

STATE OF ALASKA

Bill Sheffield, Governor

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

by

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RESEARCH PROJECT SEGMENT

State: Alaska Name: Sport Fish Investigations of Alaska

Project: F-9-17

Study: G-II Study Title: SPORT FISH STUDIES

Job: G-II-A Job Title: Coho Salmon Studies in the Resurrection Bay Area

Cooperator: Edward T. McHenry

Period Covered: July 1, 1984 to June 30, 1985

ABSTRACT

Bear Lake was restocked with 220,000 Age 0.0 coho salmon, *Oncorhynchus kisutch* (Walbaum), fingerlings on May 24, 1984 to maintain smolt production.

The Bear Creek weir downstream migrant trap was operated continuously from May 21 through September 21. A total of 93,811 smolts enumerated were comprised of 78,298 Age 1.0, 15,206 Age 2.0 and 307 Age 3.0 coho. Yearling smolt survival (Age 1.0) from the 1983 Bear Lake fingerling plant was 39.3 percent with a 5.0:1 smolt-to-fingerling biomass yield. Age 2.0 smolt survival was 6.7 percent with a 1.2:1 biomass ratio. Excepting Age 3.0 smolts, total smolt survival and biomass production from the 1982 plant were 50.7 percent and 5.9:1. Total smolt survival of the 1981 plant was 57.4 percent with a 7.3:1 biomass yield.

Large abundances of residual Age 1.0+ coho, resulting from overstocking Age 0.0 fingerlings in 1973 and stocking undersized fish in Bear Lake in 1979, severely limited yearling smolt production from the 1974 and 1980 plants to only 3.0 and 7.3 percent, respectively. Few Age 1.0+ residuals surviving from the 1980 release, instead of lake fertilization, probably allowed for the phenomenal 54.1 percent yearling smolt production of the 1981 fingerling release.

Bear Lake fertilization, initiated in late August 1981, has restored the proper nitrogen/phosphorus balance in the lake and zooplankton populations appear to be increasing. Coho feeding habit studies in 1981 and 1983 suggest that Age 1.0+ residuals utilize zooplankton as a primary food source, while the mainly insectivorous, inshore-dwelling Age 0.0 fingerlings forage only secondarily on zooplankton until fall when chironomid larvae abundance is postulated to decline in Bear Lake.

The Resurrection Bay salmon creel census (July 8-September 9) estimated that 10,361 coho were harvested in 21,064 man-days of sport trolling effort. The mean seasonal catch per angler-hour was 0.079. Enhanced coho production (1,699 fish) contributed 16.4 percent to the sport harvest. Most (55.7 percent) survived from 107,851 Bear Lake smolts emigrating in 1983. The remaining 44.3 percent returned from 47,950 and 49,900 Age 1.0 (1982 brood, Bear Lake origin) hatchery smolts released in Seward Lagoon and Grouse Lake on May 20, 1983. Estimated fishing mortalities of the Bear Lake, Grouse Lake and Seward Lagoon smolt releases were 0.9, 0.6 and 0.9 percent, respectively. Age composition of wild Resurrection Bay coho in the 1984 sport catch was 57.8 percent Age 1.1, 39.2 percent Age 2.1 and 3.0 percent Age 3.1 adults.

The Bear Creek upstream migrant trap was operated continuously from May 18 through November 14. The coho upstream migration extended from August 20 to November 7, and consisted of 3,375 adults and 13 jacks. The run was comprised of 556 marked and 2,819 unmarked Bear Lake coho. Smolt-to-adult survivals of the 1983 marked and unmarked smolts were 2.62 and 4.47 percent, respectively, with an overall marine survival of 4.0%. Age 1.0, 2.0 and 3.0 Bear Lake smolt-to-adult survivals were 3.79, 6.59 and 12.08 percent, respectively, according to the estimated 3,787 Age 1.1, 520 Age 2.1 and 11 Age 3.1 adults returning in 1984. Smolt-to-adult survivals of 1983 Seward Lagoon and Grouse Lake hatchery smolt plants were 2.35 and 1.74 percent.

The catch-to-escapement ratio of marked Bear Lake coho was 0.28:1. The male-to-female sex ratio was 1.3:1 in the Bear Lake escapement. After pathological screening for bacterial kidney (BKD) and furunculosis diseases, an estimated 615,700 artificially-spawned eggs from 139 females were fertilized by 71 males hours later at Trail Lakes Hatchery. Incidence of BKD was 13.8 percent overall for spawned coho at Bear Creek weir. Eyed egg mortality after shocking at Trail Lakes Hatchery was 14 percent or about twice that experienced for immediate fertilization at the weir.

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 exceeded 50% with adult survival up to a 10% return. Bear Lake is currently undergoing an artificial fertilization experiment 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 one year to another, smolt-to-adult survivals have ranged up to 15% with contribution to the sport harvest of 35%.

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 22-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 1986 stocking density of coho fingerlings in Bear Lake should be adjusted according to emigrating smolt abundance, age composition and condition factor in 1985.
3. Feeding habit studies should be extended into fall to determine whether Age 0.0 coho do primarily utilize zooplankton, and in late spring to ascertain if interspecific competition exists between under-yearling coho and sockeye fry co-rearing in Bear Lake's littoral zone.
4. The Bear Lake fertilization experiment should be discontinued if Age 1.0 coho smolt production does not increase significantly.
5. Upon completion of the U.S. Forest Service trail to Upper Russian Lake, research should be initiated on distribution, abundance and biological characteristics of upper Resurrection River coho populations.

