

FISHERY DATA SERIES NO. 40

MIGRATIONS AND AGE, SEX, AND LENGTH
COMPOSITIONS OF COHO *Oncorhynchus*
kisutch AND SOCKEYE *O. nerka* SALMON
IN RESURRECTION BAY, ALASKA
DURING 1987¹

By

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ABSTRACT

In 1987, 80,182 live coho salmon smolts and 18,169 live sockeye salmon smolts emigrated from Bear Lake. The majority of the coho and sockeye salmon smolts were age 1.0 (76 and 98 percent, respectively). A total of 6,021 coho salmon and 212 sockeye salmon returned to Bear Lake. The majority of the coho salmon were age 1.1 (97 percent) whereas the majority of the sockeye salmon returns were age 1.2 (35 percent) and 1.3 (48 percent). Estimated adult survival rates of 1986 Bear Lake, Seward Lagoon, and Box Canyon Creek smolts were 12.3, 8.0, and 6.0 percent, respectively.

KEY WORDS: Coho salmon, *Oncorhynchus kisutch*, Resurrection Bay, Bear Lake, chinook salmon, *Oncorhynchus tshawytscha*, sockeye salmon, *Oncorhynchus nerka*, migrations, age, length, sex, survival.

INTRODUCTION

The recreational fishery for coho salmon *Oncorhynchus kisutch* in Resurrection Bay is one of the largest fisheries in effort and harvest for this species in Alaska (Mills 1986). Historically, most of the effort in this fishery has been by private boat anglers; however, a smaller but growing charter boat industry has also developed. Effort has averaged 7,377 boat-trips annually from 1968 to 1986 (Vincent-Lang 1987). Harvests of coho salmon during this period have ranged from 8,861 fish in 1976 to 22,932 fish in 1968, and averaged 15,231 coho salmon annually. In addition to the boat fishery, anglers also fish from shore for coho salmon. Effort and harvest in this fishery is minimal compared to the boat fishery.

To increase the numbers of coho salmon available to the sport fishery in Resurrection Bay, a coho salmon enhancement program was initiated in 1962 at Bear Lake (Figure 1). The lake was rehabilitated to eradicate competing threespine stickleback *Gasterosteus aculeatus* and an annual stocking with coho salmon fingerlings was begun. After reinfestation by stickleback and a decline in coho salmon smolt yields, Bear Lake was again rehabilitated in 1971. Threespine stickleback were completely eliminated at that time. Coho salmon smolt survivals from annual fingerling plants in Bear Lake have averaged 36% since 1971 (Vincent-Lang 1988). Bear Lake also supports a small run of sockeye salmon *O. nerka* which contributes to both commercial and personal-use fisheries.

Further enhancement of coho salmon in Resurrection Bay began in 1968 with annual plants of hatchery-reared smolts at additional sites. Hatchery-reared chinook salmon *O. tshawytscha* smolts have been released annually since 1983 in an effort to diversify the Resurrection Bay sport fishery. The Fisheries Rehabilitation, Enhancement, and Development (FRED) Division currently stocks coho salmon fingerlings in Bear Lake, coho salmon smolts in Seward Lagoon, and coho and chinook salmon smolts at Lowell Creek (Figure 1). In 1987, Bear Lake and Box Canyon Creek were stocked with 226,302 and 257,461 coho salmon fingerlings, respectively, and Seward Lagoon and Lowell Creek received 65,514 and 57,232 hatchery-reared coho salmon smolts, respectively (Table 1). A total of 95,963 hatchery-reared chinook salmon smolts were released at Lowell Creek in 1986 (Table 2). Other waters stocked in recent years were Grouse Lake and Box Canyon rearing pond (coho salmon smolts), Thumb Cove (chinook salmon smolts), and Seward Lagoon (chinook salmon smolts).

Three major life history events of Resurrection Bay salmon must be monitored to evaluate enhancement efforts: (1) freshwater residency and emigration; (2) harvest in the sport fishery; and (3) immigration. Numbers (1) and (3) are largely accomplished by operating a weir on Bear Creek (Figure 1) to collect data needed to estimate the abundance and biological characteristics (age, sex, and size composition) of the smolt emigrations and the adult salmon immigrations. Number (2) is accomplished by a creel survey designed to estimate angler-effort and coho salmon harvest by the sport fishery in Resurrection Bay, the biological characteristics of harvested salmon, and the contribution of salmon from the enhancement program to the harvest. The objective of this report is to summarize data collected in conjunction with numbers (1) and (3) in 1987, particularly at Bear Lake. The creel survey, number (2), is the subject of a separate

