

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

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Resurrection Bay Area

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Period Covered: July 1, 1977 to June 30, 1978.

ABSTRACT

Bear Lake was restocked with 277,700 age 0.0 coho salmon, Oncorhynchus kisutch (Walbaum), fingerlings on June 16, 1977 to maintain smolt production.

The Bear Creek weir downstream migrant trap was operated continuously from May 16 through September 12. A total of 99,970 age 1.0, 2.0, 3.0 and 4.0 coho smolts were enumerated. Age 1.0 smolt survival of the 1976 Bear Lake fingerling plant was 22.2%.

Bear Lake's smolt out-migration timing and abundance, age and size compositions, and condition factors are presented. Bear Creek water temperatures and stream flows corresponding to migration peaks and durations are also given. The increase in Bear Lake's age 1.0 smolt production due to lowered rearing coho population densities since 1975 is reviewed.

The Resurrection Bay creel census (July 9 - September 7) indicated an estimated 16,345 coho were harvested by 23,997 man-days of sport effort. The mean seasonal catch per angler hour was 0.113 coho. Marked (fin-clipped) adult coho contributed 28.4% to the sport harvest. Most of these (57.0%) survived from 100,600 age 1.0, hatchery-reared, LV marked smolts planted in Seward Lagoon in May, 1976. An additional 25.0% resulted from 35,200 age 1.0 (same brood and origin) RV marked, hatchery-reared smolts released in Grouse Lake in May, 1976. Adult survival of age 1.0, 2.0 and 3.0 Bear Lake smolts, Ad-RV marked and released at Bear Creek weir in 1976, comprised 9.6%, and survival of 35,600 age 1.0 Ad-LV marked, hatchery-reared smolts released in lower Bear Creek contributed 8.4% to the marked adult harvest. Marked immature coho contributed an additional 5.2% to the sport harvest. These juveniles resulted from marked, hatchery-reared smolts stocked in the above waters in May, 1977.

The Bear Creek weir upstream migrant trap was operated continuously from May 16 through November 3. The adult coho upstream migration extended from August 25 to October 31 and consisted of 2,687 adults and 435 jacks. The adults were comprised of 1,301 Ad-RV, 166 Ad-LV, 859 Ad, 44 LV, 38 RV, and 279 unmarked coho. Most (91.7%) of the jacks returned from 35,100 age 1.0 (1975

brood, Bear Lake origin) Ad-RV hatchery-reared smolts released in lower Bear Creek in May, 1977. Total smolt-to-adult survivals per release lot were 2.9% Bear Lake out-migration, 2.2% Bear Creek, 4.3% Grouse Lake and 5.1% Seward Lagoon. Total survivals of smolt out-migrations from Bear Lake 1973 to 1976, Bear Creek 1969 to 1976, and Seward Lagoon 1968 to 1976 smolt releases are summarized. The overall catch-to-escapement ratio of marked Seward Lagoon, Grouse, and Bear Lake adult coho was 0.96:1. The adult male-to-female sex ratio was 2.0:1 in the Bear Creek escapement. An estimated 2,406,500 fertilized eggs were artificially spawned from 527 females and 116 males from the Seward Lagoon and Bear Lake returns. Mean fecundity was 4,566 eggs per female.

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

BACKGROUND

Wild coho 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 sport fishery has been the largest marine sport fishery for this species in Alaska. Therefore, there was a definite need to stabilize Resurrection Bay coho production to satisfy the rapidly growing angler demand in the fishery.

Bear Lake, located seven 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 that 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, O. nerka (Walbaum), (1961-1965); and 1,543 Dolly Varden, Salvelinus malma (Walbaum), (1961-1962). Downstream migrations in 1962-1963 averaged 7,933 coho smolts, 51,232 sockeye smolts, and 17,838 Dolly Varden. Though threespine stickleback, Gasterosteus aculeatus Linnaeus, 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 ppm (5% level) on August 26, 1963. A 1.5 meter (5-foot) high dam was erected at the 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 during 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 in 1963-1965, coho smolt production undoubtedly would have been considerably higher. Bear Lake's enhanced smolt production increased pre-rehabilitation abundances of adult sockeye by 11 fold and coho by 3.5 fold.

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 lowered. 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 fish-tight 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 powered rotenone was used. Overall treatment level was 1.6 ppm rotenone at 5% concentration. Caged live fish suspended from surface to bottom; 12 to 18 meters (40 to 60 feet), were all dead within one week. Population sampling two days following rehabilitation showed that threespine sticklebacks comprised 98.8% of the total 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 by electrofishing or at Bear Creek weir since the 1971 rehabilitation.

RECOMMENDATIONS

1. Retain the present objectives of the study.
2. Construct a permanent coho adult trapping-holding facility in Seward Lagoon.
3. Continue to investigate the Resurrection Bay drainage for potential coho rearing pond sites.
4. Adjust the 1979 stocking density of coho fingerlings in Bear Lake according to emigrating smolt and residual fingerling abundance, age composition and condition factor in 1978.
5. Continue to mark 25% of Bear Lake smolt out-migrations to determine whether this reduced handling will result in improved smolt-to-adult survival.

OBJECTIVES

1. To determine the distribution, abundance, and timing of outmigrant and adult coho salmon in the Resurrection Bay area.
2. To determine the age and size composition of outmigrant and adult coho salmon populations in selected tributaries.
3. To determine the sport harvest and fishing mortality of coho salmon 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

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.

Age and size composition of Bear Lake sockeye and coho smolt populations were determined by weekly sampling at the weir. Age and size structures of Bear Lake's stocked coho fingerling population were estimated by length-frequency analysis of an electrofishing sample taken in October. Age compositions of Bear Lake sockeye and coho smolt and Resurrection Bay adult coho populations were determined by examining representative scale impressions on 0.02-inch cellulose acetate with a Bruning model 200 microfiche. Smolt abundance per age group was calculated by extrapolating their age composition, as determined in weekly scale sample analysis, to the total number of smolts emigrating during those weekly periods. Age compositions of adult Bear Lake sockeye and coho returns were not sampled because the sockeye were too scarce and wild coho returning from natural production below the weir were indistinguishable from Bear Lake smolts released unmarked in 1976. Size composition of Bear Lake's coho escapement was determined by representatively sampling the migration for fork length, weight and sex. All fish sampled were anesthetized in a 1:20,000 solution of MS-222 (Tricaine methanesulfonate) to facilitate handling and minimize 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 10:00 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 three 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 marked (fin-clipped) adult coho were determined by extrapolating the marked coho catch observed during creel census and by recording marked coho in the Bear Lake, Grouse Creek and Seward Lagoon spawning escapements.

