SUMMARY DATA FROM THE 1996 SOCKEYE SALMON SMOLT INVESTIGATIONS AT RED, AKALURA, AND FRAZER LAKES

By.

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INTRODUCTION

In 1989, crude oil spilled from the *M/V Exxon Valdez* in Prince William Sound entered the Gulf of Alaska, and subsequently contaminated all of the traditional Kodiak Management Area salmon harvest areas (Barrett and Monkiewicz 1989). As a consequence of the contamination, fisheries were closed or severely restricted and sockeye salmon escapement goals were exceeded (overescapement) at several systems including Afognak River, Akalura Creek, Dog Salmon River (Frazer Lake), and Ayakulik River (Red Lake).

The most excessive escapements occurred at Red and Akalura Lakes and likely caused a decline in freshwater productivity (Schmidt et al. 1993). Previous studies (Kyle et al. 1988) have documented that excessive escapements tax rearing-limited systems by overloading the lake with too many juvenile sockeye salmon fry. This in turn results in alteration of the overall zooplankton biomass, species composition, and sizes, thereby lowering sockeye salmon survival (Koenings and Kyle 1991). These changes can reduce over-winter sockeye salmon fry survival, extend freshwater rearing for additional years, and affect multiple brood years.

Sockeye salmon smolt studies were conducted at Red and Akalura (1990-1996), Upper Station (control; 1990-1993), and Frazer (alternate control; 1994-1996) Lakes to measure smolt production responses from the 1989 escapement event. Swanton et al. (*in press.*) contains a final summary of these investigations (1990-1996) and reports estimates germane to the smolt outmigrations which supersede all earlier reports (Barrett et al. 1993a; Barrett et al. 1993b; Swanton et al. 1995; Swanton et al. 1996). This document reports the initial summary data associated with the seventh (1996) year of the study.

METHODS

Study methods associated with the 1996 investigations at Red, Akalura, and Frazer Lakes are identical to those detailed in Swanton et al. (1996) with the exceptions noted below.

Smolt Traps and Site Locations

The capture devices at the Akalura Lake site were modified during 1996 to include a weir fished in conjunction with the trap and allowing total outmigration counts (Figure 1). The trap configuration was as described in Swanton et al. (1996) and the weir effectively captured all smolt outmigrating in the remainder of the creek.

Detection of Marked Smolt over Time

The results of the 1995 experiments to determine detectability of marked smolts over time indicated that mark detectability was reliable. Therefore, these experiments were not repeated during 1996.

Data Analysis

The smolt estimators reported by Rawson (1984) and previous summaries of Kodiak smolt investigations (Barrett et al. 1993a; Barrett et al. 1993b; Swanton et al. 1995; Swanton et al. 1996) were found to be in error (Carlson et al. *in press*). Smolt outmigration for all years and systems was re-estimated according to the revised estimation procedure presented in Swanton et al. (*in press*) and Carlson et al. (*in press*).

RESULTS

The 1996 trap catches for Red, Akalura, and Frazer Lakes are presented in Tables 1-3. A summary of length, weight, and condition factor by age for sockeye smolt sampled at Red, Akalura, and Frazer Lakes are presented in Tables 4-6. The 1992-1996 catches and corresponding length summaries of young of the year (YOY) sockeye salmon from littoral zone sampling at Red Lake are reported in Tables 7-8; as well as stickleback bycatch (Table 9). Tow net catches associated with fall hydroacoustic surveys from 1990-1996 at Frazer Lake are reported in Table 10. Finally, 1996 daily climatological observations from Red, Akalura, and Frazer Lakes are reported in Tables 11-13.

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Table 1. Red Lake sockeye salmon smolt trap catch and trap efficiency estimates, 1996.

Trap Catch			Trap Efficiency Test				
Date[a]	Daily[b]	Cummulative	Marked (dyed)	Examined For Marks	Marked Recoveries	Total Recoveries for Dye Test Period[c]	Recovery Rate[d]
5/1	0	0					
5/2	1	1					
5/3	0	1					
5/4	0	1					
5/5	1	2					
5/6	0	2					
5/7	1	3					
5/8	1	4					
5/9	1	5					
5/10	0	5					
5/11	7	12					
5/12	3	15					
5/13	7	22					
5/14	16	38					
5/15	3	41					
5/16	154	195					
5/17	48	243					
5/18	67	310					
5/19	17	327	267	55	38		
5/20	26	353		31	5		
5/21	372	725		374	2		
5/22	98	823		99	1	46	17.2%
5/23	1,260	2,083					
5/24	4,003	6,086					
5/25	2,701	8,787					
5/26	93	8,880	512	144	51		
5/27	1,807	10,687		1,812	5		
5/28	326	11,013		327	1	57	11.1%
5/29	84	11,097					
5/30	238	11,335					
5/31	1,189	12,524					
6/1	1,499	14,023	526	1,525	26		
6/2	474	14,497		488	14		
6/3	5,262	19,759		5,265	3	43	8.2%
6/4	2,992	22,751					
6/5	9,729	32,480					
6/6	468	32,948					
6/7	10,038	42,986	461	10,076	38		
6/8	8,852	51,838		8,875	23		
6/9	8,778	60,616		8,779	1	62	13.4%
6/10	8,819	69,435					
6/11	2,992	72,427					

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Table 1. (page 2 of 2)

Trap Catch			Trap Efficiency Test				
Date[a]	Daily[b]	Cummulative	Marked (dyed)	Examined For Marks	Marked Recoveries	Total Recoveries for Dye Test Period[c]	Recovery Rate[d]
6/12	5,043	77,470					
6/13	7,479	84,949	539	7,512	35		
6/14	3,569	88,518		2,932	22		
6/15	8,860	97,378		8,862	2	59	10.9%
6/16	4,492	101,870					
6/17	1,702	103,572					
6/18	1,554	105,126					
6/19	814	105,940					
6/20	121	106,061					
6/21	175	106,236					
6/22	362	106,598					
6/23	1,577	108,175	528	1,615	38		
6/24	993	109,168		1,001	8		
6/25	2,475	111,643		2,475	0	46	8.7%
6/26	1,256	112,899					
6/27	477	113,376					
TOTAL	113,376		2,833	61,688	313		11.0%

[a] Each date listed covers a 24-hour period extending from noon to noon and identifies the date of the first noon of the 24-hour period.