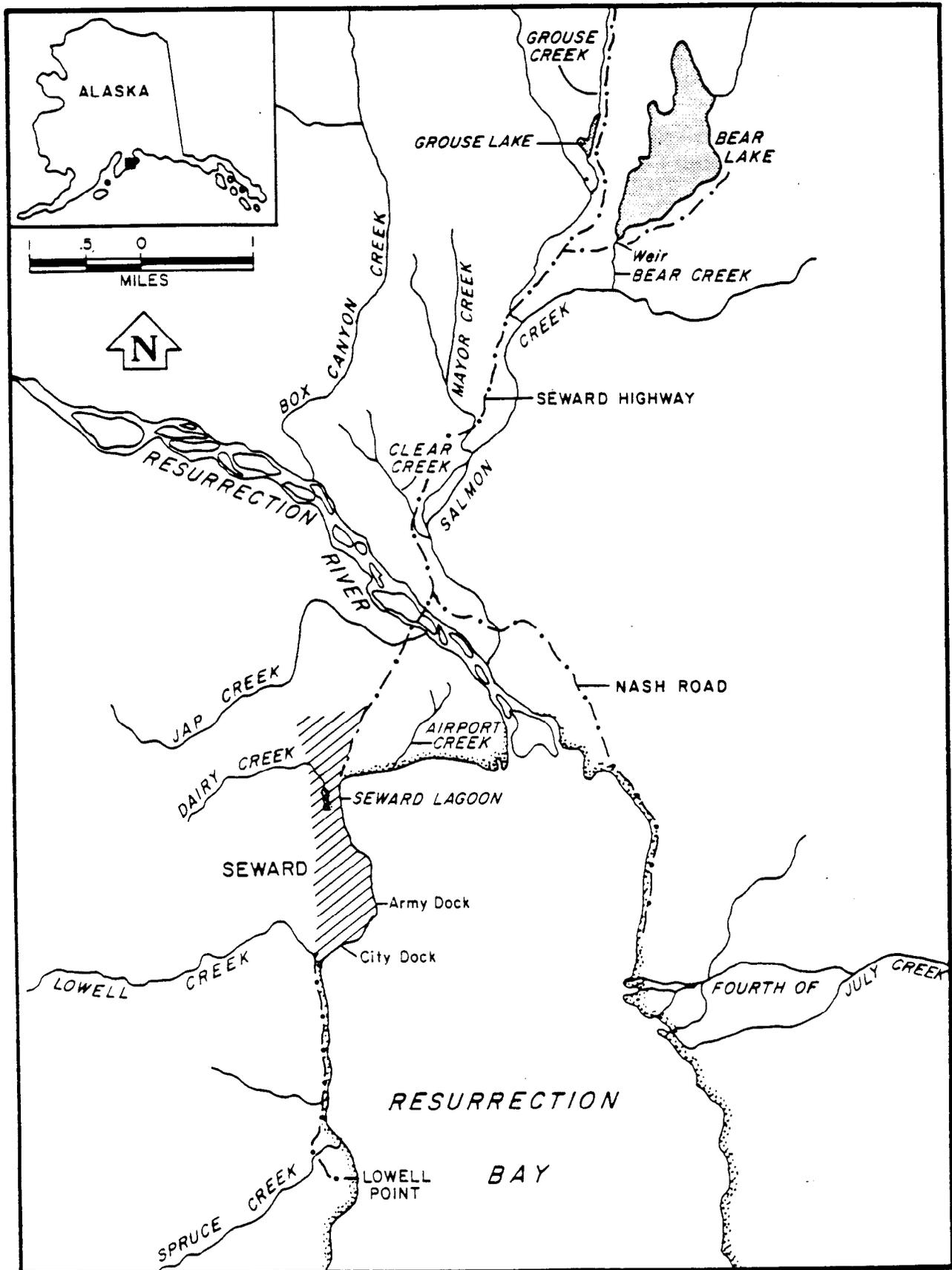


Figure 1. Map of Resurrection Bay, Alaska.

Table 1. Coho salmon fingerlings and hatchery-reared smolts of Bear Lake stock released in Resurrection Bay tributaries, 1987.

Brood Year	Type of Release ¹	Release Date	Release Location	Stocking Data				Mark Type	No. Fish Marked
				No. Fish Released	Density (No./Ha.)	Weight (Kgs.)	Size (No./Kg.)		
1986	F	7/07	Bear Lake	226,302	1,256	381	594	AD-CWT	50,226 ²
1986	F	7/08	Box Canyon Creek	257,461		388	664		
1985	S	5/27	Seward Lagoon	65,514	15,859	1,391	47	AD-CWT	27,173 ³
1985	S	5/27	Lowell Creek Outfall	57,232		1,247	46	AD-CWT	26,232 ⁴

¹ F = Fingerling release, S = Smolt release.

² Adipose finclipped and coded wire tagged; 0.5 mm tag codes 3B/3/8, 3B/3/9, 3B/3/10, 3B/3/10, and 3B/15/8.

³ Adipose finclipped and coded wire tagged; 1.0 mm tag code A 31 17/43.

⁴ Adipose finclipped and coded wire tagged; 1.0 mm tag code A 31 17/41.

Table 2. Chinook salmon smolts of Crooked Creek origin released in Resurrection Bay tributaries, 1983-1987.

Brood Year	Release Date	Release Location	No. Smolts Released	Stocking Data		Mark Type	Number Smolts Marked
				Weight (Kgs.)	Size (No./Kg.)		
1982	5/27/83	Box Canyon Rearing Pond	54,500	477	114	None	
1983	6/14/84	Thumb Cove	70,000	1,586	44	None	
1983	6/19/84	Lowell Creek Outfall	40,600	1,026	40	None	
1984	6/6-6/7/85	Lowell Creek Outfall	132,700	2,281	58	None	
1984	6/13/85	Seward Lagoon	53,250 ¹			AD-CWT ²	53,001
1985	6/13/86	Lowell Creek Outfall	101,000	1,422	71	None	
1986	6/02/87	Lowell Creek Outfall	95,963	1,484	65	None	

¹ Late-run Kenai River brood source.

² Adipose finclipped and coded wire tagged; tag code B4-14-13.

report (Vincent-Lang et al. 1988). Vincent-Lang (1987) presents a summary of all coho salmon enhancement activities in Resurrection Bay, including estimates of survival rates and contributions to the sport fishery.

METHODS

Salmon Emigration

The Bear Creek weir is a complete barrier to upstream and downstream fish migration. The weir is located 0.5 km downstream from the outlet of Bear Lake. All emigrating salmon smolts and returning salmon adults must pass through a live fish box at the weir where they are counted and sampled for biological data.

Abundance and timing of coho and sockeye salmon smolt emigrations from Bear Lake were enumerated in the weir's downstream-migrant trap from mid-May to mid-September. Smolts were dipnetted from the trap, anesthetized in MS-222, and counted by species before being released into calm water to recover and resume migration. A portion (24,000 or 29.9%) of the coho salmon smolt emigration in 1987 was adipose finclipped and tagged with 1.0 mm coded wire tags (AD-CWT) using a Northwest Marine Technologies tagging unit. Smolts were marked for later recognition as adults in the 1988 Resurrection Bay sport fishery and Bear Lake spawning immigration.

The biological characteristics of the Bear Lake coho and sockeye salmon smolt emigrations were estimated by randomly sampling about 150 smolts per temporal stratum throughout their migrations. The objective sample size was not always met due to low abundance during some strata. Smolts selected for sampling were anesthetized, scale sampled, the fork length measured to the nearest millimeter, and weighed to the nearest gram. Scale smears were taken and mounted on adhesive-coated cards. The cards were thermohydraulically pressed against plastic cards and the resulting scale impressions were displayed on a microfiche projector for age determination.

The age compositions of the coho and sockeye salmon smolt emigrations were estimated for each temporal stratum. For each species, the total number of emigrants during a stratum was multiplied by the estimated age composition to estimate the total number of emigrants by age group.

Letting \hat{p}_{ij} be the estimated proportion of age group i in stratum j , the variance of the estimated number by age group was calculated as follows (Scheaffer et al. 1979):

$$(1) \quad V(\hat{N}_{ij}) = N_{Tj}^2 [\hat{p}_{ij}(1-\hat{p}_{ij})/(n_{Tj}-1)] [1 - (n_{Tj}/N_{Tj})]$$

where:

N_{ij} = the estimated number of smolts of age group i emigrating during stratum j ,

N_{Tj} = the total number of smolts emigrating during stratum j , and

n_{Tj} = the total number of smolts sampled during stratum j.

Seasonal totals for estimated numbers and variances are the sums of these quantities over all strata. Estimates of means and standard errors for length and weight were calculated using standard normal procedures.

Salmon Immigration

Abundance and timing of coho and sockeye salmon immigrations into Bear Lake were determined by daily enumeration of these fish in the upstream-migrant trap. Fish were dipnetted from the trap, examined for sex and finclips (coho salmon only), counted, and released upstream. All adult coho salmon surplus to FRED Division's egg-take requirements were allowed to migrate into Bear Lake for natural spawning.