An index to Resurrection Bay coho escapement abundance was measured by conducting weekly foot surveys on seven local index streams throughout immigration until peak of spawning terminated. All carcasses were examined for clipped fins, sexed, and mutilated to preclude recounting on subsequent surveys.

Evaluation of Bear Lake's rehabilitated freshwater rearing environment was continued by measuring the abundance, growth and condition of smolts surviving from the 1974, 1975 and 1976 coho fingerling plants. Smolt biomass (kilograms) production was calculated by multiplying the seasonal mean smolt weight (grams) by the total number of smolts emigrating per age group in 1977.

FINDINGS

Results

The findings presented are the result of the 1977-1978 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 (1970-1977).

Bear Lake Coho Smolt Migration:

The Bear Creek weir downstream migrant trap was operated continuously from May 16 through September 12. The trap was removed on the latter date due to cessation of the Bear Lake smolt emigration. Abundance and timing of the coho salmon, O. kisutch (Walbaum), smolt out-migration are shown in Table 1. Coho were designated "smolts" based on typical smolt characteristics (silvery pigment, loss of parr marks) rather than size alone. If the fish did not have these traits they were defined "fingerlings" regardless of size. All fingerlings were retained above the weir or restocked in Bear Lake if sufficiently abundant in the trap to warrant hauling by truck.

The smolt out-migration to the downstream trap totaled 99,970 smolts. Trap mortality claimed only 126 smolts (0.1% of the out-migration). A total of 99,844 live smolts were released downstream. A predetermined 25% of the out-migration received an adipose - left ventral (Ad-LV) fin-clip for recognition in the 1978 Resurrection Bay sport fishery and upon return to Bear Creek. Table 2 shows the number and percentage of smolts marked and sampled for age, size and condition each weekly period for the season.

Smolt emigration began on May 19, peaked (50% of out-migration) on June 13, and terminated September 10. The highest daily count occurred on June 17 when 6,266 (6.3% of the total run) were enumerated from the trap.

Mean stream temperatures when smolt emigration began, peaked, and terminated were 4.2°C (39.5°F), 12.2°C (54.0°F), and 13.1°C (55.5°F), respectively. Bear Creek stream flows ranged from 18 to 145 cfs during this period.

The smolt out-migration was comprised of 49.8% (49,752) age 1.0, 48.4% (48,393) age 2.0, 1.7% (1,686) age 3.0, and 0.1% (139) age 4.0 smolts. Tables 3, 4 and 5 present the mean fork length, weight, condition factor and relative percentage of age 1.0, 2.0, and 3.0 smolts in the weekday samples. Insufficient age 4.0 smolts were sampled to warrant tabulation. Table 6 shows the weekly and seasonal smolt abundance per age group. An overall 2.1% (2,100 smolts) was representatively sampled during emigration

Table 1. Bear Lake Coho Salmon Smolts Enumerated at Bear Creek Weir by Weekly Periods, 1977.

Weekly Periods	Number of Smolts		Total
	Live	Dead	
5/13 - 5/19	6	3	9
5/20 - 5/26	31	7	38
5/27 - 6/2	4,899	30	4,929
6/3 - 6/9	29,450	25	29,475
6/10 - 6/16	30,848	18	30,866
6/17 - 6/23	20,262	11	20,273
6/24 - 6/30	7,500	7	7,507
7/1 - 7/7	3,045	8	3,053
7/8 - 7/14	2,456	4	2,460
7/15 - 7/21	717	9	726
7/22 - 7/28	191	4	195
7/29 - 8/4	11		11
8/5 - 8/11	94		94
8/12 - 8/18	190		190
8/19 - 8/25	140		140
8/26 - 9/1	1		1
9/2 - 9/8	1		1
9/9 - 9/15	<u>2</u>	<u> </u>	<u>2</u>
Total	99,844	126	99,970

Table 2. Bear Lake Coho Salmon Smolts Marked and Sampled at Bear Creek Weir by Weekly Periods, 1977.

Weekly Periods	Number of Live Smolts	Number Smolts Fin Clipped	Percent of Weekly Migration*	Number Smolts Sampled	Percent of Weekly Migration*
5/13 - 5/19	6				
5/20 - 5/26	31	15	48.4	10	32.3
5/27 - 6/2	4,899	1,219	24.9	109	2.2
6/3 - 6/9	29,450	7,361	25.0	693	2.4
6/10 - 6/16	30,848	7,712	25.0	612	2.0
6/17 - 6/23	20,262	5,065	25.0	399	2.0
6/24 - 6/30	7,500	1,875	25.0	149	2.0
7/1 - 7/7	3,045	761	25.0	61	2.0
7/8 - 7/14	2,456	614	25.0	49	2.0
7/15 - 7/21	717	179	25.0	14	2.0
7/22 - 7/28	191	28	14.7	4	2.1
7/29 - 8/4	11	7	63.6		
8/5 - 8/11	94				
8/12 - 8/18	190	125	65.8		
8/19 - 8/25	140				
8/26 - 9/1	1				
9/2 - 9/8	1				
9/9 - 9/15	2				
Total	99,844	24,961	25.0	2,100	2.1

*Minus the 125 smolts expiring from trap mortality.

Table 3. Mean Fork Length, Weight and Condition Factor of Age 1.0 Bear Lake Coho Salmon Smolts Sampled Weekly at Bear Creek Weir, 1977.

Weekly Periods	Number of Smolts	Percent of Sample	Mean Length (mm) \pm SD	Mean Weight (g) \pm SD	Condition Factor (K)*
5/27 - 6/2	55	0.5	106.8 \pm 7.6	13.30 \pm 2.44	1.09
6/3 - 6/9	300	43.3	110.7 \pm 6.8	13.77 \pm 2.41	1.02
6/10 - 6/16	275	44.9	113.1 \pm 12.0	14.49 \pm 6.61	1.00
6/17 - 6/23	220	55.1	117.7 \pm 7.5	16.51 \pm 3.38	1.01
6/24 - 6/30	100	67.1	124.8 \pm 6.7	20.48 \pm 3.60	1.05
7/1 - 7/7	49	80.3	128.8 \pm 7.2	22.15 \pm 4.58	1.04
7/8 - 7/14	29	59.2	135.1 \pm 8.5	26.76 \pm 4.64	1.09
7/15 - 7/21	4	28.6	127.8 \pm 18.7	25.55 \pm 10.22	1.22
7/22 - 7/28	2	50.0	124.5 \pm 9.2	23.05 \pm 4.17	1.19

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

Table 4. Mean Fork Length, Weight and Condition Factor of Age 2.0 Bear Lake Coho Salmon Smolts Sampled Weekly at Bear Creek Weir, 1977.