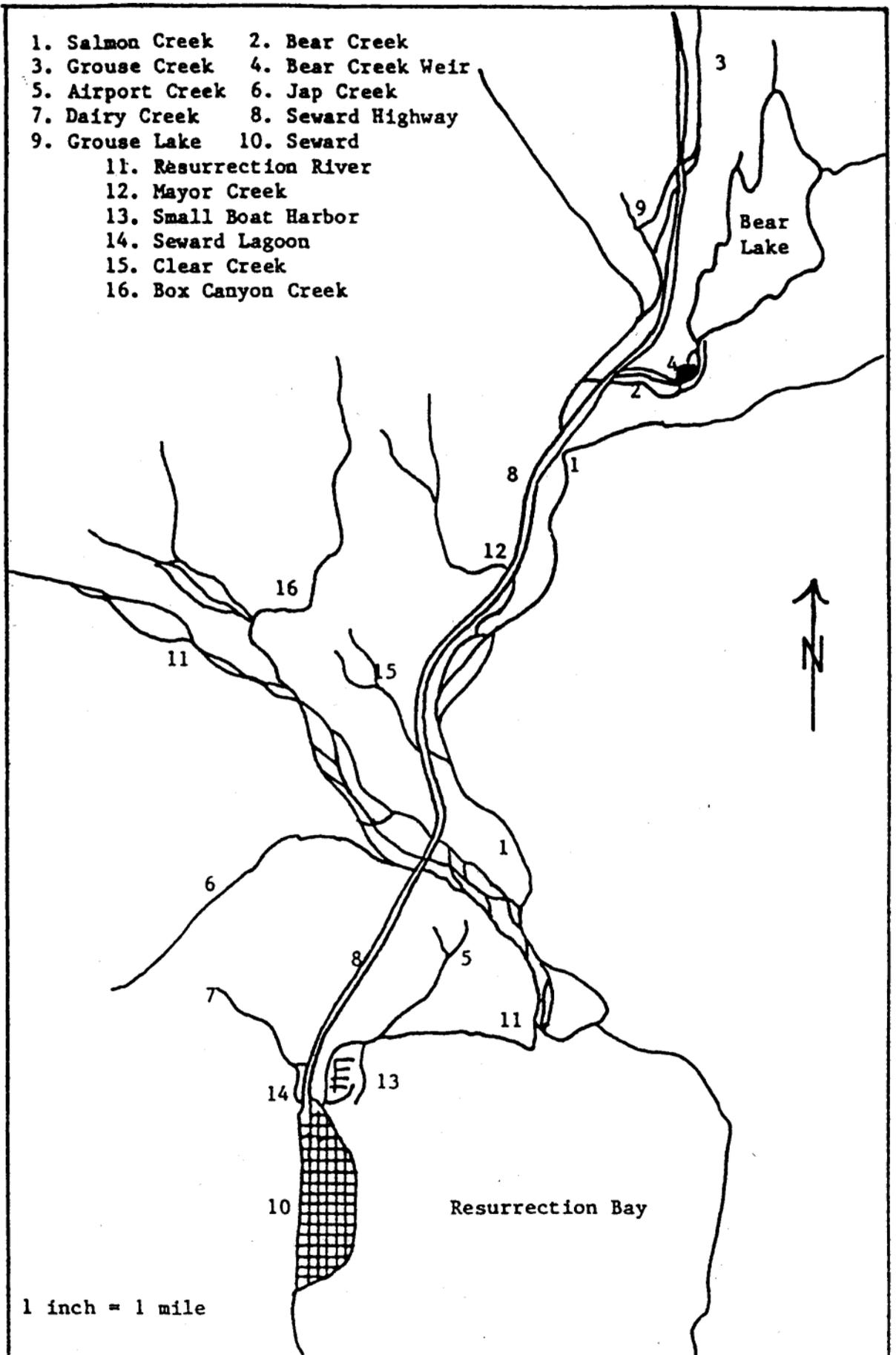


Figure 1. Resurrection Bay watershed.

Table 1. Checklist of fish species present in the Resurrection Bay drainage.

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

OBJECTIVES

1. To determine the distribution, abundance and timing of outmigrant coho salmon from May through August and adult coho salmon from August through November in Bear Creek, Bear Lake, Grouse Lake and Seward Lagoon.
2. To determine the age and size composition of outmigrant 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 through September.
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 (McHenry, 1982). Biological sampling frequencies of Bear Lake's salmon migrations were altered slightly according to differences in pre-season estimates of their abundance relative to previous years.

FINDINGS

Results

The findings presented are the result of the 1984-85 research segment of the project. For past information collected on the project, see Logan (1962-1969) and McHenry (1970-1984).

Bear Lake Coho Smolt Migration:

The Bear Creek weir downstream migrant trap was operated continuously from May 21 through September 21, 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 outmigration to the downstream trap totaled 93,811 smolts. Trap mortality claimed only 387 smolts (0.38% of the run) due to careful manipulation of the fish pass elevation during fluctuating weir pool levels at migration peak. A total of 93,424 live smolts were released downstream. A predetermined 25% of the outmigration received a right ventral (RV) fin clip for recognition in the 1985 Resurrection Bay sport fishery and Bear Lake spawning escapement. Table 3 shows the number and percentage of smolts marked and sampled each week.

Table 2. Bear Lake coho salmon smolts enumerated weekly at Bear Creek weir, 1984.

Weekly Periods	Number of Smolts		
	Live	Dead	Total
May 20 - May 26	1,366	6	1,372
May 27 - June 2	25,679	106	25,785
June 3 - June 9	32,225	28	32,253
June 10 - June 16	13,149	2	13,151
June 17 - June 23	7,839	0	7,839
June 24 - June 30	6,355	229	6,584
July 1 - July 7	2,605	0	2,605
July 8 - July 14	3,059	0	3,059
July 15 - July 21	366	1	367
July 22 - July 28	194	1	195
July 29 - August 4	51	0	51
August 5 - August 11	54	0	54
August 12 - August 18	68	0	68
August 19 - August 25	124	3	127
August 26 - September 1	0	0	0
September 2 - September 8	3	0	3
September 9 - September 15	193	4	197
September 16 - September 22	<u>94</u>	<u>7</u>	<u>101</u>
Total	93,424	387	93,811

Table 3. Bear Lake coho salmon smolts marked and sampled weekly at Bear Creek weir, 1984.

Weekly Periods	Number of Live Smolts	Number Smolts Fin Clipped	Percent of Weekly Migration*	Number Smolts Sampled	Percent of Weekly Migration*
May 20 - 26	1,366	345	25.1	14	1.0
May 27 - June 2	25,679	6,436	25.0	260	1.0
June 3 - 9	32,225	8,049	25.0	319	1.0
June 10 - 16	13,149	3,351	25.5	131	1.0
June 17 - 23	7,839	1,894	24.2	78	1.0
June 24 - 30	6,355	1,646	25.0	65	1.0
July 1 - 7	2,605	651	25.0	26	1.0
July 8 - 14	3,059	755	24.7	29	1.0
July 15 - 21	366	92	25.1	4	1.1
July 22 - 28	194	47	24.1	2	1.0
July 29 - August 4	51	14	27.5	0	
August 5 - 11	54	13	24.1	0	
August 12 - 18	68	10	14.7	0	
August 19 - 25	124	38	29.9	3	2.4
August 26 - Sept. 1	0	0		0	
September 2 - 8	3	2	66.7	0	
September 9 - 15	193	48	24.4	2	1.0
September 16 - 22	94	27	26.7	1	1.0
Total	93,424	23,418	25.0	934	1.0

* Includes the 387 smolts expiring from trap mortality.