The biological characteristics of the coho and sockeye salmon immigrations were estimated by randomly sampling returning adults during designated temporal strata. Adults were scale sampled, the sex identified, any finclips noted, and the mid-eye to fork-of-tail length measured in millimeters. Scales were removed from the preferred area (Clutter and Whitesel 1956). Scales were mounted on adhesive-coated cards and processed following the procedures described for the smolt scale samples. The age composition and mean length at age by sex of the salmon immigrations were estimated using the procedures described for the salmon smolts.

Minimum spawning escapements of wild (naturally produced) coho salmon to Bear Creek, Box Canyon Creek, and the Seward Lagoon drainage (Figure 1) were estimated by periodic foot surveys conducted from mid-October to early November. Both live and dead coho salmon observed during the surveys were counted. Carcasses were examined for finclips and then mutilated to preclude recounting. Minimum (wild and enhanced) coho salmon escapements were estimated by adding previously observed mortalities to the last live spawner count in each tributary.

Estimation of Survival Rates

Smolt to adult survival of coho salmon smolts emigrating from Bear Lake (\hat{S}_{BL}) in 1986 was estimated as:

$$(2) \quad \hat{S}_{BL} = (E_{BL} + \hat{C}_{BL}) / M_{BL}$$

where:

E_{BL} = the escapement of coho salmon to the Bear Lake weir in 1987,
 \hat{C}_{BL} = the estimated catch of Bear Lake fish in the Resurrection Bay sport fisheries, and
 M_{BL} = the number of emigrating coho salmon smolts at Bear Lake weir in 1986.

The variance of the survival estimate was calculated as:

$$(3) \quad V(\hat{S}_{BL}) = V(\hat{C}_{BL}) / M_{BL}^2$$

where the variances of the coho salmon immigration and smolt emigration are assumed to be negligible as they are completely enumerated.

The minimum smolt to adult survival rates for enhanced coho salmon smolts stocked in Seward Lagoon and Box Canyon Creek during 1986 were estimated as above with the exception that escapements were not considered. Escapements were not considered as these systems support wild coho salmon stocks. In this case, M was equal to the number of smolts released at the time of stocking. Additionally, smolt survival rates for coho salmon fingerling plants in Bear Lake in 1984, 1985, and 1986 were estimated.

RESULTS

Salmon Emigration

The Bear Lake coho salmon emigration was 80,945 smolts from 18 May to 15 September (Appendix Table 1). After trap and marking mortalities, 80,182 live smolts were released downstream. Of these, 24,000 smolts (29.9%) were AD-CWT marked. The smolt emigration in 1987 was comparable in run timing to the historical coho salmon smolt emigration from Bear Lake, however the distribution of the emigration in 1987 was bimodal with each mode representing a separate age class (Figure 2A). The smolt emigration was composed of an estimated 61,237 (76.4%) age 1.0¹, 18,686 (23.3%) age 2.0, and 259 (0.3%) age 3.0 smolts (Table 3). While the mean length and mean weight of the age 1.0 smolts increased throughout the emigration, the largest age 2.0 smolts left early in the migration and the size of later age 2.0 migrants decreased (Table 4).

The Bear Lake sockeye salmon smolt emigration totaled only 18,983 smolts from 18 May to 15 September (Appendix Table 1) of which 18,169 live smolts were released downstream. The run timing of the smolt emigration in 1987 fell within the range of the historical sockeye salmon smolt emigration from Bear Lake (Figure 2b). The sockeye salmon smolt emigration was composed of an estimated 17,794 (98.1%) age 1.0, 268 (1.2%) age 2.0 smolts, and 107 (0.7%) age 3.0 smolts (Table 5). Similarly to the coho salmon smolts, the mean length and mean weight of the age 1.0 sockeye salmon smolts increased throughout the emigration (Table 6).

Salmon Immigration

The coho salmon immigration to the Bear Creek weir totaled 6,021 from 1 September to 15 November, of which 3,247 were males and 2,774 were females (Appendix Table 2). There were 1,488 AD-CWT marked, 372 right ventral finclipped, and 4,161 unmarked fish in the coho salmon immigration. After trap and egg-take mortalities, 3,121 male and 2,532 female coho salmon were passed upstream. Mean fecundity of the 242 female coho salmon used for the egg take in 1987 was 4,200 eggs per female. The run timing of the immigration in 1987 fell within the range of the historical coho

¹ European formula: Number preceding the decimal refers to the number of freshwater annuli, number following the decimal is the number of marine annuli. Total age from brood year is the sum of these two numbers plus one.

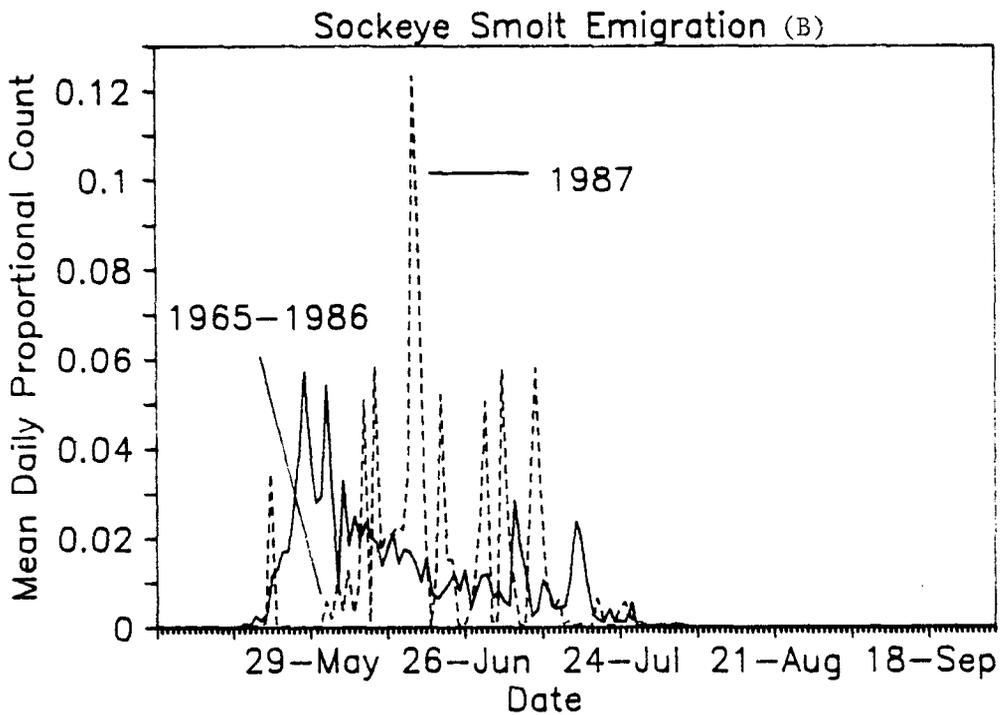
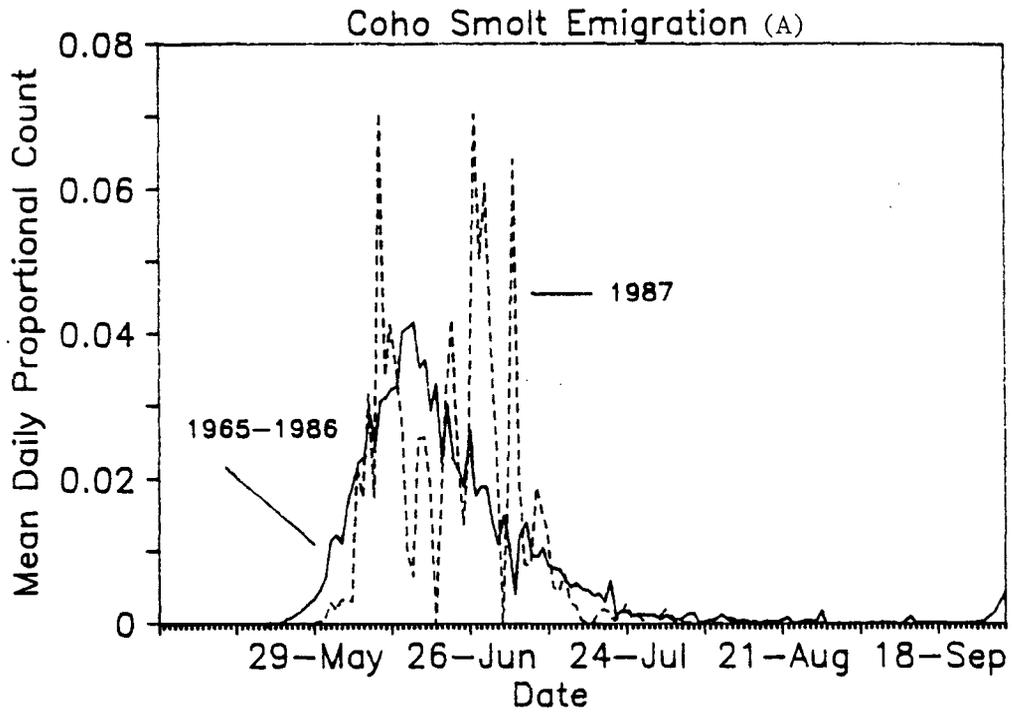