Weekly Periods	Number of Smolts	Percent of Sample	Mean Length (mm) \pm SD	Mean Weight (g) \pm SD	Condition Factor (K)
5/27 - 6/2	49	4.9	124.9 \pm 8.3	20.26 \pm 3.76	1.04
6/3 - 6/9	391	56.4	126.4 \pm 7.9	20.25 \pm 3.87	1.00
6/10 - 6/16	324	53.0	129.6 \pm 8.2	21.09 \pm 4.26	0.97
6/17 - 6/23	167	41.9	132.2 \pm 8.8	21.97 \pm 4.74	0.95
6/24 - 6/30	47	31.6	138.7 \pm 9.0	26.51 \pm 5.98	0.99
7/1 - 7/7	12	19.7	145.1 \pm 6.5	31.55 \pm 4.38	1.03
7/8 - 7/14	19	38.8	146.6 \pm 8.0	34.57 \pm 5.80	1.10
7/15 - 7/21	9	64.3	151.3 \pm 5.1	39.53 \pm 3.56	1.14
7/22 - 7/28	2	50.0	159.0 \pm 4.2	44.85 \pm 1.77	1.12

Table 5. Mean Fork Length, Weight and Condition Factor of Age 3.0 Bear Lake Coho Salmon Smolts Sampled Weekly at Bear Creek Weir, 1977.

Weekly Periods	Number of Smolts	Percent of Sample	Mean Length (mm) \pm SD	Mean Weight (g) \pm SD	Condition Factor (K)
5/20 - 5/26	9	90.0	184.4 \pm 14.0	58.06 \pm 12.40	0.93
5/27 - 6/2	5	4.6	179.0 \pm 5.2	54.28 \pm 7.78	0.95
6/3 - 6/9	2	0.3	175.0 \pm 11.3	51.10 \pm 5.94	0.95
6/10 - 6/16	11	1.8	182.8 \pm 10.3	53.75 \pm 18.33	0.88
6/17 - 6/23	11	2.8	184.4 \pm 13.6	58.83 \pm 14.26	0.94
6/24 - 6/30	2	1.3	176.5 \pm 0.7	49.90 \pm 5.09	0.91
7/1 - 7/7					
7/8 - 7/14	1	2.0	178	60.3	1.07
7/15 - 7/21	1	7.1	165	49.1	1.09
7/22 - 7/28					

Table 6. Relative Abundance and Timing of Ages 1.0, 2.0, 3.0, and 4.0 Bear Lake Coho Salmon Smolts Emigrating to Bear Creek Weir, 1977.

Weekly Periods	Number of Smolts**				Total
	Age 1.0	Age 2.0	Age 3.0	Age 4.0	
5/20 - 5/26*			42	5	47
5/27 - 6/2	2,489	2,213	227		4,929
6/3 - 6/9	12,763	16,624	88		29,475
6/10 - 6/16	13,858	16,359	556	93	30,866
6/17 - 6/23	11,170	8,494	568	41	20,273
6/24 - 6/30	5,037	2,372	98		7,507
7/1 - 7/7	2,452	601			3,053
7/8 - 7/14	1,456	955	49		2,460
7/15 - 7/21	208	467	51		726
7/22 - 7/28	98	97			195
7/29 - 8/4	6	5			11
8/5 - 8/11	47	45	2		94
8/12 - 8/18	95	92	3		190
8/19 - 8/25	70	68	2		140
8/26 - 9/1	1				1
9/2 - 9/8	1				1
9/9 - 9/15	1	1			2
Total	49,752	48,393	1,686	139	99,970
Percent	49.8	48.4	1.7	0.1	100.0

* Includes nine smolts captured during week of 5/13 - 5/19.

** Number of smolts per age group after week of 7/22 - 28 was estimated by overall age composition determined up to that point.

(Table 2). An estimated 49,689 age 1.0, 48,332 age 2.0, 1,684 age 3.0, and 139 age 4.0 smolts were released downstream after mortality.

All smolt age groups peaked during the week of June 10 to 16 when Bear Creek water temperatures averaged 11.8°C (53.3°F). Sixty-two percent (+ 5.6%) of Bear Lake's annual smolt out-migration has been observed in the past five years to be correlated ($r = 0.86$) to the first week of 10.0°C (50.0°F) mean water temperature recorded at the weir. This allows a rough estimate to be made at that time of the total smolts expected from Bear Lake on a given year. In 1977, this prediction overestimated the actual smolt run by 5.4%.

The 1,686 age 3.0 smolts resulted from the third fingerling plant (450,800 age 0.0 fingerlings in 1974) in Bear Lake after the 1971 lake rehabilitation project. Bear Lake coho fingerling plants since 1973 are summarized in Table 7, and smolt production since 1974 (through age 3.0 only) is presented in Table 8. Total fingerling-to-smolt survival for the 1974 plant was only 9.6%, the lowest observed since the 1971 lake rehabilitation. This was caused by excessive densities of rearing fingerlings resulting from overstocking Bear Lake prior to 1976 (McHenry, 1977). Age composition of the third Bear Lake smolt production cycle was 31.1% age 1.0, 65.0% age 2.0, and 3.9% age 3.0.

The 48,393 age 2.0 smolts were produced from 450,000 age 0.0 fingerlings stocked in 1975, and with the 64,083 age 1.0 smolts which emigrated in 1976, represent a 25.0% fingerling-to-smolt survival thus far. Few age 3.0 smolts surviving this plant are expected in 1978, according to population sampling of Bear Lake's residual coho in October, 1977. No age 2.0 fish were detected in length-frequency analysis of the sample ($n = 590$). Annual Bear Lake coho population samples obtained by electrofishing are shown in Table 9. Except for the few age 3.0 smolts anticipated in 1978, age composition of Bear Lake's fourth smolt production cycle was 57.0% age 1.0 and 43.0% age 2.0.