Smolt emigration began on May 21, peaked (50% of outmigration) by June 6 and terminated September 20. The highest daily count occurred on May 31 when 5,746 (6.1% of the total run) were enumerated from the trap. Mean stream temperatures when smolt emigration began, peaked and terminated, were 6.7°C (44.0°F), 12.5°C (54.5°F) and 11.1°C (52.0°F), respectively. Bear Creek stream flows ranged from 5 to 30 cfs during this period.

The smolt outmigration was comprised of 83.5% (78,298) Age 1.0, 16.2% (15,206) Age 2.0, and 0.3% (307) 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 weekly samples. Too few Age 3.0 smolts were sampled for tabulation. Table 6 shows the weekly and seasonal abundance per smolt age group. An overall 1.0% (938 smolts) were representatively sampled during emigration (Table 3). An estimated 78,009 Age 1.0, 15,135 Age 2.0 and 280 Age 3.0 live smolts were released downstream.

All three age groups peaked during June 3 through June 9 when Bear Creek water temperatures averaged 12.3°C (54.1°F); this was 1 week earlier than the 1983 peak migration period of June 10 through June 16, with a mean stream temperature of 11.7°C (53.1°F). Approximately 63% of the 1984 Bear Lake smolt migration had descended to the weir by June 9, compared to 57% and 46% of the 1983 and 1982 outmigrations, respectively. This was due primarily to Bear Lake's ice cover thawing 2 weeks earlier than normal on May 14, elevating water temperatures. 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's mean water temperature exceeded 10°C (50°F). Only 29% of the 1984 outmigration, however, had reached Bear Creek weir by June 2 when that week's stream temperature averaged 10.2°C (50.4°F).

The 307 Age 3.0 smolts resulted from the tenth fingerling plant (247,845 Age 0.0 fingerlings in 1981) in Bear Lake following the 1971 lake rehabilitation project. Total fingerling-to-smolt survival from the 1981 plant was 57.4%, the highest smolt yield of any annual restocking in the project's 22-year history. Judging from the second lowest total smolt survival (13.7%) ever realized from a Bear Lake fingerling plant observed for the 1980 restocking, there were few survivors from the latter to compete with the 1981 release. Age composition of the 1981 smolt production cycle was 94.2% Age 1.0, 5.6% Age 2.0 and 0.2% Age 3.0 fish. Bear Lake coho fingerling plants since 1980 are summarized in Table 7 and smolt production since 1981 is presented in Table 8.

The 15,206 Age 2.0 smolts were produced from 227,800 Age 0.0 fingerlings stocked in 1982. With the 100,368 Age 2.0 smolts which emigrated in 1983, 50.7% of that plant has survived to smolts thus far. This production is very acceptable and approximates that of the 1978 release (225,800 fingerlings) yielding 43% survival to Age 1.0 smolts and total survival of 52.1%, prior to lake fertilization. Excepting Age 3.0 smolt production in 1985, age composition of Bear Lake's eleventh smolt production cycle since the 1971 lake rehabilitation was 86.8% Age 1.0 and 13.2% Age 2.0.

The 78,298 Age 1.0 smolts survived from 199,000 Age 0.0 fingerlings released in Bear Lake in 1983. The 39.3% yearling smolt production

Table 4. Mean fork length, weight and condition factor of Age 1.0 Bear Lake coho salmon smolts sampled weekly at Bear Creek weir, 1984.

Weekly Periods	Number of Smolts	Percent of Sample	Mean Length (mm) \pm SD	Mean Weight (g) \pm SD	Condition Factor (K)*
May 20 - 26	6	42.9	112.8 \pm 5.7	13.43 \pm 1.50	0.94
May 27 - June 2	199	76.5	116.1 \pm 6.9	15.20 \pm 2.70	0.97
June 3 - 9	273	85.6	115.9 \pm 7.2	14.97 \pm 2.63	0.96
June 10 - 16	113	86.3	120.2 \pm 5.6	16.74 \pm 2.49	0.96
June 17 - 23	71	91.0	124.8 \pm 6.1	19.46 \pm 2.79	1.00
June 24 - 30	59	90.8	128.4 \pm 5.6	21.70 \pm 2.89	1.03
July 1 - 7	23	88.5	137.3 \pm 5.4	27.07 \pm 3.58	1.05
July 8 - 14	25	86.2	145.0 \pm 6.7	32.13 \pm 4.56	1.05
July 15 - 21	3	75.0	151.7 \pm 9.7	36.33 \pm 7.66	1.04
July 22 - 28	2	100.0	164.5 \pm 4.9	48.05 \pm 4.31	1.08
July 29 - Sept. 22	5	83.3	165.0 \pm 2.2	47.86 \pm 3.07	1.07

* $K = \frac{W \times 10^5}{L^3}$, 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, 1984.

Weekly Periods	Number of Smolts	Percent of Sample	Mean Length (mm) \pm SD	Mean Weight (g) \pm SD	Condition Factor (K)*
May 20 - 26	8	57.1	158.4 \pm 7.8	37.24 \pm 5.68	0.94
May 27 - June 2	60	23.1	141.8 \pm 15.5	27.26 \pm 7.90	0.96
June 3 - 9	45	14.1	134.2 \pm 9.2	22.43 \pm 3.68	0.93
June 10 - 16	18	13.7	141.4 \pm 14.2	26.27 \pm 7.33	0.93
June 17 - 23	7	9.0	140.6 \pm 3.4	25.71 \pm 1.22	0.93
June 24 - 30	6	9.2	146.7 \pm 6.9	24.45 \pm 3.18	0.96
July 1 - 7	3	11.5	151.3 \pm 5.5	33.93 \pm 4.81	0.98
July 8 - 14	3	10.3	158.3 \pm 4.0	35.83 \pm 6.48	0.90
July 15 - 21	1	25.0	159	41.9	1.04
July 29 - Sept. 22	1	16.7	182	53.9	0.89

* $K = \frac{W \times 10^5}{L^3}$, 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, 1984.