Figure 2. Migrational timings of the 1987 coho (A) and sockeye (B) salmon emigrations compared to the historical emigrational timings of these species.

Table 3. Estimated abundance by age group of coho salmon smolts emigrating through Bear Creek weir, 1987.

Period ¹		Age Group			Total
		1.0	2.0	3.0	
5/18-6/09 (n = 150)	Percent	19.3	80.0	0.7	100.0
	Estimated Number	1,496	6,191	52	7,739
	Standard Error	248	251	51	
6/10-6/23 (n = 150)	Percent	64.0	35.3	0.7	100.0
	Estimated Number	19,942	11,010	208	31,160
	Standard Error	1,222	1,217	207	
6/24-6/30 (n = 150)	Percent	94.0	6.0		100.0
	Estimated Number	21,322	1,361		22,683
	Standard Error	440	440		
7/01-9/15 (n = 150)	Percent	99.3	0.7		100.0
	Estimated Number	18,476	124		18,600
	Standard Error	127	127		
Total (n=600)	Percent	76.4	23.3	0.3	100.0
	Estimated Number	61,237	18,686	259	80,182
	Standard Error	1,328	1,324	213	

¹ n = number sampled.

Table 4. Mean fork length (mm) and weight (g) of coho salmon smolts sampled at Bear Creek weir, 1987.

Period		Age Group					
		1.0		2.0		3.0	
		Length	Weight	Length	Weight	Length	Weight
5/18-6/09	Mean	106.0	11.5	157.2	34.6	218.0	84.0
	Standard Error	2.7	0.9	1.0	0.6		
	Sample Size	29	29	120	120	1	1
6/10-6/23	Mean	109.4	11.6	144.6	27.9	224.0	
	Standard Error	0.7	0.3	1.8	1.4		
	Sample Size	96	56	53	34	1	
6/24-6/30	Mean	114.9	14.7	152.8	31.5		
	Standard Error	0.6	0.3	2.8	2.9		
	Sample Size	141	56	9	4		
7/01-9/15	Mean	123.7		131.0			
	Standard Error	0.9					
	Sample Size	149		1			

Table 5. Estimated abundance by age group of sockeye salmon smolts emigrating through Bear Creek weir, 1987.

Period ¹		Age Group			Total
		1.0	2.0	3.0	
5/18-6/09 (n = 249)	Percent	98.4	0.8	0.8	100.0
	Estimated Number	1,756	14	14	1,784
	Standard Error	13	9	9	
6/10-6/30 (n = 249)	Percent	98.4	0.8	0.8	100.0
	Estimated Number	11,373	93	93	11,559
	Standard Error	91	65	65	
7/01-9/15 (n = 90)	Percent	96.7	3.3		100.0
	Estimated Number	4,665	161		4,826
	Standard Error	91	91		
Total (n = 588)	Percent	98.1	1.2	0.7	100.0
	Estimated Number	17,794	268	107	18,169
	Standard Error	130	112	65	

¹ n = number sampled.

Table 6. Mean fork length (mm) and weight (g) of sockeye salmon smolts sampled at Bear Creek weir, 1987.

Period		Age Group					
		1.0		2.0		3.0	
		Length	Weight	Length	Weight	Length	Weight
5/18-6/09	Mean	111.5	12.8	172.5	46.5	215.8	83.0
	Standard Error	0.5	0.2	2.5	1.5	21.0	12.0
	Sample Size	245	245	2	2	2	2
6/03-6/16	Mean	113.9	13.1	192.0	45.0	199.0	62.0
	Standard Error	0.6	0.4	16.0		7.0	
	Sample Size	245	176	2	1	2	1
6/17-7/14	Mean	118.9	14.2	170.7			
	Standard Error	0.7	0.6	10.8			
	Sample Size	87	15	3			

salmon immigration to Bear Lake (Figure 3A). The immigration was composed of an estimated 5,839 (97.0%) age 1.1 and 133 (2.2%) age 2.1 adults and 49 (0.8%) age 0.1 jacks (Table 7). Age 1.1 male and female coho salmon in the Bear Lake immigration averaged 591 mm and 610 mm, respectively, in length and age 2.1 males and females averaged 675 mm and 636 mm, respectively (Table 8). Age 0.1 coho salmon jacks averaged 405 mm. Minimum escapements of coho salmon to Bear Creek, Box Canyon Creek, and the Seward Lagoon drainage were 24, 1,158, and 602, respectively (Table 9).

The sockeye salmon immigration to the Bear Creek weir totaled 212 adults from 18 May to 31 July (Appendix Table 3). After trap mortalities, 83 male and 125 female sockeye salmon were passed upstream. The run timing of the immigration in 1987 fell within the range of the historical sockeye salmon immigration to Bear Lake (Figure 3B). The estimated age composition of the immigration in 1987 was 75 (35.4%) age 1.2, 26 (12.3%) age 2.2, 4 (1.9%) age 3.2, 102 (48.0%) age 1.3, and 5 (2.4%) age 2.3 adults (Table 10). Sockeye salmon mean lengths ranged from 484 mm for age 1.2 females to 572 mm for age 1.3 males (Table 11).

