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Annual Performance Report for
COHO SALMON STUDIES IN THE RESURRECTION BAY AREA

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RESEARCH PROJECT SEGMENT

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the Resurrection Bay Area

Cooperator: Edward T. McHenry

Period Covered: July 1, 1983 to June 30, 1984

ABSTRACT

Bear Lake was restocked with 199,000 Age 0.0 coho salmon, Oncorynchus kisutch (Walbaum), fingerlings on May 27, 1983 to maintain smolt production.

The Bear Creek weir downstream migrant trap was operated continuously from May 18 through August 31. A total of 108,398 Age 1.0, 2.0 and 3.0 smolts were enumerated. Yearling (Age 1.0) smolt survival from the 1982 Bear Lake fingerling plant was 44.0 percent, with a 4.8:1.0 smolt-to-fingerlings biomass (kilogram) yield. Age 2.0 smolt survival was 3.2 percent, with a 0.5:1.0 smolt-to-fingerling biomass ratio, for a 57.3 percent total smolt survival and 7.2:1.0 biomass ratio production from the 1981 fingerling release.

Bear Lake's smolt out-migration timing and abundance, age and size compositions, and condition factors are presented. Bear Creek water temperatures and stream flows corresponding to migration peaks and durations are also given. The 1983 decline in Bear Lake's yearling coho smolt abundance, size and condition versus its potential sockeye salmon production with lake fertilization is discussed.

The Resurrection Bay salmon creel census (July 8-September 11) estimated that 12,646 coho were harvested in 24,371 man-days of sport effort. The mean seasonal catch per angler hour was 0.071. Enhanced coho production (1,759 fish) contributed an estimated 13.9 percent to the sport harvest. All were Bear Lake coho as no discernible adult returns resulted from the 67,200 Age 1.0 hatchery smolts stocked in Seward Lagoon and Grouse Lake in 1982. Factors related to recent lack of coho production from the hatchery smolt program are reviewed.

The Bear Creek upstream migrant trap was operated continuously from May 18 through November 14. The coho upstream migration to the trap extended from August 29 to November 14, and consisted of 5,797 adults

and three jacks. The run was comprised of 856 marked and 4,941 unmarked Bear Lake coho. Smolt-to-adult survivals of the 1982 marked and unmarked Bear Lake smolt lots were 3.29 and 6.37 percent, respectively, with overall marine survival estimated at 5.60 percent. Age 1.0 and 2.0 Bear Lake smolt-to-adult survivals were 5.39 and 8.44 percent, respectively. Total survival of Bear Lake smolt out-migrations (1977-1982), Seward Lagoon (1968-1982), and Grouse Lake (1976-1982) hatchery smolt releases are summarized.

The catch-to-escapement ratio of marked Bear Lake coho was 0.28:1. The male-to-female sex ratio was 1.7:1 in the Bear Lake escapement. An estimated 1,138,000 coho eggs were artificially spawned from 246 females and fertilized by males from the Bear Lake return. Eyed egg survival at Elmendorf Hatchery was 89 percent.

Data on the timing and abundance of other fish species ascending and descending Bear Creek to the weir are presented. Minimum wild coho escapements in seven local index streams are reviewed.

KEY WORDS

Bear Lake, rehabilitation, fertilization, coho salmon, fingerling, smolt, stocking, Resurrection Bay, sport fishery, creel census, escapement, artificial spawning.

BACKGROUND

Since 1961, the marine recreational fishery for Resurrection Bay coho salmon has become the largest in effort and harvest of this species in Alaska. Wild coho salmon production in Resurrection Bay is believed to be directly affected by the extreme fluctuations in stream flows and water temperatures characteristic of its coastal drainage tributaries. Therefore, it became imperative to stabilize or enhance Resurrection Bay's coho production to satisfy the rapidly growing angler demand evident in the early 1960's.

Bear Lake was chosen in 1962 as the main thrust for experimental coho salmon enhancement via lake rehabilitation to eradicate competing threespine sticklebacks and subsequent annual restocking with coho fingerlings for increased smolt production. After reinfestation by sticklebacks and resultant decline of favorable smolt yields, Bear Lake was rehabilitated again in 1971. Threespine sticklebacks were completely eliminated, and Bear Lake's yearling coho smolt yields from annual fingerling plants attained 50%, with adult survival up to 10% return. Bear Lake is currently undergoing artificial fertilization to further increase its carrying capacity for juvenile salmon production.

Another facet of Resurrection Bay coho salmon enhancement began in 1968 with annual plants of hatchery-reared smolts at three local release sites having diverse habitat characteristics. Though variable from one site and 1 year to another, smolt-to-adult survivals have ranged up to 15% with contribution to the sport harvest over 40%.

Lastly, impediments to smolt and spawning migrations such as beaver dams have been removed on a timely basis, and two natural rearing ponds were made accessible to juvenile coho in an attempt to improve wild stock survivals in the Resurrection River drainage.

For more detailed description and background information on the 21-year history of this project, see Logan (1969) and McHenry (1982). Figure 1 shows the Resurrection Bay drainage, and Table 1 lists the anadromous fish species indigenous to its tributaries.

RECOMMENDATIONS

1. The present objectives of the study should be retained.
2. The 1985 stocking density of coho fingerlings in Bear Lake should be adjusted according to emigrating smolt abundance, age composition and condition factor in 1984.
3. Size of fingerlings stocked annually in Bear Lake should average not less than 772/kg (350/lb) to preclude residualism beyond Age 1.0 smolts.
4. The Bear Lake fertilization experiment should be discontinued if coho smolt biomass production does not increase significantly.

OBJECTIVES

1. To determine the distribution, abundance and timing of out-migrant and adult coho salmon in Bear Creek, Bear Lake, Grouse Lake and Seward Lagoon from May through November.
2. To determine the age and size composition of out-migrant and adult coho salmon populations in Bear Creek, Bear Lake, Grouse Lake and Seward Lagoon from May through December.
3. To determine the sport harvest and relative survivals of wild and enhanced coho salmon stocks in Resurrection Bay from July to December.
4. To determine the methods and means of increasing or extending the freshwater spawning and rearing areas of the Resurrection Bay watershed and mitigating freshwater mortality.

TECHNIQUES USED

All research methods employed in the past several years to accomplish the foregoing objectives remain essentially the same as previously described (see McHenry, 1982). Biological sampling frequencies of Bear