The 49,752 age 1.0 smolts resulted from the fifth annual Bear Lake plant of 224,600 age 0.0 fingerlings in 1976. This was the first fingerling release made since 1972 to reduce stocking density by one half (Table 7.) Fingerling-to-smolt survival of this age group was 22.2%, or 1.6 times the age 1.0 smolt survival (14.2%) of the previous fingerling plant. The aforementioned population sampling disclosed that only 2.0% of the residual coho were age 1.0 in 1977. However, since only moderate correlation ($r = 0.77$) exists between percentage of age 1.0 fingerlings in fall sampling and resultant age 2.0 smolts, relative abundance of the latter in 1978 is unpredictable.

Smolt growth, as the season progressed, was considered excellent, surpassing that of 1976 smolts. The improved growth was manifested in higher condition factors of both age 1.0 and 2.0 smolts from peak of migration through late July. Age 1.0 smolts averaged 113.1 mm and 14.49 g for a condition factor (K) of 1.00 during June 10-16, compared to 106.3 mm and 11.47 g ($K = 0.95$) for age 1.0 smolts during June 24-30 in 1976. The weighted K for age 1.0

Table 7. Summary of Bear Lake Coho Salmon Fingerling Plants Since 1972.

Brood Year	Source of Eggs	Number of Fish	Weight		Size		Density		Dates of Plants	Planning Method
			lbs.	kg.	No./lb	No./kg.	No./acres	No./ha		
1972	Bear Lake	96,900	113	51.3	857	1,889	218	538	June 19	Truck-boat
	Lake Rose Tead*	<u>346,400</u>	<u>538</u>	<u>244.0</u>	<u>644</u>	<u>1,419</u>	<u>778</u>	<u>1,922</u>	June 20	Scattered
	Total**	443,300	651	295.3	681	1,501	996	2,460	1973	
1973	Upper Station*	240,900	476	215.9	506	1,115	541	1,336	July 15	Truck-boat
	Upper Station*	200,900	416	188.7	483	1,064	452	1,116	July 16	Scattered
	Upper Station*	<u>9,000</u>	<u>29</u>	<u>13.2</u>	<u>310</u>	<u>683</u>	<u>20</u>	<u>49</u>	July 16	
	Total**	450,800	921	417.8	489	1,078	1,013	2,502	1974	
1974	Bear Lake	245,600	454	205.9	541	1,192	552	1,363	June 19	Aircraft
	Bear Lake	<u>204,400</u>	<u>455</u>	<u>206.4</u>	<u>449</u>	<u>989</u>	<u>459</u>	<u>1,134</u>	July 1	Scattered
	Total**	450,000	909	412.3	495	1,091	1,011	2,492	1975	
1975	Bear Lake	149,800	433	196.4	346	763	337	832	June 10	Aircraft
	Bear Lake	<u>74,800</u>	<u>185</u>	<u>83.5</u>	<u>405</u>	<u>893</u>	<u>168</u>	<u>415</u>	June 14	Scattered
	Total**	224,600	618	280.3	363	800	505	1,247	1976	
1976	Bear Lake	227,700	780	353.8	292	644	512	1,265	June 16	Truck-boat
									1977	Scattered

* These systems are located on Kodiak Island.

** Weighted averages.

Table 8. Summary of Bear Lake Coho salmon Smolt Abundance and Biomass Produced From Annual Fingerling Plants Since 1972.

Year of Plant	Number Fingerlings and Weight (kg)	Smolt Production by Year				Total Production	Survival to Smolt (%)
		1974	1975	1976	1977		
<u>1973</u>							
Number	443,300	64,119	153,525	1,017		218,661	49.3
Weight (kg)	295.5	1,462.2	3,182.6	71.7		4,716.5	
Weight Ratio		4.9:1	10.8:1	0.2:1		16.0:1	
<u>1974</u>							
Number	450,800		13,487	28,211	1,686	43,384	9.6
Weight (kg)	418.1		155.9	1,029.5	94.1	1,279.5	
Weight Ratio			0.4:1	2.5:1	0.2:1	3.1:1	
<u>1975</u>							
Number	450,000			64,083	48,393	112,476	25.0*
Weight (kg)	412.7			915.6	1,050.6	1,966.2	
Weight Ratio				2.2:1	2.5:1	4.8:1	
<u>1976</u>							
Number	224,600				49,752		
Weight (kg)	280.3				795.5		
Weight Ratio					2.8:1		22.2**

* Data is minimal because age 3.0 smolts (1978 out-migration) are not included in total production.

** Includes only age 1.0 smolt production.

Table 9. Age Composition of Bear Lake Residual Coho Populations Sampled by Electrofishing in October, 1973-1977. (Mean Fork Length Per Age Group in mm Shown in Parentheses).

Sampling Year	No. Fish Sampled	Catch Per Hour	Age Composition*			
			0.0	1.0	2.0	3.0
1973	349	462	75.4% (88.1)	24.6% (131.2)		
1974	325	645	40.9% (73.4)	52.3% (124.4)	6.8% (163.8)	
1975	506	510	86.4% (77.0)	9.5% (114.7)	1.0% (159.6)	3.1%** (192.0)
1976	500	418	91.2% (85.8)	7.2% (118.0)	1.0% (161.0)	0.6% (186.0)
1977	590	788	97.8% (93.4)	2.0% (124.5)		0.2% (185)

* Determined by age group separation points in length-frequency analysis.

** Comprised of sexually mature males attempting to spawn.

smolts was 1.02 compared to 0.95 in 1976 during the same sampling period (June 3 - July 28). Similarly, age 2.0 smolts averaged 129.5 mm and 21.09 g ($K = 0.97$) during June 10-16, compared to 134.9 mm and 22.45 g ($K = 0.91$) during June 24-30 in 1976. Weighted K for age 2.0 smolts was 0.98 compared to 0.92 in 1976 during the above sampling period.

Though Bear Lake's estimated smolt biomass production was slightly lower (76.6 kg) than in 1976 (Table 8), it is expected to improve substantially in 1978. The ratio of age 1.0 smolt biomass yield per annual fingerling plant (kg) declined abruptly from 8.9:1 (1973) to 0.4:1 (1975), then increased to 2.2:1 (1976) and 2.8:1 in 1977. Also, weighted mean condition factor for all smolts sampled per year exhibited a similar pattern: $K = 0.98$ (1973), dropped to 0.89 (1975), but returned to 0.98 (1976) and further increased to 1.02 in 1977. These suggest that Bear Lake is recovering its optimum age 1.0 smolt production capability through lowered rearing population density, thereby resulting in less intraspecific competition for fingerling growth and survival to early smoltification.

