days were clear, 55% partly cloudy, and 33% were completely overcast. A total of 177 mm of rain fell during this period (Appendix 2).

Table 2. Average seasonal zooplankton densities for Upper and Lower Paint Lake, 1989-2003

Upper Paint Lake										
			Annual mean - areal density (number/m^2)							
Year	sample dates N	stations N	*Epischura*	*Heterocope*	*Diaptomus*	*Cyclops*	*Bosmina*	*Daphnia*	*Holopedium*	*Copepod nauplii*
1989	3	1	0	3,450	23,797	82,095	4,069	0	3,318	
1990	4	1	0	1,128	35,430	124,204	4,717	0	2,654	
1991	4	1	708	239	39,614	65,870	5,096	0	1,398	
1992	4	1	1,194	796	47,691	91,574	3,623	531	1,831	
1993	4	1	1,796	247	38,712	48,580	4,260	212	2,203	
1994	4	2	265	536	24,867	36,287	2,650	1,486	820	
1995	3	2	239	460	30,722	28,613	3,200	849	1,524	
1996	4	2	1,115	531	30,309	63,573	3,842	2,867	159	
1997	NA	NA	ND	ND	ND	ND	ND	ND	ND	
1998	NA	NA	ND	ND	ND	ND	ND	ND	ND	
1999	NA	NA	ND	ND	ND	ND	ND	ND	ND	
2000	NA	NA	ND	ND	ND	ND	ND	ND	ND	
2001	NA	NA	ND	ND	ND	ND	ND	ND	ND	
2002	2	1	743	637	27,708	30,468	3,928	0	1,274	
2003	3	1	874	71	34,654	8,386	2,300	71	799	708

Lower Paint Lake										
			Annual mean - areal density (number/m2)							
Year	sample dates N	stations N	*Epischura*	*Heterocope*	*Diaptomus*	*Cyclops*	*Bosmina*	*Daphnia*	*Holopedium*	*Copepod nauplii*
1989	3	1	1,062	0	6,635	3,052	30,078	0	929	
1990	4	1	2,320	0	2,718	9,535	32,861	0	80	
1991	4	1	372	0	3,723	5,136	13,655	0	531	
1992	4	1	743	159	1,619	3,981	7,351	743	0	
1993	3	1	127	0	1,486	3,158	7,974	849	707	
1994	3	2	606	32	3,134	848	7,767	1,927	154	
1995	4	2	398	138	4,143	1,592	10,010	318	85	
1996	4	2	2,336	265	4,238	8,789	43,496	350	0	
1997	NA	NA	ND	ND	ND	ND	ND	ND	ND	
1998	NA	NA	ND	ND	ND	ND	ND	ND	ND	
1999	NA	NA	ND	ND	ND	ND	ND	ND	ND	
2000	NA	NA	ND	ND	ND	ND	ND	ND	ND	
2001	NA	NA	ND	ND	ND	ND	ND	ND	ND	
2002	2	1	0	106	2,283	1,296	8,058	0	213	
2003	3	1	219	11	1,072	170	13,543	0	7	549

Smolt Enumeration

In 2003, a total of 6,865 sockeye smolts migrated from the lake (Appendix 3). The peak of the 2003 smolt migration occurred about 19 June (See Recommendations).

Smolt Characteristics and Enhanced Contribution

In 2003, characteristics of the smolt migration were evaluated from scale samples collected throughout the migration and from measurements of length and weight. Based on these samples and measurements, all migrating sockeye salmon smolts were age 1 and of hatchery origin. The average length and weight of the age 1 sockeye smolts were 95 mm (±1.5mm) and 7.9g (±0.46 g). (Table 3).

Table 3. Age structure, length, and weight characteristics of the Paint Lakes sockeye smolt, 2003

	Age Class (%)				Mean length (mm)				Mean weight (g)			
Smolt Year	Age 1.0	95% C.I.	Age 2.0	95% C.I.	Age 1.0	95% C.I.	Age 2.0	95% C.I.	Age 1.0	95% C.I.	Age 2.0	95% C.I.
2003	100	-	0	-	94.7	(±1.5)	-	-	7.94	(±0.46)	-	-

In 2003, the proportion of hatchery-incubated fry in the sockeye smolt migration was 100% as expected (Table 4).