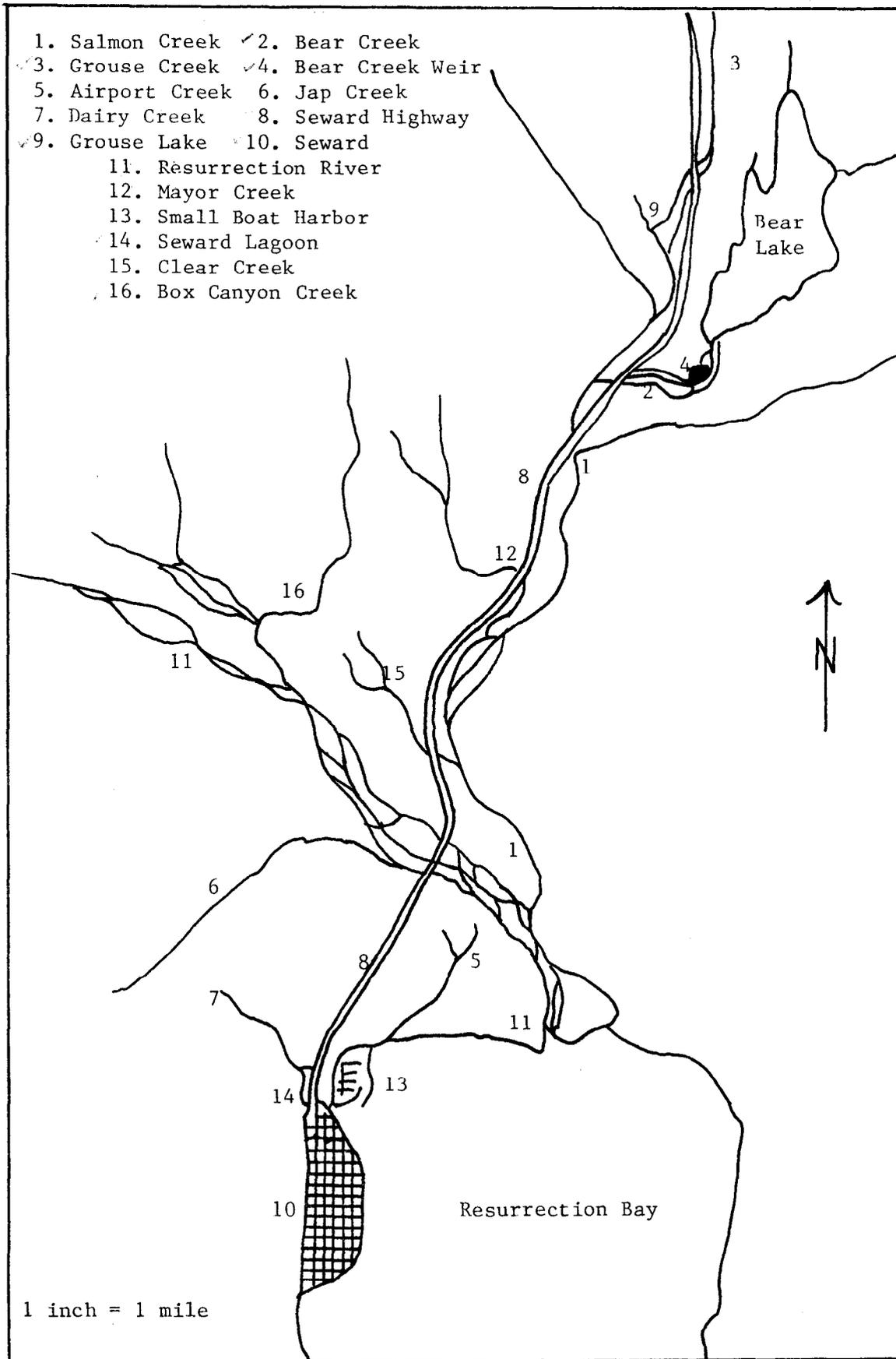


Figure 1. Resurrection Bay Watershed.

Table 1. Checklist of Fish Species Present in the Resurrection Bay Drainage.

Common Name	Scientific Name and Author
Dolly Varden	<u>Salvelinus malma</u> (Walbaum)
Rainbow-steelhead trout	<u>Salmo gairdneri</u> (Richardson)
Sockeye salmon	<u>Oncorhynchus nerka</u> (Walbaum)
Coho salmon	<u>Oncorhynchus kisutch</u> (Walbaum)
Chum salmon	<u>Oncorhynchus keta</u> (Walbaum)
Chinook salmon	<u>Oncorhynchus tshawytscha</u> (Walbaum)
Pink salmon	<u>Oncorhynchus gorbuscha</u> (Walbaum)
Threespine stickleback	<u>Gasterosteus aculeatus</u> (Linnaeus)
Sculpin	<u>Cottus</u> sps.

Lake salmon migrations were altered slightly according to differences in pre-season estimates of their abundance relative to previous years. Age compositions of the Resurrection Bay wild coho run and Bear Lake unmarked coho escapement were for the first time since 1976 randomly sampled (1% and 10%, respectively) due to the anticipated and realized failure of the 1982 hatchery coho smolt releases in Grouse Lake and Seward Lagoon to produce returning adults in 1983.

FINDINGS

Results

The findings presented are the result of the 1982-83 research segment of the project. For past information collected on the project, see Logan (1962-1969) and McHenry (1970-1983).

Bear Lake Coho Smolt Migration:

The Bear Creek weir downstream migrant trap was operated continuously from May 18 through August 31, when the trap was removed due to cessation of the Bear Lake smolt emigration. Abundance and timing of the coho salmon outmigration are shown in Table 2. Stocked fingerlings emigrating Bear Lake were retained above the weir.

The out-migration to the downstream trap totaled 108,398 smolts. Trap mortality claimed only 547 smolts (0.47% of the run) due to careful manipulation of the fishpass elevation during fluctuating weir pool levels at migration peak. A total of 107,851 live smolts were released downstream. A predetermined 25.0% of the out-migration received a left ventral (LV) fin-clip for recognition in the 1984 Resurrection Bay sport fishery and Bear Lake spawning escapement. Table 3 shows the number and percentage of smolts marked and sampled in each weekly period.

Smolt emigration began on May 19, peaked (50% of out-migration) by June 14, and terminated August 30. The highest daily count occurred on June 10 when 7,619 (7.0% of the total run) were enumerated from the trap. Mean stream temperatures when smolt emigration began, peaked and terminated were 5.6°C (42.0°F), 12.5°C (54.5°F) and 14.4°C (58.0°F), respectively. Bear Creek stream flows ranged from 9 to 42 cfs during this period.

The smolt out-migration was comprised of: 92.6% (100,368) Age 1.0; 7.3% (7,938) Age 2.0 and; 0.1% (92) Age 3.0 smolts. Tables 4 and 5 present the mean fork length, weight, condition factor and relative percentage of Age 1.0 and 2.0 smolts in the weekly samples. Too few Age 3.0 smolts were observed for tabulation. Table 6 shows the weekly and seasonal abundance per smolt age group. An overall 1.0% (1,083 smolts) were representatively sampled during emigration (Table 3). An estimated 99,862 Age 1.0, 7,898 Age 2.0 and 91 Age 3.0 live smolts were released downstream.

Age 1.0 and 2.0 smolt migrations peaked during June 10-16 when Bear Creek water temperatures averaged 11.7°C (53.1°F), whereas Age 3.0

Table 2. Bear Lake Coho Salmon Smolts Enumerated at Bear Creek Weir by Weekly Periods, 1983.

Weekly Periods	Number of Smolts		Total
	Live	Dead	
May 13 - May 19		1	1
May 20 - May 26	37	4	41
May 27 - June 2	1,792	18	1,810
June 3 - June 9	24,982	400	25,382
June 10 - June 16	34,876	36	34,912
June 17 - June 23	22,495	18	22,513
June 24 - June 30	14,781	24	14,805
July 1 - July 7	3,489	12	3,501
July 8 - July 14	3,035	7	3,042
July 15 - July 21	468	7	475
July 22 - July 28	125	3	128
July 29 - August 4	329	6	335
August 5 - August 11	617	4	621
August 12 - August 18	255	1	256
August 19 - August 25	548	4	552
August 26 - September 1	<u>22</u>	<u>2</u>	<u>24</u>
Total	107,851	547	108,398

Table 3. Bear Lake Coho Salmon Smolts Marked and Sampled at Bear Creek Weir by Weekly Period, 1983.

Weekly Periods	Number of Live Smolts	Number Smolts Fin Clipped	Percent of Weekly Migration*	Number Smolts Sampled	Percent of Weekly Migration*
May 20 - 26	37				1.1
May 27 - June 2	1,792	520	28.7	20	1.0
June 3 - 9	24,982	6,615	26.1	260	1.0
June 10 - 16	34,876	8,488	24.3	360	1.0
June 17 - 23	22,495	5,798	25.8	223	1.0
June 24 - 30	14,781	3,742	25.3	150	1.0
July 1 - 7	3,489	762	21.8	21	0.6
July 8 - 14	3,035	355	11.7	16	0.5
July 15 - 21	468	250	52.6	18	3.8
July 22 - 28	125				
July 29 - August 4	329	224	66.9	3	0.9
August 5 - 11	617	178	28.7	4	0.6
August 12 - 18	255	40	15.6		
August 19 - 25	548	132	23.9	8	1.4
August 26 - Sept. 1	<u>22</u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>
Total	107,851	27,104	25.0	1,083	1.0

* Includes the 547 smolts expiring from trap mortality.