Bear Lake's residual fingerling population may be at its highest level of abundance according to fall population sampling (Table 9). Despite that Bear Lake was restocked at one-half previous stocking densities for the second consecutive year, 1.1 electrofishing hours captured 867 fingerlings (788 coho/hr.). This catch rate is the highest recorded in the five years of sampling Bear Lake's coho population by this method, and may reflect a similar degree of fingerling abundance in 1977. It is anticipated that a large portion of the age 0.0 residuals will result in age 1.0 smolts in 1978 due to their mean size (93.4 mm) when sampled.

Other Species:

The total sockeye salmon, *O. nerka* (Walbaum), smolt out-migration enumerated from the trap was 857 fish. Trap mortality claimed only nine smolts, or 1.1% of the downstream migration. The first smolt was captured on May 21, and the last on July 20. The highest daily count occurred on June 13 when 169 smolts (19.7% of the migration) were enumerated. The majority (88.8%) emigrated between June 1 and 30, when water temperatures ranged from 8.3°C to 16.7°C (47°C-62°F) and stream flows from 32 to 69 cfs. The smolt out-migration was comprised of 573 (66.9%) age 3.0 and 284 (33.1%) age 2.0 smolts. Age 3.0 smolts resulted from the 1973 escapement of 145 females and 91 males. Including the 1,044 age 1.0 and 868 age 2.0 smolts which emigrated in 1975 and 1976, respectively, the total smolt production was 2,485 smolts (17.1 per female) for the second, post-rehabilitation sockeye escapement into Bear Lake. Age 2.0 smolts were produced by the 36 females and 24 males that spawned in Bear Lake in 1974. With the six age 1.0 smolts resulting from this parent brood in 1976, a total of 290 smolts (8.1 per female) have survived thus far. Age 3.0 smolts peaked during the week of June 10-16 followed by age 2.0 smolts one week later. At peak of migration, age 2.0 and 3.0 smolts averaged 177.0 and 187.7 mm in fork length, respectively. Condition factors per age group during migration peaks were 0.91 (age 2.0) and 0.86 (age 3.0).

A total of 421 Dolly Varden, Salvelinus malma (Walbaum), were captured in the downstream trap and released below the weir. No threespine sticklebacks, Gasterosteus aculeatus Linnaeus, were captured in the trap nor observed while electrofishing in Bear Lake.

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 9 and terminated September 7. Very few coho were taken before the creel census since most sport fishing effort was directed toward the more abundant rockfish, Sebastes spps., from mid-May through early July.

The season's total harvest was an estimated 16,345 coho. This estimate was extrapolated from interviews with 6,501 anglers harvesting 4,316 coho during the creel census period. Peak of the harvest occurred on August 13, first day of the Seward Silver Salmon Derby, when an estimated 1,054 fish (6.4% of the season's harvest) were taken. The season's total and derby harvests are summarized for 1973 through 1977 in Table 10.

The total sport fishing effort exerted for Resurrection Bay coho was an estimated 23,997 man-days. Twenty-seven percent 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, 3.23; weekends, 3.37; and the salmon derby 3.27. Fishing effort and mean seasonal catch per hour are summarized in Table 12. The fishing effort was 7,220 man-days on weekdays and 7,656 on weekends, excluding the derby. Military personnel and dependents, fishing on boats provided by the Army and Air Force recreation camps at Seward, contributed 11.6% (2,781 man-days) to the total effort. The seasonal mean catch per hour was 0.113 coho. Civilian anglers fishing on weekdays realized the highest coho catch per hour (0.156), whereas the lowest catch rate (0.062) occurred during the derby when effort was the greatest. The average number of hours anglers fished per day were as follows: weekdays, 5.51; weekends, 5.43; and salmon derby 6.31.

Examination of 303 scale samples randomly collected throughout the sport fishery disclosed that the wild coho population was comprised of 70.6% age 1.1, 27.4% age 2.1, and 2.0% age 3.1 adults. This age composition is similar to that of the 1976 sample (77.0% age 1.1, 21.6% age 2.1, and 1.4% age 3.1 fish). The dominant age class of wild Resurrection Bay coho populations has changed from age 2.1 (4-year-old) to age 1.1 (3-year-old) fish (McHenry, 1977). Mean fork lengths and weights of wild coho are presented in Table 13. The male-to-female sex ratio was 1.3:1 in the fishery.

Chinook, O. tshawytscha (Walbaum), and pink salmon, O. gorbuscha (Walbaum), were taken incidentally with coho during the season. An estimated 321 chinook salmon were harvested during the census period at an average rate of 0.05 per boat. This species was most abundant during mid-July when anglers averaged 0.27 fish per boat. Most chinook salmon taken were immature fish in their first and second ocean years. Origins of these

Table 10. Derby and Total Sport Harvest of Coho Salmon in Resurrection Bay, 1973-1977.

Year	Total Sport Harvest	Derby Harvest	% Derby Harvest
1973	13,911	4,334	31.2
1974	18,629	5,646	30.3
1975	19,793	3,799	19.2
1976	9,456	2,708	28.6
1977	16,345	6,007	36.8

Table 11. Mean Number and Percentage of Sport Fishing Boats Returning to the Seward Small Boat Harbor During Each Sampling Period, 1977.

Periods (hours)	Weekends		Weekdays	
	Mean No. of Boats	Percent	Mean No. of Boats	Percent
8:00 am - 11:30 am*	13.9	11.6	7.0	14.3
11:30 am - 3:00 pm	24.3	20.2	8.9	18.2
3:00 pm - 6:30 pm	53.3	44.3	18.9	38.7
6:30 pm - 10:00 pm	<u>28.7</u>	<u>23.9</u>	<u>14.1</u>	<u>28.8</u>
Total	120.2	100.0	48.9	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, 1973-1977.

Year	Period of Census	Total Effort	Derby Effort	% Derby Effort	Catch Per Hour
1973	7/7 - 9/9	24,301	9,885	40.7	0.095
1974	7/2 - 9/9	25,902	10,225	39.5	0.109
1975	7/9 - 9/7	20,047	5,871	29.3	0.135
1976	7/8 - 9/12	19,681	8,421	42.8	0.084
1977	7/9 - 9/7	23,997	9,121	38.0	0.113

Table 13. Mean Fork Length (mm) and Weight (kg) of Wild Adult Coho Salmon Sampled From the 1977 Resurrection Bay Sport Fishery.

