

Job No. G-II-A

G-II-B

G-II-D

G-II-H

G-II-J

STATE OF ALASKA

William A. Egan, Governor



Annual Progress Report for

LAKE AND STREAM INVESTIGATIONS

by

E. T. McHenry

S. W. Kubik

D. A. Watsjold

P. Kepler

ALASKA DEPARTMENT OF FISH AND GAME

James W. Brooks, Commissioner

DIVISION OF SPORT FISH

Rupert E. Andrews, Director

Howard E. Metsker, Coordinator

TABLE OF CONTENTS

Page No.

Job No. G-II-A	Silver Salmon Studies in the Resurrection Bay Area. Edward T. McHenry.	1
Job No. G-II-B	Anadromous Fish Population Studies - Upper Cook Inlet Drainage. Stanley W. Kubik.	23
Job No. G-II-C	<i>Inactive.</i>	
Job No. G-II-D	Salmonid Rearing and Migration Study: Ship Creek System. Stanley W. Kubik.	35
Job No. G-II-E	<i>Life History Studies of Rainbow Trout in the Kvichak Drainage of Bristol Bay</i> <i>D. L. Siedelman, P. B. Cunningham,</i> <i>and R. B. Russell - published as a</i> <i>separate report.</i>	
Job No. G-II-F	<i>Inactive.</i>	
Job No. G-II-G	<i>Studies on the Russian River Salmon Sport Fishery. David C. Nelson. -</i> <i>published as a separate report.</i>	
Job No. G-II-H	Anadromous Fish Population Studies - Matanuska Valley and East Side Tributaries of the Susitna River and Tributaries of the Chulitna River. D. Watsjold.	45
Job No. G-II-I	<i>Inactive.</i>	
Job No. G-II-J	Population Studies of Northern Pike and Whitefish in the Minto Flats Complex with Emphasis on the Chatanika River. P. Kepler.	59

sport harvest.

The Bear Creek weir upstream migrant trap was operated continuously from May 16 to November 21. The adult silver salmon upstream migration extended from September 2 to October 31, and peaked on October 16. The adult migration totaled 149 silver salmon, and consisted of 48 age 1.1 Ad marked and 101 unmarked (wild) fish. Unmarked adults were comprised of 25 age 1.1 and 76 age 2.1 fish. Marine survivals of marked and unmarked adults were 0.09 and 5.8%, respectively. The adult male-to-female sex ratio was 1.6:1. An estimated 144,000 eggs were artificially spawned from 40 female silver salmon at Bear Creek weir. Average fecundity was 3,600 eggs per female.

Data on the timing and abundance of other fish species ascending Bear Creek to the weir are presented. Minimum silver salmon escapements in seven local index streams, and a natural rearing pond made accessible to juvenile silver salmon, are also discussed.

Additional and detailed data collected during this report segment are on file at the Seward field office.

RECOMMENDATIONS

1. Retain the present objectives of the study.
2. Adhere to the Alaska Board of Fish and Game's Bear Lake Management and Research Policy of February 22, 1971.
3. Investigate the Resurrection Bay drainage for potential sites to excavate natural rearing ponds for juvenile silver salmon.
4. Summarize all Bear Lake red and silver salmon production data collected since 1961 for inclusion in a single research report.

OBJECTIVES

1. To collect and analyze biological data concerning the distribution, abundance, and timing of out-migrant and adult silver salmon in the Resurrection Bay area.
2. To determine the age and size compositions of out-migrant and adult silver salmon populations in selected tributaries.
3. To determine the sport harvest of silver salmon in Resurrection Bay and natural mortality in salt water.
4. To evaluate the freshwater environmental limitations on juvenile silver salmon production in this area.
5. To determine the methods and means of increasing or extending the freshwater spawning and rearing areas of the watershed, and mitigating freshwater mortality.
6. To provide recommendations for the management of silver salmon in these waters and direct the course of future studies.