Table 4. Mean Fork Length, Weight and Condition Factor of Age 1.0 Bear Lake Coho Salmon Smolts Sampled Weekly at Bear Creek Weir, 1983.

Weekly Periods	Number of Smolts	Percent of Sample	Mean Length (mm) \pm SD	Mean Weight (g) \pm SD	Condition Factor (K)*
May 27 - June 2	14	70.0	112.6 \pm 4.6	13.39 \pm 1.60	0.94
June 3 - 9	229	89.1	115.0 \pm 6.3	14.48 \pm 2.37	0.95
June 10 - 16	331	92.5	114.8 \pm 5.9	14.31 \pm 2.20	0.95
June 17 - 23	208	93.7	120.4 \pm 6.2	17.01 \pm 2.96	0.97
June 24 - 30	144	96.6	123.0 \pm 5.8	18.15 \pm 2.72	0.98
July 1 - 7	20	95.2	129.2 \pm 6.2	21.86 \pm 3.57	1.01
July 8 - 14	16	100.0	133.8 \pm 3.5	24.18 \pm 2.11	1.01
July 15 - 21	18	100.0	132.6 \pm 11.8	24.50 \pm 5.50	1.05
July 29 - Aug. 4	3	100.0	154.0 \pm 9.5	37.50 \pm 6.10	1.03
August 5 - 11	4	100.0	153.3 \pm 13.0	37.25 \pm 9.15	1.03
August 19 - 25	8	100.0	160.8 \pm 6.4	41.39 \pm 4.24	1.00

* $K = \frac{W \times 10^5}{L^3}$, Where W = mean weight in grams, and L = mean fork length in millimeters.

Table 5. Mean Fork Length, Weight and Condition Factor of Age 2.0 Bear Lake Coho Salmon Smolts Sampled Weekly at Bear Creek Weir, 1983.

Weekly Periods	Number of Smolts	Percent of Sample	Mean Length (mm) \pm SD	Mean Weight (g) \pm SD	Condition Factor (K)*
May 27 - June 2	5	25.0	132.2 \pm 14.3	21.74 \pm 6.27	0.94
June 3 - 9	28	10.9	128.6 \pm 8.4	19.72 \pm 3.18	0.93
June 10 - 16	27	7.5	128.6 \pm 9.4	20.21 \pm 3.62	0.95
June 17 - 23	14	6.3	133.1 \pm 6.3	22.41 \pm 3.11	0.95
June 24 - 30	5	3.4	136.0 \pm 4.6	25.00 \pm 2.26	0.99
July 1 - 7	1	4.8	145	27.9	0.92

* $K = \frac{W \times 10^5}{L^3}$, Where W = mean weight in grams, and L = mean fork length in millimeters.

Table 6. Relative Abundance and Timing of Age 1.0, 2.0 and 3.0 Bear Lake Coho Salmon Smolts Migrating to Bear Creek Weir, 1983.

Weekly Periods	Number of Smolts			Total
	Age 1.0	Age 2.0	Age 3.0	
May 13 - 26*	29	11	2	42
May 27 - June 2	1,267	453	90	1,810
June 3 - 9	22,615	2,767		25,382
June 10 - 16	32,294	2,618		34,912
June 17 - 23	21,095	1,418		22,513
June 24 - 30	14,302	503		14,805
July 1 - 7	3,333	168		3,501
July 8 - 14	3,042			3,042
July 15 - 21	475			475
July 22 - 28**	128			128
July 29 - August 4	335			335
August 5 - 11	621			621
August 12 - 18**	256			256
August 19 - Sept. 1**	<u>576</u>	<u> </u>	<u> </u>	<u>576</u>
Total	100,368	7,938	92	108,398
Percent	92.6	7.3	0.1	100.0

* Number of smolts per age group for May 13 - 26 is estimated by age composition (70% Age 1.0, 25% Age 2.0 and 5.0% Age 3.0) determined for May 27 - June 2 sample.

** All smolts emigrating during these non-sampled weekly periods were considered Age 1.0 because no older smolts were detected after early July.

smolts peaked 2 weeks earlier, May 27-June 2, at a mean stream temperature of 7.2°C (44.9°F). Bear Creek weekly stream temperatures averaged 4.3°C (7.7°F) warmer than those measured during the mid-June peak migration period in 1982, resulting in about a two week advance in the overall 1983 emigration compared to 1982. Approximately 57% of the 1983 Bear Lake smolt migration had descended to the weir by June 16. Only 46% of the 1982 out-migration had reached Bear Creek weir by that date, however, at an average weekly stream temperature of 7.4°C (45.4°F). In previous years (1974-1979), about 65% of Bear Lake smolt migrations had passed the weir by the end of the first week that Bear Creek mean water temperature exceeded 10°C (50°F).

The 92 Age 3.0 smolts resulted from the ninth fingerling plant (150,000 Age 0.0 fingerling in 1980) in Bear Lake following the 1971 lake rehabilitation project. Total fingerling-to-smolt survival from the 1980 plant was only 13.7%. This is the lowest percentage of Bear Lake fingerling releases resulting in smolts since the 1974 plant (9.6%). Age composition of this smolt production cycle was: 52.9% Age 1.0, 46.6% Age 2.0 and 0.5% Age 3.0. Bear Lake coho fingerling plants since 1979 are summarized in Table 7 and smolt production since 1980 is presented in Table 8.

The 7,938 Age 2.0 smolts were produced from 247,845 Age 0.0 fingerlings stocked in 1981. With the 134,003 Age 1.0 smolts which emigrated in 1982, 57.3% of that plant has survived to smolts thus far. In contrast to the poor smolt production of the 1980 fingerling plant, that of the 1981 release realized the highest smolt yield of any annual restocking in the project's 21-year history. Excepting Age 3.0 smolt production in 1984, age composition of Bear Lake's tenth smolt production cycle since the 1971 lake rehabilitation was 94.4% Age 1.0 and 5.6% Age 2.0.

The 100,368 Age 1.0 smolts survived from 227,800 Age 0.0 fingerlings released in Bear Lake in 1982. Although 44.0% of this plant surviving to yearling smolts is adequate, higher production was anticipated due to the promising results realized in 1982 (54.1% Age 1.0 smolt production from the 1981 stocking), believed to have occurred from the recently-initiated Bear Lake fertilization experiment. However, the 10.1% reduction in yearling smolt survival may have been caused by environmental factors unrelated to introduction of nitrates in Bear Lake. Age 2.0 smolt abundance in 1984 will depend upon the extent of Age 1.0 residualism and overwinter survival of the 1982 fingerling plant.

Age 1.0 smolts averaged 114.8 mm and 14.31 g for a condition factor (K) of 0.95 at migration peak, June 10-16. Growth of the 1982 Age 0.0 fingerlings surviving to yearling smolts was fair considering that they averaged 50mm and 1.51 g at release 1 year earlier. Age 2.0 smolts had a mean fork length of 128.6 mm and weight of 20.21 g for a K = 0.95 in mid-June. The one Age 3.0 smolt sampled was 188 mm and 59.4 g for a K = 0.89. All three smolt age groups exhibited somewhat depressed condition (and smaller size) compared to 1982 smolts.

Bear Lake's estimated smolt biomass production in 1983 was 1,810.7 kg, down 632 kg from the 2,442.7 kg produced in 1982, and 261.6 kg

Table 7. Summary of Bear Lake Coho Salmon Fingerling Plants, 1979-1983.