	Number of Fish	Mean Length (mm) and SD	Mean Weight (kg) and SD
Males	182	675.4 + 66.4	4.41 + 1.37
Females	143	659.7 + 48.3	3.02 + 0.89
Total	325	668.5 + 59.6	4.18 + 1.21

stocks are unknown as chinook salmon rarely ascend Resurrection Bay streams. An attempt is being made, however, to establish a chinook run in Box Canyon Creek, tributary to Resurrection River. Hatchery Services released 25,100 age 0.0 (1975 brood, Ship Creek origin) smolts marked with an LV clip on June 3, 1976 and 50,000 age 0.0 (1976 brood, Ship Creek origin) smolts with an RV mark on June 1, 1977 in Box Canyon Creek. Several LV marked age 0.1 jacks returning from the 1976 release were observed during creel census. Age 0.2 jacks from this lot as well as RV marked 0.1 jacks from the 1977 release are expected in 1978.

Resurrection Bay pink salmon reverted to their odd-year level of abundance despite being produced by an apparently large parent brood in 1975. The estimated pink salmon harvest in 1977 (1,094 fish) was only 41.1% of that estimated taken in 1975 (2,659 fish). However, the latter evidently were harvested from stocks bound for systems elsewhere, as Resurrection Bay streams had typically poor, odd-year spawning escapements in 1975 (McHenry, 1976). Negligible spawning escapements in local streams (Schroeder, personal communication) further confirmed that the return of Resurrection Bay pink salmon was relatively weak in 1977. This species was most abundant in mid-July when anglers averaged 0.60 fish per boat. Pink salmon catch per boat averaged 0.15 fish for the census period.

Bear Lake Upstream Migration:

The Bear Creek weir upstream migrant trap was operated continuously from May 16 through November 3. The first adult coho entered the trap on August 25 and the last one was captured October 31. An estimated 157 coho spawned below the weir according to foot surveys made after the adult run had entered the trap.

A total of 2,687 adults and 435 jacks were enumerated from the trap. Abundance and timing of the adult coho migration are shown in Table 14. Weekly breakdown of the adult and jack migrations by release lot are presented in Tables 15 and 16.

The adult migration peaked (50%) on September 26, and the highest daily count of 141 fish (5.2% of the adult run) occurred on October 10. Mean stream temperatures at the beginning, peak, and end of migration were 15.3°C (59.5°F), 9.4°C (49°F), and 3.6°C (38.5°F), respectively. Most of the migration (74.7%) occurred from September 9 through October 20 when Bear Creek temperatures ranged from 3.9°C to 13.9°C (39°F - 57°F) and flows, from 17 cfs to 81 cfs.

Since no Ad (only) marked smolts were released in Bear Creek in 1976, the 859 Ad adults returning in 1977 (Table 15) resulted from ventral fin regeneration in the Ad-RV and Ad-LV lots. The 859 Ad fish, therefore, were apportioned to those groups on the basis of their relative abundance at the weir (88.7% Ad-RV vs. 11.3% Ad-LV). This assumes that both lots experienced equal ventral fin regeneration. Time did not permit measuring ventral fins of Ad marked fish or recording ventral fin abnormalities on Ad-RV and Ad-LV fish.

Table 14. Bear Lake Adult Coho Salmon Enumerated Through Bear Creek Weir by Weekly Periods, 1977.

Weekly Periods	Marked	Unmarked*	Male	Female	Total
8/19 - 8/25	47	3	49	1	50
8/26 - 9/1	55	3	51	7	58
9/2 - 9/8	161	21	162	20	182
9/9 - 9/15	541	46	404	183	587
9/16 - 9/22	249	24	186	87	273
9/23 - 9/29	385	57	296	146	442
9/30 - 10/6	228	30	157	101	258
10/7 - 10/13	401	51	277	175	452
10/14- 10/20	204	27	126	105	231
10/21- 10/27	109	16	67	58	125
10/28- 11/3	<u>28</u>	<u>1</u>	<u>15</u>	<u>14</u>	<u>29</u>
Total	2,408	279	1,790	897	2,687

* Adults returning from natural smolt production below the weir.

Table 15. Marked Adult Coho Salmon Enumerated Through Bear Creek Weir by Weekly Periods, 1977.

Weekly Periods	Mark (Fin-clip)*					Total
	Ad-RV	Ad-LV	Ad	LV	RV	
8/19 - 8/25	20		27			47
8/26 - 9/1	22	1	32			55
9/2 - 9/8	84	2	75			161
9/9 - 9/15	245	6	290			541
9/16 - 9/22	171	5	73			249
9/23 - 9/29	256	16	111	2		385
9/30 - 10/6	149	7	71		1	228
10/7 - 10/13	247	38	112		4	401
10/14- 10/20	76	42	51	24	11	204
10/21- 10/27	29	37	14	10	19	109
10/28- 11/3	<u>2</u>	<u>12</u>	<u>3</u>	<u>8</u>	<u>3</u>	<u>28</u>
Total	1,301	166	859	44	38	2,408

* Ad-RV (adipose-right ventral)-1976 Bear Lake smolts marked at weir
 Ad-LV (adipose-left ventral)-1976 Bear Creek smolt release
 Ad (adipose)-Resulting from ventral fin regeneration of above marks
 LV (left ventral)-1976 Seward Lagoon smolt release
 RV (right ventral)-1976 Grouse Lake smolt release

Table 16. Marked Jack Coho Salmon Enumerated Through Bear Creek Weir by Weekly Periods, 1977.

Weekly Periods	Mark (Fin-clip)*				Unmarked	Total
	Ad-RV	Ad-LV	LV	RV		
8/19 - 8/25	1				1	2
8/25 - 9/1	6			1		7
9/2 - 9/8	24				1	25
9/9 - 9/15	118	1			2	121
9/16 - 9/22	53	1	1			55
9/23 - 9/29	42		4			46
9/30 - 10/6	21	1	3			25
10/7 - 10/13	94		4	1		99
10/14- 10/20	37		4	6	2	49
10/21- 10/27	3		3			6
10/28- 11/3	—	—	—	—	—	—
Total	399	3	19	8	6	435

* Ad-RV (adipose-right ventral)-1977 Bear Creek smolt release
 Ad-LV (adipose-left ventral)-1977 Bear Lake smolts marked at weir
 LV (left ventral)-1977 Grouse Lake smolt release
 RV (right ventral)-1977 Seward Lagoon smolt release
 Unmarked-1977 smolts from either natural production below weir or unclipped Bear Lake smolts.