Survival Rate Estimates

The emigration of coho salmon from Bear Lake in 1986 (72,685 smolts, Conrad et al. 1987) contributed adult coho salmon to the Resurrection Bay sport fishery and Bear Lake immigration in 1987 (Table 12). The majority of these smolts were from the 1984 and 1985 fingerling plants in Bear Lake. Estimated sport harvests of coho salmon from Bear Lake in the boat and beach fisheries in 1987 was 2,860 (standard error of 347) (Vincent-Lang et al. 1988). These estimates, combined with the 1987 Bear Lake coho salmon immigration, result in an estimated smolt-to-adult survival for the Bear Lake coho salmon smolt emigration in 1986 of 12.3% (standard error of 0.5%) (Table 13).

Hatchery-reared smolts released in Seward Lagoon and Box Canyon Creek in 1986 also contributed to the sport fisheries and escapements to these stream systems in 1987 (Table 12). The estimated sport harvests of Seward Lagoon and Box Canyon Creek coho salmon to the 1987 boat and beach fisheries were 4,138 (standard error of 424) and 3,234 (standard error of 353), respectively (Vincent-Lang et al. 1988). These estimates yield estimated minimum smolt-to-adult survival rates for coho salmon smolts planted in 1986 in Seward Lagoon and Box Canyon Creek of 8.0% (standard error of 0.8%) and 6.0% (standard error of 0.7%), respectively (Table 13).

Fingerling-to-smolt survival of Bear Lake fingerling plants in 1984, 1985, and 1986 were 52.8%, 26.6%², and 13.7%³.

RECOMMENDATIONS

To better estimate the smolt to adult survival of coho salmon smolts planted in Seward Lagoon, we recommend that a fish trap be installed in

² Excluding age 3.0 smolts.

³ Excluding age 2.0 and 3.0 smolts.

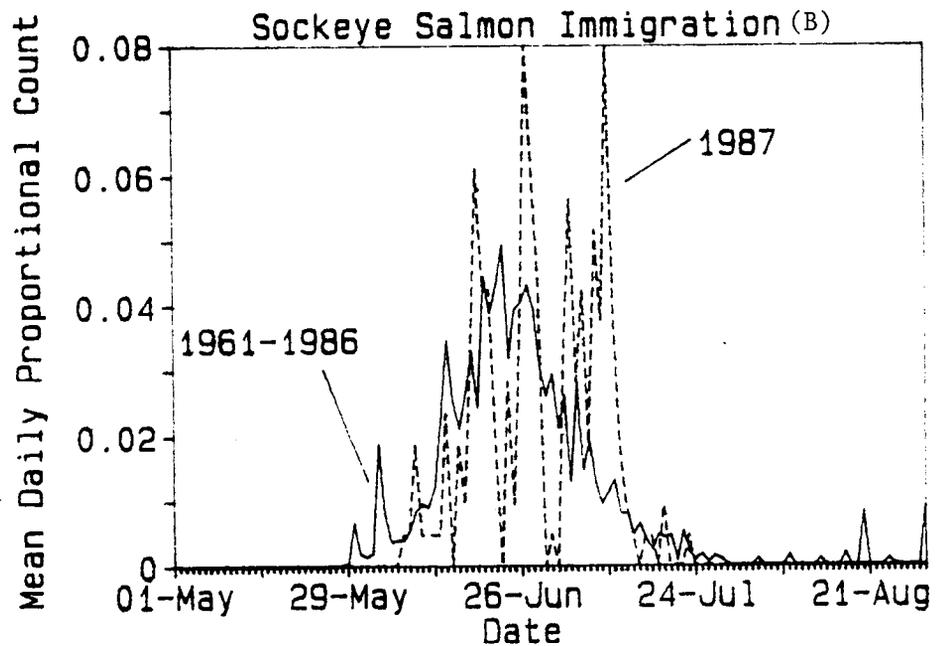
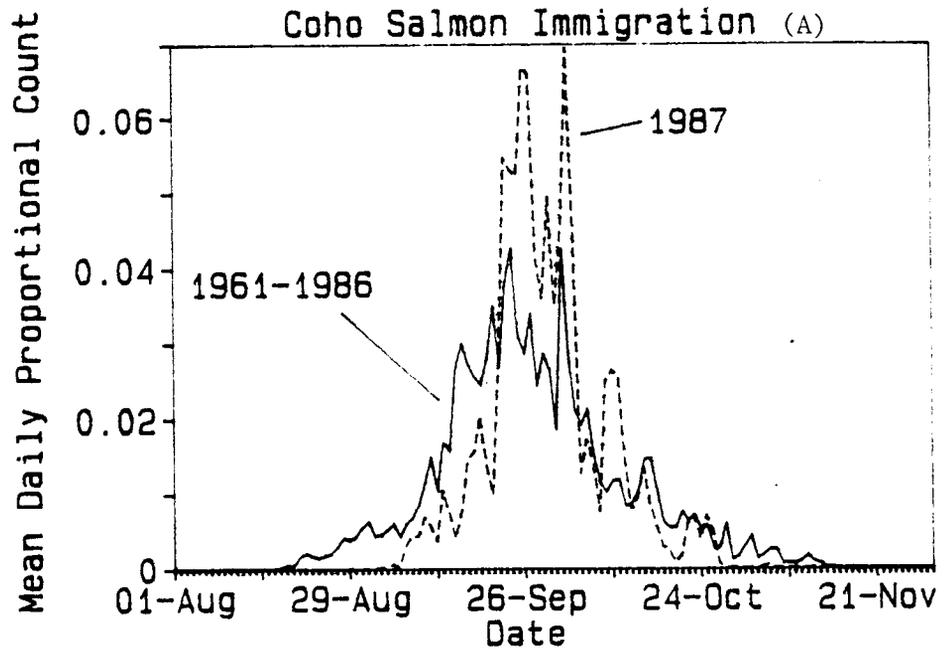


Figure 3. Migrational timings of the 1987 coho (A) and sockeye (B) salmon immigrations compared to the historical immigrational timings of these species.

Table 7. Estimated abundance by age group of the coho salmon immigration through Bear Creek weir, 1987.

Sex ¹		Age Group			Total
		0.1	1.1	2.1	
Male	Percent	0.8	52.1	1.0	53.9
	Estimated Abundance	49	3,140	58	3,247
	Standard Error	23	34	25	
Female	Percent		44.9	1.2	46.1
	Estimated Abundance		2,699	75	2,774
	Standard Error		25	25	
Total (n=563)	Percent	0.8	97.0	2.2	100.0
	Estimated Abundance	49	5,839	133	6,021
	Standard Error	20	41	36	

¹ n = number sampled.

