

STATE OF ALASKA

Jay S. Hammond, 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
Project No.: F-9-13
Study No.: G-II Study Title: SPORT FISH STUDIES
Job No.: G-II-A Job Title: Coho Salmon Studies in the
Resurrection Bay Area

Cooperator: Edward T. McHenry

Period Covered: July 1, 1980 to June 30, 1981

ABSTRACT

Bear Lake was restocked with 150,000 Age 0.0 coho salmon, Oncorhynchus kisutch (Walbaum), fingerlings on June 12, 1980 to maintain smolt production.

The Bear Creek weir downstream migrant trap was operated continuously from May 22 through September 16. A total of 74,980 Age 1.0, 2.0 and 3.0 smolts were enumerated. Yearling (Age 1.0) smolt survival from the 1979 Bear Lake fingerling plant was 24.2 percent, with a ratio of 6.8:1.0 smolt-to-fingerling biomass (kilogram) yield.

Bear Lakes's smolt out-migration timing and abundance, age and size composition, and condition factors are presented. Bear Creek water temperatures and stream flows corresponding to migration peaks and durations are also given. The abrupt decline in 1980 yearling smolt production from small fingerlings stocked in 1979, and the possibility of improving Bear Lake's carrying capacity via artificial fertilization, are discussed.

The Resurrection Bay creel census (July 8 - September 7) indicated an estimated 20,981 coho were harvested by 25,527 man-days of sport effort. The mean seasonal catch per angler hour was 0.145. Enhanced adult production contributed an estimated 18.2 percent to the sport harvest. Most (57.6 percent) survived from 97,840 and 44,000 Age 1.0 (1977 brood, Bear Lake origin) hatchery smolts released in Seward Lagoon and Grouse Lake in mid-May, 1979. The remaining 42.4 percent returned from 104,476 Bear Lake smolts and 40,400 hatchery smolts released in lower Bear Creek in mid-May, 1979.

The Bear Creek weir upstream migrant trap was operated continuously from May 16 through November 14. The coho upstream migration to the trap extended from September 3 to October 31, and consisted of 4,486 adults and 34

jacks. Adults were comprised of three Ad-CWT, 54 RV, 102 LV and 4,327 unmarked coho. The 34 jacks resulted from 74,922 Bear Lake smolts released past Bear Creek weir in 1980.

Total smolt-to-adult survival per release lot were 5.1 percent (Bear Lake), 2.2 percent (Bear Creek), 3.0 percent (Grouse Lake) and 4.0 percent (Seward Lagoon). Total survival of Bear Lake smolt out-migrations (1973-1979), Bear Creek (1969-1979), Seward Lagoon (1968-1979) and Grouse Lake (1976-1979) hatchery smolt releases are summarized.

The catch-to-escapement ratio of marked Bear Lake coho was 0.26:1. The adult male-to-female sex ratio was 2.1:1 in the Bear Creek escapement. An estimated 2,384,000 fertilized eggs were artificially spawned from 601 females and 169 males from the Bear Lake and Bear Creek returns.

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.

BACKGROUND

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 drainage streams. Since 1961, the Resurrection Bay coho recreational fishery has become the largest marine sport fishery for this species in Alaska. Therefore, it became imperative to stabilize or improve Resurrection Bay coho production to satisfy growing angler demand in the fishery. Figure 1 shows the Resurrection Bay drainage, and Table 1 lists the anadromous fish species indigeneous to its tributaries.

Bear Lake, located 7 miles north of Seward, was chosen for coho rearing because it is the largest (180 hectares or 445 acres) stable body of clear fresh water in the Resurrection River drainage, and is accessible by road. It was determined after a survey in 1962 that Bear Lake should be rehabilitated with rotenone to eradicate all predator and competitor fish species inhabiting the lake. Without predation and interspecific competition, it was believed Bear Lake could then produce a high sustained smolt yield from annual coho fingerling plants.

Pre-rehabilitation species abundances were measured by a temporary weir situated at the Bear Creek-Salmon Creek confluence from 1961 to 1964. Upstream migrations averaged 921 adult coho, (1961-1964); 4,801 adult sockeye salmon, (1961-1965); and 10,543 Dolly Varden, (1961-1962). Downstream migrations in 1962-1963 averaged 7,933 coho smolts, 51,232 sockeye smolts, and 17,838 Dolly Varden. Though threespine stickleback downstream migrations were not estimated at the weir, beach seine sampling indicated that this species was abundant in Bear Lake.

Bear Lake was rehabilitated with powdered rotenone at 1.0 mg/l (5% level) on August 26, 1963. A 1.5-meter (5 foot) high dam was erected at the

FIGURE 1.

RESURRECTION BAY WATERSHED

- | | |
|------------------------|--------------------|
| 1. Salmon Creek | 2. Bear Creek |
| 3. Grouse Creek | 4. Bear Creek Weir |
| 5. Airport Creek | 6. Jap Creek |
| 7. Dairy Creek | 8. Seward Highway |
| 9. Grouse Lake | 10. Seward |
| 11. Resurrection River | |
| 12. Mayor Creek | |
| 13. Small Boat Harbor | |
| 14. Seward Lagoon | |
| 15. Clear Creek | |
| 16. Box Canyon Creek | |