TECHNIQUES USED

The timing and abundance of stocked silver salmon fingerling 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 silver and red 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 flows were recorded daily at the weir.

Age structures of adult Bear Lake silver and red salmon populations were determined by examining representative scale impressions on 0.02-inch thick cellulose acetate with a microprojector. All silver salmon fingerling were known age 0.0. Size composition of Bear Lake silver salmon fingerling was determined by periodic sampling at the weir, electrofishing Bear Lake inlets, and beach seining. Size compositions of adult silver and red salmon escapements were determined by sampling most fish for fork length, weight and sex. All fish sampled were anesthetized in a 1:20,000 solution of MS-222 to facilitate handling.

The Resurrection Bay silver salmon sport harvest and angler effort were measured by a stratified, random creel census conducted at the Seward small boat harbor. Fishing mortality of marked (fin-clipped) fish resulting from the 1971 smolt plants was determined by examining as many silver salmon as feasible during creel census interviews.

An index to silver salmon escapement abundance was measured by conducting weekly foot surveys on seven index streams. All carcasses were examined for clipped fins, sexed, and mutilated to preclude recounting on subsequent surveys.

Evaluation of the rehabilitated freshwater rearing environment in the Bear Lake system was initiated by measuring the growth of stocked silver salmon fingerling. A natural rearing pond for juvenile silver salmon was physically surveyed and its outlet modified to improve fish migration access to and from Resurrection River.