[b] Number of fish caught does not include mark recoveries from trap efficiency tests.

[c] Represents the sum of marked recoveries for the particular dye test period.

[d] Determined from the cumulative number of marked and recovered fish by test period.

Table 2. Akalura Lake sockeye salmon smolt trap catch, trap efficiency estimates, and weir catches, 1996.

Trap Catch			Trap Efficiency Test					Total Weir Catch	
Date[a]	Daily[b]	Cummulative	Marked (dyed)	Examined For Marks	Marked Recoveries	Total Recoveries for Dye Test Period[c]	Recovery Rate[d]	Daily[b]	cum.
1-May								3	3
2-May								2	5
3-May								88	93
4-May								217	310
5-May								942	1,252
6-May								1,086	2,338
7-May								12,388	14,726
8-May								15,711	30,437
9-May								13,947	44,384
10-May	2,292	2,292						16,055	60,439
11-May	3,193	5,485	522	3,288	95			12,738	73,177
12-May	6,033	11,518		6,087	54			41,953	115,130
13-May	4,585	16,103		4,586	1	150	29%	19,832	134,962
14-May	3,960	20,063		3,960				16,381	151,343
15-May	2,115	22,178		2,115				6,905	158,248
16-May	1,735	23,913		1,735				5,950	164,198
17-May	3,878	27,791		3,878				12,048	176,246
18-May	1,203	28,994	518	1,226	23			2,824	179,070
19-May	491	29,485		533	42			2,471	181,541
20-May	519	30,004		532	13			1,781	183,322
21-May	227	30,231		228	1	79	15%	0	183,322
22-May	104	30,335		104				0	183,322
23-May	254	30,589		254				2,157	185,479
24-May	484	31,073	484	494	10			4,174	189,653
25-May	488	31,561		500	12			4,173	193,826
26-May	471	32,032		475	4			5,298	199,124
27-May	658	32,690		658				5,363	204,487
28-May	1,346	34,036		1,349	3	29	6%	11,239	215,726
29-May	964	35,000		964				3,203	218,929
30-May	1,395	36,395	525	1,412	17			4,232	223,161
31-May	1,110	37,505		1,150	40			2,720	225,881
1-Jun	2,225	39,730		2,232	7			5,748	231,629
2-Jun	2,019	41,749		2,024	5	69	13%	4,234	235,863
3-Jun	327	42,076		327				1,025	236,888
4-Jun	220	42,296		220				1,335	238,223
5-Jun	504	42,800		504				1,642	239,865
6-Jun	488	43,288	525	496	8			1,948	241,813
7-Jun	366	43,654		392	26			1,411	243,224
8-Jun	171	43,825		181	10			438	243,662
9-Jun	140	43,965		147	7			491	244,153

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Trap Catch			Trap Efficiency Test					Total Weir Catch	
Date[a]	Daily[b]	Cummulative	Marked (dyed)	Examined For Marks	Marked Recoveries	Total Recoveries for Dye Test Period[c]	Recovery Rate[d]	Daily[b]	cum.
10-Jun	161	44,126		162	1			492	244,645
11-Jun	138	44,264		141	3	55	10%	306	244,951
12-Jun	72	44,336		72				208	245,159
13-Jun	64	44,400	387	74	10			158	245,317
14-Jun	38	44,438		58	20			255	245,572
15-Jun	32	44,470		37	5			90	245,662
16-Jun	29	44,499		32	3			96	245,758
17-Jun	24	44,523		25	1	39	10.1%	63	245,821
18-Jun	0	44,523		0					
19-Jun	4	44,527		4					
20-Jun	0	44,527		0					
21-Jun	7	44,534		7					
22-Jun	1	44,535		1					
23-Jun	0	44,535		0					
TOTAL	44,535		2,961	42,664	421		14.2%	245,821	

[a] Each date listed covers a 24-hour period extending from noon to noon and identifies the date of the first noon of the 24-hour period.
[b] Number of fish caught does not include mark recoveries from trap efficiency tests.
[c] Represents the sum of marked recoveries for the particular dye test period.
[d] Determined from the cumulative number of marked and recovered fish by test period.

Table 3. Frazer Lake sockeye salmon smolt trap catch and trap efficiency estimates, 1996.

Trap Catch			Trap Efficiency Test				
Date[a]	Daily[b]	Cummulative	Marked (dyed)	Examined For Marks	Marked Recoveries	Total Recoveries for Dye Test Period[c]	Recovery Rate[d]
5/9	18,966	18,966					
5/10	10,703	29,669	1,076	10,307	107		
5/11	757	30,426		768	11		
5/12	1,277	31,703		1,277	0	118	11.0%
5/13	19,948	51,651					
5/14	5,256	56,907					
5/15	14,868	71,775	1,062	12,968	54		
5/16	15,929	87,704		15,934	5		
5/17	3,618	91,322		3,618	0	59	5.6%
5/18	19,354	110,676					
5/19	10,286	120,962					
5/20	9,179	130,141					
5/21	6,805	136,946					
5/22	2,495	139,441	1,111	2,419	50		
5/23	1,098	140,539		1,111	13		
5/24	172	140,711		175	3	66	5.9%
5/25	2,675	143,386					
5/26	1,154	144,540					
5/27	6,795	151,335					
5/28	432	151,767					
5/29	979	152,746					
5/30	7,343	160,089	1,140	7,121	32		
5/31	15,716	175,805		15,721	5		
6/1	8,687	184,492		8,688	1	38	3.3%
6/2	9,812	194,304					
6/3	2,771	197,075					
6/4	2,246	199,321					
6/5	1,533	200,854	1,095	1,588	55		
6/6	3,084	203,938		3,092	8		
6/7	1,130	205,068		1,130	0	63	5.8%
6/8	796	205,864					
6/9	437	206,301					
6/10	180	206,481					
6/11	296	206,777					
6/12	152	206,929					
6/13	94	207,023					
6/14	109	207,132	539	146	37		
6/15	134	207,266		138	4		
6/16	22	207,288		23	1	42	7.8%
6/17	19	207,307					
6/18	19	207,326					

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Table 3. (page 2 of 2)

Trap Catch			Trap Efficiency Test				
Date[a]	Daily[b]	Cummulative	Marked (dyed)	Examined For Marks	Marked Recoveries	Total Recoveries for Dye Test Period[c]	Recovery Rate[d]
6/19	35	207,361					
6/20	36	207,397					
6/21	35	207,432					
6/22	99	207,531					
6/23	9	207,540					
TOTAL	207,540		6,023	86,224	386		6.4%

[a] Each date listed covers a 24-hour period extending from noon to noon and identifies the date of the first noon of the 24-hour period.
[b] Number of fish caught does not include mark recoveries from trap efficiency tests.
[c] Represents the sum of marked recoveries for the particular dye test period.
[d] Determined from the cumulative number of marked and recovered fish by test period.