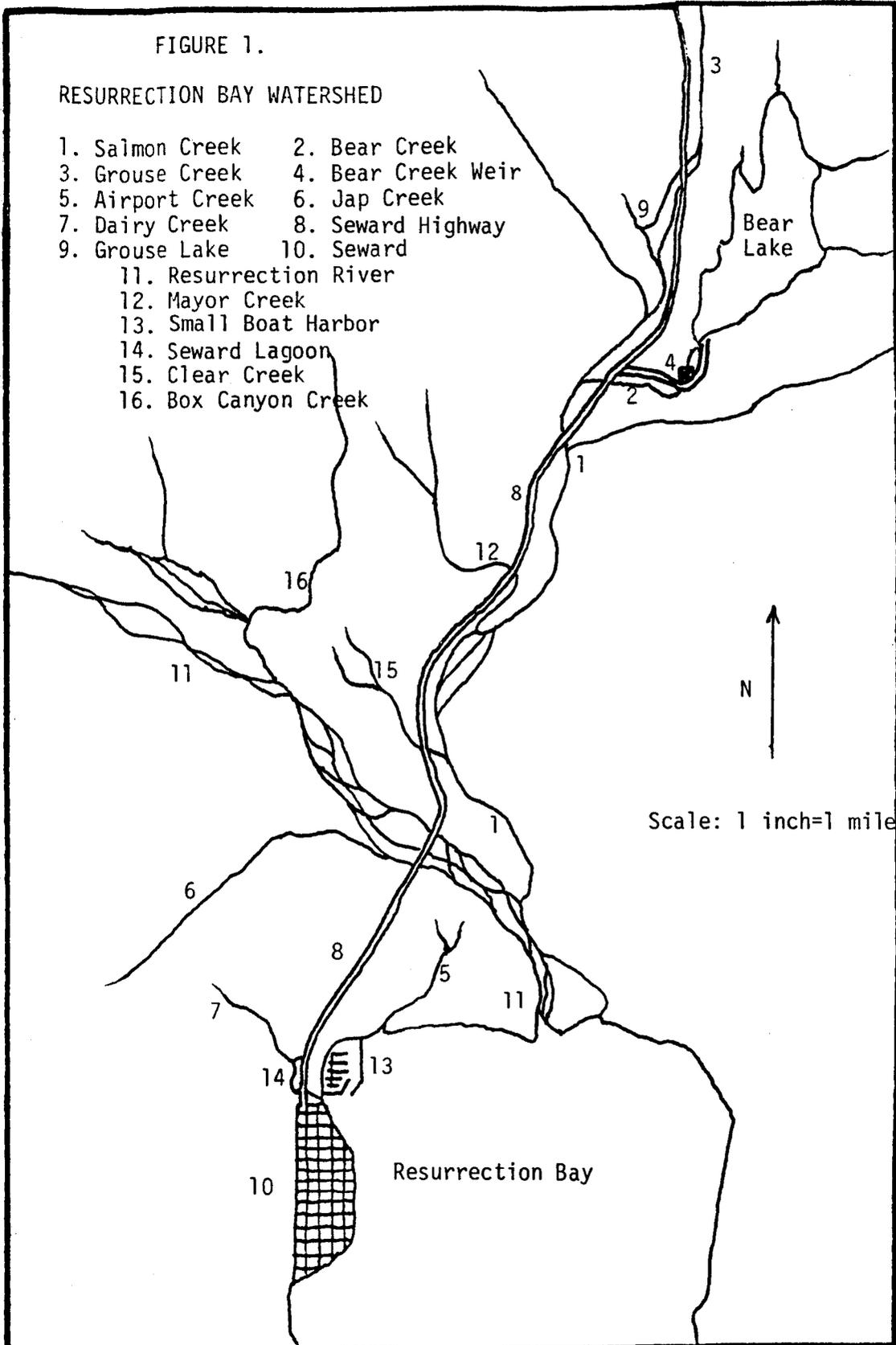


Table 1. Checklist of Fish Species Present in the Resurrection Bay Drainage.

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
Rockfish	<u>Sebastes sp.</u>

outlet to contain the treated water until detoxification and to prevent subsequent immigration of undesirable species. Bear Lake detoxified by October 17, 52 days after the water was treated, and received its first annual fingerling plant that winter through the ice. All fingerling plants except the 1966 release were fin-marked at Fire Lake Hatchery to facilitate smolt survival evaluation.

The Good Friday earthquake on March 27, 1964 destroyed the outlet dam, which washed out completely on May 25. This allowed unobstructed entry of all fish ascending Bear Creek into Bear Lake until June 15, when the barrier was repaired. A permanent weir was constructed 533.4 meters (1,750 feet) downstream from the outlet to assess Bear Lake's coho smolt production and returning adult migrations.

Bear Lake became reinfested with threespine sticklebacks. It is not known whether this was due to insufficient rotenone treatment or the destruction of the outlet barrier. Also, Dolly Varden were able to negotiate the weir during fall flood levels and immigrate into the lake on most years.

Before rapid expansion of the stickleback population occurred, Bear Lake's coho and sockeye smolt production increased several fold as a result of favorable rearing conditions from 1964 to 1966. Coho smolt biomass (weight) production attained 4.2 kilograms for each kilogram of fingerlings planted in 1964. Smolt age structures changed from predominantly Age 2.0 to Age 1.0 with growth exceeding that of former Age 2.0 smolts. Smolt survival from stocked coho fingerlings reached 43.5% of the 1964 and 48.1 of the 1965 plants. Had sufficient coho fingerlings been available for stocking Bear Lake at desired densities of 1963-1965, coho smolt production would have been considerably higher. Bear Lake's enhanced smolt production increased pre-rehabilitation abundances of adult sockeye and coho by 11 and 3.5 times, respectively.

Bear Lake's high smolt production was short lived, however, due to the sticklebacks' rapid takeover of the rearing environment, beginning in 1967. Smolt age structures reverted to Age 2.0 dominance, growth rates declined, and fingerling-to-smolt survivals decreased. Coho fingerling plants were terminated after 1967 because smolt production was obviously dropping below pre-rehabilitation levels. By 1968, threespine sticklebacks had already reached pre-rehabilitation abundance in the lake.

In 1969, it was decided to rehabilitate Bear Lake again. Stickleback population sampling in 1970 showed that this species inhabited all areas and depths in Bear Lake. Bear Creek Weir was reconstructed in 1969 and made entirely fishtight by removing the sloping upstream fence and adding three permanent, perforated plate screens above the upstream migrant trap.

Bear Lake was rehabilitated again in 1971, and lake treatment was conducted essentially the same as in 1963 except that 100% emulsified instead of powdered rotenone was used. Overall treatment level was 1.6 mg/l rotenone at 5% concentration. Caged live fish suspended from surface to bottom, 12 to 18 meters (40 to 60 feet), were all dead within 1 week. Population

sampling 2 days following rehabilitation showed that the threespine sticklebacks comprised 98.8% of the total fish sample (n = 9,065) collected randomly on and around Bear Lake. From this it was concluded that obtaining less than total lake rehabilitation in 1963 ultimately resulted in lower-than-normal salmon production in Bear Lake over the long term.

Bear Lake remained toxic through the winter of 1971-1972, and finally detoxified shortly after spring overturn. Annual coho fingerling plants in Bear Lake resumed in June 1972 at desired stocking densities. Resultant smolts were enumerated, sampled weekly for age and size composition as well as condition factor, and fin-marked for recognition in the fishery before being released at Bear Creek weir. No threespine sticklebacks have been detected in Bear Lake during fall population sampling of juvenile coho by electrofishing or at Bear Creek weir since the 1971 rehabilitation.

Bear Lake was stocked from 1972-1975 at densities ranging from 2,461 to 2,503 fingerlings per surface hectare. The cumulative effect in just 3 years resulted in critically overstocking Bear Lake's coho rearing habitat.

Intense intraspecific competition among fingerlings evidently depressed growth rates, lowered survival and extended rearing duration to smoltification. Mean seasonal condition factors of all smolts sampled each year were observed to drop from 0.98 (1973) to 0.90 (1974) and 0.89 (1975). The percentage of fingerling plants resulting in Age 1.0 smolts also decreased from 17.2% (1973) to 14.5% (1974) and 3.0% (1975). Similarly, biomass ratios of Age 1.0 smolts produced per fingerling release declined abruptly from 8.9:1 (1973) to 4.9:1 (1974) and 0.4:1 (1975).

Increased stress from overcrowding apparently led to greater susceptibility (lowered resistance) of rearing fingerlings to natural diseases in Bear Lake. Though the 1975 smolt out-migration (168,036 smolts) was the largest ever recorded for Bear Lake, over 91% were Age 2.0 smolts in relatively poor condition. Nearly 13% of the smolt run died from "eye fluke", Diplostomulum spathaceum, and fungus, saprolegnia sp., diseases at the weir. Only 1.1% of the 143,589 smolts released in 1975 survived to return as adults in 1976. A downward adjustment in Bear Lake's fingerling stocking density was, therefore, clearly indicated from these findings. Bear Lake has been stocked since 1976 at only 1,247 to 1,265 per hectare, or approximately one-half previous levels, to enhance fingerling growth and survival to smolts. The following report presents the findings and discusses the results of this reduced fingerling stocking density on Bear Lake's coho salmon production.

RECOMMENDATIONS

1. The present objectives of the study should be retained.
2. The 1982 stocking density of coho fingerlings in Bear Lake should be adjusted according to emigrating smolt abundance, age composition and condition factor in 1981.

3. Size of fingerlings stocked annually in Bear Lake should not average less than 772/kg (350/lb.).

OBJECTIVES

1. To determine the distribution, abundance, and timing of out-migrant and adult coho salmon in the Resurrection Bay area.
2. To determine the age and size composition of out-migrant and adult coho salmon populations in selected tributaries.
3. To determine the sport harvest and relative survival of wild and enhanced coho salmon stocks in Resurrection Bay.
4. To determine the methods and means of increasing or extending the freshwater spawning and rearing areas of the watershed, and mitigating freshwater mortality.
5. To provide recommendations for the management of coho salmon in these waters and direct the course of future studies.