Weekly Periods	Number of Smolts			Total
	Age 1.0	Age 2.0	Age 3.0	
May 20 - 26	589	783		1,372
May 27 - June 2	19,726	5,956	103	25,785
June 3 - 9	27,609	4,547	97	32,253
June 10 - 16	11,349	1,802		13,151
June 17 - 23	7,133	706		7,839
June 24 - 30	5,978	606		6,584
July 1 - 7	2,305	300		2,605
July 8 - 14	2,637	315	107	3,059
July 15 - 21	275	92		367
July 22 - 28	195			195
July 29 - Sept. 22*	<u>502</u>	<u>99</u>	<u>—</u>	<u>601</u>
Total	78,298	15,206	307	93,811
Percent	83.5	16.2	0.3	100.0

* Age composition (83.5% Age 1.0 and 16.5% Age 2.0) of the 601 smolts emigrating after July 28 was estimated from combining three sporadic weekly samples conducted during the 8-week period.

Table 7. Summary of Bear Lake coho salmon fingerling plants, 1979-1984.

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
1983	Bear Lake	<u>220,000</u>	<u>757</u>	<u>343.5</u>	<u>291</u>	<u>640</u>	<u>494</u>	<u>1,222</u>	May 24	Truck-boat
									1984	Scattered

Table 8. Summary of Bear Lake coho salmon smolt abundance and biomass produced since 1981 from annual fingerling plants, 1980-1983.

Year of Plant	No. of Fingerlings and Weight (g)	Smolt Production by Year				Total Production	Survival to Smolt (%)
		1981	1982	1983	1984		
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	307	142,248	57.4
Weight (kg)	330.8		2,227.1	166.0	21.9	2,415.0	
Weight Ratio			6.7	0.5:1	0.1:1	7.3:1	
1982							
Number	227,800			100,368	15,206	115,574	50.7*
Weight (kg)	344.0			1,639.2	404.9	2,044.1	
Weight Ratio				4.8:1	1.2:1	5.9:1	
1983							
Number	199,000				78,298		39.3**
Weight (kg)	273.4				1,368.6		
Weight Ratio					5.0:1		

* Does not include Age 3.0 smolt production.

** Includes only Age 1.0 smolt production.

marks a further reduction in Age 1.0 smolt yields since lake fertilization was initiated in 1981. However, the 14.8% reduction in yearling smolt survival compared to 1982 (54.1%) may have resulted from environmental factors unrelated to introduction of nitrates in Bear Lake. Age 2.0 smolt abundance in 1985 will depend upon the extent of Age 1.0 residualism and overwinter survival of the 1983 plant.

Age 1.0 smolts averaged 115.9 mm and 14.97 g for a condition factor (K) of 0.96 at migration peak, June 3 through June 9. Growth of the 1983 Age 0.0 fingerlings was fair, considering they averaged 49 mm and 1.37 g when stocked in Bear Lake 1 year earlier. Age 2.0 smolts had a mean fork length of 134.2 mm and weighed 22.43 g for a K = 0.93 during June 3 through June 9. The three Age 3.0 smolts sampled averaged 192.7 mm and 71.27 g for a K = 1.00 during their migration.

Bear Lake's estimated smolt biomass production was 1,795.5 kg, down 15.2 kg from the 1,810.7 kg produced in 1983, and 253 kg (556.6 lb) less than the 11-year annual average of 2,048.5 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, 1984 with 220,000 Age 0.0 coho salmon fingerlings (1983 brood, Bear Lake origin) averaging 640 kg (291 lb) to maintain smolt production. Fish delivered in the first two of three transport tanks were in good condition on arrival, but were severely distressed with excessive mortality in the third tank. Evidently, the recently recoated tank with acetone-based paint had not fully cured and was toxic to the fingerlings (Krolick, pers. comm.). Delayed mortality of fingerlings stocked in Bear Lake from this tank, therefore, is probable.

Other Species:

The total sockeye salmon smolt outmigration enumerated from the trap was 10,474 fish. The first smolt was captured on May 22 and the last on August 24. The highest daily count occurred on May 25 when 1,595 smolts (15.2% of the migration) were enumerated. The majority (89.0%) emigrated between May 22 and June 16 when Bear Creek water temperatures ranged from 5.6°C to 16.1°C (42°F-61°F) and stream flows from 10 to 30 cfs. The smolt outmigration was comprised of 7,713 (73.6%) Age 1.0, 2,463 (23.5%) Age 2.0 and 298 (2.9%) Age 3.0 smolts. Age 3.0 smolts were produced by 673 males and 785 females that spawned in Bear Lake in 1980. With the 46,142 Age 1.0 smolts estimated in 1982 and 1,965 Age 2.0 smolts in 1983, a total of 48,405 smolts (61.7 per female) resulted from this escapement. Age 2.0 smolts were produced from 309 males and 385 females in the 1981 escapement. Compared to spawning success of the 1980 parent brood, that of the 1981 spawners was only mediocre, with 34.9 smolts produced per female. Age 1.0 smolts were produced by 184 males and 279 females in the 1982 Bear Lake escapement. Only 27.6 smolts survived per spawning female thus far. Age 1.0 and 2.0 smolts peaked (50% of migration) during May 27 through June 2, whereas Age 3.0 smolts peaked 1 week later. Age 1.0 smolts averaged

Table 9. Summary of abundance, total annual biomass and seasonal condition factor of Bear Lake smolt migrations, 1973-1984.

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
1984	93,811	1.00	1,795.5
Average (1973-83)	101,288	1.01	2,048.5

115.8 mm and 15.39 g for a condition factor (K) = 0.99 and Age 2.0 smolts 153.0 mm and 35.76 g for a K = 1.00 at migration peak. The nine Age 3.0 smolts sampled during their migration averaged 183.8 mm and 57.31 g for a K = 0.92. All smolt age groups showed improved growth and condition over that observed for 1983 sockeye smolts.

A total of 476 outmigrant 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 1984 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 9. Few coho were taken before creel census began, since most sport fishing effort was directed toward the more abundant rockfish from mid-May through early July.

The season's total harvest was an estimated 10,361 coho. This estimate was extrapolated from interviews with 3,947 anglers harvesting 1,879 coho during the creel census period. Peak of the harvest occurred on August 17 during the Seward Silver Salmon Derby when an estimated 580 coho (5.6% of the season's harvest) were taken. The season's total and derby harvests are summarized for 1980 through 1984 in Table 10.