Table 4. Red Lake sockeye salmon smolt length, weight, and condition factor of samples collected by age and statistical week, 1996.

			Length			Weight			Condition		
Age	Week	Dates	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error
1	19	(5/03-5/09)	1	90		1	5.5		1	0.76	
1	20	(5/10-5/16)	5	99	6.5	4	7.4	0.5	4	0.95	0.11
1	21	(5/17-5/23)	11	93.8	5.4	11	7.1	1.5	11	0.74	0.04
1	22	(5/24-5/30)	37	102	0.9	37	8.3	0.2	37	0.78	0.01
1	23	(5/31-6/06)	198	104	0.4	198	9	0.1	198	0.81	0.01
1	24	(6/07-6/13)	299	104	0.3	299	9	0.1	299	0.8	0.01
1	25	(6/14-6/20)	239	102	0.3	239	8.3	0.1	239	0.8	0.01
1	26	(6/21-6/27)	238	105	0.3	238	9.3	0.1	238	0.8	0.01
Total			**1,028**	**103**	**0.2**	**1,027**	**8.9**	**0.0**	**1,027**	**0.8**	**0.01**
2	18	(4/26-5/02)	1	96		1	6.9		1	0.78	
2	19	(5/03-5/09)	2	108	8.5	2	9.4	2.1	2	0.74	0.01
2	20	(5/10-5/16)	10	122	2.9	10	15.1	1.3	10	0.83	0.03
2	21	(5/17-5/23)	168	116	0.6	168	13.1	0.2	168	0.82	0.01
2	22	(5/24-5/30)	154	114	0.7	154	12.4	0.2	154	0.82	0.01
2	23	(5/31-6/06)	140	115	0.8	140	12.8	0.2	140	0.83	0.01
2	24	(6/07-6/13)	46	108	1.3	46	10.4	0.4	46	0.81	0.01
2	25	(6/14-6/20)	38	101	1.3	38	8.2	0.3	38	0.79	0.01
2	26	(6/21-6/27)	42	105	0.8	42	9.4	0.2	42	0.8	0.01
Total			**601**	**113**	**0.4**	**601**	**12.1**	**0.1**	**601**	**0.82**	**0.01**
3	20	(5/10-5/16)	20	130	1.5	18	18.1	0.9	18	0.81	0.02
3	21	(5/17-5/23)	66	123	1	66	15.4	0.4	66	0.83	0.01
3	22	(5/24-5/30)	16	123	1.4	16	15.7	0.5	16	0.84	0.01
3	23	(5/31-6/06)	10	109	4.9	10	11.4	1.6	10	0.85	0.02
3	24	(6/07-6/13)	1	105		1	9.3		1	0.81	
3	25	(6/14-6/20)	1	96		1	7.4		1	0.84	
Total			**114**	**122**	**1**	**112**	**15.4**	**0.3**	**112**	**0.83**	**0.01**

Table 5. Akalura Lake sockeye salmon smolt length, weight, and condition factor of samples collected by age and statistical week, 1996.

			Length			Weight			Condition		
Age	Week	Dates	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error
1	19	(5/03-5/09)	7	92.1	1.1	7	6.2	0.2	7	0.8	0.02
1	20	(5/10-5/16)	10	87.3	1.7	10	5.2	0.3	10	0.78	0.02
1	21	(5/17-5/23)	10	87	1.6	10	5.5	0.3	10	0.84	0.02
1	22	(5/24-5/30)	30	92.2	1.1	30	6.6	0.2	30	0.84	0.02
1	23	(5/31-6/06)	32	84	1.4	32	5.2	0.3	32	0.87	0.03
1	24	(6/07-6/13)	223	81	0.5	223	4.7	0.1	223	0.89	0.01
1	25	(6/14-6/20)	88	81.3	0.7	88	4.1	0.1	88	0.76	0.02
Total			400	82.6	0.4	400	4.8	0.1	400	0.85	0.01
2	18	(4/26-5/02)	4	90.8	3.1	4	6	0.5	4	0.8	0.03
2	19	(5/03-5/09)	339	91.3	0.2	339	6.1	0.1	339	0.8	0.01
2	20	(5/10-5/16)	266	89.3	0.2	266	5.7	0	266	0.81	0.01
2	21	(5/17-5/23)	331	90.3	0.2	331	6	0	331	0.82	0.01
2	22	(5/24-5/30)	296	92.6	0.3	296	6.6	0	296	0.84	0.01
2	23	(5/31-6/06)	178	92.5	0.4	178	6.9	0.1	178	0.87	0.01
2	24	(6/07-6/13)	36	86.8	1.2	36	5.7	0.2	36	0.87	0.02
2	25	(6/14-6/20)	1	94		1	7.6		1	0.92	
Total			1,451	91	0.1	1,451	6.2	0	1,451	0.82	0.01
3	19	(5/03-5/09)	1	94		1	6.8		1	0.82	
3	20	(5/10-5/16)	3	98.7	3	3	7.8	0.9	3	0.81	0.03
Total			4	97.5	2.4	4	7.5	0.7	4	0.81	0.02

Table 6. Frazer Lake sockeye salmon smolt length, weight, and condition factor of samples collected by age and statistical week, 1996.