TECHNIQUES USED

The timing and abundance of sockeye and coho salmon smolts emigrating from Bear Lake downstream to Bear Creek weir were determined by enumerating these fish at the downstream migrant trap. Weir location and description of the downstream trapping facilities were presented by Logan (1969). The timing and abundance of adult sockeye and coho salmon were measured by enumerating these fish at the weir's upstream migrant trap. Adult trapping facilities, rebuilt in 1969 and modified in 1970, were described by McHenry (1971). Bear Creek water temperatures and stream flows were recorded daily at the weir to subsequently correlate these physical parameters with the onset, peak, and termination of migrations.

Age and size composition of Bear Lake sockeye and coho smolt populations were determined by weekly sampling at the weir. Age compositions of Bear Lake sockeye and coho smolt populations were determined by examining representative scale impressions on 0.02-inch cellulose acetate with a Bruning model 200 microfiche reader. Smolt abundance per age group was calculated by extrapolating the age composition, as determined in weekly scale sample analysis, to the total number of smolts emigrating during those weekly periods. Age composition of the Resurrection Bay wild coho return was not sampled because these fish could not be differentiated from adults surviving from the unmarked components of hatchery smolt releases in 1979. Age composition of the Bear Lake unmarked coho return was not sampled because unmarked coho returning from hatchery smolts released below the weir were indistinguishable from Bear Lake smolts released unmarked in 1979. Age and size composition of the Bear Lake adult sockeye return was sampled

by randomly sampling 25% of the escapement. Size composition of Bear Lake's coho escapement was determined by representatively sampling 20% of the migration for fork length, weight and sex. All fish sampled were anesthetized in a 50 mg/l solution of MS-222 (Tricaine methanesulfonate) to facilitate handling and minimizing mortality.

Resurrection Bay coho sport harvest and angler effort (man-days) were measured by a stratified, random creel census conducted at the Seward small boat harbor. Sampling design and interview method were nearly identical to that described by Logan (1966). The average number and percentage of sport fishing boats returning to the Seward small boat harbor were determined for each of three 3.5-hour sampling periods extending from 11:30 a.m. to 10 p.m. Returning boats were not sampled from 8:00 a.m. to 11:30 a.m. because only 11.6% of the weekend and 14.3% of the weekday sport craft returned during this period in the 3 years sampled (1964-1966). The mean number of boats returning during this morning period was extrapolated using the above percentages. These estimates were then added to those determined for the three periods sampled to estimate total daily boats.

Total sport fishing effort and harvest were estimated for the season by multiplying weekly means (anglers/boat and salmon/boat) times total returning boats for all weekends and weekdays included in the creel census period. Fishing mortality and catch-to-escapement ratio of unmarked and marked (fin-clipped) adult coho were determined by extrapolating the marked coho catch observed during creel census and by recording marked versus unmarked coho in the Bear Lake, Grouse Creek and Seward Lagoon spawning escapements. Coho taken in the shore fishery after the boat creel census terminated were considered "escapement" for the Resurrection Bay catch-to-escapement ratio determination. An index to Resurrection Bay coho escapement abundance was established by conducting weekly foot surveys on seven local index streams throughout immigration until peak of spawning terminated. All carcasses were examined for clipped fins and sex determination, then mutilated to preclude recounting on subsequent surveys.

Evaluation of Bear Lake's rehabilitated rearing environment was continued by measuring the abundance, growth, and condition of smolts surviving from the 1977, 1978 and 1979 coho fingerling plants. Smolt biomass (kilograms) production was calculated by multiplying the seasonal mean smolt weight (grams) per age group by the total number of smolts emigrating in each age group in 1980.

FINDINGS

Results

The findings presented are the result of the 1980-81 research segment of the project. For a description of the Resurrection Bay drainage and past information collected on the project, see Logan (1962-1969) and McHenry (1979-1980).

Bear Lake Coho Smolt Migration:

Bear Creek weir downstream migrant trap was operated continuously from May 22 through September 16, when the trap was removed due to cessation of Bear Lake smolt emigration in early September. Abundance and timing of Bear Lake coho salmon smolt out-migration are shown in Table 2. Stocked fingerlings emigrating Bear Lake were retained above the weir.

Smolt out-migration to the downstream trap totaled 74,980 smolts. Trap mortality claimed only 58 smolts (0.08% of the run) due to careful manipulation of fishpass elevation during fluctuating weir pool levels at emigration peak. A total of 74,922 live smolts were released downstream. A study determined 24.5% of the out-migration received a right ventral (RV) fin-clip for recognition in the 1981 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 28, peaked (50% of out-migration) by June 19, and terminated September 3. The highest daily count occurred on June 14 when 8,671 (11.6% of the total run) were enumerated from the trap.

Mean stream temperatures when smolt emigration began, peaked, and terminated were 2.5°C (36.5°F), 8.1°C (46.5°F), and 9.7°C (49.5°F), respectively. Bear Creek stream flows ranged from 17 to 131 cfs during this period.

The smolt out-migration was comprised of 72.8% (54,580) Age 1.0, 27.1% (20,294) Age 2.0, and 0.1% (106) 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. Table 6 shows the weekly and seasonal smolt abundance per age group. An overall 1.0% (746 smolts) was representatively sampled during emigration (Table 3). An estimated 54,538 Age 1.0, 20,278 Age 2.0, and 106 Age 3.0 smolts were released downstream.

Age 2.0 and 3.0 smolt migrations peaked during the week of June 10-16 when Bear Creek water temperatures averaged 6.3°C (43.4°F), whereas Age 1.0 smolts peaked in the week following (June 17-23) at a mean stream temperature of 7.6°C (45.7°F). Evidently, increasing photoperiod was more of a determinant than was Bear Lake water temperature in 1980 smolt migration timing.

Approximately 65% of previous years' (1974-1979) smolt out-migrations had emigrated to the weir by the end of the first week in which Bear Creek mean water temperature exceeded 10°C (50°F). The exceptionally deep snow pack experienced in the Bear Lake drainage during the 1979-1980 winter probably was responsible for ice-out being delayed until June 7. Bear Creek water temperatures did not average 10°C until June 29.

The 106 Age 3.0 smolts resulted from the sixth fingerling plant (277,700 Age 0.0 fingerlings in 1977) in Bear Lake following the 1971 lake rehabilitation project. Total fingerling-to-smolt survival from the 1977 plant was 39.2%. Age composition of this smolt production cycle was 90.7% Age 1.0, 9.2% Age 2.0, and 0.1 Age 3.0. Bear Lake coho fingerling plants since 1975 are summarized in Table 7, and smolt production since 1977 is presented in Table 8.

Table 2. Bear Lake Coho Salmon Smolts Enumerated at Bear Creek Weir by Weekly Periods, 1980.

Weekly Periods	Number of Smolts		Total
	Live	Dead	
May 27 - June 2	3		3
June 3 - June 9	3,549	12	3,561
June 10 - June 16	26,455	2	26,457
June 17 - June 23	22,458	25	22,483
June 24 - June 30	9,882	5	9,887
July 1 - July 7	8,337		8,337
July 8 - July 14	3,548	3	3,551
July 15 - July 21	425	5	430
July 22 - July 28	175	4	179
July 29 - August 4	80	2	82
August 5 - August 11	3		3
August 12 - August 18			
August 19 - August 25	4		4
August 26 - September 1	1		1
September 2 - September 8	2		2
Total	74,922	58	74,980

Weekly	Number of Live Smolts	Number Smolts Fin Clipped	Percent of Weekly Migration*	Number Smolts Sampled	Percent of Weekly Migration*
May 27 - June 2	3				
June 3 - 9	3,549	490	13.8	31	0.9
June 10 - 16	26,455	6,855	25.9	251	0.9
June 17 - 23	22,458	4,866	21.7	234	1.0
June 24 - 30	9,882	2,698	27.3	100	1.0
July 1 - 7	8,337	2,250	27.0	73	0.9
July 8 - 14	3,548	845	23.8	47	1.3
July 15 - 21	425	295	69.4	10	2.4
July 22 - 28	175	78	44.6		
July 29 - August 4	80				
August 5 - 11	3				
August 12 - 18					
August 19 - 25	4				
August 26 - Sept. 1	1				
Sept. 2 - 8	2				
Sept. 9 - 15					
Sept. 16 - 22					
Sept. 23 - 29					
Total	74,922	18,377	24.5	746	1.0

* Minus the 58 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, 1980.