Table 4. The contribution of enhanced sockeye to the Paint Lakes smolt migration, 2003

	Total		Number		% Hatchery	
Smolt Year	No.	95% C.I.	Wild	Hatchery	%	95% C.I.
2003	6,865	-	-	6,865	100	-

*All smolts are or hatchery origin. There is no native population of sockeye salmon.

Adult Return & Escapement

Sockeye salmon have been returning to the Paint River since 1989, though none have been able to migrate up the river to the lakes. Table 5 displays the annual rerun to the falls at Paint River.

Table 5. Annual sockeye salmon return to Paint River Falls, 1989-2003

Year	Number of Adults
1989	150
1990	0
1991	700
1992	300
1993	800
1994	550
1995	250
1996	200
1997	400
1998	1,870
1999	900
2000	30
2001	75
2002	30
2003	0
Total	6,255
Average	417

Currently, the Paint River Fish Ladder in not operating; thus, there is no salmon escapement to the Paint Lakes.

Special Studies

On 21 October, a hydroacoustics survey of Upper and Lower Paint Lake was conducted by ADF&G and CIAA. The purpose of the survey was to determine if smolts had remained in the lake system; and would emigrate the following year. The survey showed that the sockeye salmon were not present within the Lake (See Attached Report). Therefore, there will be no smolt migration study done in 2004.

RECOMMENDATIONS

The mid-October fry release was designed to by-passed the summer rearing period and to avoid predation by lake trout and grayling. However, the large size of the presmolt may have allowed them to emigrate from the lakes soon after release, or earlier in the spring than expected. (The 3.6 gram presmolt release size is approximately the same as age 1 sockeye smolt migrating from Kirschner Lake, approximately 25 miles northeast of Upper Paint Lake). Therefore, the amount of smolts collected at the smolt trap does not definitively reflect the actual survival and success of the October release program. Future returns to the Paint River Falls could help provide extra data for determining the success of the program. Further investigations are recommended and modifications to the evaluation program should be initiated.

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APPENDICES

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Appendix 1. Paint Lakes 2003 – Macrozooplankton Density

Upper Paint Lake

Species	22-May	12-Jun	22-Aug	Seasonal Mean (No/m2)
Heterocope		212	0	71
Epischura	287	212	2,123	874
Diaptomus	32	15,287	86,518	33,946
Ovigerous *Diaptomus*	0	0	2,123	708
Cyclops	8,068	14,013	531	7,537
Ovigerous *Cyclops*	2,335	212	0	849
Bosmina	0	1,062	5,308	2,123
Ovigerous *Bosmina*	0	0	531	177
Daphnia l.	212	0	0	71
Daphnia g.	0	0	0	0
Holopedium	637	1,699	0	779
Chydorinae	0	0	0	0
Copepod nauplii	1,699	425	0	708
			Total	47,134

**Copepod nauplii* is not included in the Total

Lower Paint Lake

Species	22-May	12-Jun	22-Aug	Seasonal Mean (No/m2)
Heterocope	0	32	0	11
Epischura	21	0	637	219
Diaptomus	53	191	2,972	1,072
Ovigerous *Diaptomus*	0	0	0	0
Cyclops	297	202	0	166
Ovigerous *Cyclops*	0	11	0	4
Bosmina	64	1,847	37,580	13,164
Ovigerous *Bosmina*	11	64	1,062	379
Daphnia l.	0	0	0	0
Daphnia g.	0	0	0	0
Holopedium	0	21	0	7
Chydorinae	0	0	0	0
Copepod nauplii	1,221	425	0	549
			Total	15,022