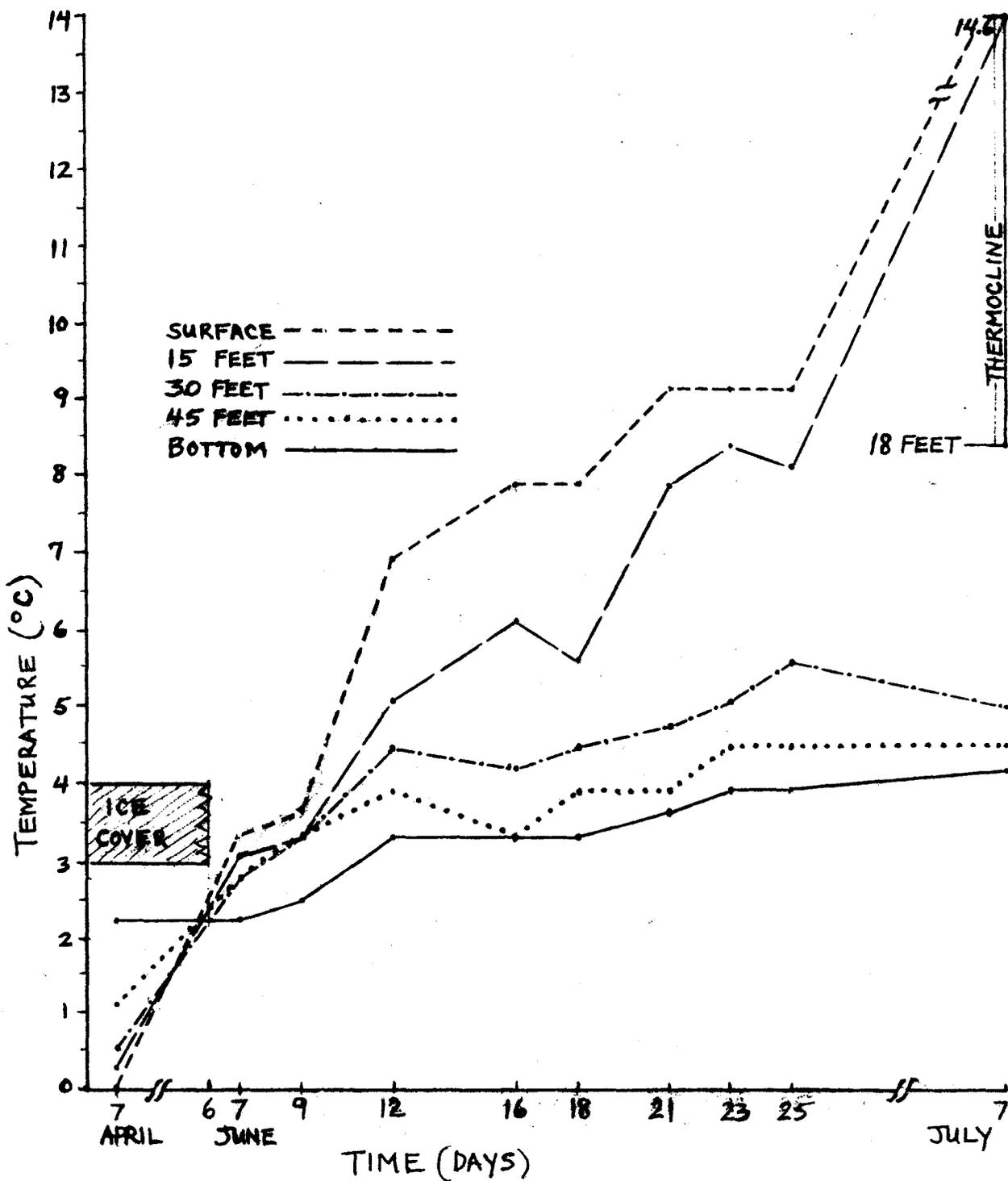


FIGURE 1 BEAR LAKE WATER TEMPERATURES (°C) PER 15-FOOT DEPTH INTERVALS, APRIL 7 TO JULY 7, 1972.

FINDINGS

The findings presented are the result of the 1972-73 research segment of this project. For a description of the project, see Dunn (1961), Logan (1962-1969), and McHenry (1970-1972).

Bear Lake Project

The history of this project was summarized by Logan (1969). The Bear Lake system was completely rehabilitated in 1971 with emulsified rotenone in order to reclaim its maximum rearing potential for juvenile salmon. The lake rehabilitation project was discussed in detail by McHenry (1972).

Bear Lake Pestocking

It was determined by using caged silver salmon, Oncorhynchus kisutch, fingerling that Bear Lake's residual rotenone toxicity and/or anoxia in the bottom strata (55-60 feet) had dissipated during spring turnover (June 7-12). Dissolved oxygen determinations of bottom water samples taken on April 7 and July 7 were 0.5 and 11.0 ppm, respectively. Figure 1 shows the lake circulation by temperature changes per 15-foot depth intervals during this period. On June 26 and 27, a total of 450,300 age 0.0 (1971 brood, Bear Lake origin) silver salmon fingerling were stocked in the lake. These fish resulted from eggs obtained by artificially spawning surplus adults from the 1971 Seward Lagoon escapement. Most (87.3%) of the adults spawned resulted from the 1970 release of Bear Lake origin age 1.0 (1968 brood year) marked smolts in the Lagoon.

Bear Lake Downstream Migration

Silver Salmon:

The Bear Creek weir downstream migrant trap was operated continuously from May 16 through October 31. Many fingerling emigrated from Bear Lake to the weir soon after being stocked.

TABLE 1 Silver Salmon Fingerling Enumerated From the Bear Creek Weir Downstream Migrant Trap by Weekly Periods, 1971.

<u>Weekly Periods</u>	<u>Number of Fingerling (1971 Brood)</u>		
	<u>Live</u>	<u>Dead</u>	<u>Total</u>
7/ 1- 7/ 7	13,000		13,000
7/ 8- 7/14	19,200	100	19,300
7/15- 7/21	900		900
7/22- 7/28	200		200
7/29- 8/ 4	100		100
8/ 5- 8/11	50		50
8/12- 8/18			
8/19- 8/25	242	8	250
8/26- 9/ 1	1,141	9	1,150
9/ 2- 9/ 8	3,100	50	3,150
9/ 9- 9/15	2,237	863*	3,100
9/16- 9/22	3,220	30	3,250
9/23- 9/29	123	2	125
9/30- 10/ 6	414	6	420
10/ 7- 10/13	228	6	234
10/14-10/20	695	5	700
10/21-10/27	125	3	128
10/28-11/ 3	<u>57</u>	<u>3</u>	<u>60</u>
Total	45,032	1,085	46,117

*Due to not adjusting fishpass when flows suddenly increased from 38 to 59 cfs on September 13.