Weekly Periods	Number Smolts	Percent Sample	Mean Length (mm) \pm SD	Mean Weight (g) \pm DS	Condition Factor (K)*
June 3 - 9	14	48.3	119.9 \pm 5.6	18.13 \pm 2.17	1.05
June 10 - 16	142	58.3	121.0 \pm 7.9	17.20 \pm 3.57	0.97
June 17 - 23	180	78.9	121.8 \pm 7.8	17.81 \pm 3.38	0.99
June 24 - 30	82	83.7	125.3 \pm 8.0	19.92 \pm 4.51	1.01
July 1 - 7	65	89.0	131.8 \pm 7.1	23.99 \pm 3.58	1.05
July 8 - 14	43	95.6	129.2 \pm 8.4	23.37 \pm 4.50	1.08
July 15 - 21	8	88.9	132.4 \pm 7.3	25.66 \pm 3.58	1.11

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

Table 5. Mean Fork Length, Weight and Condition Factor of Age 3.0 Bear Lake Coho Salmon Smolts Sampled Biweekly at Bear Creek Weir, 1976.

Biweekly Periods	Number of Smolts	Percent of Sample	Mean Length (mm) \pm SD	Mean Weight (g) \pm SD	Condition Factor (K)
6/3 - 6/16	2	1.8	178.0 \pm 4.2	51.00 \pm 2.12	0.90
6/17 - 6/30	2	1.0	161.0 \pm 15.6	39.10 \pm 11.31	0.94
7/1 - 7/14	1	0.5	205.0	83.40	0.97
7/15 - 7/28	4	2.0	178.3 \pm 11.0	56.43 \pm 14.59	1.00
7/29 - 8/11	3	1.5	176.7 \pm 3.1	52.50 \pm 3.84	0.95
8/12 - 8/25	6	4.5	181.2 \pm 13.2	60.87 \pm 12.06	1.02
8/26 - 9/8*	14	14.0	187.2 \pm 9.4	64.26 \pm 9.53	0.98
9/9 - 9/22	35	20.7	198.4 \pm 12.1	76.33 \pm 15.84	0.98

* Only week of 8/26 - 9/1 sampled during this period.

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, 1980.

Weekly Periods	Number of Smolts*			Total
	Age 1.0	Age 2.0	Age 3.0	
May 27 - June**	1	2		3
June 3 - 9	1,720	1,841		3,561
June 10 - 16	15,451	10,900	106	26,457
June 17 - 23	17,739	4,744		22,483
June 24 - 30	8,275	1,612		9,887
July 1 - 7	7,420	917		8,337
July 8 - 14	3,395	156		3,551
July 15 - 21	382	48		430
July 22 - 28	130	49		179
July 29 - August 4	60	22		82
August 5 - 11	2	1		3
August 12 - 18				
August 19 - 25	3	1		4
August 26 - Sept. 1	1			1
Sept. 2 - 8	<u>1</u>	<u>1</u>		<u>2</u>
Total	54,580	20,294	106	74,980
Percent	72.8	27.1	0.1	100.0

* Number of smolts per age group after July 15-21 is estimated by overall age composition (72.8% Age 1.0, 27.1% Age 2.0, and 0.1% Age 3.0) determined up to that point.

** Age composition is based on June 3-9 weekly sample (4.38% Age 1.0, and 51.7% Age 2.0).

Table 7. Summary of Bear Lake Coho Salmon Fingerling Plants, 1975 - 1980.

Brood Year	Source of Eggs	No. Fish Stocked	Weight		Size*		Density		Dates of Plants	Planting Method
			lb	kg	No./lb	No./kg	No./acre	No./ha		
1974	Bear Lake	245,600	454	205.9	541	1,192	552	1,363	June 19	Aircraft Scattered
	Bear Lake	204,400	455	206.4	449	989	459	1,135	July 1	
	Total	450,000	909	412.3	495	1,091	1,011	2,598	1975	
1975	Bear Lake	149,800	433	196.4	346	763	337	832	June 10	Aircraft Scattered
	Bear Lake	74,800	185	83.9	405	893	168	415	June 14	
	Total	224,600	618	280.3	363	800	505	1,247	1976	
1976	Bear Lake	227,700	780	353.8	292	644	512	1,264	June 16 1977	Truck-Boat Scattered
1977	Bear Lake	157,000	457	207.3	345	757	353	871	June 20	Truck-boat Scattered
	Bear Lake	68,800	216	98.0	320	705	154	382	June 20	
	Total	225,800	673	305.3	337	743	507	1,253	1978	
1978	Bear Lake	225,500	340	154.2	663	1,462	507	1,253	May 24 1979	Aircraft Scattered
1979	Bear Lake	134,375	542	245.8	248	546	302	746	June 12	Aircraft Truck-boat
	Bear Lake	15,625	68	30.8	231	508	35	86	June 18	
	Total	150,000	610	276.6	246	542	337	832	1980	Scattered

* Weighted averages

Table 8. Summary of Bear Lake Coho Salmon Smolt Abundance and Biomass Produced Since 1977 from Annual Fingerling Plants, 1976 - 1979.

Year of Plant	No. of Fingerlings and Weight (kg)	Smolt Production by Year				Total Production	Survival to Smolt (%)
		1977	1978	1979	1980		
<u>1976</u>							
Number	224,600	49,752	16,457	0		66,209	29.5
Weight (kg)	280.3	795.5	424.0			1,219.5	
Weight Ratio		2.8:1	1.5:1			4.4:1	
<u>1977</u>							
Number	227,700		81,014	8,172	106	89,292	39.2
Weight (kg)	353.8		1,422.8	255.0	7.2	1,685.0	
Weight Ratio			4.0:1	0.7:1	0.0:1	4.8:1	
<u>1978</u>							
Number	225,800			97,144	20,294	117,438	52.0*
Weight (kg)	305.3			1,808.0	504.8	2,312.8	
Weight Ratio				5.9:1	1.7:1	7.6:1	
<u>1979</u>							
Number	225,500				54,580		24.2**
Weight (kg)	154.2				1,053.3		
Weight Ratio					6.8:1		

* Does not include Age 3.0 smolt production.

** Includes only Age 1.0 smolt production.

The 20,294 Age 2.0 smolts were produced from 225,800 Age 0.0 fingerlings stocked in 1978. With the 97,144 Age 1.0 smolts which immigrated in 1979, 2.0% of that plant has survived to smolts thus far. This is the highest percentage of any Bear Lake fingerling release resulting in smolts in the project's 18 year history. Excepting Age 3.0 smolt production from this plant, age composition of Bear Lake's seventh smolt production cycle was 2.7% Age 1.0 and 17.3% Age 2.0.

The 54,580 Age 1.0 smolt survived from 225,500 Age 0.0 fingerlings released in Bear Lake in 1979. This was the fourth fingerling plant made since 1972 at a reduced stocking density. Fingerlings comprising this plant, however, were small (663/lb) and either realized poor survival relative to previous releases consisting of larger fish, or had not achieved sufficient size to smolt as yearlings. Fingerling-to-smolt survival of this age group declined to 24.2%, or about 19% lower than that of the 1978 plant when fingerlings were approximately twice as large (337/lb). Age 2.0 smolt abundance in 1981 will depend upon the extent of Age 1.0 residualism and overwinter survival of the 1979 fingerling plant.