**Copepod nauplii* is not included in the Total

Appendix 1(cont'd). Paint Lakes 2003 – Macrozooplankton Biomass

Upper Paint Lake

Species	22-May	12-Jun	22-Aug	Seasonal Means: Mean Length (mm)	Seasonal Means: Weighted Length (mm)	Seasonal Means: Biomass (mg/m³)	Seasonal Means: Weighted Biomass (mg/m³)
Heterocope		1.75	2.92	2.34	1.75	4	2
Epischura	0.94	1.2	1.45	1.20	1.37	7	10
Diaptomus	0.88	0.71	1.21	0.93	1.13	120	209
Ovigerous *Diaptomus*			1.23	1.23	1.23	5	5
Cyclops	0.95	0.82	0.95	0.91	0.87	22	20
Ovigerous *Cyclops*	1.22	1.17		1.20	1.22	4	5
Bosmina	0.61	0.45	0.64	0.57	0.61	7	8
Ovigerous *Bosmina*		0.91	0.7	0.81	0.70	1	1
Daphnia l.	0.56			0.56	0.56	0.09	0.09
Daphnia g.							
Holopedium	0.54	0.83		0.69	0.75	4	4
Chydorinae							
Copepod nauplii							
					Total	174	263

Lower Paint Lake

Species	22-May	12-Jun	22-Aug	Seasonal Means: Mean Length (mm)	Seasonal Means: Weighted Length (mm)	Seasonal Means: Biomass (mg/m³)	Seasonal Means: Weighted Biomass (mg/m³)
Heterocope		2.53		2.53	2.53	0.85	0.85
Epischura	0.95		1.45	1.20	1.43	1.66	2.75
Diaptomus	0.81	0.60	1.09	0.83	1.06	2.76	5
Ovigerous *Diaptomus*							
Cyclops	0.72	0.87		0.80	0.78	0.37	0.35
Ovigerous *Cyclops*							
Bosmina	0.40	0.45	0.57	0.47	0.56	28	40
Ovigerous *Bosmina*	0.78	0.77	0.67	0.74	0.68	2	2
Daphnia l.							
Daphnia g.							
Holopedium		0.54		0.54	0.54	0.02	0.02
Chydorinae							
Copepod nauplii							
					Total	35	51

Appendix 1(cont'd). Paint Lakes 2003 –Water Quality

UPPER PAINT LAKE

Date	Sta	Depth (m)	TP (ug/l)	TFP (ug/l)	FRP (ug/l)	TKN (ug/l)	NH3+NH4 (ug/l)	NO2+NO3 (ug/l)	TN:TP	RSi (ug/l)	Carbon (ug/l)	Chla (ug/l)	Phaeo (ug/l)	EZD (m)
22-May	A	1	4.4	1.7	1.6	69	6.8	266.9	169 :1	2366	ND	0.19	0.06	ND
	A	20	2.1	2.0	1.8	49	5.7	191.2	253 :1	2335	ND	0.18	0.06	
12-Jun	A	1	2.0	4.2	3.2	43	14.6	131.2	193 :1	2125	ND	0.20	0.05	24.3
	A	27	1.7	2.1	1.8	35	8.1	182.9	284 :1	2201	ND	0.23	0.07	
22-Aug	A	1	2.6	1.5	1.6	78	11.1	81.2	135 :1	2153	ND	0.26	0.06	ND
	A	30	1.8	1.3	1.6	47	13.1	105.4	188 :1	2168	ND	0.40	0.21	
Mean			2.4	2.1	1.9	53.5	9.9	159.8	204 :1	2224.7	ND	0.2	0.1	24.3
Min			1.7	1.3	1.6	35.0	5.7	81.2	135 :1	2125.0	ND	0.2	0.1	24.3
Max			4.4	4.2	3.2	77.7	14.6	266.9	284 :1	2366.0	ND	0.4	0.2	24.3

Date	Sta	Depth (m)	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb (NTU)	Color (Pt)	Ca (mg/l)	Mg (mg/l)	Fe (ug/l)	Secchi (meters)
22-May	A	1	38	5.4	7.5	0.6	6	ND	ND	38	6.0
	A	20	39	5.8	4.5	0.5	6	ND	ND	36	
12-Jun	A	1	35	6.0	5.0	0.2	10	ND	ND	28	10.0
	A	27	45	6.5	10.7	0.3	5	ND	ND	22	
22-Aug	A	1	34	6.1	5.4	0.2	4	ND	ND	31	9.0
	A	30	36	5.6	4.8	0.5	6	ND	ND	38	
Mean			38	5.9	6.3	0.4	6.2	ND	ND	32.2	8.3
Min			34	5.4	4.5	0.2	4.0	ND	ND	22.0	6.0
Max			45	6.5	10.7	0.6	10.0	ND	ND	38.0	10.0