Marked adult coho contributed 3.7%, or an estimated 379 fish, to the 1984 Resurrection Bay sport harvest. An additional 1,320 unmarked coho, resulting from the unmarked segments of hatchery smolt releases and the Bear Lake smolt outmigration in 1983, comprised an estimated 12.7% of the sport catch. The total contribution of enhanced adult coho production, therefore, was 1,699 fish or 16.4% to the sport fishery.

Adipose-clipped and coded wire tagged (Ad-CWT) adult coho survived from 47,950 (28.1% marked) and 49,900 (31.5% marked) Age 1.0 hatchery smolts released in Seward Lagoon and Grouse Lake, respectively, on May 20, 1983. These plants were comprised of Bear Lake origin (1981 brood), yearling smolts averaging 20.1 g (22.6/lb) and noted in good condition at release. Left ventral (LV) marked coho resulted from Bear Lake smolts fin-clipped at Bear Creek weir in 1983. These smolts averaged 16.8 g (26.6/lb) with a seasonal condition factor (K) = 0.98. Relative fishing mortalities of the Seward Lagoon, Grouse and Bear Lake smolt releases were 0.9, 0.6 and 0.9%, respectively.

Grouse Lake and Seward Lagoon were planted with 34,100 (44.3% Ad-CWT) and 40,700 (54.5% Ad-CWT) Age 1.0 hatchery coho smolts of 1982 brood, Bear Lake origin, on June 5 and 6, respectively. These smolts were in good condition, averaging 27.5 g (16.6/lb), and should provide a good return to the 1985 sport fishery.

An estimated 900 coho were taken during the early August through mid-September beach fishery adjacent to the Seward Lagoon culvert outfall into Resurrection Bay. Since about 74% of the beach harvest is comprised of Seward Lagoon-bound fish (McHenry, 1980), 666 coho were

Table 10. Derby and total sport harvest of coho salmon in Resurrection Bay, 1979-1984.

Year	Total Sport Harvest	Derby Harvest	% Derby Harvest
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
1984	10,361	3,718	35.9

estimated taken from this system's return and included 130 Ad-CWT and 536 unmarked fish. The remainder, 234 coho, were estimated to be from the Grouse Lake return and included 45 Ad-CWT and 189 unmarked fish. No LV-marked Bear Lake coho were observed in the beach fishery sport catch.

The total sport trolling effort exerted for Resurrection Bay coho was an estimated 21,064 man-days. Sampling during creel census periods accounted for 18.7% of the season's effort. The mean number and percentage of sport fishing boats returning daily to the Seward Small Boat Harbor are shown in Table 11. The average number of anglers per boat were as follows: 2.95, weekdays; 3.00, weekends; and 3.06, salmon derby. Fishing effort and mean seasonal catch per hour are summarized for 1980 through 1984 in Table 12. The fishing effort was 6,521 man-days on weekdays and 5,868 on weekends excluding the derby (8,675 man-days). Military personnel and dependents, fishing on boats provided by the Army and Air Force recreation camps at Seward, contributed 12.8% (2,703 man-days) to the total effort. Civilian anglers fishing on weekdays realized the highest coho catch per hour (0.152), whereas the lowest catch rate (0.065) occurred during the derby when effort was most intense. The average number of hours anglers fished per day were as follows: 4.81, weekdays; 5.50, weekends; and 6.48, salmon derby.

Examination of 296 scale samples randomly collected throughout the sport fishery disclosed that the wild Resurrection Bay coho population was comprised of 57.8% Age 1.1, 39.2% Age 2.1 and 3.0% Age 3.1 adults. This age composition is nearly identical to that determined for the 1983 Resurrection Bay coho return. Table 13 shows the wild age composition trend from 1972-1978 with 1983-1984 for comparison. Mean fork lengths and weights of wild coho in 1984 are presented in Table 14. The male-to-female sex ratio was 1.2:1.0 in the sport fishery.

The Resurrection Bay pink salmon sport catch was 4,894 in 1984. A limited commercial seine fishery conducted on July 23-24, July 30-31 and August 6-7 for 24-hour periods harvested 118,500 pink and 3,100 chum salmon by 10-12 boats (Schroeder, pers. comm.). Pink salmon were most abundant in the sport fishery from July 15-21 when anglers averaged 2.44 fish per boat. Pink salmon catch per man-day averaged 0.21 in 1984, compared to 0.23 in 1982, the parent brood year producing the 1984 return.

Only 69 chinook salmon were harvested during the census period at an average of 0.004 per boat. This harvest was substantially below the 20-year average (1961-80) catch of this species (371 chinook) in Resurrection Bay. Chinook salmon were most abundant during July 15 through July 21 when anglers averaged 0.02 chinook per boat. Most fish taken were immature chinook in their first and second ocean years. Origins of these stocks are unknown, as relatively few wild chinook ascend Resurrection River. An estimated 20 adult chinook returned to Box Canyon Creek according to foot surveys conducted on July 26 and August 3, 1984. These fish resulted from natural spawning of the 20 Age 0.3 and 0.4 adults surviving from the 1976 and 1977 plants of Ship Creek brood chinook smolts, which returned to Box Canyon Creek in 1979-1980.

Table 11. Mean number and percentage of sport fishing boats returning to the Seward Small Boat Harbor during each sampling period, 1984.

Period (hours)	Weekends		Weekdays	
	Mean No. of Boats	Percent	Mean No. of Boats	Percent
8:00 am - 11:30 am*	13.0	11.6	5.7	14.3
11:30 am - 3:00 pm	19.8	17.7	10.9	27.5
3:00 pm - 6:30 pm	59.5	53.1	15.3	38.5
6:30 pm - 10:00 pm	<u>19.7</u>	<u>17.6</u>	<u>7.8</u>	<u>19.7</u>
Total	112.0	100.0	39.7	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, 1980-1984.

Year	Period of Census	Total Effort	Derby Effort	% Derby Effort	Seasonal Catch Per Hour
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
1984	July 8 - Sept. 9	21,064	8,675	41.2	0.079

Table 13. Age composition of wild Resurrection Bay coho salmon populations, 1972-1978 and 1983-1984.

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
1984	July 8 - Sept. 9	296	57.8	39.2	3.0	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 1984 Resurrection Bay sport fishery.