			Length			Weight			Condition		
Age	Week	Dates	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error
1	21	(5/17-5/23)	1	85		1	4.9		1	0.8	
1	22	(5/24-5/30)	9	102	3.4	9	8.8	0.9	9	0.8	0.03
1	23	(5/31-6/06)	11	87.9	3.7	11	5.4	0.9	11	0.75	0.02
1	24	(6/07-6/13)	4	79.5	0.5	4	3.8	0.1	4	0.75	0.02
1	25	(6/14-6/20)	7	93.7	2.3	7	6.7	0.5	7	0.81	0.03
1	26	(6/21-6/27)	10	88.8	1.4	10	5.6	0.4	10	0.8	0.02
Total			42	91.3	1.6	42	6.2	0.4	42	0.78	0.01
2	19	(5/3-5/9)	56	90.9	0.5	56	5.9	0.1	56	0.79	0.01
2	20	(5/10-5/16)	317	88	0.2	317	5.4	0	317	0.79	0.01
2	21	(5/17-5/23)	310	86.9	0.2	310	5.2	0	310	0.79	0.01
2	22	(5/24-5/30)	253	89	0.3	253	5.4	0.1	253	0.76	0.01
2	23	(5/31-6/06)	322	84.9	0.2	322	4.7	0	322	0.77	0.01
2	24	(6/07-6/13)	126	83.6	0.4	126	4.5	0.1	126	0.77	0.01
2	25	(6/14-6/20)	234	87.7	0.4	234	5.5	0.1	234	0.8	0.01
2	26	(6/21-6/27)	100	89.6	0.7	100	5.9	0.2	100	0.8	0.01
Total			1,718	87.2	0.1	1,718	5.2	0	1,718	0.78	0.01
3	19	(5/10-5/16)	12	98.1	2.2	12	7.4	0.5	12	0.78	0.01
3	20	(5/17-5/23)	29	93.5	1.1	29	6.5	0.2	29	0.8	0.01
3	21	(5/24-5/30)	25	96.2	3.1	25	7.7	1	25	0.79	0.01
3	22	(5/31-6/06)	29	112	2.8	29	12.2	1	29	0.82	0.02
3	23	(6/07-6/13)	7	121	2.9	7	15	1	7	0.85	0.02
3	25	(6/14-6/20)	14	117	4.4	14	14.3	1.5	14	0.85	0.02
Total			116	104	1.5	116	9.7	0.5	116	0.81	0.01

Table 7. Number of young-of-year (YOY) sockeye salmon captured by beach seine sampling of standard littoral zone areas at Red Lake, 1992-1996.

	1992					1993					1994					1995					1996				
	Site No.					Site No.					Site No.					Site No.					Site No.				
Date	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total
6-May																					0	2	4	178	184
7-May																									
8-May	0	0	0	0	0																				
9-May											2	0	0	4	6										
10-May																									
11-May																									
12-May																					36	0	0	61	97
13-May						39	3	215	0	257															
14-May																15	4	0	83	102					
15-May	0	0	0	0	0																				
16-May											10	5	23	2	40										
17-May																									
18-May																									
19-May																									
20-May						10	26	1	58	95											25	2	1	209	237
21-May	2	47	1	0	50																				
22-May																83	0	313	16	412					
23-May											250	16	6	0	272										
24-May																									
25-May																									
26-May																									
27-May						21	0	15	27	63															
28-May																									
29-May																11	0	8	1	20	276	0	22	57	355
30-May	16	1	0	26	43						252	2	1	56	311										
31-May						171	1	4	8	184															
1-Jun																									
2-Jun																									
3-Jun																									
4-Jun																									
5-Jun	2	0	0	15	17											0	0	14	2	16					
6-Jun											116	2	5	3	126										
7-Jun																									
8-Jun						93	3	2	3	101															
9-Jun																									
10-Jun																									
11-Jun																16	1	2	1	20					
12-Jun																					48	2	20	4	74
13-Jun	23	2	0	3	28						241	1	1	7	250										
14-Jun						44	7	10	16	77															
15-Jun																									
16-Jun																									

-Continued-

Table 7. (page 2 of 2)

	1992					1993					1994					1995					1996				
	Site No.					Site No.					Site No.					Site No.					Site No.				
Date	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total
17-Jun																									
18-Jun																12	0	4	1	17					
19-Jun	53	20	0	6	79																				
20-Jun											43	20	0	7	70										
21-Jun						4	8	5	1	18															
22-Jun																									
23-Jun																									
24-Jun																									
25-Jun																17	0	3	8	28					
26-Jun																									
27-Jun	39	8	5	14	66						21	18	2	3	44										
28-Jun																									
29-Jun																									
30-Jun						52	21	18	1	92															
1-Jul																									
2-Jul																									
3-Jul																									
4-Jul	106	6	1	5	118																				
5-Jul																									
6-Jul																									
7-Jul																									
8-Jul																									
9-Jul																									
10-Jul	73	2	20	8	103																				
11-Jul																									
12-Jul																									
13-Jul																									
14-Jul																									
15-Jul																									
16-Jul																									
17-Jul	27	2	8	14	51																				
18-Jul																									
19-Jul																									
20-Jul																									
21-Jul																									
22-Jul																									
23-Jul																									
24-Jul	24	4	31	a	59																				

[a] Did not sample due to beach spawning sockeye.

Table 8. Average length of young-of-year (YOY) sockeye salmon captured by beach seine sampling of standard littoral zone areas at Red Lake, 1992-1996.

	1992					1993					1994					1995					1996				
	Site No.					Site No.					Site No.					Site No.					Site No.				
Date	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total
6-May																						32	33	32	32
7-May																									
8-May																									
9-May											31			32	31										
10-May																									
11-May																									
12-May																					34			33	33
13-May						32	33	31		32															
14-May																32	37		32	32					
15-May																									
16-May											34	31	33	32	32										
17-May																									
18-May																									
19-May																									
20-May						30	32	31	34	33											36	34	34	34	34
21-May	33	35	35		35																				
22-May																33		33	32	33					
23-May											33	32	33		33										
24-May																									
25-May																									
26-May																									
27-May						34		32	35	34															
28-May																									
29-May																34		33	33	34	37		35	36	37
30-May	35	30		35	35						33	34	33	33	33										
31-May						35		36	36	35															
1-Jun																									
2-Jun																									
3-Jun																									
4-Jun																									
5-Jun	32			33	33													36	37	36					
6-Jun											34	34	34	34	34										
7-Jun																									
8-Jun						36	36	34	36	36															
9-Jun																									
10-Jun																									
11-Jun																39	29	41	37	39					
12-Jun																					35	33	38	47	36
13-Jun	34	37		36	34						34	34	32	34	33										
14-Jun						35	38	35	35	35															
15-Jun																									
16-Jun																									

-Continued-

Table 8. (page 2 of 2)