Despite the small size (about 38 mm and 0.68 g) of 1979 fingerlings when stocked, their growth appeared to be excellent. Age 1.0 smolts averaged 121.8 mm and 17.81 g for a condition factor (K) of 0.99 at migration peak, June 17-23. In contrast, Age 2.0 smolts were 11.4 mm and 7.59 g smaller than this age group at migration peak, June 10-16, in 1979. Age 2.0 smolts averaged 134.8 mm and 24.04 g for a K=0.98 in 1980. The one Age 3.0 smolt sampled was 191 mm and 67.7 g.

Bear Lake's estimated smolt biomass production in 1980 was only 1,565.3 kg, or 497.7 kg (1,097.2 lb) less than that produced in 1979. It is believed that the lowered abundance of Age 1.0 smolts resulting from the smaller fingerlings stocked in 1979 was solely responsible for the large reduction in Bear Lake's 1980 smolt biomass. 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 June 12 and 18, 1980 with 150,000 Age 0.0 coho fingerlings (1979 brood, Bear Lake origin) averaging 542/kg (246/lb) to maintain smolt production.

Other Species:

The total sockeye salmon smolt out-migration enumerated from the trap was 2,419 fish. The first smolt was captured on May 28, and the last on August 2. The highest daily count occurred on June 4 when 486 smolts (14.2% of the migration) were enumerated. The majority (88.0%) emigrated between June 3 and July 14, when water temperatures ranged from 2.8°C to 13.3°C (37°F - 56°F) and stream flows, from 53 to 131 cfs. The smolt out-migration was comprised of 3,374 (98.7%) Age 1.0, 21 (0.6%) Age 2.0, and 24 (0.7%) Age 3.0 smolts. Age 3.0 smolts resulted from the 1976 Bear Lake escapement of 271 females and 307 males. Including the 11,678 Age 1.0 and 201 Age 2.0 smolts estimated in 1978 and 1979, respectively, the total

Table 9. Summary of Abundance, Total Annual Biomass and Seasonal Condition Factor of Bear Lake Smolt Migrations, 1973 - 1980.

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	<u>74,980</u>	<u>1.01</u>	<u>1,565.3</u>
Average	98,645	1.01	2,091.1

Smolt production was 12,403 smolts (45.8 per female) for the fourth, post-rehabilitation sockeye salmon escapement into Bear Lake. Age 2.0 smolts were produced from the 13 females and 22 males that spawned in 1977. With the 31 Age 1.0 smolts estimated in 1979, only 52 smolts (4.0 per female) have resulted from this meager escapement. As stated previously (McHenry, 1978), this Bear Lake spawning escapement was subjected to an electrical ground problem in Bear Creek below the weir and subsequent molestation by the local public. All 35 fish, dip-netted below the trap and passed above the weir, probably arrived at Bear Lake in too poor condition to complete spawning. Age 1.0 smolts resulted from 18 females and 9 males in the 1978 escapement. Evidently, spawning success was high despite so few fish comprising the run, with 187.4 smolts produced per female thus far. Age 1.0 smolts peaked (50% of migration) during June 17-23, whereas Age 2.0 and 3.0 smolts emigrated earlier, June 3-9. At peak of migration, Age 1.0, 2.0 and 3.0 smolts averaged 119.3, 187.0 and 215.0 mm in fork length, respectively.

A total of 420 Dolly Varden was captured in the downstream trap and released below the weir. No threespine sticklebacks were caught in the trap nor observed in Bear Lake during the 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 7. Few coho were taken before creel census began since most sport fishing effort was directed toward the more abundant rockfish (Table 1) from mid-way through early July.

The season's total harvest was an estimated 20,981 coho. This estimate was extrapolated from interviews with 4,242 anglers harvesting 3,351 coho during the creel census period. Peak of the harvest occurred on August 12, the fourth day of the Seward Silver Salmon Derby, when an estimated 1,148 coho (5.5% of the season's harvest) were taken. The season's total and derby harvests are summarized for 1976 through 1980 in Table 10. Marked adult coho contributed 4.5% or an estimated 953 fish to the 1980 Resurrection Bay sport harvest.

An additional 2,861 unmarked coho resulting from the unmarked segments of hatchery smolt releases and the Bear Lake smolt out-migration in 1979 comprised an estimated 13.6% to the sport catch. The total contribution of enhanced adult coho production, therefore, was 3,814 fish or 18.2% to the sport fishery.

The Ad-CWT marked adult coho survived from 46,570 Age 1.0 (1977 brood, Bear Lake origin) hatchery smolts released in Seward Lagoon (23,620) and Grouse Lake (11,750). The RV marked coho resulted from 11,200 hatchery smolts released in Bear Creek below the weir in 1979. Left ventral marked coho were produced by 10,462 Bear Lake smolts marked at Bear Creek weir. Unmarked hatchery coho resulted from 135,670 smolts (same brood year and origin) stocked in Seward Lagoon (74,220), Grouse Lake (32,250) and lower Bear Creek (29,200). Additional unmarked coho survived from 94,014 Bear Lake smolts released unmarked past Bear Creek weir in 1979.

Table 10. Derby and Total Sport Harvest of Coho Salmon in Resurrection Bay, 1976 - 1980.

Year	Total Sport Harvest	Derby Harvest	% Derby Harvest
1976	9,456	2,708	28.6
1977	16,345	6,007	36.8
1978	15,550	7,258	46.7
1979	17,785	6,073	34.1
1980	20,981	6,732	32.1

A total of 42,440 Ad-CWT marked, Age 0.0 (1979 brood, Bear Lake origin) hatchery coho smolts were stocked in Seward Lagoon (26,860) and Grouse Lake (15,580) on June 25-26, 1980. An additional 124,230 unmarked, hatchery smolts (same brood year and origin) were released in Seward Lagoon (73,940), and Grouse Lake (50,290) with the marked smolts. These plants were comprised of considerably smaller smolts (11.5-13.3 g 39-34/lb) compared to those made in 1979 (15-18 g or 29-25/lb). Age 0.1 marked Ad-CWT and unmarked adults surviving from these smolt releases will return in 1981.

The total sport fishing effort exerted for Resurrection Bay coho was an estimated 25,527 man-days. About 17% 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 number of anglers per boat was as follows: Weekdays, 2.98; weekends, 3.10; and salmon derby, 3.07. Fishing effort and mean seasonal catch per hour are summarized for 1976-1980 in Table 12. The fishing effort was 8,575 man-days on weekdays and 8,066 on weekends, excluding the derby (8,886 man-days). Military personnel and dependents, fishing on boats provided by the Army and Air Force recreation camps at Seward, contributed 13.9% (3,550 man-days) to the total effort. Civilian anglers fishing on weekdays realized the highest coho catch per hour (0.228), whereas the lowest catch rate (0.131) occurred during the Derby when effort was more intense. The average number of hours anglers fished per day were as follows: weekdays, 4.97; weekends, 5.21; and salmon derby, 5.79.

An estimated 452 chinook salmon were harvested during the census period at an average rate of only 0.05 per boat. This harvest was 103 fish below the 20-year average catch (555) of this species in Resurrection Bay. This species was most abundant during July 8-14 when anglers averaged 0.14 chinook per boat. Most fish taken were immature chinook in their first and second ocean years. Origins of these stocks are unknown as chinook rarely ascend Resurrection Bay streams. A total of 18 adult and 19 jack chinook salmon returned to Box Canyon Creek from four annual (1976-1979) smolt releases in that tributary, according to a foot survey conducted on August 18. Of the four adult carcasses examined, one was fin-marked LV, two were RV and one was unmarked. Therefore, the adult escapement was estimated to be comprised of six Age 0.4 fish surviving from 27,100 LV-marked smolts stocked in 1976 and 12 Age 0.3 fish from 50,000 RV-marked smolts released in 1977. Several of the jacks observed were Age 0.2 fish from the 1978 release of 150,000 smolts, but the majority were smaller Age 0.1 fish returning from 218,500 smolts stocked in 1979. One Ad-CWT immature chinook, snout-sampled during the Seward Silver Salmon Derby, resulted from a smolt lot released by the Quinalt Development Project in Queets River, Oregon in June, 1979 (Flagg, personal communication).