Brood Year	Source of Eggs	No. Fish Stocked	Weight		Size		Density		Dates of Plants	Planting Method
			lbs	kg	No./lb	No./kg	No./acre	No./ha		
1978	Bear Lake	<u>225,500</u>	<u>340</u>	<u>154.2</u>	<u>663</u>	<u>1,462</u>	<u>507</u>	<u>1,253</u>	May 24	Aircraft
									1979	Scattered
1979	Bear Lake	134,375	542	245.8	248	546	302	746	June 12	Aircraft
	Bear Lake	<u>15,625</u>	<u>68</u>	<u>30.8</u>	<u>231</u>	<u>508</u>	<u>35</u>	<u>96</u>	June 18	Truck-boat
	Total	<u>150,000</u>	<u>610</u>	<u>276.6</u>	<u>246</u>	<u>542</u>	<u>337</u>	<u>832</u>	1980	Scattered
1980	Bear Lake	143,427	439	198.9	327	716	322	796	June 2	
	Bear Lake	<u>104,418</u>	<u>291</u>	<u>131.9</u>	<u>359</u>	<u>792</u>	<u>235</u>	<u>580</u>	June 2	Truck-boat
	Total	<u>247,845</u>	<u>730</u>	<u>330.8</u>	<u>340</u>	<u>749</u>	<u>557</u>	<u>1,376</u>	1981	Scattered
1981	Bear Lake	<u>227,800</u>	<u>759</u>	<u>344.0</u>	<u>300</u>	<u>662</u>	<u>512</u>	<u>1,265</u>	June 7	Truck-boat
									1982	Scattered
1982	Bear Lake	<u>199,000</u>	<u>603</u>	<u>273.4</u>	<u>330</u>	<u>728</u>	<u>447</u>	<u>1,104</u>	May 24	Truck-boat
									1983	Scattered

* Weighted averages.

Table 8. Summary of Bear Lake Coho Salmon Smolt Abundance and Biomass Produced Since 1980 from Annual Fingerling Plants, 1979-1982.

Year of Plant	No. of Fingerlings and Weight (g)	Smolt Production by Year				Total Production	Survival to Smolt (%)
		1980	1981	1982	1983		
1979							
Number	225,500	54,580	61,750	110	116,440	51.6	
Weight (kg)	154.2	1,053.0	1,348.7	7.9	2,409.6		
Weight Ratio		6.8:1	8.7:1	0.1:1	15.6:1		
1980							
Number	150,000		10,899	9,605	92	20,596	13.7
Weight (kg)	276.6		192.8	207.7	5.5	406.0	
Weight Ratio			0.7:1	0.8:1	0.0:1	1.5:1	
1981							
Number	247,845			134,003	7,938	141,941	57.3*
Weight (kg)	330.8			2,227.1	166.0	2,393.1	
Weight Ratio				6.7	0.5:1	7.2:1	
1982							
Number	227,800				100,368		44.0**
Weight (kg)	344.0				1,639.2		
Weight Ratio					4.8:1		

* Does not include Age 3.0 smolt production.

** Includes only Age 1.0 smolt production.

(575.5 lb) less than the 10-year annual average of 2,072.3 kg following the 1971 lake rehabilitation project. Table 9 summarizes total numbers of smolts, estimated annual biomass and seasonal condition factor of Bear Lake smolt migrations since 1973.

Bear Lake was restocked on May 24, 1983 with 199,000 Age 0.0 coho salmon fingerlings (1982 brood, Bear Lake origin) averaging 728/kg (330/lb) to maintain smolt production.

Other Species:

The total sockeye salmon smolt out-migration enumerated from the trap was 12,975 fish. The first smolt was captured on May 19 and the last on August 5. The highest daily count occurred on May 28 when 5,567 smolts (42.9% of the migration) were enumerated. The majority (86.3%) emigrated between May 20 and June 9, when Bear Creek water temperatures ranged from 4.4°C to 12.2°C (40°F-54°F) and stream flows from 27 to 42 cfs. The smolt out-migration was comprised of: 10,974 (84.6%) Age 1.0, 1,965 (15.1%) Age 2.0, and 36 (0.3%) Age 3.0 smolts. Age 3.0 smolts were produced from the six females and six males that spawned in Bear Lake in 1979. With the 2,805 Age 1.0 smolts estimated in 1981 and 123 Age 2.0 smolts in 1982, a total of 2,964 smolts (494.0 per female) resulted from this meager escapement. Age 2.0 smolts resulted from 673 males and 785 females in the 1980 escapement. Compared to spawning success of the 1979 parent brood, that of the 1980 spawners was only mediocre, with 61.3 smolts produced per female. Age 1.0 smolts were produced by 309 males and 385 females in the 1981 Bear Lake escapement. Only 28.5 smolts survived per spawning female thus far. Age 1.0 and 2.0 smolts peaked (50% of migration) during May 27-June 2, whereas Age 3.0 smolts were not detected until mid-June. Age 1.0 smolts averaged 111.5 mm and 13.50 g for a condition factor (K) = 0.97, and Age 2.0 smolts 149.3 mm and 32.93 g for a K = 0.99 at migration peak. The Age 3.0 smolt sampled was 166 mm and 39.9 with a K = 0.87.

A total of 1,306 out-migrant Dolly Varden was captured in the downstream trap and released below the weir. No threespine sticklebacks were caught in the trap or observed in Bear Lake during the 1983 field season.

Resurrection Bay Coho Salmon Harvest and Effort:

A stratified, random creel census to determine the Resurrection Bay coho sport harvest and effort was initiated at the Seward small boat harbor on July 8 and terminated September 11. Few coho were taken before creel census began since most sport fishing effort was directed toward the more abundant rockfish, Sebastes sp., from mid-May through early July.

The season's total harvest was an estimated 12,646 coho. This estimate was extrapolated from interviews with 4,595 anglers harvesting 2,137 coho during the creel census period. Peak of the harvest occurred on August 13, the first day of the Seward Silver Salmon Derby, when an estimated 669 coho (5.3% of the season's harvest) were taken. The season's total and derby harvests are summarized for 1979 through 1983 in Table 10.

Table 9. Summary of Abundance, Seasonal Condition Factor and Total Annual Biomass of Bear Lake Smolt Migrations, 1973-1983.

Year	Total No. of Smolts	Condition Factor (K)	Total Biomass (kg)
1973	77,343	1.06	2,149.3
1974	72,389	0.93	1,743.2
1975	168,036	0.89	3,381.3
1976	93,311	1.07	2,016.8
1977	99,970	1.03	1,940.2
1978	97,814	0.99	1,869.3
1979	105,316	1.05	2,063.0
1980	74,980	1.01	1,565.3
1981	72,888	1.04	1,551.7
1982	143,718	1.00	2,442.7
1983	108,398	0.98	1,810.7
Average (1973-82)	100,577	1.02	2,072.3

Table 10. Total and Derby Sport Harvest of Coho Salmon in Resurrection Bay, 1979-1983.

Year	Total Sport Harvest	Derby Harvest	% Derby Harvest
1979	17,785	6,073	34.1
1980	20,981	6,732	32.1
1981	15,743	4,758	30.2
1982	17,813	4,504	25.3
1983	12,646	3,477	27.5

Marked (RV) adult coho contributed 2.0%, or an estimated 258 fish, to the 1983 Resurrection Bay sport harvest. These coho were produced by Bear Lake smolts finmarked at Bear Creek weir in 1982. An additional 1,501 unmarked coho surviving from Bear Lake smolts released unmarked past the weir comprised an estimated 11.9% of the sport catch. No discernible adult coho harvest resulted from 67,200 unmarked Age 1.0 hatchery coho smolts stocked in Seward Lagoon and Grouse Lake in 1982. Therefore, the total contribution of enhanced adult coho production was 1,759 fish, or 13.9%, to the sport fishery.

A total of 47,950 which were 28.1% adipose clipped and coded wire tagged (Ad-CWT) and 49,900 (31.5% Ad-CWT) Age 1.0 hatchery reared coho smolts were released on May 20, 1983 in Seward Lagoon and Grouse Lake, respectively. These plants were comprised of yearling smolts averaging 20.1 g (22.6/lb) and noted in good condition at release. Age 1.1 adults surviving from these smolt plants will return in 1984, and hopefully make some contribution to the sport catch.