	1992					1993					1994					1995					1996				
	Site No.					Site No.					Site No.					Site No.					Site No.				
Date	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total
17-Jun																									
18-Jun																36		31	36	35					
19-Jun	34	40		34	36																				
20-Jun											34	40		34	36										
21-Jun						36	39	35	32	37															
22-Jun																									
23-Jun																									
24-Jun																									
25-Jun																37		35	41	38					
26-Jun																									
27-Jun	34	39	32	34	35						40	37	39	46	40										
28-Jun																									
29-Jun																									
30-Jun						38	41	33	36	37															
1-Jul																									
2-Jul																									
3-Jul																									
4-Jul	36	38	30	34	36																				
5-Jul																									
6-Jul																									
7-Jul																									
8-Jul																									
9-Jul																									
10-Jul	34	36	32	37	34																				
11-Jul																									
12-Jul																									
13-Jul																									
14-Jul																									
15-Jul																									
16-Jul																									
17-Jul	31	42	36	38	34																				
18-Jul																									
19-Jul																									
20-Jul																									
21-Jul																									
22-Jul																									
23-Jul																									
24-Jul	40	48	39		40																				

Table 9. Number of stickleback captured by beach seine sampling of standard littoral zone areas at Red Lake, 1992-1996.

	1992					1993					1994					1995					1996				
	Site No.					Site No.					Site No.					Site No.					Site No.				
Date	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total
6-May																					12	1	3	523	539
7-May																									
8-May	0	0	0	78	78																				
9-May											1	1		1	3										
10-May																									
11-May																									
12-May																					280	1	360	1340	1981
13-May						174	20	86	10	290															
14-May																16	31	18	54	119					
15-May	1	2	0	0	3																				
16-May											5	12			17										
17-May																									
18-May																									
19-May																									
20-May						1916	139	1172	2600	5827											250	25	2000	507	2782
21-May	1078	408	26	279	1791																				
22-May																29	5	46	8	88					
23-May											214	26	7		247										
24-May																									
25-May																									
26-May																									
27-May						1840	0	617	443	2900															
28-May																									
29-May																7	9	557	59	632	5200	176	30	11	5417
30-May	1091	9	0	502	1602						157	16	8	588	769										
31-May						5535	608	59	415	6617															
1-Jun																									
2-Jun																									
3-Jun																									

-Continued-

Table 9. (page 2 of 3)

	1992					1993					1994					1995					1996				
	Site No.					Site No.					Site No.					Site No.					Site No.				
Date	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total
4-Jun																									
5-Jun	357	34	1	744	1136											1	27	949	750	1727					
6-Jun											78	88	17	520	703										
7-Jun																									
8-Jun						736	882	147	513	2278															
9-Jun																									
10-Jun																									
11-Jun																614	39	1861	257	2771					
12-Jun																					1550	110	9940	4585	16185
13-Jun	685	124	0	58	867						679	71	36	24	810										
14-Jun						876	661	156	171	1864															
15-Jun																									
16-Jun																									
17-Jun																									
18-Jun																5	52	155	99	311					
19-Jun	1685	805	0	24	2514																				
20-Jun											154	1126	11	9	1300										
21-Jun						10000[a]	424	126	49	10599															
22-Jun																									
23-Jun																									
24-Jun																									
25-Jun																25	26	1222	72	1345					
26-Jun																									
27-Jun	68	178	2	56	304						152	188	95	9	444										
28-Jun																									
29-Jun																									
30-Jun						7396	38	54	49	7537															
1-Jul																									
2-Jul																									

-Continued-

Table 9. (page 3 of 3)

	1992					1993					1994					1995					1996				
	Site No.					Site No.					Site No.					Site No.					Site No.				
Date	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total
3-Jul																									
4-Jul	785	192	1	56	1034																				
5-Jul																									
6-Jul																									
7-Jul																									
8-Jul																									
9-Jul																									
10-Jul	432	250	1	83	766																				
11-Jul																									
12-Jul																									
13-Jul																									
14-Jul																									
15-Jul																									
16-Jul																									
17-Jul	894	121	768	95	1878																				
18-Jul																									
19-Jul																									
20-Jul																									
21-Jul																									
22-Jul																									
23-Jul																									
24-Jul	553	501	1025a	b	2079																				

[a] Estimated due to heavy algae.

[b] Did not sample due to beach spawning sockeye.

Table 10. Tow net survey catches from Frazer Lake, 1990-1996.

	Tow		Catch by Species					
			Sockeye			Stickleback		
Year	No.	Min.	No.	%	CPUE	No.	%	CPUE
1990	1	20	0	0.0	0	15	100.0	0.8
	2	20[a]						
	3	20	46	93.9	2.3	3	6.1	0.2
	4	20	60	81.1	3	14	18.9	0.7
Total		60	106	76.8	1.8	32	23.2	0.5
1991	1	20	117	79.6	5.9	30	20.4	1.5
	2	20	9	64.3	0.5	5	35.7	0.3
	3	20	48	68.6	2.4	22	31.4	1.1
Total		60	174	75.3	2.9	57	24.7	1.0
1992	1	30	123	49.6	4.1	125	50.4	4.2
	2	30	163	16.6	5.4	820	83.4	27.3
	3	30	42	7.1	1.4	551	92.9	18.4
Total		90	328	18.0	3.6	1496	82.0	16.6
1993	1	20	3	2.8	0.2	106	97.2	5.3
	2	20	12	10.3	0.6	104	89.7	5.2
	3	20	1	3.4	0.1	28	96.6	1.4
Total		60	16	6.3	0.3	238	93.7	4.0
1994	1	20	1	0.2	0.1	506	99.8	25.3
	2[b]	20	0		0.0	0		0.0
	3	20	1	12.5	0.1	7	87.5	0.4
Total		60	2	0.4	0.0	513	99.6	8.6
1995	1	15	0	0.0	0.0	2	100.0	0.1
	2	15	0	0.0	0.0	10	100.0	0.7
	3	15	1	0.5	0.1	218	99.5	14.5
	4	15	1	25.0	0.1	3	75.0	0.2
Total		60	2	0.9	0.0	233	99.1	3.9

-Continued-

Table 10. (page 2 of 2)

	Tow		Catch by Species					
			Sockeye			Stickleback		
Year	No.	Min.	No.	%	CPUE	No.	%	CPUE
1996	1	15	9	11.3	0.6	71	88.8	4.7
	2	15	18	21.2	1.2	67	78.8	4.5
	3	15	49	17.9	3.3	225	82.1	15.0
	4	15	20	13.5	1.3	128	86.5	8.5
	5	15	17	20.2	1.1	67	79.8	4.5
	Total	75	113	16.8	1.5	558	83.2	7.4

[a] Tow net survey for this transect not conducted due to severe weather conditions.