The Resurrection Bay pink salmon sport catch in 1980 (13,292 fish) was more than twice the largest (6,021 in 1976) ever recorded for this fishery. A limited commercial seine fishery conducted on July 31 - August 1 (48 hrs.) and August 6 (18 hrs.) by 13 fishing vessels harvested approximately

Table 11. Mean Number and Percentage of Sport Fishing Boats Returning to the Seward Small Boat Harbor During Each Sampling Period, 1980.

Periods (hours)	Weekends		Weekdays	
	Mean No. of Boats	Percent	Mean No. of Boats	Percent
8:00 a.m. - 11:30 a.m.*	17.1	11.6	7.5	14.3
11:30 a.m. - 3:00 p.m.	34.6	23.4	10.4	19.8
3:00 p.m. - 6:30 p.m.	58.0	39.2	21.0	39.9
6:30 p.m. - 10:00 p.m.	<u>38.1</u>	<u>25.8</u>	<u>13.7</u>	<u>26.0</u>
Total	147.8	100.00	52.6	100.0

* Percentage for this period determined by three-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, 1976 - 1980.

Year	Period of Census	Total Effort	Derby Effort	% Derby Effort	Seasonal Catch Per Hour
1976	July 8 - Sept. 12	19,681	8,421	42.8	0.084
1977	July 9 - Sept. 7	23,997	9,121	38.0	0.113
1978	July 8 - Sept. 10	22,291	10,064	45.1	0.126
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

54,000 pink salmon. This catch was about three times the previous record of 17,560,000 fish taken in 1955 (Kyle, personal communication). In addition, a minimum estimated 45,000 pink salmon comprised the 1980 spawning escapement in major Resurrection Bay pink salmon tributary systems. Pink salmon were most abundant in the sport fishery from early July through early August when anglers averaged 3.01 fish per boat. Pink salmon catch per boat-day averaged 0.46 in 1980 compared to 0.36 in 1978, the parent brood year which produced the 1980 return.

Adult Coho Timing and Abundance in Index Streams:

Peak of the 1980 index escapements ranged from mid-October through early November, and peak of spawning occurred within the following 2 weeks. Estimated minimum escapements of wild coho salmon in each stream index area since 1976 are presented in Table 13.

The total combined index escapement of 502 wild coho is slightly larger than the previous cycle (1976-1979) mean.

Bear Lake Upstream Migration:

The Bear Creek weir upstream migrant trap was operated continuously from May 16 through November 14. The first adult coho entered the trap on September 3 and the last one was captured October 31. Only 52 coho spawned in lower Bear Creek after the adult run had entered the trap according to a foot survey conducted on November 10.

A total of 4,486 adults and 34 jacks were enumerated from the trap. Abundance and timing of the adult coho migration are shown in Table 14. Weekly breakdown by marked release lot is presented in Table 15. The adult migration peaked (50%) on September 30, and the highest daily count of 273 (6.1% of the adult run) occurred on September 30. Mean stream temperatures at the beginning, peak, and end of migration were 9.7°C (49.5°F), 8.1°C (46.5°F), and 4.2°C (39.5°F), respectively. Most of the migration (72.5%) occurred from September 2 through October 6 when Bear Creek temperatures ranged from 6.7°C to 10.6°C (44°F - 51°F) and flows, from 13 to 80 cfs.

Most (64.2%) of the marked coho escapement to the weir returned from 10,462 Age 1.0 and 2.0 Bear Lake smolts marked with an LV fin clip at Bear Creek weir in 1979. With the additional 27 estimated taken in Resurrection Bay boat fishery and one stray observed in Mayor Creek, total return of the LV lot was only 130 fish (1.2% smolt-to-adult survival). This apparent low smolt survival may be related to ventral fin regeneration (McHenry, 1979) and/or higher differential mortality of ventral fin clipped smolts (Flagg, personal communication). An estimated 5,238 unmarked adult coho survived from the 94,014 Bear Lake smolts released unmarked past the weir in 1979. Total smolt-to-adult survival of this lot was 5.6%. Table 16 shows the various run components comprising total adult returns of Bear Creek, Bear Lake, Grouse Lake and Seward Lagoon production from 1979 smolt releases.

Table 13. Minimum Wild Coho Salmon Escapement in Seven Index Streams in The Resurrection Bay Area, 1976 - 1980.

Name of Stream	Minimum Escapement					Mean 1976-79
	1976	1977	1978	1979	1980	
Airport	24	7	14	1	9	11
Box Canyon	45	45	28	121	32	60
Clear	89	37	59	42	88	57
Dairy	17	134	146	68	122	91
Grouse	27	187	360	14	108	147
Jap	94	62	51	61	49	67
Mayor	<u>46</u>	<u>42</u>	<u>50</u>	<u>30</u>	<u>94</u>	<u>42</u>
Total	342	514	708	337	502	475

Table 14. Bear Lake Adult Coho Salmon Enumerated Through Bear Creek Weir by Weekly Periods, 1980.

Weekly Periods	Marked	Unmarked*	Male	Female	Total
Sept. 2 - 8		11	8	3	11
Sept. 9 - 15	9	356	258	107	365
Sept. 16 - 22	30	938	737	231	968
Sept. 23 - 29	32	811	576	267	843
Sept. 30 - Oct. 6	41	1,029	707	363	1,070
Oct. 7 - 13	13	350	224	139	363
Oct. 14 - 20	13	280	152	141	293
Oct. 21 - 27	18	512	339	191	530
Oct. 28 - Nov. 3	<u>3</u>	<u>40</u>	<u>23</u>	<u>20</u>	<u>43</u>
Total	159	4,327	3,024	1,462	4,486

* Ninety percent of the 1979 Bear Lake smolt out-migration and 72 percent of the Bear Creek hatchery smolt plant were released unmarked to enhance smolt-to-adult survival.

Table 15. Bear Lake Adult Coho Salmon Enumerated Through Bear Creek Weir by Weekly Periods, 1976.

Weekly Periods	Ad-Marked	Unmarked	Male	Female	Total
8/26 - 9/1	3		3		3
9/2 - 9/8	1		1		1
9/9 - 9/15	98	8	80	26	106
9/16 - 9/22	264	33	201	96	297
9/23 - 9/29	92	7	67	32	99
9/30 - 10/6	37	3	21	19	40
10/7 - 10/13	7		3	4	7
10/14 - 10/20	4			4	4
10/21 - 10/27	2			2	2
10/28 - 11/3					
11/4 - 11/10					
11/11 - 11/17	1		1		1
Total	509	51	377	183	560

Bear Lake Upstream Migration:

The Bear Creek weir upstream migrant trap was operated continuously from May 25 through November 30. The first adult coho entered the trap on August 28 and the last one was captured November 14. An estimated 155 Bear Lake coho remained below the weir to spawn, according to foot surveys made after most of the adult run had entered the trap.

A total of 560 adults and 23 jacks were enumerated from the trap. Abundance and timing of the adult coho migration are shown in Table 15.

Water Body and Fin Mark	Boat Harvest*	Beach Harvest**	Escapement	Strays*	Total Return	Smolt-to-Adult Survival (%)
Bear Creek***						
RV	141	25	54	6	226	2.0
UNM	368	65	222		655	2.2
Bear Lake***						
LV	27		102	1	130	1.2
UNM	1,081		4,157		5,238	5.6
Grouse Lake						
Ad-CWT	214	109	29	5	357	3.0
UNM	456	324	200		980	3.0
Seward Lagoon						
Ad-CWT	571	309	60	15	955	4.0
UNM	<u>956</u>	<u>1,845</u>	<u>200</u>		<u>3,001</u>	<u>4.0</u>
Total						
Marked	953	443	245	27	1,668	2.9
UNM	2,861	2,234	4,779		9,874	4.3

* Boat harvest and strays of Ad-CWT coho were apportioned according to relative abundance of Ad-CWT escapements estimated in each system. Boat harvest of unmarked (UNM) hatchery coho were apportioned according to UNM escapements estimated by Ad-CWT smolt-to-adult survivals per system.