Only 200 coho were estimated taken during the popular Seward beach fishery. It generally runs from mid-August when returning Seward Lagoon hatchery coho start milling off the lagoon culvert outfall until September 15 when this fishery is closed to allow some escapement for egg-take purposes, if needed. Due to the failure of the 1982 hatchery coho smolt releases to produce surviving adults, this fishery apparently concentrated on the few wild stock coho returning to Seward Lagoon. About 74% of the beach harvest is generally comprised of Seward Lagoon bound fish (McHenry, 1980), and only 64 coho were estimated in the lagoon's escapement.

The total sport fishing effort exerted for Resurrection Bay coho was an estimated 24,371 man-days. A percentage of 18.9 of the season's effort was sampled during the creel census period. The mean number and percentage of sport fishing boats returning daily to the Seward small boat harbor are shown in Table 11. The average numbers of anglers per boat were as follows: weekdays, 2.81; weekends, 3.20; and salmon derby, 3.16. Fishing effort and mean seasonal catch per hour are summarized for 1978-1983 in Table 12. The fishing effort was 6,698 man-days on weekdays and 6,718 on weekends, excluding the derby (10,955 man-days). Military personnel and dependents, fishing on boats provided by the Army and Air Force recreation camps at Seward, contributed 11.1% (2,717 man-days) to the total effort. Civilian anglers fishing on weekdays realized the highest coho catch per hour (0.157), whereas the lowest catch rate (0.044) occurred during the Derby when effort was more intense. The average number of hours anglers fished per day were as follows: weekdays, 5.06; weekends, 5.48; and salmon derby, 7.36.

Examination of 323 scale samples randomly collected throughout the sport fishery disclosed that the wild Resurrection Bay coho population was comprised of 58.2% Age 1.1, 38.9% Age 2.1 and 2.9% Age 3.1 adults. Table 13 shows the wild age composition trend from 1972 through 1978, including 1983 for comparison. Although scale sampling was not conducted from 1979-1982 because of unmarked hatchery coho returns, wild populations may be reverting to a 4-year-old (Age 2.1) dominance. Mean fork lengths and weights of wild coho are presented in Table 14. The male-to-female sex ratio was 1.1:1.0 in the sport fishery.

Table 11. Mean Number and Percentage of Sport Fishing Boats Returning to the Seward Small Boat Harbor During Each Sampling Period, 1983.

Period (hours)	Weekends		Weekdays	
	Mean No. of Boats	Percent	Mean No. of Boats	Percent
8:00 am - 11:30 am*	15.3	11.6	7.4	14.3
11:30 am - 3:00 pm	27.2	20.7	10.8	20.8
3:00 pm - 6:30 pm	60.5	45.9	20.0	38.5
6:30 pm - 10:00 pm	<u>28.7</u>	<u>21.8</u>	<u>13.7</u>	<u>26.4</u>
Total	131.7	100.0	51.9	100.0

* Percentage for this period determined by 3-year mean, 1964-1966.

Table 12. Derby and Total Sport Effort (Man-Days) Exerted for Coho Salmon and Mean Catch Per Hour in Resurrection Bay, 1979-1983.

Year	Period of Census	Total Effort	Derby Effort	% Derby Effort	Seasonal Catch Per Hour
1979	July 8 - Sept. 9	24,651	8,280	33.6	0.131
1980	July 8 - Sept. 7	25,527	8,886	34.8	0.145
1981	July 8 - Sept. 8	22,937	7,933	34.6	0.122
1982	July 8 - Sept. 8	25,403	9,681	38.1	0.106
1983	July 8 - Sept. 11	24,371	10,955	45.0	0.071

Table 13. Age Composition of Wild Resurrection Bay Coho Samlon Populations, 1972-1978 and 1983.

Year	Sampling Period	No. of Fish	Age Composition			Total
			1.1	2.1	3.1	
1972	July 4 - Sept. 4	179	34.7	59.2	6.1	100.0
1973	July 7 - Sept. 2	201	42.8	49.7	7.5	100.0
1974	July 2 - Sept. 1	236	49.1	49.2	1.7	100.0
1975	July 9 - Sept. 11	250	58.0	35.2	6.8	100.0
1976	July 8 - Sept. 3	213	77.0	21.6	1.4	100.0
1977	July 9 - Sept. 7	303	70.6	27.4	2.0	100.0
1978	July 8 - Sept. 10	377	68.0	27.3	4.7	100.0
1979-82*	Not Sampled					
1983	July 8 - Sept. 11	316	58.2	38.9	2.9	100.0

* Scale samples were not taken during these years because unmarked adults returning from hatchery-reared smolt releases could not be differentiated from wild fish.

Table 14. Mean Fork Length (mm) and Weight (kg) of Wild Adult Coho Salmon Sampled from the 1983 Resurrection Bay Sport Fishery.

	Number of Fish	Mean Length (mm) and SD	Mean Weight (kg) and SD
Males	170	665.4 ± 56.8	4.39 ± 1.17
Females	151	641.2 ± 45.7	3.85 ± 0.88
Total	321	654.0 ± 53.2	4.14 ± 1.08

An estimated 167 chinook salmon were harvested during the census period at an average of only 0.01 per boat. This harvest was substantially below the 20-year average (1961-1980) catch of this species (371 fish) in Resurrection Bay. Chinook salmon were most abundant during July 8-14 when anglers averaged 0.04 chinook per boat. Most fish taken were immature chinook in their first and second ocean years. Origins of these stocks are unknown as wild chinook rarely ascend Resurrection Bay streams. A total of 111 adult chinook salmon returned to Box Canyon Creek (foot survey July 26) from 218,500 hatchery-reared, Age 0.0 (1978 brood, Ship and Crooked creeks origin) smolts released in that tributary in 1979. Of the two carcasses examined, one was Ad-CWT marked and one unmarked. No Ad-CWT marked chinook were observed in the sport harvest during creel census. Total smolt-to-adult survivals of the 1976 (25,100 smolts), 1977 (50,000), 1978 (150,500) and 1979 smolt releases in Box Canyon Creek were estimated at 0.06%, 0.04%, 0.05% and 0.10%, respectively. This program was discontinued after 1979 due to the negligible returns obvious at that time. However, in a further attempt to establish this species for the Resurrection Bay sport fishery, 54,500 Age 0.0 (1982 brood, Crooked Creek origin) hatchery smolts were released in Box Canyon Creek rearing pond on May 27, 1983.

The Resurrection Bay pink salmon sport catch was 4,663 in 1983. A limited commercial fishery conducted on July 21, 27 and August 4 for one 12-hr period each day harvested 26,970 pink, 6,860 chum and 22 sockeye salmon by 10 seine boats (Hammarstrom, pers. comm.). Pink salmon were most abundant in the sport fishery from mid-July through early August when anglers averaged 1.14 fish per boat. Pink salmon catch per man-day averaged 0.17 in 1983, compared to 0.31 in 1981, the parent brood year which produced the 1983 return.

Adult Coho Timing and Distribution in Index Streams:

Peak of the 1983 index escapements ranged from mid-October through early November, and peak of spawning occurred within the following 2 weeks in index streams. Estimated minimum escapements of wild coho salmon in each stream index area since 1979 are presented in Table 15. The total minimum index escapement of 842 spawning coho suggests an above-average wild coho return occurred in 1983.

Bear Lake Upstream Migration:

The Bear Creek weir upstream migrant trap was operated continuously from May 18 through November 14. The first adult coho entered the trap on August 29 and the last one was captured November 14. A total of 405 coho spawned in lower Bear Creek after the adult run had entered the trap, according to a foot survey conducted on November 14.