[b] Results from this tow are suspect, however because of severe weather a replicate tow was not conducted.

Table 11. Daily climatological observations, water temperature, and water depth monitored at Red Lake field station, 1996.

Date	Time	Temperature Air(c)	Temperature Water(c)	Cloud Cover %	Wind Dir.	Wind Vel. (Mph)	Stream Gauge (1 cm)	Comments
30-Apr	1800	15	6	50	SW	5-10	17	Nice day
1-May	1800	16	7	0	WSW	5-10	17	CAVU
2-May	1800	10	8	0	SW	0-5	16	Clear and sunny
3-May	1830	14	8	0	NW	0-3	16	Sunny and warm
4-May	1800	14	9	0	NW	0-5	16	CAVU
5-May	1800	12	7	90	SW	5-10	16	2000' ceiling
6-May	1800	12	8	5	W	0-5	16	Overcast in the AM, clearing by afternoon
7-May	1800	7	8	95	NW	10-15	15	Cold/windy all day, 2000' ceiling
8-May	1800	9	8	10	NW	5-10	15	Clear
9-May	1800	16	9	0	SE	0-5	15	CAVU
10-May	1800	19	9	0	NW	0-5	15	CAVU
11-May	1830	24	12	0	N	0-5	15	Clear and warm
12-May	1800	19	11	0	NW	5-10	15	Clear and warm
13-May	1830	20	10	0	W	0-5	15	Clear and warm
14-May	1800	15	11	0	W	5-10	15	Clear and sunny
15-May	1800	15	11	3	NW	0-5+	15	CAVU
16-May	1800	10	9	60	SE	0-5	15	
17-May	1800	12	11	35	N	5-10	15	Unlimited visibility, windy
18-May	1800	12	11	15	W	10-15	15	Clear
19-May	1800	11	10	0	W	15-20	15	CAVU
20-May	1930	9	9	65	N	0-5+	15	Cloud cover changing rapidly all day
21-May	1800	6	9	60	NE	0-5	15	Snow flurries in the morning, brief hail in afternoon
22-May	1830	8	8	100	E	5-10	15	Light rain and 15+mph winds in early afternoon, 2000' ceiling
23-May	1820	8	9	100	NE	10-15+	15	Fog and rain most of day, 30+ mph wind at night
24-May	1800	8	9	100	E	5-10	16	1500' ceiling, rained on and off all day
25-May	1815	8	8	100	NW	5-10	16	intermittent light rain, 1800' ceiling
26-May	1800	7	7	100	NE	5-10	16	Rain, two mile visibility
27-May	1800	8	7	100	NE	0-3	16	1000' ceiling, occasional rain, fog in afternoon
28-May	1800	11	9	80	N	0-3	16	1000' ceiling, lifting and becoming partially sunny by 1800 hrs

-Continued-

Table 11. (page 2 of 2)

Date	Time	Temperature Air(c)	Temperature Water(c)	Cloud Cover %	Wind Dir.	Wind Vel. (Mph)	Stream Gauge (1 cm)	Comments
29-May	1815	11	10	W	W	5-10	16	Partly cloudy in the AM, clearing by afternoon
30-May	1800	12	11	20	NW	5-10	16	Sunny and clear
31-May	1800	13	11	5	W	0-5	16	CAVU
1-Jun	1800	19	12	5	SSE	5-10	16	CAVU, nice warm day, wind died off by 1900 hrs
2-Jun	1800	13	13	10	W	0-5	16	Sunny and warm, light breeze
3-Jun	1800	11	12	60	W	0-5	16	Light haze
4-Jun	1800	21	14	20	NW	0-5	16	Warm day, light haze
5-Jun	1800	19	15	2	NW	10-15+	15	CAVU, windy all day
6-Jun	1800	14	10	10	NW	10-15	15	CAVU, calm in the morning, wind picking up in afternoon
7-Jun	1900	10	10	100	NW	5-10	15	1500' ceiling-solid
8-Jun	1800	8	9	100	W	5-10	15	1800' ceiling-solid
9-Jun	1800	9	10	95	NW	10-15	15	2000' ceiling, sporadic showers
10-Jun	1805	10	12	40	NW	15-20+	15	Unlimited visibility
11-Jun	1800	10	10	10	NNW	20-25	14	Unlimited visibility, windy
12-Jun	1835	15	14	80	NNE	5-10	15	Sunny most of day, wind picking up and clouds moving in evening
13-Jun	1800	14	15	75	SE	5-10+	15	Clouds moving in-looks like rain
14-Jun	1800	16	14	90	NW	5-10	14	Warm, 2000' ceiling with clear skies to the west
15-Jun	1800	13	13	90	-	calm	14	Visibility clear, 1500' ceiling-broken
16-Jun	1800	15	15	5	SE	5-10	15	CAVU
17-Jun	1800	11	10	100	E	10-15	14	2000' solid, wind blowing 30+mph earlier in day
18-Jun	1825	10	11	100	W	5-10	14	Light rain, visibility 5 miles
19-Jun	1950	10	11	100	SE	5-10	14	Occasional rain, 1500' solid
20-Jun	1800	13	12	100	SE	0-5	14	1500' ceiling
21-Jun	1800	11	12	100	W	0-5	14	Light rain, 500-1000' ceiling, some ground fog
22-Jun	1800	14	14	40	SE	5-10	14	Sunny by afternoon
23-Jun	1800	11	10	100	E	5-10	15	Light rain most of day, 1500' solid
24-Jun	1800	10	11	100	SE	5-10	15	1500' ceiling, visibility 5 miles, occasional light rain
25-Jun	1800	9	10	100	E	5-10	15	Rain, 5-6 mile visibility
26-Jun	1800	9	10	100	SE	0-5	16	intermittent rain, 1500' ceiling, low patches of fog
27-Jun	1900	9	11	100	W	0-5	16	Rain with occasional sunshine
28-Jun	1800	8	11	90	-	calm	17	Light rain through the day, sun coming out in the early evening

Table 12. Daily climatological observations, water temperature, and water depth monitored at Akalura Lake field station, 1996.