** Beach harvests of Bear Creek and Grouse Lake hatchery coho were estimated proportional to their respective escapements after apportioning 74% (1973-1978 average) of the total beach harvest to the Seward Lagoon return.

*** Boat harvest of unmarked Bear Creek and Bear Lake coho were estimated by applying the 1.66:1 and 0.26:1 catch: escapement ratios, respectively, of RV and LV marked fish in the UNM Bear Lake escapements. Contribution of UNM Bear Lake coho to the beach fishery was unknown but believed to be small due to no LV coho being observed in the catch.

Only 54 RV marked adult coho were enumerated in the Bear Creek escapement. An additional 141 and 25 RV fish estimated taken in the Resurrection Bay boat and beach fisheries, respectively, plus six strays noted in local tributaries, totaled 226 adults (2.0% smolt-to-adult survival) returning from 11,200 RV marked hatchery smolts released in lower Bear Creek in 1979. An additional 655 unmarked adults were estimated surviving (2.2%) from 29,200 unmarked hatchery smolts released with the above RV marked lot. The low survival (less than half that of the 1978 release) of this smolt plant to returning adults is believed to be related to smolt size (18 g or 25/lb) at release. Hatchery smolts stocked in Bear Creek in 1978 averaged 45.0 g (10/lb) and realized 4.7% smolt-to-adult survival in 1979.

The three Ad-CWT marked adult coho captured in the upstream trap probably resulted from straying of the Grouse Lake Ad-CWT marked returns.

Mean fork length and weight of adult coho sampled at the weir are presented in Table 17. It is noteworthy that the two Ad-CWT fish sampled were 66 mm and 1.2 kg smaller than the mean size of adult coho comprising the Bear Creek escapement. The male:female sex ratio, excluding jacks, was 2.1:1 in the Bear Creek escapement. Six (17.6%) of the 34 jack coho enumerated from the trap resulted from 18,377 Bear Lake smolts fin marked and released at the weir in 1980. The 28 unmarked jacks returned prematurely from the unmarked segment (56,545 smolts) of the 1980 Bear Lake out-migration passed downstream.

Coho Salmon Egg-Takes:

A total of 258 males and 1,050 females were held in the Bear Creek holding facility from September 11 to October 25. Stream temperatures ranged from 5.0°C to 10°C (41°F - 50°F), and flows from 15 to 174 cfs during this period. Male and female holding mortalities were 15.5% and 29.6%, respectively. A total of 601 females and 169 males were artificially spawned, yielding an estimated 2,384,000 fertilized eggs. Mean fecundity was 3,967 eggs per female, only slightly higher than that obtained (3,846) from females in 1979. Eggs were fertilized at an average rate of 1 male: 3.6 females. Dead egg loss after physical shocking at Fort Richardson Hatchery averaged 6.1% (Krolick, personal communication). All spawned carcasses were deposited in Bear Lake for natural fertilization.

Assistance was provided to Dr. Joseph Sullivan, Fisheries Rehabilitation, Enhancement and Development Division pathologist, in conducting an experiment to determine the extent Bear Lake coho were infected with bacterial kidney disease (BKD), Renibacterium salmoninarum, and whether injecting them with the antibiotic erythromycin-phosphate would help to minimize holding mortality. The heavy holding losses, 75.9% and 70.3% for males and females respectively, experienced at Bear Creek in 1979 precluded obtaining the 1.9 million egg requirement, and prompted the need for this experiment.

Test results indicated (Sullivan, personal communication) that of the 65 Erythromycin-phosphate (Ery-PO₄) and saline injected coho spawners sampled, over 50% were positive for BKD. Saline injected fish showed only slightly

Lot	Males			Females			Sexes Combined		
	No.	FL	Wt.	No.	FL	Wt.	No.	FL	Wt.
Ad-CWT	1	587	2.04	1	596	2.45	2	591.5	2.25
LV	16	666.6	3.43	4	667.8	3.85	20	666.9	3.51
RV	9	650.8	3.13	3	678.7	3.54	12	657.8	3.23
UNM	<u>549</u>	<u>658.0</u>	<u>3.40</u>	<u>291</u>	<u>656.4</u>	<u>3.54</u>	<u>840</u>	<u>657.5</u>	<u>3.45</u>
Total	575	658.0	3.40	299	656.6	3.54	874	657.5	3.34

higher (6%) incidence of the disease than did those with the antibiotic. The 142 mortalities (dead prior to egg-takes) examined failed to show any evidence of BKD, possibly due to kidney tissue deterioration and/or bacterial cell breakdown. Substantial increases in survival of both the saline and Ery-PO₄ (22% and 30%, respectively) fish were noted for the second experimental lot, 9/25/80, compared to the first one, 9/19/80. This suggests that a more advanced reproductive state may provide the pre-spawners with a greater resistance to the disease. Paradoxically, saline injected coho survived 4% better than the Ery-PO₄ lot in this experiment. Therefore, further experimentation on Bear Lake coho with this antibiotic to prevent future holding losses appears to be unjustifiable.

Other Species:

A total of 1,458 adult and two jack sockeye salmon were captured in the upstream trap from June 5 to July 21. Most adults (99.1%) were Age 1.2, surviving from 11,670 Age 1.0 smolts that emigrated Bear Lake in 1978. With the six Age 1.1 jacks and 1,445 Age 1.2 adults estimated in 1979 and 1980, respectively, smolt-to-adult survival thus far is 12.4%. Three-ocean adults are expected to return from this smolt out-migration in 1981. No three-ocean adults were detected in the population sample (n=351), nor were anticipated in the 1980 Bear Lake escapement because no smolts were produced by the 1975 parent brood year (seven Age 1.1 jacks). Three Age 2.2 adults (0.9%) in the sample apparently strayed from the Grouse Lake escapement, since this age group would have had to result from Age 2.0 smolts in 1978, also produced by 1975 brood year escapement. Though not sampled for age, the two jacks observed in 1980 were probably Age 2.1 fish returning from 701 age 2.0 smolts emigrating in 1979. Only 31 Age 1.0 smolts were estimated in the 1979 Bear Lake out-migration. Mean for lengths for Age 1.2 males and females were 560.4 and 526.6 mm, respectively.

Pink salmon first entered the trap in late July, and eventually moved downstream to spawn from mid-August to early September. An estimated 13,300 pink salmon spawned in lower Bear Creek in 1980 (Kyle, personal communication).

One chum salmon was captured in the upstream trap on September 12. This species is relatively uncommon in Bear Creek in any year.

Upstream migrating Dolly Varden ascended Bear Creek to the weir in mid-July, 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.