A total of 5,797 adults and three jacks were enumerated from the trap. Abundance and timing of the adult coho migration are shown in Table 16. The adult migration peaked (50%) on October 1, and the highest daily count of 391 (6.7% of the adult run) occurred on September 23. Mean stream temperatures at the beginning, peak and end of migration were 14.4°C (58.0°F), 9.2°C (48.5°F) and 3.3°C (38.0°F), respectively. Most of the migration (78.1%) occurred from September 16 through October 27

Table 15. Minimum Wild Coho Salmon Escapement in Seven Index Streams in the Resurrection Bay Area, 1979-1983.

Name of Stream	Minimum Escapement					Mean 1979-82
	1979	1980	1981*	1982	1983	
Airport	1	9	...	0	0	3
Box Canyon	121	32	...	248	154	134
Clear	42	88	...	241	62	124
Dairy	68	122	...	108	64	99
Grouse	14	108	...	307	408	143
Jap	61	49	...	328	85	146
Mayor	<u>30</u>	<u>94</u>	<u>...</u>	<u>145</u>	<u>69</u>	<u>90</u>
Total	337	502	...	1,377	842	739

* Insufficient foot surveys were performed in 1981 to delineate minimum escapements.

Table 16. Bear Lake Adult Coho Salmon Enumerated through Bear Creek Weir by Weekly Periods, 1983.

Weekly Periods	RV or LV Marked	Unmarked*	Male	Female	Total
Aug. 26 - Sept. 1		4	2	2	4
Sept. 2 - 8**					
Sept. 9 - 15**	43	296	267	72	339
Sept. 16 - 22	263	1,423	1,173	513	1,686
Sept. 23 - 29	82	522	365	239	604
Sept. 30 - Oct. 6	100	609	520	189	709
Oct. 7 - 13	38	209	176	71	247
Oct. 14 - 20	37	336	196	177	373
Oct. 21 - 27	144	765	483	426	909
Oct. 28 - Nov. 3	25	143	108	60	168
Nov. 4 - 10	100	546	321	325	646
Nov. 11 - 17	<u>24</u>	<u>88</u>	<u>46</u>	<u>66</u>	<u>112</u>
Total	856	4,941	3,657	2,140	5,797

* Approximately 75% of the 1982 Bear Lake smolt out-migration was released unmarked to enhance smolt-to-adult survival.

** Upstream migrant trap was inoperative from September 2 - 12 to repair and clean the salmon holding tank.

when Bear Creek temperatures ranged from 2.2°C to 12.2°C (36°F-54°F) and flows, from 7 to 18 cfs.

The marked coho escapement to the weir returned from 35,904 Age 1.0, 2.0 and 3.0 Bear Lake smolts marked with an RV finclip at Bear Creek weir in 1982. One LV marked adult recorded from the trap resulted either from being fin-clipped on the wrong side in 1982 or returned from a "holdover" 1981 Bear Lake smolt that remained in lower Bear Creek until 1982. With the additional 258 estimated taken in the Resurrection Bay sport fishery and 69 estimated in lower Bear and Grouse Creeks, the total return (1,183 fish) of the marked Bear Lake lot resulted in a 3.29% smolt-to-adult survival.

The 4,941 unmarked coho enumerated from the upstream trap were produced from 107,711 Bear Lake smolts released without a finclip at Bear Creek weir. Including 1,501 estimated caught in the Resurrection Bay boat fishery and 421 estimated in lower Bear and Grouse Creeks, the total return (6,863 fish) of the unmarked Bear Lake segment realized a 6.37% smolt-to-adult survival.

Analysis of 500 scale samples representatively sampled from the Bear Lake escapement disclosed that the run (catch plus escapement) was comprised of 7,210 Age 1.1 (89.6%), 810 Age 2.1 (10.0%) and 35 Age 3.1 (0.4%) adults. This extrapolation includes the 405 spawners in lower Bear Creek and 85 Bear Lake fish estimated straying into Grouse Creek. The adult age composition, therefore, translates to 1982 Bear Lake smolt-to-adult survivals of 5.39% Age 1.0 (133,907 smolts), 8.44% Age 2.0 (9,598 smolts) and 31.82% Age 3.0 (110 smolts). The latter survival appears to be highly exaggerated, and is probably due to underestimating abundance of Age 3.0 smolts in the 1982 Bear Lake out-migration or to unknown natural production of this smolt age class in lower Bear Creek.

Mean fork length and weight of adult coho salmon sampled at the weir are presented in Table 17. The male-to-female sex ratio in the Bear Lake escapement was 1.7:1.0.

Coho Salmon Egg Takes:

A total of 144 males and 536 females were held in the Bear Creek holding facility from September 14 to October 28. Stream temperatures ranged from 2.2°C to 13.3°C (36°F-56°F) and flows from 7 to 19 cfs during this period. Male and female holding mortalities were 25.7% and 16.4%, respectively. A total of 246 females and 74 males were artificially spawned, yielding an estimated 1,138,300 fertilized eggs. Mean fecundity was 4,628 eggs per female, or nearly 600 higher than that obtained (4,045) from females in 1982. Eggs were fertilized at an average rate of 1.0 male: 3.3 females. Dead egg loss after physical shocking at Elmendorf Hatchery averaged 11% (Kiefer, pers. comm.).

Other Species:

A total of 627 adult and 29 jack sockeye salmon were captured in the upstream migrant trap from June 3 to July 26. Most adults (49.8%) were

Table 17. Mean Fork Length (mm) and Weight (kg) of Adult Coho Salmon Sampled at Bear Creek Weir in 1983.

Lot	Males			Females			Sexes Combined		
	No.	FL	Wt.	No.	FL	Wt.	No.	FL	Wt.
RV	42	638.1	2.98	26	664.3	3.64	68	648.1	3.23
UNM	<u>261</u>	<u>655.0</u>	<u>3.38</u>	<u>171</u>	<u>673.8</u>	<u>3.89</u>	<u>432</u>	<u>662.4</u>	<u>3.58</u>
Total	303	652.7	3.33	197	672.6	3.86	500	660.5	3.53

Age 1.3, surviving from 3,365 Age 1.0 smolts that emigrated Bear Lake in 1980. With the 403 Age 1.2 fish estimated in the 1982 spawning escapement, total smolt-to-adult survival of this cycle was 21.2%. The second most abundant (44.3%) were Age 1.2 adults, resulting from 2,801 Age 1.0 smolts estimated in the 1981 Bear Lake out-migration. Excepting Age 1.3 adults returning in 1984, smolt-to-adult survival is 9.9% thus far. A total of 29 Age 1.1 jack sockeye salmon returned from 46,118 Age 1.0 smolts emigrating in 1982. Age 1.2 and 1.3 adults are expected in 1984 and 1985, respectively, from this out-migration. An additional 24 Age 2.2 and 13 Age 2.3 adults comprised the remaining 5.9% of the 1983 spawning escapement. Mean sizes of the one, two and three-ocean fish in 1983 were 379.4 mm in fork length (0.68 kg), 549.5 mm (2.08 kg) and 583.2 mm (2.51 kg), respectively.

Pink salmon first entered the trap on August 8, and eventually moved downstream to spawn from mid-August to early September. A minimum estimated escapement of 825 pink salmon spawned in lower Bear Creek in 1983 (Hammarstrom, pers. comm.), according to a foot survey conducted on August 17.

Upstream migrating Dolly Varden ascended Bear Creek to the weir on July 20, and continued moving in and out of the trap throughout the remaining field season.

All fish species other than sockeye or coho salmon were retained below the weir due to the lack of suitable spawning area upstream and/or the undesirability of having these species depredating upon or competing with juvenile salmon for survival in Bear Lake.

Enhanced Coho Salmon Production:

Overall, total smolt-to-adult survival of 1982 marked and unmarked Bear Lake smolts was 5.60%, or 1.26% higher than that realized for the 1981 out-migration. That the former was comprised of 93.2% Age 1.0 smolts with a relatively higher condition factor ($K=0.99$) than the 84.7% Age 2.0 smolts with $K=0.96$ of the latter, may have been responsible for this improved survival to returning adults. Table 18 summarizes Bear Lake smolt out-migrations since 1977 and subsequent adult returns through 1983.