	Number of Fish	Mean Length (mm) and SD*	Mean Weight (kg) and SD
Males	163	686.4 \pm 58.4	4.94 \pm 1.29
Females	137	644.0 \pm 52.4	3.87 \pm 1.01
Total	300	667.1 \pm 59.6	4.45 \pm 1.28

* SD = Standard Deviation

This program was discontinued after 1979 due to the negligible returns (McHenry, 1984) obvious at that time. However, in a continuing attempt to establish chinook salmon for the Resurrection Bay sport fishery, 54,500 Age 0.0 (1982 brood, Crooked Creek origin) hatchery smolts were released in Box Canyon rearing pond on May 27, 1983. Age 0.2 jack chinook are expected in 1985 if any significant survival occurred from this plant. Also, 71,400 and 39,200 Age 0.0 (1983 brood, Crooked Creek origin) hatchery smolts were released in Thumb Cove and Lowell Creek outflow on June 14 and 19, 1984, respectively, to hopefully contribute chinook to future Resurrection Bay sport fisheries.

Adult Coho Timing and Distribution in Index Streams:

Peak of the 1984 index escapements ranged from late 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 1980 are presented in Table 15. The total minimum index escapement of 1,190 spawning coho suggests an above-average wild coho return in 1984.

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 20 and the last fish was captured November 7. A minimum of 53 coho spawned in lower Bear Creek after the adult run had entered the trap according to a foot survey conducted on November 15 when severe stream icing was encountered.

A total of 3,375 adults and 13 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 2 and the highest daily count of 271 (8.0% of the adult run) occurred on October 1. Mean stream temperatures at the beginning, peak and end of migration were 16.7°C (62°F), 9.4°C (49°F) and 1.7°C (35°F), respectively. Most of the migration (90.5%) occurred from September 16 through October 13 when Bear Creek temperatures ranged from 6.7°C to 13.3°C (44°F-56°F) and flows from 15 to 141 cfs.

Most (99.5%) of the marked coho escapement to the weir returned from 27,104 Age 1.0, 2.0 and 3.0 Bear Lake smolts marked with an LV fin clip at Bear Creek weir in 1983. The catch-to-escapement ratio of LV marked Bear Lake coho was 0.28:1.0. With the additional 157 estimated taken in the Resurrection Bay sport fishery, the total return (710 fish) of the marked Bear Lake lot resulted in a 2.62% smolt-to-adult survival. Three Ad-CWT marked coho recorded from the trap probably were strays from the Grouse Lake hatchery coho return.

The 2,819 unmarked coho enumerated from the upstream trap were produced from 80,747 Bear Lake smolts released in 1983 without a fin clip at Bear Creek weir. Including 789 estimated caught in the Resurrection Bay boat fishery, the total return (3,608 fish) of the unmarked Bear Lake segment realized a 4.47% smolt-to-adult survival or 1.7 times that of marked smolts.

Table 15. Minimum wild coho salmon escapement in seven index streams in the Resurrection Bay area, 1980-1984.

Name of Stream	Minimum Escapement					Mean 1980-83
	1980	1981*	1982	1983	1984	
Airport	9	...	0	0	0	3
Box Canyon	32	...	248	154	144	145
Clear	88	...	241	62	140	130
Dairy	122	...	108	64	251	98
Grouse	108	...	307	408	396	274
Jap	49	...	328	85	121	154
Mayor	<u>94</u>	<u>...</u>	<u>145</u>	<u>69</u>	<u>138</u>	<u>103</u>
Total	502	...	1,377	842	1,190	907

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

Table 16. Bear Lake adult coho salmon enumerated weekly through Bear Creek weir, 1984.

Weekly Periods	AD or LV Marked	Unmarked*	Male**	Female	Total
Aug. 19 - 25	3	19	13	9	22
Aug. 26 - Sept. 1	1	1	2		2
Sept. 2 - 8		1	1		1
Sept. 9 - 15	5	14	16	3	19
Sept. 16 - 22	91	447	361	177	538
Sept. 23 - 29	70	464	331	203	534
Sept. 30 - Oct. 6	234	1,210	816	628	1,444
Oct. 7 - 13	102	435	236	301	537
Oct. 14 - 20	20	86	51	55	106
Oct. 21 - 27	25	120	73	72	145
Oct. 28 - Nov. 3	4	19	16	7	23
Nov. 4 - 10	<u>1</u>	<u>3</u>	<u>1</u>	<u>3</u>	<u>4</u>
Total	556	2,819	1,917	1,458	3,375

* Approximately 75% of the 1983 Bear Lake smolt out-migration was released unmarked to enhance smolt-to-adult survival.

** Does not include 13 unmarked jacks returning prematurely from the 1984 out-migration.

Analysis of 383 scale samples representatively sampled from the Bear Lake escapement disclosed that the run (catch plus escapement) was comprised of 3,787 Age 1.1 (87.7%), 520 Age 2.1 (12.0%) and 11 Age 3.1 (0.3%) adults. The adult age composition, therefore, translates to 1983 Bear Lake smolt-to-adult survivals of 3.79% Age 1.0 (99,862 smolts), 6.59% Age 2.0 (7,898 smolts) and 12.08% Age 3.0 (91 smolts). The one jack coho sampled (7.7% of jack return) was Age 2.0 from the 1984 Bear Lake smolt outmigration.

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 1.3:1.0.

Coho Salmon Egg Takes:

A total of 117 males and 421 females were held in the Bear Creek holding facility from September 17 to October 22. Stream temperatures ranged from 2.8°C to 13.3°C (37°F-56°F) and flows from 16 to 141 cfs during this period. Male and female holding mortalities were 9.4% and 23.8%, respectively. All fish were screened for bacterial kidney disease (BKD) and furunculosis by Fisheries Rehabilitation and Enhancement Development Division (F.R.E.D.) pathologists prior to uniting sperm and eggs several hours later. Incidence of BKD was 14.7% positive for females and 11.3% for males (13.8% overall). Gametes from these spawners were destroyed at Trail Lakes Hatchery. A total of 139 females and 71 males were artificially spawned yielding an estimated 615,700 fertilized eggs. Eggs were fertilized at an average ratio of 1.0 male:2.0 females. Dead egg loss after physical shocking at Trail Lakes Hatchery averaged 14% or about twice the egg mortality usually experienced from immediate fertilization at Bear Creek weir.