Table 8. Mean length¹ (mm) by sex and age group of adult coho salmon sampled at Bear Creek weir, 1987.

Sex		Age Group		
		0.1	1.1	2.1
Male	Length	405	591	675
	Standard Error	34	3	11
	Sample Size	4	263	5
Female	Length		610	636
	Standard Error		2	14
	Sample Size		287	8

¹ Length measured from mid-eye to fork-of-tail.

Table 9. Summary of coho salmon escapement counts for Resurrection Bay tributaries foot surveyed in 1987.

Stream	Minimum Escapement	Carcasses		
		Number Examined	Number Marked ¹	Number Unmarked
Lower Bear Creek	24	16	4	12
Box Canyon Creek	1,158	231	50	181
Seward Lagoon System ²	602	373	77	296

¹ Marked with an adipose fin clip.

² Seward Lagoon system includes Dairy Creek, Pasture Creek, Railroad Creek, and First Lake Creek.

Table 10. Estimated abundance by age group of the sockeye salmon immigration through Bear Creek weir, 1987.

Sex		Age Group					Tot
		1.2	2.2	3.2	1.3	2.3	
Male	Percent	13.2	0.9		25.5		39
	Est. Number	28	2		54		
	Standard error	5	2		5		
Female	Percent	22.1	10.4	1.4	24.1	2.4	60
	Est. Number	47	22	3	51	5	
	Standard error	4	3	1	5	2	
Total (n=116)	Percent	35.4	12.3	1.9	48.0	2.4	100
	Est. Number	75	26	4	102	5	
	Standard error	6	4	2	7	2	

¹ n = sample size.

Table 11. Mean length¹ (mm) by sex and age group of adult sockeye salmon sampled at Bear Creek weir, 1987.

Sex		Age Group				
		1.2	2.2	1.3	2.3	3.2
Male	Length	516	510	572		
	Standard Error	7		4		
	Sample Size	15	1	25		
Female	Length	484	513	544	540	528
	Standard Error	3	6	4	10	10
	Sample Size	26	13	30	2	3

¹ Length measured from mid-eye to fork-of-tail.

Table 12. Summary of 1984-1986 Bear Lake coho salmon fingerling plants, 1986 Bear Lake coho salmon smolt emigration, and 1986 hatchery-reared smolt releases contributing to the 1987 adult coho salmon return.

FINGERLING PLANTS

Brood ¹ Year	Release Date	Release Location	No. Fish Released	Stocking Data			Mark Type	No. Fish Marked
				Density (No./Acre)	Weight (Lbs.)	Size (No./Lb.)		
1983	5/24/84	Bear Lake	220,000	494	757	291	None	0
1984	6/05/85	Bear Lake	300,000	674	649	462	None	0
1985	7/09/86	Bear Lake	445,700	1,002	1,946	229	Ad-CWT	47,148 ²

SMOLT OUT-MIGRATION

Brood Year	Date	Location	No. Out- Migrants	Stocking Data			Mark Type	Number Fish Marked
				Density (No./Acre)	Weight (Lbs.)	Size (No./Lb.)		
1983	6/1-9/15/85	Bear	310 ³	NA	NA		RVC ⁴ /Ad-CWT ⁵	
1984	6/1-9/15/85	Creek	11,515 ³	NA	NA	10.0	RVC ⁴ /Ad-CWT ⁵	
1985	6/1-9/15/85	Weir	60,860 ³	NA	NA	23.1	RVC ⁴ /Ad-CWT ⁵	
		Total	72,685					23,732 ⁶

-continued-

Table 12. Summary of 1984-1986 Bear Lake coho salmon fingerling plants, 1986 Bear Lake coho salmon smolt emigration, and 1986 hatchery-reared smolt releases contributing to the 1987 adult coho salmon return (continued).

SMOLT RELEASES

Brood ¹ Year	Release Date	Release Location	No. Fish Released	Stocking Data			Mark Type	No. Fish Marked
				Density (No./Acre)	Weight (Lbs.)	Size (No./Lb.)		
1984	5/29/86	Seward Lagoon	51,500	5,049	2,483	20.7	AD-CWT ⁷	15,221
1984	5/30/86	Box Canyon Creek	53,600		2,671	20.0	AD-CWT ⁸	15,445

¹ All coho salmon plants were of Bear Lake brood stock.

² Adipose finclipped and coded wire tagged, tag code 3 B 13/14.

³ Estimated from age composition.

⁴ Right ventral finclipped.

⁵ Adipose finclipped and coded wire tagged, tag code 31-17-31

⁶ Total marked of all emigrants of which 7,000 were RV and 16,732 were Ad-CWT marked.

⁷ Adipose finclipped and coded wire tagged, tag code A 31 17/21.

⁸ Adipose finclipped and coded wire tagged, tag code A 31 17/20.

Table 13. Estimated smolt-to-adult survivals of Bear Lake, Seward Lagoon, and Box Canyon Creek coho salmon smolts.

Location	Number of Smolts	Sport Harvest ¹		Escapement	Survival	
		Number	SE ²		Percent	SE ²
Bear Lake	72,685 ³	2,860	347	6,045 ⁵	12.3	0.48
Seward Lagoon	51,500 ⁴	4,138	424	--- ⁶	8.0	0.82
Box Canyon Creek	53,600 ⁴	3,234	353	--- ⁶	6.0	0.66

¹ Reported in Vincent-Lang et al. (1988).

² Standard error (expressed as a percent).

³ The number of live smolts that emigrated past the Bear Creek weir in 1986.

⁴ The number of hatchery-reared smolts stocked into this location in 1986.

⁵ Bear Creek weir escapement (6,021) plus the lower Bear Creek escapement (24).

⁶ Escapements to these systems not considered as they support wild coho salmon stocks.

the entrance to Seward Lagoon for 1988 so that the Seward Lagoon immigration can be enumerated. Installation of a fish trap was attempted in 1987, however, high flows caused the trap to fail. A new design will be used in 1988. This will allow the number of marked fish returning to Seward Lagoon to be determined which will improve the estimates of the Seward Lagoon contribution to the sport fisheries and smolt-to-adult survival for Seward Lagoon smolts.

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APPENIDX TABLES

Appendix Table 1. Daily emigration of coho and sockeye salmon smolts from Bear Lake, 1987.