LOWER PAINT LAKE

Date	Sta	Depth (m)	TP (ug/l)	TFP (ug/l)	FRP (ug/l)	TKN (ug/l)	NH3+NH4 (ug/l)	NO2+NO3 (ug/l)	TN:TP	RSi (ug/l)	Carbon (ug/l)	Chla (ug/l)	Phaeo (ug/l)	EZD (m)
22-May	A	1	4.4	1.7	1.6	69	6.8	266.9	169 :1	2366	ND	0.19	0.06	ND
	A	20	2.1	2.0	1.8	49	5.7	191.2	253 :1	2335	ND	0.18	0.06	
12-Jun	A	1	2.0	4.2	3.2	43	14.6	131.2	193 :1	2125	ND	0.20	0.05	24.3
	A	27	1.7	2.1	1.8	35	8.1	182.9	284 :1	2201	ND	0.23	0.07	
22-Aug	A	1	2.6	1.5	1.6	78	11.1	81.2	135 :1	2153	ND	0.26	0.06	ND
	A	30	1.8	1.3	1.6	47	13.1	105.4	188 :1	2168	ND	0.40	0.21	
Mean			2.4	2.1	1.9	53.5	9.9	159.8	204 :1	2224.7	ND	0.2	0.1	24.3
Min			1.7	1.3	1.6	35.0	5.7	81.2	135 :1	2125.0	ND	0.2	0.1	24.3
Max			4.4	4.2	3.2	77.7	14.6	266.9	284 :1	2366.0	ND	0.4	0.2	24.3

Date	Sta	Depth (m)	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb (NTU)	Color (Pt)	Ca (mg/l)	Mg (mg/l)	Fe (ug/l)	Secchi (meters)
22-May	A	1	38	5.4	7.5	0.6	6	ND	ND	38	6.0
	A	20	39	5.8	4.5	0.5	6	ND	ND	36	
12-Jun	A	1	35	6.0	5.0	0.2	10	ND	ND	28	10.0
	A	27	45	6.5	10.7	0.3	5	ND	ND	22	
22-Aug	A	1	34	6.1	5.4	0.2	4	ND	ND	31	9.0
	A	30	36	5.6	4.8	0.5	6	ND	ND	38	
Mean			38	5.9	6.3	0.4	6.2	ND	ND	32.2	8.3
Min			34	5.4	4.5	0.2	4.0	ND	ND	22.0	6.0
Max			45	6.5	10.7	0.6	10.0	ND	ND	38.0	10.0

Appendix 2. Paint Lakes 2003 – Environmental Conditions.