Other Species:

A total of 3,552 adult and one jack sockeye salmon were captured in the upstream migrant trap from May 26 to July 25. Most adults (96.2%) were Age 1.2, surviving from 46,118 Age 1.0 Bear Lake smolts released past the weir in 1982. Including the 3,360 sockeye taken in the commercial seine fishery from May 24 through June 21, 1984, the maximum Bear Lake sockeye return was an estimated 6,912 fish. Therefore, 6,650 were estimated to be Age 1.2 adults. With the 29 Age 1.1 jacks estimated in the 1983 spawning escapement, smolt-to-adult survival of the 1982 Age 1.0 smolt outmigration is 14.5% thus far. Age 1.3 adults from this cycle will return in 1985. The second most abundant (2.3%) were 159 Age 1.3 adults resulting from 2,801 Age 1.0 smolts estimated in the 1981 Bear Lake sockeye outmigration. Including the 278 Age 1.2 adults estimated in the 1983 Bear Lake return, total smolt-to-adult survival of this cycle was 15.6%. The remainder of the 1984 Bear Lake sockeye run was comprised of an estimated 80 Age 2.2 (1.2%), 14 Age 2.3 (0.2%) and 10 Age 2.1 (0.1%) fish. Mean sizes of the one, two and three-ocean fish in 1984 were 369 mm in fork length (0.59 kg), 544.5 mm (2.03 kg) and 593.5 mm (2.54 kg), respectively. Mean weight of the commercially-caught sockeye in Resurrection Bay was 2.05 kg, indicating that most were two-ocean fish. Due to the ongoing fertilization experiment to enhance Bear Lake's coho smolt production, and that sockeye fry are competitively advantaged over coho in an environment with expanding

Table 17. Mean fork length (mm) and weight (kg) of adult coho salmon sampled at Bear Creek weir in 1984.

Lot	Males			Females			Sexes Combined		
	No.	FL	Wt.	No.	FL	Wt.	No.	FL	Wt.
LV	29	673.4	3.69	28	669.8	3.87	57	671.6	3.78
UNM	<u>200</u>	<u>671.5</u>	<u>3.71</u>	<u>141</u>	<u>664.0</u>	<u>3.81</u>	<u>341</u>	<u>668.4</u>	<u>3.75</u>
Total	229	671.8	3.71	169	664.9	3.82	398	668.9	3.76

zooplankton populations, the potential 3,533 sockeye spawning escapement was limited to 538 fish (281 males and 257 females) with the remainder being donated to charitable organizations.

Pink salmon first entered the trap on July 20 and eventually moved downstream to spawn from mid-August to early September. A minimum estimated escapement of 7,700 pink salmon spawned in lower Bear Creek in 1984 (Schroeder, pers. comm.) according to foot surveys conducted in August and September.

Upstream migrating Dolly Varden ascended Bear Creek to the weir on July 14 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 depre-dating upon or competing with juvenile salmon in Bear Lake.

Enhanced Coho Salmon Production:

Overall, total smolt-to-adult survival of the 1983 marked and unmarked Bear Lake smolts was 4.00%, or 1.60% lower than that realized for the 1982 outmigration. Because the former group was comprised of 92.6% Age 1.0 smolts with a relatively lower condition factor (K) = 0.95 than the 93.2% Age 1.0 smolts with K = 0.97, the latter's condition may have been partially responsible for this decreased survival. Table 18 summarizes Bear Lake smolt outmigrations since 1978 and subsequent adult returns through 1984.

Adult production from the 1983 hatchery smolt releases in Grouse Lake and Seward Lagoon was the first significant contribution to the Resurrection Bay sport fishery from this stocking program since 1980. Improved water quality with consequent less disease loss at Elmendorf Hatchery, relative to previous years, may have positively affected smolt health and condition prior to release (Kiefer, pers. comm.). Return composition of Ad-CWT marked coho sampled during the marine sport fishery and the relative number of Ad-CWT fish estimated in Seward Lagoon and Grouse Lake spawning escapements were in close agreement. According to analyses of the 64 Resurrection Bay Ad-CWT samples submitted to F.R.E.D. Division's Coded-wire Tag Laboratory in Juneau, 52 (81.2%) had tags and 12 (18.8%) were without tags. Of the 52 with tags, 29 (55.8%) were from the Seward Lagoon lot and 23 (44.2%) from Grouse Lake. The estimated 193 and 175 Ad-CWT marked coho in the Seward Lagoon and Grouse Lake escapements, respectively, comprised relative abundances of 52.4 and 47.6% in these systems. This indicates that the Resurrection Bay creel census and fish sampling program is fairly representative throughout the fishery. 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 1984, with a total of 3,528 gallons of liquid ammonium nitrate and phosphorus being dispersed from June 4 to October 5 in 3-day increments. Forty 28-gallon

Table 18. Survival of Bear Lake coho salmon adults from seaward migrations of smolts fin marked at Bear Creek weir, 1978-1983.

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
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		
	342	0.4% - Age 3.0	191.7	LV,RV		
	<u>97,659</u>					
1979	96,327	92.2% - Age 1.0	120.6	LV	5,368	5.14
	8,149	7.8% - Age 2.0	146.2	LV		
	<u>104,476</u>					
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		
	106	0.1% - Age 3.0	191.0	RV		
	<u>74,922</u>					
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		
	238	0.3% - Age 3.0	161.5	LV		
	<u>72,623</u>					
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		
	110	0.1% - Age 3.0	189.0	RV		
	<u>143,615</u>					
1983	99,862	92.6% - Age 1.0	114.8	LV	4,318	4.00
	7,898	7.3% - Age 2.0	128.6	LV		
	91	0.1% - Age 3.0	188.0	LV		
	<u>107,851</u>					

* Includes boat and shore sport harvest estimates plus escapements.

Table 19. A summary of hatchery reared coho salmon smolt releases in Seward Lagoon.

Brood Year	Origin	Mark	Smolt Liberation Data			Adult Return Data*				Total Number	Return Percent
			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
1981	Bear Lake	Ad-CWT**	5/20/83	47,950	49.8 (22.6)	0	0.00	1,128	2.35	1,128	2.35

* Include boat and shore harvest estimates plus escapements.

** Release consisted of 13,480 marked (28.1%) and 34,470 unmarked (71.9%) smolts.

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(lb)	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
1981	Bear Lake	Ad-CWT**	5/20/83	49,900	49.8 (22.6)	1	0.00	868	1.74	869	1.74

* Include boat and shore sport harvest estimates plus escapements.