Enhanced Coho Salmon Production:

Marked (Ad-CWT) coho spawning escapements bound for Seward Lagoon and Grouse Lake were estimated at 384 and 143 adults, respectively. A total of 85 RV and 103 LV marked coho were estimated in the Bear Creek and Bear Lake

escapements, respectively. Also, unmarked coho escapements attributed to unmarked segments of 1979 Seward Lagoon, Grouse Lake, Bear Creek, and Bear Lake smolt releases were 2,045, 524, 287, and 4,157 adults, respectively. These escapements include observed strays in local index streams and coho salmon estimated taken in the shore fishery after the Resurrection Bay sport trolling effort terminated (Table 16). Overall smolt-to-adult survival of marked and unmarked Bear Lake smolts was 5.14%, or 1.14% higher than that realized for the 1978 Bear Lake out-migration. It is noted that Bear Lake smolts in 1979 were more robust ($K=1.05$) than smolts in 1978 ($K=0.99$) on the average. Total estimated smolt-to-adult survival of the Bear Creek hatchery smolt lot, however, was only 2.18% or nearly 3.0% lower than that of Bear Lake smolts. The reason for this relatively low survival is unknown in view of the successful returns from the two previous Bear Creek plants, and that Bear Creek hatchery smolts were about the same size (18.2 g - 25/lb) as Bear Lake smolts (19.5 g - 23/lb) in 1979. Total smolt survival of the Seward Lagoon and Grouse Lake hatchery smolt plants were estimated at 4.04% and 3.04% respectively. Summaries of total survivals for Bear Lake, Seward Lagoon, Bear Creek and Grouse Lake smolt releases are presented in Tables 18, 19, 20 and 21, respectively.

DISCUSSION

Since 1976, Bear Lake has been stocked at approximately 1,250 instead of formerly (1972-1975) 2,500 coho salmon fingerlings per hectare with the following results: (1) Though Bear Lake averaged about 1,700 fewer smolts per year (1977-1979) at the reduced stocking density, fingerling-to-smolt survival increased 70% over the previous (1973-1976) smolt production period; (2) the percentage of fingerling releases resulting in yearling (Age 1.0) smolts increased from only 3% (1975) to 43% (1979), with yearling smolt-to-fingerling biomass (kg) ratios similarly rising from 0.4:1 to 5.9:1 in that time span; (3) healthier, more robust smolts in 1977-1979 (condition factor $K=1.02$) averaged 66% higher smolt-to-adults survival than their earlier counterparts with $K=0.97$.

Although the 1980 yearling smolt biomass ratio (6.8:1) produced from the 1979 Bear Lake fingerling plant was the highest observed since 1973 (8.9:1), approximately 26,000 fewer age 1.0 smolts resulted from the small fingerlings stocked. Only 24.2% of the 1979 fingerling plant emigrated as age 1.0 smolts, compared to 43.0% for the 1978 fingerling release, resulting in nearly a 500 kg reduction in total smolt biomass produced. It is not known whether a large portion of the 1979 plant died at Age 0.0, or chose to remain in Bear Lake as Age 1.0 residuals to emigrate as Age 2.0 smolts in 1981. The latter occurred in 1975 from the 1973 Bear Lake fingerling release, consisting of fish averaging the same size (1,500/kg or 681/lb), when 34.6% of that plant produced Age 2.0 smolts. Should this prove to be the case for the 1979 plant, an unhealthy situation may exist for the 1981 fingerling release due to an abundance of predatory Age 2.0 smolts remaining in Bear Lake simultaneous with stocking small fingerlings. Therefore, future Bear Lake fingerling releases should consist of fish averaging no smaller than 772/kg (350/lb) to allow the major portion to emigrate as yearling smolts.

Table 18. Survival of Bear Lake Coho Salmon Adults from Seaward Migrations of Smolts Fin Marked at Bear Creek Weir, 1975-1979.

Seaward Migration Year	Number of Smolt Release	Age Composition of Out-Migration	Mean Fork Length (mm)	Fin-clip Used	Number of Adults Returning*	Percentage Return
1975	11,532	8.0% - Age 1.0	107.3	Ad	1,603	1.12
	131,180	91.4% - Age 2.0	129.2	Ad		
	877	0.6% - Age 3.0	150.7	Ad		
	<u>143,589</u>					
1976	63,674	68.7% - Age 1.0	106.3	Ad-RV	2,674	2.88
	28,031	30.2% - Age 2.0	134.9	Ad-RV		
	1,010	1.1% - Age 2.0	161.0	Ad-LV		
	<u>92,715</u>					
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		
	139	0.1% - Age 4.0	192.0	Ad-LV		
	<u>99,844</u>					
1978**	80,886	82.2% - 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>					

* Includes boat and shore sport harvest estimates.

** Marked only 25.0% of out-migration.

*** Marked only 10.0% of out-migration.

Table 19. A Summary of Hatchery Reared Coho Salmon Smolt Release 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) No.	%	1-Ocean 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

* Includes boat and shore sport harvest estimates.

** Release consisted of 74,220 unmarked (75.9%) and 23,620 marked (24.1%) smolts.

Table 20. A Summary of Hatchery Reared Coho Salmon Smolt Releases in Lower Bear Creek.

Brood Year	Origin	Mark	Smolt Liberation Data			Adult Return Data*				Total Number	Return Percent
			Release Data	Number	Fish/kg(lb)	0+Ocean(jacks)		1-Ocean			
						No.	%	No.	%		
1967	Oregon	Ad	5/8-13/69	47,470	30.4 (13.8)	8	0.02	17	0.04	25	0.05
1968	Bear Lake	Ad	5/27/70	6,400	22.7 (10.3)	76	1.19	285	4.45	361	5.64
1969	Bear Lake	Ad	5/18-21/71	51,100	31.3 (14.2)	14	0.03	178	0.35	192	0.38
1970	Kodiak	Ad	5/15-24/72	155,500	32.3 (14.8)	155	0.10	470	0.30	625	0.40
1974	Bear Lake	Ad-LV	5/12-14/76	35,600	25.1 (11.4)	16	0.05	756	2.12	772	2.17
1975	Bear Lake	Ad-RV	5/13-15/77	35,100	23.1 (10.5)	436	1.24	1,709	4.87	2,145	6.11
1976	Seward Lagoon	Ad-CWT	5/31/78	28,574	22.2 (10.0)	153	0.54	1,343	4.70	1,496	5.24
1977	Bear Lake	Ad-CWT**	5/18/79	40,400	55.1 (25.0)	0	0.00	881	2.18	881	2.18

* Includes boat and shore sport harvest estimates.

** A total of 29,200 smolts (72.3%) were unmarked and 11,200 (27.7%) were marked.

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.	%	Nos.	%		
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	5/30/78	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

* Includes boat and shore sport harvest estimates.

** A total of 11,750 smolts (26.7%) were marked, 32,250 (73.3%) were unmarked.

Barring future egg shortages, the current Bear Lake stocking density (1,250/hectare or 500/acre) will be maintained until findings indicate it should be readjusted to increase smolt production in the future. Despite the reduced Age 1.0 smolt production in 1980, Bear Lake's optimum annual smolt yield under natural conditions still appears to approximate 100,000 smolts with $K=1.01$ for a total biomass production of 2,100 kg.

It may be possible to increase Bear Lake's carrying capacity of juvenile coho via artificial fertilization of its rearing environment. The F.R.E.D. Division limnological research section has collected baseline data on Bear Lake's water chemistry, primary productivity levels, benthic communities and zooplankton populations during the past 2 years to determine the feasibility of conducting such an experiment in Bear Lake. Although the Bear Lake Enhancement Report has not yet been finalized, preliminary findings indicate that the lake's salmon production likely will benefit from artificial nutrient enrichment. Depending on final recommendations concluded from the report, and possible sources of funding, artificial fertilization of Bear Lake under carefully controlled conditions may commence in the near future.

Two variable mesh (1/2" - 2" bar measure) monofilament gill nets were set in Seward Lagoon on November 24 to obtain a holdover abundance index estimate of June's 0-age coho smolt plant (100,800 at 39/lb). The 4.0 juvenile coho catch per net-hour was twice the highest catch rate (July, 1972 - 2.0 coho/net-hr) observed for residual Age 1.0 planted smolts in Seward Lagoon since 1970. The Age 0.0 fish sampled ($n=51$) averaged 112.5 mm and 14.61 g, were 36% Ad-CWT marked, and probably represent the smallest individuals at time of release. Test-netting will be conducted again in the spring of 1981, prior to the 1981 0-age smolt release, to compare that CPUE with the previous fall's.

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