Smolts Date	Sky	Precip. (mm)	Stage (ft)	Flow	Water Temp. (°C)	Air Temp. (°C)
21-May	1	0		ND		
22-May	1	0		ND	10.0	
23-May	2	0	0.41	ND	12.1	21.0
24-May	1	0	0.48	ND	11.5	8.0
25-May	2	0	0.48	ND	13.0	18.0
26-May	4	0	0.43	ND	11.0	10.0
27-May	4	1	0.42	ND	11.0	11.0
28-May	2	0	0.60	ND	10.5	11.0
29-May	2	0	0.62	ND	10.0	13.0
30-May	3	0	0.60	ND	10.5	10.0
31-May	2	4	0.68	ND	11.5	12.0
1-Jun	3	2	0.70	ND	10.5	13.0
2-Jun	2	0	0.60	ND	10.5	8.0
3-Jun	2	0	0.60	ND	10.5	7.0
4-Jun	5	24	0.60	ND	10.5	13.0
5-Jun	4	7	0.90	ND	10.5	7.0
6-Jun	3	0	1.01	ND	9.7	9.0
7-Jun	3	0	0.82	ND	10.0	11.0
8-Jun	5	14	0.76	ND	9.0	8.0
9-Jun	5	2	1.00	ND	9.5	11.0
10-Jun	5	3	1.11	ND	9.7	12.0
11-Jun	5	4	0.88	ND	10.0	16.0
12-Jun	2	0	0.84	ND	14.0	16.0
13-Jun	1	0	0.82	ND	13.0	16.0
14-Jun	3	0	0.78	ND	13.0	14.0
15-Jun	3	0	0.66	ND	13.0	12.0
16-Jun	3	0	0.58	ND	13.2	14.0
17-Jun	2	0	0.52	ND	13.0	16.0
18-Jun	2	0	0.48	ND	13.1	18.0
19-Jun	3	28	0.42	ND	12.5	14.0
20-Jun	3	0	0.38	ND	13.0	12.0
21-Jun	5	7	0.36	ND	13.0	12.0
22-Jun	2	0	0.34	ND	14.5	19.5
23-Jun	5	18.1	0.26	ND	14.0	12.0
24-Jun	5	19.5	0.42	ND	11.5	13.0
25-Jun	3	0	0.78	ND	12.0	14.0
26-Jun	5	8.1	0.68	ND	11.5	13.0
27-Jun	4	0	0.62	ND	11.0	11.0
28-Jun	1	0	0.56	ND	14.0	18.0
29-Jun	2	0	0.48	ND	14.5	16.0
30-Jun	3	0	0.40	ND	14.5	17.0
1-Jul	4	4.8	0.38	ND	15.0	16.0
2-Jul	3	3.2	0.38	ND	14.5	18.0
3-Jul	2	0	0.36	ND	15.5	17.0
4-Jul	3	0	0.30	ND	15.0	14.0
5-Jul	5	7.8	0.32	ND	15.0	15.0
6-Jul	3	0	0.36	ND	15.1	16.0
7-Jul	2	0	0.30	ND	17.0	23.0
8-Jul	1	0	0.29	ND	19.1	28.0
9-Jul	3	0	0.28	ND	18.0	23.0
10-Jul	4	0	0.19	ND	18.5	16.0
11-Jul	5	21	0.22	ND	17.0	13.0
Total	52	177				

ND = No Data

	Precip (mm)	Stage (ft).	Flow	Water Temp	Air Temp
Avg.	3.4	0.55	ND	12.7	14.1
Min.	0	0.19	ND	9	7
Max.	28	1.11	ND	19	28

Cloud Cover - No. of Days

Meas. Rain	100%	<100% >50%	<50% >0%	Clear
18	17	15	14	6
35%	33%	29%	27%	12%

= Clear
=Cloud Cover <50%
=Cloud Cover>50%
=Overcast
=Rain

Appendix 3. Paint Lakes – Smolt Migration.