An estimated 2,063 Ad-RV coho (1,301 + 762 Ad) returned to the weir, with an additional 80 that spawned below the weir and 85 which strayed to Grouse Creek. The total Ad-RV coho escapement, therefore, was an estimated 2,228 fish. These fish returned from the 92,715 age 1.0, 2.0 and 3.0 Bear Lake smolts marked and released past Bear Creek weir in 1976. Marine survival of this group was 2.4%.

An estimated 263 Ad-LV coho (166 + 97 Ad) returned to the weir, with an additional 24 that spawned below the weir and 80 which strayed into local streams. The total Ad-LV coho escapement, therefore, was an estimated 367 fish. These fish resulted from 35,600 age 1.0 (1974 brood, Bear Lake origin) smolts marked at Fort Richardson and released by Hatchery Services in Bear Creek below the weir on May 12-14, 1976. Marine survival of this lot was 1.0%.

The 44 LV coho enumerated from the trap, plus 10 that spawned below the weir and 65 that strayed into local streams, totaled 119 LV adults. These fish strayed from the 1976 smolt release in Seward Lagoon. The 38 RV coho recorded at the weir, with an additional 23 that spawned below the weir and 4 observed in local streams, totaled 64 RV adults. These fish strayed from the 1976 Grouse Lake smolt release. The 279 unmarked adults in the trap evidently resulted from natural smolt production below the weir in 1976. Only 13 smolts were released unmarked past the weir in 1976.

Most (91.7%) of the jack coho migration resulted from prematurely returning Ad-RV hatchery-reared smolts released in Bear Creek below the weir. These fish (35,100) were age 1.0 (1975 brood, Bear Lake origin) and averaged 10.5 per pound in mid-May, 1977 when stocked. In contrast, only three of the 24,961 Bear Lake smolts marked and released at Bear Creek weir returned as jacks. Bear Lake smolts averaged 23 per pound (19.68 g) overall. The six unmarked jacks evidently returned from the 74,883 Bear Lake smolts released unmarked. Straying of jack coho was also noted from the 35,100 LV and 100,450 RV marked, hatchery-reared smolts released in Grouse Lake and Seward Lagoon, respectively. These fish were of the same brood, origin and approximate weight as the Bear Creek smolt release.

Most of the Department's coho egg requirements for the Southcentral region's needs were obtained from the Bear Creek and Seward Lagoon adult returns. A total of 319 males and 819 females (78 from Seward Lagoon) were held to ripen in the Bear Creek holding facility from August 21 to October 28. Stream temperatures ranged from 2.2°C to 16.7°C (36°F - 62°F) during this period. Male and female holding mortalities were 14.4% and 13.6%.

A total of 527 females and 116 males were artificially spawned, yielding an estimated 2,406,500 fertilized eggs. Mean fecundity was 4,566 eggs per female. Eggs were fertilized at an average ratio of 1 male: 4.5 females. Dead egg loss after shocking at Fire Lake Hatchery averaged only 4.0% (Ratray, personal communication).

Mean Fork length and weight of adult coho sampled at the weir are presented in Table 17. It is interesting to note that although females averaged 33 mm less in fork length than did males (n = 85, \bar{x} FL = 691.0 mm) in 1976,

Table 17. Mean Fork Length (mm) and Weight (kg) of Adult Coho Sampled at Bear Creek Weir in 1977.

Lot	Males			Females			Sexes Combined		
	No.	FL	Wt.	No.	FL	Wt.	No.	FL	Wt.
Ad-Rv	368	628.2	3.08	190	656.5	3.77	558	637.8	3.32
Ad-LV	31	632.9	2.91	12	689.8	4.17	43	648.8	3.26
Ad (only)	231	617.9	2.95	117	652.3	3.66	348	629.5	3.19
LV	11	678.9	3.54				11	678.9	3.54
RV	11	631.8	2.87	2	663.5	3.50	13	636.7	2.97
Unmarked	<u>70</u>	<u>648.4</u>	<u>3.37</u>	<u>42</u>	<u>670.5</u>	<u>3.87</u>	<u>112</u>	<u>656.7</u>	<u>3.56</u>
Total	722	627.9	3.06	363	657.9	3.76	1,085	637.9	3.29

mean fecundity averaged 413 more eggs per female in 1977. Females (n - 417) averaged 4,153 eggs in 1977. Both sexes were substantially smaller in size compared to 1976 adults returning to the weir.

The male-to-female sex ratio, excluding jacks, was 2.0:1 in the Bear Creek escapement. All spawned carcasses were deposited in Bear Lake for natural fertilization.

Other Species:

Only 35 adult sockeye salmon were passed above the weir despite an escapement of possibly 10 times this number returning to Bear Creek between June 9 and August 24. An electrical ground problem, subsequently discovered by city electric utility crews to be caused by deteriorated thaw wires installed by the Alaska Railroad Commission, stopped the entire upstream migration of sockeye below the weir where the field was evidently strongest. Although many fish were killed directly by repeated or constant exposure to the electricity, most probably died due to molestation and illegal taking by the local public. Of the eight sockeye sampled, seven were age 1.3 and one was age 2.3, as determined by scale analysis. Mean fork length of the four females, was 631.5 mm and males 652.3 mm.

Pink salmon first entered the trap on August 4, and eventually moved downstream to spawn in lower Bear Creek.

Two king salmon, a 1-ocean jack and an adult male, entered the trap on August 11. These fish probably resulted from king salmon fingerlings or smolts unintentionally stocked with coho fingerling or smolt releases in Bear Lake or Bear Creek in recent years.

Upstream migrating Dolly Varden ascended Bear Creek to the weir in early 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.

Adult Coho Timing and Abundance in Index Streams:

Peak of the 1977 index escapements ranged from October 24 to November 3, and peak of spawning generally occurred within the following two weeks in these index areas. Estimated minimum escapements of wild coho in each stream index area since 1973 are presented in Table 18. As noted previously, straying of marked, hatchery-reared smolt releases including marked Bear Lake smolts was observed in most index streams. However, the incidence of straying accounted for only 0.1% to 0.2% of any release lot, and is considered insignificant.