Date	Time	Temperature Air(c)	Temperature Water(c)	Cloud Cover %	Wind Dir.	Wind Vel. (Mph)	Stream Gauge (1 cm)	Comments
1-May	1700	11	9	0	NW	GUSTS 10		
2-May	1700	12	9	0	NW	5	37	
3-May	1700	13	10	0	SE	<5	36.5	
4-May	1700	13	11	0	NW	GUSTS 10	36.5	
5-May	1700	8	8	50	CALM	CALM	36.5	
6-May	1700	10	10	0	CALM	CALM	36.5	
7-May	1700	13	11	0	CALM	CALM	36.5	
8-May	1700	13	11	0	CALM	CALM	35.5	
9-May	1700	13	12	0	CALM	CALM	35	
10-May	1700	13	12	0	CALM	CALM	35	
11-May	1700	15	14	0	VAR.	<5	35	
12-May	1700	15	14	0	NE	5-10	35	
13-May	1700	15	15	0	VAR.	10/GUSTS 20	35	
14-May	1700	16	15	0	VAR.	<5	35	
15-May	1700	17	15	0	SE	15	34.5	
16-May	1700	12	13	90	VAR.	<5	36	
17-May	1700	11	12	80	VAR.	<5	36	
18-May	1700	14	14	50	CALM	CALM	35.5	
19-May	1700	11	11	100	CALM	CALM	36	
20-May	1700	12	12	90	SE	10	35	
21-May	1700	10	11	90	SE	10-15	34	
22-May	1700	10	9	80	VAR.	<5	34	
23-May	1700	11	9	100	SE	20	38	
24-May	1700	9	10	100	SE	5-10	38	
25-May	1700	10	10	100	CALM	CALM	39	
26-May	1700	9	10	100	SE	<5	40	
27-May								
28-May	1700	8	9	100	SE	15-20	40	
29-May	1700	11	9	30	SE	5	40	

-Continued-

Table 12. (page 2 of 2)

Date	Time	Temperature Air(c)	Temperature Water(c)	Cloud Cover %	Wind Dir.	Wind Vel. (Mph)	Stream Gauge (1 cm)	Comments
30-May	1700	11	12	30	CALM	CALM	39	
31-May	1700	13	12	0	CALM	CALM	39	
1-Jun	1700	19	15	0	CALM	CALM	39	
2-Jun	1700	17	15	0	NW	10	39	
3-Jun	1700	16	15	10	CALM	CALM	38	
4-Jun	1700	21	16	0	NW	10	38	
5-Jun	1700	21	17	10	CALM	CALM	37	
6-Jun	1700	20	16	0	NE	10	37	
7-Jun	1700	14	14	100	NE	5	36	
8-Jun	1700	12	13	100	CALM	CALM	36	
9-Jun	1700	13	13	100	NE	15	36	
10-Jun	1700	15	13	40	VAR.	5	36	
11-Jun	1700	11	14	20	NW	10	35	
12-Jun	1700	11	14	100	CALM	CALM	35	
13-Jun	1700	14	14	0	CALM	CALM	35	
14-Jun	1700	16	15	100	SE	10	34	
15-Jun	1700	15	14	90	CALM	CALM	34	
16-Jun	1700	16	15	0	SE	20	34	
17-Jun	1700	10	12	100	SE	25-30	33	
18-Jun	1700	12	13	100	SE	5	33	DRIZZLE
19-Jun	1700	11	13	100	SE	5	33	
20-Jun	1700	16	15	60	SE	<5	32	
21-Jun	1700	10	13	100	CALM	CALM	32	RAIN
22-Jun	1700	16	15	70	SE	10	32	
23-Jun	1700	15	13	100	SE	5-10	33	

Table 13. Daily climatological observations, water temperature, and water depth monitored at Frazer Lake field station, 1996.

Date	Time	Temperature Air(c)	Temperature Water(c)	Cloud Cover %	Wind Dir.	Wind Vel. (Mph)	Stream Gauge (1 cm)	Comments
9-May	1800	17	8	0	W	5	57	Heavy ground fog at 0000
10-May	1800	16	8	0	NW	10	57	Cavu, evening winds
11-May	1800	18	9	5	NW	10	56	Afternoon gusts to 20, dropping water level
12-May	1800	19	9	0	NW	5	57	Afternoon gusts to 20, cavu
13-May	1800	17	10	0	W	15	58	Gusts to 20, cavu, wind pushing up water level
14-May	1800	19	10	0	NW	10	58	Cavu
15-May	1800	16	11	0	NW	15	58	Gusts to 25, cloudy in morning
16-May	1800	10	9	60	SE	10	58	3500 broken, lt. rain showers
17-May	1800	13	9	50	W	5	59	3000 broken, occasional lt. showers
18-May	1800	11	9	45	NW	15	59	3000 broken, gusts to 20
19-May	1800	13	10	15	W	15	58	High thin scattered, unl. vis., gusts
20-May	1800	9	9	35	NW	15	58	2500 broken, gusts, cold
21-May	1800	5	9	85	--	--	59	2500 partly broken, cold. snow flurries
22-May	1800	7	6	100	SE	30	57	2000 solid, 10 mile vis., cold
23-May	1800	6	6	100	SE	25	59	500 solid, 3 mile vis., rain, fog
24-May	1800	8	6	100	SE	5	60	2000 solid, 10 mile vis., lt. rain
25-May	1800	8	6	100	--	--	62	2500 solid, 15 mile vis.
26-May	1800	8	6	100	SW	5	62	1000 solid, 5 mile vis., lt. rain
27-May	1800	10	7	100	--	--	64	1000 solid, 5 mile vis., mist
28-May	1800	10	7	35	SE	15	65	3000 broken, 20 mile vis.
29-May	1800	13	7	10	E	15	63	3000 scattered, unl. vis.
30-May	1800	13	8	60	W	5	64	2500 broken, unl. vis.
31-May	1800	14	9	20	NW	5	64	High thin scattered, unl. vis.
1-Jun	1800	21	10	40	--	--	63	High thin scattered, unl. vis.
2-Jun	1800	14	10	30	NW	5	63	3000 scattered, unl. vis.
3-Jun	1800	16	11	70	NE	5	63	High thin scattered, unl. vis.
4-Jun	1800	22	10	45	NW	10	65	High thin overcast, unl. vis., water level up due to fish pass diversion weir.
5-Jun	1800	19	12	0	NW	5	63	Ceiling and vis. unl., smoke from big lake fire.