Failure of the 1982 hatchery smolt releases in Grouse Lake and Seward Lagoon to produce returning adults was unusual because they were comprised of yearling (Age 1.0) smolts of normal size (24.0/1b) and noted in good condition when stocked. However, these fish had undergone severe stress at Elmendorf Hatchery during a period of deteriorating water quality and heavy disease losses when they normally would have been Ad-CWT marked (Keifer, pers. comm.). Hence, rather than incur additional losses from the extra handling to mark these smolts in relatively poor health, they were left alone and released unmarked to improve their survival to adults. With the possible exception of the Grouse Lake smolt release (Grouse Creek had a larger-than-average spawning escapement), it appears the stocked smolts never fully recovered from hatchery stress and could not cope with the natural

Table 20. A summary of Hatchery Reared Coho Salmon Smolt Releases in Grouse Lake.

Brood Year	Origin	Smolt Liberation Data				Adult Return Data*				Total Number	Return Percent
		Mark	Release Date	Number	Fish/kg(1b)	0+Ocean(jacks)		1-Ocean			
						No.	%	No.	%		
1974	Bear Lake	RV	5/10-12/76	35,200	26.8 (12.2)	50	0.14	1,498	4.26	1,548	4.40
1975	Bear Lake	LV	5/15-17/77	35,100	22.3 (10.1)	446	1.27	2,304	6.56	2,750	7.83
1976	Seward Lagoon	Ad-CWT	5/20/78	53,555	24.9 (11.3)	118	0.22	801	1.50	919	1.72
1977	Bear Lake	Ad-CWT	5/16/79	44,000	62.6 (28.4)	0	0.00	1,337	3.04	1,337	3.04
1979	Bear Lake	Ad-CWT	6/26/80	50,290	75.0 (34.0)	0	0.00	569	1.13	569	1.13
1980	Bear Lake	UNM*	5/27/82	13,230	52.8 (24.0)	0	0.00	0	0.00	0	0.00

* Includes boat and shore sport harvest estimates plus escapements.

** Release consisted of only unmarked smolts due to hatchery disease losses at marking time.

environment. Summaries of total survivals for Seward Lagoon and Grouse Lake hatchery smolt releases are presented in Tables 19 and 20.

Bear Lake Fertilization Project:

Fertilization of Bear Lake's northern epilimnion continued in 1983, with a total of 4,060 gallons of liquid ammonium nitrate being dispersed from June 1 to October 4 in 10-day increments. Considerable logistical support, coordination and assistance was provided to F.R.E.D. Division limnology personnel in transporting the fertilizer from Seward to Bear Lake and collecting samples for water chemistry, chlorophyll-a and plankton determinations.

Though 1983 field samples have not yet been fully analyzed, preliminary results indicate that Bear Lake's water quality has changed from nitrogen-deficient to nitrogen-rich due to the 2½ years of nitrates addition and low (1 x or less) complete flushing rates of the lake in 1982 and 1983. Inorganic nitrogen levels in the water column have more than doubled since the base period (1979-1980), and it is recommended that phosphorous be applied in 1984 to bring the N:P ratio back into balance (Koenings, pers. comm.).

A limited food habits study of stocked Age 0.0 fingerling and residual Age 1.0 coho in 1983 suggests that the former remain in littoral waters to feed primarily (72%) on midge larvae and pupae (Chironomid sp.), whereas the residual yearlings appeared to forage mainly offshore (75%) on bosminid and daphniid cladoceran zooplankton. Foregut samples collected from beach-seined Age 0.0 fingerlings in June 1981, prior to fertilization, also indicated that a majority (56%) of ingested items was comprised of midge larvae and pupae, 41% were copepods and cladocera, with the remaining 3% being spiders, snails, clams, shrimp and miscellaneous crustacea. Nineteen outmigrant smolts sampled at Bear Creek weir in May 1981 contained 99% midge larvae and pupae and 1% shrimp. Hence, it appears that Age 0.0 coho inhabit the limited littoral area in Bear Lake where they can forage on their preferred food, midge larvae and pupae, rather than graze on zooplanktons offshore. This life pattern is well documented in research literature concerning coho rearing in natural, multi-species lakes.

In recent discussions with F.R.E.D. Division's limnology personnel directing the Bear Lake fertilization experiment, it was further learned that rearing sockeye fry may be the primary benefactors of Bear Lake fertilization thus far in that their primary food sources, Bosmina and Daphnia sps. cladoceran populations, have rapidly expanded, and the sockeye to coho smolt ratio has increased ten-fold since 1981. With an average of 1,128,853 (841,960-1,338,980) sockeye eggs deposited annually in Bear Lake since 1981 by meager spawning escapements and the aforementioned improved rearing conditions, a dramatic increase in Bear Lake's sockeye smolt production may suddenly eventuate. Moreover, about 5,500 adult sockeye are expected to return in 1984 from nearly 50,000 smolts which emigrated in 1981 and 1982, to spawn several million more eggs in Bear Lake.

Table 19. A Summary of Hatchery Reared Coho Salmon Smolt Releases in Seward Lagoon.

Brood Year	Origin	Smolt Liberation Data				Adult Return Data*				Total Number	Return Percent
		Mark	Release Date	Number	Fish/kg(lb)	0+Ocean(jacks)		1-Ocean			
						No.	%	No.	%		
1966	Oregon	Ad	4/18-22/68	42,200	40.1 (18.2)	0	0.00	15	0.04	15	0.04
1967	Oregon	Ad	5/6-7/69	27,100	32.2 (14.6)	1	0.00	6	0.02	7	0.03
1968	Bear Lake	Ad	5/19-27/70	39,750	23.8 (10.8)	952	2.39	5,114	12.87	6,066	15.26
1969	Bear Lake	Ad	5/17/71	10,900	31.3 (14.2)	3	0.03	1,519	13.94	1,522	13.96
1970	Kodiak	Ad	5/31/72	66,500	37.0 (16.8)	915	1.38	2,963	4.46	3,878	5.83
1971	Seward Lagoon	Ad-LV	5/7-9/73	30,200	19.6 (8.9)	140	0.46	125	0.41	265	0.88
1972	Kodiak	Ad-RV	5/6-11/74	100,000	20.7 (9.4)	4,764	4.76	3,885	3.89	8,649	8.65
1973	Seward Lagoon	Ad-LV	5/15-19/75	100,700	20.1 (9.1)	2,610	2.59	1,971	1.96	4,581	4.55
1974	Bear Lake	LV	5/4-10/76	100,600	28.2 (12.8)	600	0.60	4,513	4.49	5,113	5.08
1975	Bear Lake	RV	5/6-13/77	100,450	27.7 (10.3)	1,622	1.61	7,710	7.68	9,332	9.29
1976	Seward Lagoon	Ad-CWT	6/1-5/78	125,979	21.7 (9.9)	147	0.12	1,080	0.86	1,227	0.98
1977	Bear Lake	Ad-CWT	5/14-15/79	97,840	63.9 (29.0)	0	0.00	3,956	4.04	3,956	4.04
1979	Bear Lake	Ad-CWT	6/25/80	100,800	86.1 (39.1)	0	0.00	1,129	1.12	1,129	1.12
1980	Bear Lake	Ad-CWT	6/15/81	108,700	55.6 (25.2)	48	0.04	835	0.77	883	0.81
1980	Bear Lake	UNM**	5/27/82	53,970	52.8 (24.0)	0	0.00	0	0.00	0	0.00

* Includes boat and shore harvest estimates plus escapements.

** Release consisted of only unmarked smolts due to hatchery disease losses at marking time.

Table 18. Survival of Bear Lake Coho Salmon Adults from Seaward Migrations of Smolts Fin Marked at Bear Creek Weir, 1977-1982.