** Release consisted of 15,694 marked (31.5%) and 34,206 unmarked (68.5%) smolts.

barrels (1,120 gal) of 27-6-9 formula and 86 barrels (2,408 gal) of 32-0-0 formula comprised the season's fertilizer application. Considerable logistical support, coordination and manpower assistance was also provided to F.R.E.D. Division's limnology personnel in collecting samples for water chemistry, plankton abundance, coho feeding habits and distribution studies.

Though 1984 field samples have not yet been fully analyzed, preliminary results indicate that Bear Lake's water quality has attained the proper nitrogen:phosphorus balance due to fertilization and low complete flushing rates of the lake since 1982. Consequently, Bear Lake's phyto and zooplankton populations appear to be seasonally abundant and healthy (Kyle, pers. comm.).

Hydro-acoustic survey data suggest that Age 0.0 coho fingerlings may move into Bear Lake's limnetic portion in late September, presumably to feed on zooplankton, because they have achieved the necessary threshold size of 70 mm enabling them to migrate offshore, and/or their primary food source, chironomid insects, has been exhausted in the littoral zone (Kyle, 1984 report to Board of Fisheries). This offshore plankton-feeding existence has been tentatively demonstrated for Age 1.0+ residual coho in Bear Lake and shown by other studies of lake-dwelling, over-yearling coho elsewhere. However, further study through fall overturn to freeze-up is required to establish that this postulated migrational feeding behavior also is valid for under-yearling coho in Bear Lake.

Bear Lake sockeye fry may be faring better than coho fingerlings with lake fertilization. Comparing the average smolt biomass production of the 3 post-fertilization years (1982-1984) to that of the 5 pre-fertilization years (1977-1981) indicates that coho have achieved a modest 12% increase while sockeye have increased 354%. Sockeye smolt abundance has increased twelvefold relative to coho smolts since initiation of lake fertilization, and both Age 1.0 and 2.0 sockeye were of larger average size than Age 1.0 and 2.0 coho smolts in 1984.

DISCUSSION

The continuing decline in Bear Lake's yearling coho smolt production since 1982, when 54% of the 1982 fingerling plant survived to Age 1.0 smolts, is puzzling in view of the ongoing lake fertilization experiment to enhance coho production. The 39.3% Age 1.0 smolt yield from the 1983 plant was nearly 4% (18,846 smolts) lower than the 43% yearling smolt production realized from the 1978 fingerling release prior to lake fertilization. This reduction in smolt output could result in a potential loss of 940 Bear Lake coho at the 5.9% average marine survival (1978-1982 adult returns) to the 1985 Resurrection Bay sport fishery. Although Bear Lake's 1984 coho smolt biomass production was only 15.2 kg less than that for 1983, it was 253 kg (557 lb.) lower than the 11-year annual average yield (2,048.5 kg) since the 1971 lake rehabilitation project.

Population dynamics probably exert a stronger influence on Bear Lake's annual coho smolt production than do the effects of lake fertilization.

For example, excessive residualism of Age 0.0 fingerling to Age 1.0+ holdovers occurred in the 1973 and 1979 plants because of too high a stocking density and stocking undersized fingerlings, respectively, in those years. Resultant yearling smolt yields were relatively low (14.5% and 24.2%), with most of these plants surviving to Age 2.0 smolts (34.9% and 27.4%). The large abundances of Age 1.0+ residual coho rearing in Bear Lake in 1974 and 1980, prior to achieving Age 2.0 smolt status, evidently had a disastrous effect on Age 0.0 fingerlings stocked in both 1974 and 1980. Yearling smolt production from these plants was only 3.0% and 7.3%, respectively. That few Age 1.0+ residuals survived from these releases is evident, since only 6.6% and 6.5%, respectively, of these plants attained Age 2.0 smolts. The outstanding Age 1.0 smolt yield from the 1981 fingerling plant was not unexpected, since relatively few Age 1.0+ coho were present in the lake, which resulted in improved conditions for planted fingerlings. Thus, it is believed that rearing density of residual older coho plays an important role in determining not only yearling but total smolt yields from a subsequent fingerling plant.

Paradoxically, lake fertilization may aggravate rather than alleviate the potential residual coho situation in Bear Lake. Feeding habit studies in 1981 and 1983 suggest that zooplankton may constitute the primary food source for Age 1.0+ coho. With expanding zooplankton populations due to fertilization, enhanced survival and increased abundance of these older residual coho could result in serious competition and/or depredation of newly-stocked Age 0.0 fingerlings as illustrated above. The 15,206 Age 2.0 smolts emigrating in 1984 represent a 12% survival of the 127,432 potential Age 1.0+ residual coho remaining from the 1982 plant, or about 5% higher than that for Age 2.0 smolts surviving from Age 1.0+ residuals of both the 1980 and 1981 plants. Moreover, determining whether Age 0.0 coho actually do utilize zooplankton to achieve the 40-50 mm growth between fall and the following spring to smolt is also critical to continuing the lake fertilization program. If this postulated feeding pattern cannot be established for Age 0.0 coho and abundance of Age 1.0+ residuals is observed to increase as a result of enhanced zooplankton populations in Bear Lake, then the fertilization experiment should be terminated.

In light of the 1984 Board of Fisheries reaffirmation of the 1971 Bear Lake salmon management policy, which mandates continuing the fertilization program for coho salmon enhancement with strict limits on sockeye salmon escapement, perhaps the most important question needing answering is this: Does interspecific competition really exist between coho and sockeye fry, particularly when both species occupy the littoral zone in late spring-early summer prior to the sockeye moving into the limnetic portion of Bear Lake to take up their plankton foraging life? It is this earliest part of the first rearing season when both newly-stocked coho fingerlings and recently emerged sockeye fry are most vulnerable to competition for identical food items and/or predation by older and larger fish. If it is eventually found that sockeye fry present no undue threat to juvenile coho survival, then there is no justification to continue limiting Bear Lake sockeye spawning escapements and the lake can be managed for optimal sustained production of both species.

With the soon-to-be-completed U.S. Forest Service trail from Exit Glacier bridge to Upper Russian Lake, foot access along upper Resurrection River to its headwater tributaries will be greatly facilitated. Therefore, research on the distribution, abundance and biological characteristics of the 80 to 90% of Resurrection Bay's coho salmon production, believed to occur in upper Resurrection River, will be undertaken in the near future.

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