		Sockeye		Rainbow		Dolly Varden	
Date	Daily	Mort.	Total	Daily	Total	Daily	Total
21-May	0	0	0	0	0	0	0
22-May	0	0	0	0	0	0	0
23-May	0	0	0	0	0	0	0
24-May	0	0	0	0	0	0	0
25-May	0	0	0	0	0	0	0
26-May	1	0	1	0	0	0	0
27-May	0	0	1	0	0	0	0
28-May	1	0	2	0	0	0	0
29-May	0	0	2	0	0	0	0
30-May	0	0	2	0	0	0	0
31-May	0	0	2	0	0	0	0
1-Jun	22	0	24	0	0	0	0
2-Jun	20	0	44	0	0	0	0
3-Jun	102	0	146	0	0	0	0
4-Jun	26	0	172	0	0	0	0
5-Jun	74	0	246	0	0	0	0
6-Jun	136	0	382	0	0	0	0
7-Jun	113	0	495	0	0	0	0
8-Jun	39	0	534	0	0	0	0
9-Jun	151	0	685	0	0	0	0
10-Jun	654	0	1,339	0	0	0	0
11-Jun	459	0	1,798	0	0	0	0
12-Jun	667	0	2,465	0	0	0	0
13-Jun	322	0	2,787	0	0	0	0
14-Jun	583	0	3,370	0	0	0	0
15-Jun	126	0	3,496	0	0	0	0
16-Jun	84	0	3,580	0	0	0	0
17-Jun	187	0	3,767	0	0	0	0
18-Jun	420	0	4,187	0	0	0	0
19-Jun	559	0	4,746	0	0	0	0
20-Jun	179	0	4,925	0	0	0	0
21-Jun	69	0	4,994	0	0	0	0
22-Jun	189	0	5,183	0	0	0	0
23-Jun	142	0	5,325	0	0	0	0
24-Jun	11	0	5,336	0	0	0	0
25-Jun	78	0	5,414	0	0	0	0
26-Jun	117	0	5,531	0	0	0	0
27-Jun	141	0	5,672	0	0	0	0
28-Jun	203	0	5,875	0	0	0	0
29-Jun	198	0	6,073	0	0	0	0
30-Jun	88	0	6,161	0	0	0	0
1-Jul	101	0	6,262	0	0	0	0
2-Jul	155	0	6,417	0	0	0	0
3-Jul	112	0	6,529	0	0	0	0
4-Jul	116	0	6,645	0	0	0	0
5-Jul	109	0	6,754	0	0	0	0
6-Jul	47	0	6,801	0	0	0	0
7-Jul	45	0	6,846	0	0	0	0
8-Jul	19	0	6,865	0	0	0	0
9-Jul	0	0	6,865	0	0	0	0
10-Jul	0	0	6,865	0	0	0	0
11-Jul	0	0	6,865	0	0	0	0
Total	6,865	0	6,865		0		0

Appendix 3. Paint Lakes 2003 - Project Update.

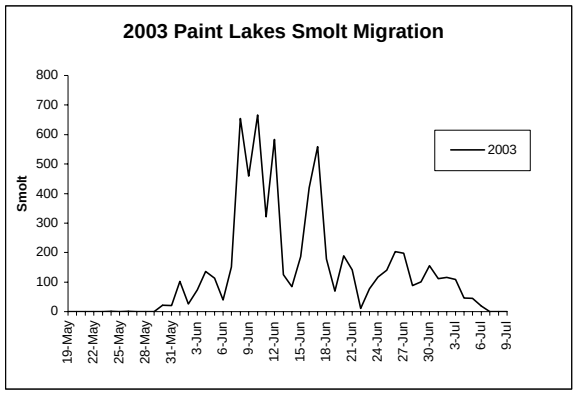
2003 Paint Lake Project Update

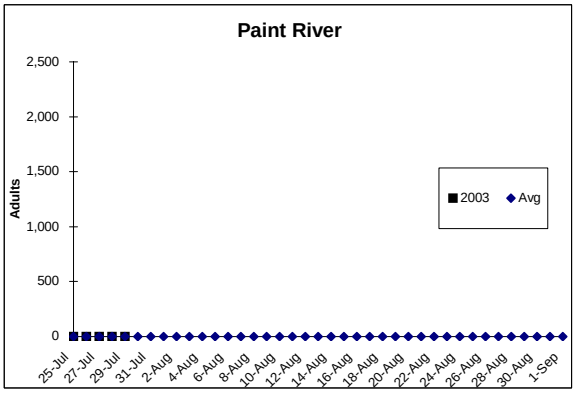
Stocking & Misc. Activities	
Crew on-site:	20-May
Ice-out:	ND
Crew off-site:	14-Jul
Fry Release:	None

Smolt Migration		
Dates:	20-May to 12-Jul	
Sockeyes:		6,865
Mortalities:		0
Percent age 1:		100%
Percent age 2:		0%
Percent hatchery:		100%

Egg Take
Dates:
No. of broodstock used:
Green eggs:
Fecundity:
Eyed eggs:
Survival

Adult Migration
Dates:
Sockeye total return:
Paint River Return:
Sport/PU Harvest:
Commercial Harvest
Paint Lakes Return:





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