Date	Coho Salmon Smolts			Sockeye Salmon Smolts		
	Dead	Live	Total	Dead	Live	Total
5/18	2	0	2	3	0	3
5/19	0	4	4	1	2	3
5/20	0	2	2	0	3	3
5/21	1	12	13	0	19	19
5/22	8	0	8	552	106	658
5/23	0	0	0	0	0	0
5/24	0	1	1	0	0	0
5/25	0	0	0	0	0	0
5/26	0	1	1	0	0	0
5/27	0	7	7	0	0	0
5/28	0	8	8	0	0	0
5/29	1	12	13	0	0	0
5/30	0	34	34	0	2	2
5/31	0	31	31	0	0	0
6/01	0	242	242	0	112	112
6/02	0	153	153	0	40	40
6/03	0	269	269	0	193	193
6/04	1	273	274	0	74	74
6/05	2	241	243	0	238	238
6/06	0	1,765	1,765	0	60	60
6/07	4	1,409	1,410	0	181	181
6/08	648	1,873	2,557	238	729	967
6/09	0	1,405	1,405	0	25	25
6/10	5	5,707	5,712	0	1,108	1,108
6/11	4	2,748	2,752	0	327	327
6/12	2	3,331	3,333	0	394	394
6/13	2	2,829	2,831	0	398	398
6/14	0	2,271	2,271	0	432	432
6/15	1	764	765	0	416	416
6/16	0	522	522	0	657	657
6/17	0	2,056	2,056	1	2,340	2,341
6/18	2	2,069	2,071	2	1,557	1,559
6/19	0	1,589	1,589	0	447	447
6/20	0	0	0	0	0	0
6/21	1	1,319	1,320	1	221	222
6/22	1	2,561	2,562	2	987	989
6/23	3	3,394	3,397	1	284	285
6/24	3	1,907	1,910	0	280	280
6/25	1	1,903	1,904	0	12	12
6/26	0	1,926	1,926	1	0	1
6/27	0	5,687	5,687	0	65	65
6/28	3	4,071	4,074	1	207	208

-continued-

Appendix Table 1. Daily emigration of coho and sockeye salmon smolts from Bear Lake, 1987 (continued).

Date	Coho Salmon Smolts			Sockeye Salmon Smolts		
	Dead	Live	Total	Dead	Live	Total
6/29	2	4,917	4,919	0	467	467
6/30	1	3,082	3,083	0	960	960
7/01	3	1,874	1,877	0	26	26
7/02	0	0	0	4	11	15
7/03	16	1,544	1,560	0	1,091	1,091
7/04	1	5,189	5,190	1	435	436
7/05	3	1,591	1,594	0	195	195
7/06	0	642	642	0	14	14
7/07	0	643	643	0	0	0
7/08	0	1,527	1,527	0	573	573
7/09	1	1,244	1,245	0	1,099	1,099
7/10	1	1,015	1,016	0	519	519
7/11	1	398	399	0	161	161
7/12	0	351	351	0	72	72
7/13	0	545	545	1	116	117
7/14	0	225	225	0	11	11
7/15	0	187	187	0	31	31
7/16	0	40	40	0	3	3
7/17	0	0	0	0	13	13
7/18	0	0	0	0	0	0
7/19	0	115	115	0	0	0
7/20	0	165	165	0	123	123
7/21	0	128	128	0	45	45
7/22	0	33	33	0	6	6
7/23	2	92	94	0	2	2
7/24	0	217	217	0	82	82
7/25	0	81	81	0	108	108
7/26	0	120	120	0	43	43
7/27	1	33	34	0	19	19
7/28	0	90	90	0	22	22
7/29	0	101	101	0	0	0
7/30	0	50	50	0	0	0
7/31	0	157	157	0	6	6
8/01	0	54	54	1	0	1
8/02	0	20	20	0	0	0
8/03	0	21	21	1	0	1
8/04	0	11	11	0	0	0
8/05	0	0	0	0	0	0
8/06	0	2	2	0	0	0
8/07	0	4	4	0	0	0
8/08	0	0	0	0	0	0
8/09	0	6	6	0	0	0

-continued-

Appendix Table 1. Daily emigration of coho and sockeye salmon smolts from Bear Lake, 1987 (continued).

Date	Coho Salmon Smolts			Sockeye Salmon Smolts		
	Dead	Live	Total	Dead	Live	Total
8/10	0	0	0	0	0	0
8/11	0	55	55	3	0	3
8/12	0	21	21	0	0	0
8/13	0	6	6	0	0	0
8/14	0	0	0	0	0	0
8/15	0	0	0	0	0	0
8/16	0	0	0	0	0	0
8/17	0	0	0	0	0	0
8/18	0	0	0	0	0	0
8/19	0	0	0	0	0	0
8/20	0	0	0	0	0	0
8/21	0	0	0	0	0	0
8/22	0	0	0	0	0	0
8/23	0	0	0	0	0	0
8/24	0	2	2	0	0	0
8/25	0	0	0	0	0	0
8/26	0	0	0	0	0	0
8/27	0	0	0	0	0	0
8/28	0	0	0	0	0	0
8/29	0	0	0	0	0	0
8/30	0	1	1	0	0	0
8/31	0	0	0	0	0	0
9/01	0	0	0	0	0	0
9/02	0	0	0	0	0	0
9/03	0	0	0	0	0	0
9/04	0	0	0	0	0	0
9/05	0	0	0	0	0	0
9/06	0	0	0	0	0	0
9/07	0	0	0	0	0	0
9/08	0	0	0	0	0	0
9/09	0	0	0	0	0	0
9/10	0	0	0	0	0	0
9/11	0	0	0	0	0	0
9/12	0	0	0	0	0	0
9/13	0	0	0	0	0	0
9/14	0	0	0	0	0	0
9/15	0	0	0	0	0	0
Total	763	80,182	80,945	814	18,169	18,983

Appendix Table 2. Coho salmon immigration through Bear Creek weir, 1987.

Date	Males			Females			Daily Total	Marked Fish	
	Dead	Live	Total	Dead	Live	Total		RVC ¹	AD-CWT ²
8/25	0	0	0	0	0	0	0	0	0
8/26	0	0	0	0	0	0	0	0	0
8/27	0	0	0	0	0	0	0	0	0
8/28	0	0	0	0	0	0	0	0	0
8/29	0	0	0	0	0	0	0	0	0
8/30	0	0	0	0	0	0	0	0	0
8/31	0	0	0	0	0	0	0	0	0
9/01	0	0	0	0	0	0	0	0	0
9/02	0	1	1	0	0	0	1	0	0
9/03	0	1	1	0	0	0	1	0	0
9/04	0	1	1	0	0	0	1	0	0
9/05	0	3	3	0	1	1	4	1	0
9/06	0	2	2	0	0	0	2	0	0
9/07	0	17	17	0	1	1	18	1	5
9/08	0	23	23	0	4	4	27	3	6
9/09	0	19	19	0	7	7	26	3	6
9/10	0	30	30	0	11	11	41	1	5
9/11	0	24	24	0	10	10	34	2	5
9/12	0	19	19	0	3	3	22	1	6
9/13	0	46	46	0	17	17	63	2	15
9/14	0	23	23	0	22	22	45	3	8
9/15	0	10	10	0	14	14	24	0	6
9/16	0	25	25	0	21	21	46	5	11
9/17	0	50	50	0	38	38	88	5	20
9/18	0	59	59	0	34	34	93	3	26
9/19	0	67	67	0	56	56	123	6	34
9/20	0	37	37	0	45	45	82	6	27
9/21	0	34	34	0	25	25	59	3	13
9/22	0	97	97	0	67	67	164	9	40
9/23	0	234	234	0	95	95	329	22	80
9/24	0	207	207	0	112	112	319	31	68
9/25	0	173	173	0	141	141	314	19	71
9/26	0	224	224	0	177	177	401	21	107
9/27	0	190	190	0	206	206	396	17	81
9/28	0	121	121	0	128	128	249	13	65
9/29	0	105	105	0	111	111	216	12	59
9/30	0	129	129	0	168	168	297	18	69
10/01	0	103	103	0	108	108	211	10	58
10/02	0	134	134	0	135	135	269	25	66

-continued-

Appendix Table 2. Coho salmon immigration through Bear Creek weir, 1987 (continued).