The total combined index escapement of 514 wild adults is only slightly larger (23%) than the 1974 parent brood escapement that mainly produced it, but 1.9 times the size of the previous cycle (1973-1976) mean.

Table 18. Minimum Wild Coho Salmon Escapement in Seven Index Streams in the Resurrection Bay Area, 1973-1977.

Name of Stream	Minimum Escapement					Mean 1973-76
	1973	1974	1975	1976	1977	
Airport	4	23	2	24	7	13
Box Canyon	36	28	8	45	45	29
Clear	37	60	15	89	37	50
Dairy	63	114	32	17	134	57
Grouse	34	64	12	27	187	34
Jap	40	77	31	94	62	61
Mayor	<u>4</u>	<u>51</u>	<u>5</u>	<u>46</u>	<u>42</u>	<u>27</u>
Total	218	417	105	342	514	271

Fin-Marked Coho Returns:

Marked adult coho contributed 28.4%, or an estimated 4,625 fish, to the 1977 Resurrection Bay sport harvest. A total of 2,643 (57.0%) of these fish resulted from 100,600 age 1.0 (1974 brood, Bear Lake origin) hatchery-reared, LV marked smolts stocked in Seward Lagoon in May, 1976. The second most abundant contribution (25.0%), 1,157 RV marked adults, returned from 35,200 age 1.0 (same brood and origin) hatchery-reared smolts released in Grouse Lake in May, 1976. The remaining 835 Ad, Ad-RV and Ad-LV marked adults (18.0%) survived from the aforementioned Bear Lake and Bear Creek smolt releases in 1976.

Marked coho spawning escapements bound for Seward Lagoon and Grouse and Bear creeks were estimated at 1,870 LV, 431 RV, and 2,595 Ad+ adults, respectively. These escapements include 978 LV and 38 RV coho estimated taken in the shore fishery after the Resurrection Bay sport trolling season terminated. Total smolt-to-adult survival for the Seward Lagoon coho, including 600 age 1.0 LV marked immatures and jacks estimated in 1976, was 5.1%. Smolt-to-adult survival of Bear Lake smolts was 2.9%, compared to 2.2% for the Bear Creek smolt release and 4.3% for the Grouse Lake smolt plant. The overall catch-to-escapement ratio of marked Seward Lagoon, Grouse and Bear Lake adult coho was 0.96:1. Summaries of total smolt-to-adult returns for Bear Lake, Bear Creek and Seward Lagoon smolt releases are presented in Tables 19, 20 and 21.

In addition to the marked adult catch, an estimated 847 marked immatures and jacks contributed 5.2% to the sport harvest. These fish resulted mainly from 100,450 age 1.0 (1975 brood, Bear Lake origin) hatchery-reared, RV marked smolts stocked in Seward Lagoon from May 6-13, and 35,100 (same age and origin) LV marked smolts released in Grouse Lake from May 15-17, 1977. An estimated 356 RV (42.0%) and 446 LV (52.7%) juveniles contributed the bulk of the immature harvest, with 37 Ad-RV (4.4%) and 8 Ad-LV (0.9%) fish from the Bear Creek and Bear Lake smolt releases comprising the remainder. Age 1.1 adults surviving from these smolt plants will return in 1978. The total marked coho contribution to the Resurrection Bay fishery, including adult and immature fish, was 33.8% in 1977.

DISCUSSION

The decline in Bear Lake's coho smolt production due to overstocking its juvenile rearing environment from 1972-1975 was previously discussed (McHenry, 1977).

Since 1976, Bear Lake has been stocked at approximately 500 instead of the 1,000 fingerlings per acre with the following results: 1. Age composition of Bear Lake's juvenile standing crop in October increased to 98% young-of-the-year (age 0.0) fingerlings, the highest apparent abundance (788 per electrofishing hour) yet observed. 2. the percentage and biomass production of recent annual fingerling releases resulting in yearling (age 1.0) smolts have steadily improved, and 3. faster fingerling growth has resulted in superior smolts, as evidenced by condition factors

Table 19. Return of Bear Lake Coho Salmon Adults from Seward Migration of Smolts Fin Marked at Bear Creek Weir, 1973-1977.

<u>Seward Migration Year</u>	<u>Number of Smolts Released</u>	<u>Age Composition of Out-migration</u>	<u>Mean Fork Length (mm)</u>	<u>Fin-clip Used</u>	<u>Number of Adults Returning</u>	<u>Percentage Return</u>
1973	76,652	100.0% - age 1.0	107.5	Ad	5,040	6.58
1974	62,698	88.6% - age 1.0	117.8	Ad	1,762	2.49
	8,067	11.4% - age 2.0	147.6	Ad		
	<u>70,765</u>					
1975	11,532	8.0% - age 1.0	107.3	Ad		
	131,180	91.4% - age 2.0	129.2	Ad	1,603	1.12
	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		
	28,031	30.2% - age 2.0	134.9	Ad-RV	2,674	2.88
	1,010	1.1% - age 3.0	161.0	Ad-RV		
	<u>92,715</u>					
1977*	49,689	49.8% - age 1.0	113.1	Ad-LV		
	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>					

* Marked only 25.0% of out-migration.

Table 20

A Summary of Coho Salmon Smolt Liberation and Return Data at Bear Creek

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.	%		
1967	Oregon	Ad	5/8-13/69	47,470	30.4 (13.98)	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	32.6 (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	2.7
1975	Bear Lake	Ad-RV	5/13-15/77	35,100	23.1 (10.5)	399	1.14				

* Includes boat sport harvest estimates.

Table 21.

A Summary of Coho Salmon Smolt Liberation and Return Data at 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	6,006	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				

* Includes boat and shore sport harvest estimates.

exceeding 1.0 and more favorable survival to returning adults in 1977. Therefore, the current Bear Lake stocking density will be maintained until findings indicate that it should be readjusted for increased smolt production in the future.

At present, it appears that Bear Lake's optimum annual smolt production level is at least 100,000 healthy coho smolts at current fingerling stocking densities under natural conditions. It may be possible, however, to increase Bear Lake's carrying capacity of juvenile coho via artificial fertilization. Although this concept is now under consideration for Bear Lake, two more years of stocking it at 500 fingerling per acre are required to further define its carrying capacity under natural conditions. Once the latter has been determined to establish a control, experimentation with nutrient levels and new stocking rates may logically proceed toward evaluation.

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