-Continued-

Table 13. (page 2 of 2)

Date	Time	Temperature Air(c)	Temperature Water(c)	Cloud Cover %	Wind Dir.	Wind Vel. (Mph)	Stream Gauge (1 cm)	Comments
6-Jun	1800	16	12	5	NW	20	63	Ceiling and vis. unl., gusts to 25.
7-Jun	1800	11	11	100	SW	10	62	2500 solid, 20 mile vis.
8-Jun	1800	9	11	100	W	5	62	2000 solid, 15 mile vis., cold
9-Jun	1800	9	11	90	W	10	61	2500 slightly broken, 15 mile vis., cold
10-Jun	1800	9	12	30	NW	20	61	3000 scattered, unl. vis. gusts, cold
11-Jun	1800	11	11	30	NW	20	61	3000 scattered, unl. vis., gusts
12-Jun	1800	11	10	95	VAR.	5	59	3000 scattered, unl. vis.,dropping water level
13-Jun	1800	13	10	50	SW	5	58	2500 broken, unl. vis.
14-Jun	1800	16	11	100	--	--	59	2500 solid, unl. vis.
15-Jun	1800	13	10	80	SW	5	58	2500 broken, 20 mile vis.
16-Jun	1800	13	10	0	SE	20	56	Cavu
17-Jun	1800	9	8	100	SE	20	57	1500 solid, 10 miles vis., rain
18-Jun	1800	10	8	100	SE	10	56	2000 solid, 10 mile vis.
19-Jun	1800	9	8	100	SE	10	56	1000 solid, 7 mile vis., fog and rain
20-Jun	1800	12	9	100	--	--	56	2000 solid, 10 mile vis.
21-Jun	1800	9	9	100	SW	5	57	1000 solid, 7 mile vis., fog
22-Jun	1800	13	12	80	W	5	57	2000 slightly broken, 15 mile vis.
23-Jun	1800	10	10	100	SW	10	58	1500 solid, 5 mile vis., fog and rain
24-Jun	1800	9	9	100	SW	5	58	1000 solid, 5 miles vis., fog and rain

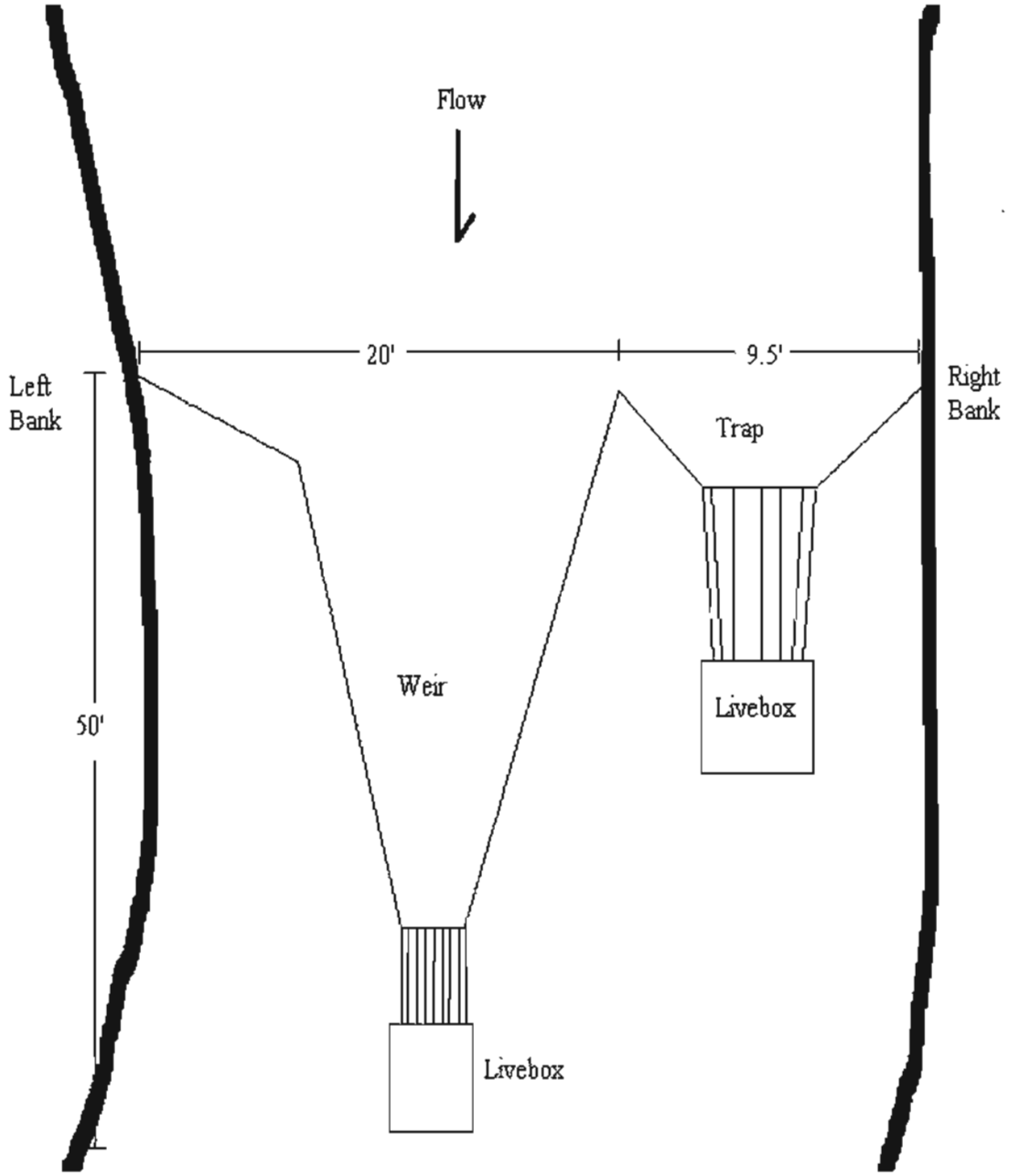

Figure 1. Trap and weir configuration at the Akalura study site during 1996.

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