Date	Males			Females			Daily Total	Marked Fish	
	Dead	Live	Total	Dead	Live	Total		RVC ¹	AD-CWT ²
10/03	0	212	212	0	205	205	417	37	87
10/04	0	135	135	0	131	131	266	13	54
10/05	0	25	25	0	48	48	73	0	22
10/06	0	28	28	0	75	75	103	7	31
10/07	0	26	26	0	59	59	85	8	26
10/08	0	25	25	0	20	20	45	2	13
10/09	0	76	76	0	74	74	150	9	38
10/10	0	88	88	0	71	71	159	8	55
10/11	0	96	96	0	57	57	153	7	44
10/12	0	52	52	0	37	37	89	7	21
10/13	0	19	19	0	28	28	47	2	10
10/14	0	28	28	0	29	29	57	2	27
10/15	0	42	42	0	39	39	81	8	18
10/16	0	24	24	0	26	26	50	1	14
10/17	0	16	16	0	17	17	33	1	9
10/18	0	12	12	0	5	5	17	1	2
10/19	0	7	7	0	8	8	15	1	3
10/20	0	2	2	0	2	2	4	0	0
10/21	0	26	26	0	5	5	31	1	2
10/22	0	24	24	0	12	12	36	4	8
10/23	0	25	25	0	17	17	42	4	15
10/24	0	9	9	0	14	14	23	3	7
10/25	0	22	22	0	20	20	42	4	17
10/26	0	15	15	0	15	15	30	0	8
10/27	0	1	1	0	3	3	4	0	1
10/28	0	0	0	0	0	0	0	0	0
10/29	0	0	0	0	0	0	0	0	0
10/30	0	1	1	0	0	0	1	0	1
10/31	0	0	0	0	0	0	0	0	0
11/01	0	0	0	0	0	0	0	0	0
11/02	0	0	0	0	0	0	0	0	0
11/03	0	2	2	0	0	0	2	0	1
11/04	0	1	1	0	0	0	1	0	0
11/05	0	0	0	0	0	0	0	0	0
11/06	0	0	0	0	0	0	0	0	0
11/07	0	0	0	0	0	0	0	0	0
11/08	0	0	0	0	0	0	0	0	0
11/09	0	0	0	0	0	0	0	0	0
11/10	0	0	0	0	0	0	0	0	0

-continued-

Appendix Table 2. Coho salmon immigration to Bear Creek weir, 1987 (continued).

Date	Males			Females			Daily Total	Marked Fish	
	Dead	Live	Total	Dead	Live	Total		RVC ¹	AD-CWT ²
11/11	0	0	0	0	0	0	0	0	0
11/12	0	0	0	0	0	0	0	0	0
11/13	0	0	0	0	0	0	0	0	0
11/14	0	0	0	0	0	0	0	0	0
11/15	0	0	0	0	0	0	0	0	0
Total	0	3,247	3,247 ³	0	2,774	2,774 ⁴	6,021	372	1,488

¹ Right ventral fin clipped.

² Adipose fin clipped and coded wire tagged.

³ 126 males were used to fertilize the 1987 egg-take.

⁴ 242 females were used in the 1987 egg-take.

Appendix Table 3. Sockeye salmon immigration through Bear Creek weir, 1987.

Date	Males			Females			Daily Total
	Dead	Live	Total	Dead	Live	Total	
6/01	0	0	0	0	0	0	0
6/02	0	0	0	0	0	0	0
6/03	0	0	0	0	0	0	0
6/04	0	0	0	0	0	0	0
6/05	0	0	0	0	0	0	0
6/06	0	0	0	0	0	0	0
6/07	0	1	1	0	0	0	1
6/08	0	1	1	0	0	0	1
6/09	0	1	1	0	3	3	4
6/10	0	0	0	0	1	1	1
6/11	0	0	0	0	1	1	1
6/12	0	0	0	0	1	1	1
6/13	0	0	0	0	1	1	1
6/14	0	2	2	0	3	3	5
6/15	0	0	0	0	0	0	0
6/16	0	1	1	0	3	3	4
6/17	0	1	1	0	1	1	2
6/18	0	2	2	0	5	5	7
6/19	0	6	6	0	7	7	13
6/20	0	6	6	0	3	3	9
6/21	0	4	4	0	5	5	9
6/22	0	2	2	0	2	2	4
6/23	0	0	0	0	0	0	0
6/24	0	3	3	0	3	3	6
6/25	0	2	2	0	0	0	2
6/26	0	4	4	0	4	4	8
6/27	1	3	4	0	13	13	17
6/28	0	4	4	0	9	9	13
6/29	0	2	2	2	5	7	9
6/30	0	0	0	0	0	0	0
7/01	0	0	0	0	1	1	1
7/02	0	0	0	0	0	0	0
7/03	0	4	4	0	3	3	7
7/04	0	3	3	0	9	9	12
7/05	0	3	3	0	3	3	6
7/06	0	2	2	0	7	7	9
7/07	0	0	0	1	3	4	4

-continued-

Appendix Table 3. Sockeye salmon immigration to Bear Creek weir, 1987 (continued).

Date	Males			Females			Daily Total
	Dead	Live	Total	Dead	Live	Total	
7/08	0	7	7	0	4	4	11
7/09	0	4	4	0	4	4	8
7/10	0	6	6	0	11	11	17
7/11	0	3	3	0	5	5	8
7/12	0	1	1	0	3	3	4
7/13	0	1	1	0	1	1	2
7/14	0	1	1	0	0	0	1
7/15	0	0	0	0	0	0	0
7/16	0	1	1	0	0	0	1
7/17	0	0	0	0	0	0	1
7/18	0	0	0	0	0	0	0
7/19	0	2	2	0	0	0	2
7/20	0	0	0	0	0	0	0
7/21	0	0	0	0	0	0	0
7/22	0	0	0	0	0	0	0
7/23	0	0	0	0	1	1	1
7/24	0	0	0	0	0	0	0
7/25	0	0	0	0	0	0	0
7/26	0	0	0	0	0	0	0
7/27	0	0	0	0	0	0	0
7/28	0	0	0	0	0	0	0
7/29	0	0	0	0	0	0	0
7/30	0	0	0	0	0	0	0
7/31	0	0	0	0	0	0	0
Total	1	83	84	3	125	128	212