Seaward Migration Year	Number of Smolts Released	Age Composition of Out-Migration	Mean Fork Length (mm)	Fin-clip Used	Number of Adults Returning*	Percentage Return
1977	49,689	49.8% - age 1.0	113.1	Ad-LV	3,835	3.84
	48,332	48.4% - age 2.0	129.5	Ad-LV		
	1,684	1.7% - age 3.0	182.8	Ad-LV		
	<u>139</u>	0.1% - age 4.0	192.0	Ad-LV		
	99,844					
1978	80,886	82.8% - age 1.0	120.0	LV,RV	3,910	4.00
	16,431	16.8% - age 2.0	134.8	LV,RV		
	<u>342</u>	0.4% - age 3.0	191.7	LV,RV		
	97,659					
1979	96,327	92.2% - age 1.0	120.6	LV	5,368	5.14
	<u>8,149</u>	7.8% - age 2.0	146.2	LV		
	104,476					
1980	54,538	72.8% - age 1.0	121.8	RV	5,596	7.95
	20,278	27.1% - age 2.0	134.8	RV		
	<u>106</u>	0.1% - age 3.0	191.0	RV		
	74,922					
1981	10,859	15.0% - age 1.0	121.5	LV	3,154	4.34
	61,526	84.7% - age 2.0	127.0	LV		
	<u>238</u>	0.3% - age 3.0	161.5	LV		
	72,623					
1982	133,907	93.2% - age 1.0	115.8	RV	8,046	5.60
	9,598	6.7% - age 2.0	127.1	RV		
	<u>110</u>	0.1% - age 3.0	189.0	RV		
	143,615					

* Includes boat and shore sport harvest estimates plus escapements.

DISCUSSION

Bear Lake's Age 1.0 coho salmon smolt production in 1983 (44.0% of the 1982 fingerling plant) was substantially lower than expected; the highest yield (54.1%) of any Bear Lake restocking resulting in yearling smolts occurred in 1982 from the 1981 release. Hopefully the latter was directly related to the recently-initiated lake fertilization experiment to expand Bear Lake's carrying capacity for juvenile coho by increasing its zooplankton production. Limited feeding habits studies, however, indicate that stocked Age 0.0 coho in Bear Lake prefer midge larvae and pupae inshore rather than foraging offshore for smaller zooplankters. Thus, a more plausible explanation for the unprecedented yearling coho smolt production in 1982 may be that few residual Age 2.0 and 1.0 fish remaining from the 1979 and 1980 plants reduced intraspecific competition and predation sufficiently to allow the majority of the 1981 release to smolt at Age 1.0.

Yearling smolt yields of annual Bear Lake restockings were observed to steadily rise from about 14% at high stocking densities (2,550/ha) following the 1971 lake rehabilitation to 43% at reduced densities (1,250/ha) prior to the 1979 release of undersized fingerlings (Table 7) and apparently poor condition of the 1980 plant (Table 8). Yearling smolt survivals of the latter two plants abruptly declined to 24% and 7%, respectively. Therefore, it is entirely possible that the 54.2% Age 1.0 coho smolt yield from the 1981 fingerling release would have occurred with or without the benefit of lake fertilization. Size and health of planted fingerlings relative to rearing density of residual coho from previous plants may be the crucial elements determining yearling smolt yields from a given restocking.

That the 1982 Bear Lake coho restocking was comprised of good-sized fingerlings (728/kg) at a sparse density (1,104/ha) in a fertilized environment theoretically should have produced a greater yield of Age 1.0 smolts in 1983. However, the 33,635 fewer yearling smolts (25% reduction compared to 1982) resulted in a 588 kg (1,296 lb) loss in smolt biomass and, potentially, of 1,682 returning adults to the 1984 Resurrection Bay sport fishery at the 5.0% average marine survival realized from the 1977-1981 smolt outmigrations. Moreover, mean size and condition of all coho smolt age groups were observed to decline in 1983, causing a 262 kg drop in Bear Lake's 1983 coho smolt biomass production compared to its 10-year annual average (2,072 kg) following the 1971 lake rehabilitation.

It could be argued that 1982 was a cooler rearing year than either 1981 or 1983 (Koenings, pers. comm.), which may have depressed growth rates of stocked fingerlings to achieve threshold size (70-80 mm) by fall, thereby precluding the majority to smolt at Age 1.0 in 1983. This would be convincing except that Age 1.0 and 2.0 Bear Lake sockeye smolts in 1983 were noted to be slightly larger than in 1982. Also, stocked Age 0.0 coho sampled in late September 1983 averaged only 70.8 mm despite being about 49 mm when stocked 4 months earlier. This translates to only 0.18 mm/day increase in fork length during most of the 1983 growing season, with fertilization. Mean daily growth estimated for stocked Age 0.0 fingerlings, even at relatively high rearing densities (1972-1977)

under natural conditions, averaged 0.35 mm/day or nearly double that for the 1983 fingerlings. Thus, it would appear from the foregoing evidence that lake fertilization is having no beneficial effect, and in fact may actually be detrimental via some unknown means, to Bear Lake's coho smolt production.

In contrast to the questionable effects of lake fertilization on Bear Lake coho production, all signs seem to indicate that the stage is set for Bear Lake to once again become a formidable sockeye salmon producer. Rearing sockeye fry are rapidly gaining in smolt survival compared to stocked juvenile coho in Bear Lake, probably as a direct result of the increasing zooplankton populations. The potential to transform Bear Lake's salmon smolt production from primarily coho to sockeye in just a short time is evident in light of this improved sockeye fry-to-smolt survival, greatly increased spawn deposition since 1981 and an anticipated large spawning escapement returning in 1984. The implications of these findings to primary management of Bear Lake for optimum sustained coho production to augment Resurrection Bay fishery demands, are fairly obvious.

Bear Lake will continue to be treated during the 1984 summer with liquid fertilizer containing phosphorous in a 20-7.6-0 formulation to enrich the lakes' current N:P ratio in favor of P. Dispersion will be modified to concentrate some fertilizer in the littoral areas to possibly increase inshore populations of large copepods such as Diaptomus, Epischura and Cyclops sps. for coho forage. Since chironomid larvae, the preferred food of Age 0.0 coho in Bear Lake, feed mainly on algae, higher aquatic plants and organic detritus (Pennak, 1978), it is hoped this new fertilizer will enhance, not diminish, these growths to improve midge insect abundance throughout the 1984 growing season. Stocking density will remain at 1,250/ha with fingerlings no smaller than 770/kg to prevent over-crowding the potentially limiting, littoral rearing area and to preclude residualism of Age 1.0 holdover coho. Distribution and feeding habits research on Bear Lake Age 0.0 coho will be continued and intensified in 1984.

The complete failure of the 1982 hatchery coho smolt releases to produce any returning adults for the 1983 sport fishery, despite that they were comprised of normal-sized smolts, strongly suggests that either their condition was too poor to survive in the wild or they were not physically ready to smolt. In either case, the problem appears to lie in current culturing practices and/or deteriorating water quality at the hatchery, compared to earlier years. Formerly, hatchery smolts released in Grouse Lake, lower Bear Lake and Seward Lagoon realized higher survivals and contributed more adult coho in the Resurrection Bay sport harvest than did Bear Lake smolts. Since 1981, however, annual hatchery smolt-to-adult survivals have been less than 1.0%, and contributed less than 5.0% to the sport harvest, whereas Bear Lake smolts have averaged 6.0% adult survival and over 10.0% contribution to the fishery during this period. Clearly, it is time to either revert to previous, proven culturing techniques, use a different hatchery, or modify the present hatchery water exchange system, if we are ever again to realize acceptable survival and fishery contribution from the hatchery smolt program. F.R.E.D. Division plans to perform limited research on residency duration of stocked coho smolts in Seward Lagoon in 1984.

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