Timing and abundance of the migration to Bear Creek weir are shown in Table 1. An estimated 8,000 fingerling were removed from the trap on July 6, 10 days after stocking began. The outmigration peaked between July 6 and 13 when 32,000 fish (69.4% of the downstream migration) were captured. Stream temperatures increased from 12.3⁰ to 16.8⁰C (54⁰ - 62⁰F) and flows ranged from 19-21 cfs during this period. A secondary migration peak occurred from September 1 to 18 on rising stream flows (40-60 cfs) while water temperatures fluctuated between 8.4⁰ to 15.1⁰C (47⁰ - 59⁰F). The last fingerling were captured on October 31 when stream temperatures decreased to 1.7⁰C (35⁰F).

The total outmigration to the downstream trap was an estimated 46,117 fish, or 10.4% of those stocked in Bear Lake. Trap mortality claimed 1,085 fingerling (2.4% of the outmigration), allowing 45,032 to be restocked in the lake for continued rearing to smolt stage. Of the larger fingerling (>80 mm), 196 were marked at the weir with an adipose-left ventral (Ad-LV) fin-clip combination to determine whether those restocked were emigrating again. Only one fingerling was recaptured, indicating that most restocked fish remained in the lake.

Fingerling, stocked at a density of 1,000 per surface acre, grew rapidly in the rehabilitated Bear Lake system. Averaging 862 per pound, the fingerling had a mean fork length of 35 mm when stocked in late June (Wallis; personal communication). On September 5, 100 fingerling sampled at the weir averaged 70.8 mm (45-85 mm) fork length. Between September 27 and October 12, 139 fingerling sampled in Bear Lake and inlets by beach seine and electroshocker averaged 76.6 mm (66-100 mm). The latter mean length approximates that of age 1+.0 wild fingerling in local waters, and represents a 119% increase in size in the 3.5 months lake residence. It is anticipated that a substantial portion of the 1972 fingerling plant will reach smolt stage by spring of 1973. All smolts will be Ad clipped before being released at the weir to determine their contribution to the 1974 Resurrection Bay sport fishery, catch-to-escapement ratio, and marine and total survival rates.

Other Species:

No species other than silver salmon were captured in the weir's downstream migrant trap or by beach seining and electrofishing in Bear Lake and its inlets. A complete eradication

of all fish inhabiting the Bear Lake system is believed to have occurred during the 1971 lake rehabilitation project.

Resurrection Bay Silver Salmon Harvest and Effort

A stratified, random creel census to determine the Resurrection Bay silver salmon sport harvest and effort was initiated at the Seward small boat harbor on July 4 and terminated on September 10. Silver salmon were first observed taken on July 1, though most sport fishing effort was directed toward the more abundant rockfish, Sebastes spps., at this time. Silver salmon did not become abundant until mid-July, according to creel census interviews.

The season's total harvest was estimated at 15,240 silver salmon. This estimate was extrapolated from interviews with 9,064 completed anglers harvesting 4,235 silver salmon during the creel census. Peak of the harvest occurred on August 12, the first day of the Seward silver salmon derby, when an estimated 1,140 fish (7.5% of the season's harvest) were taken. The season's total and derby harvests are summarized for 1968-1972 in Table 2. A large portion (31.2%) of the total harvest occurred during the derby, extending from August 12 to 20.

TABLE 2 Derby and Total Sport Harvests of Silver Salmon in Resurrection Bay, 1968-1972.

<u>Year</u>	<u>Total Sport Harvest</u>	<u>Derby Harvest</u>	<u>% Derby Harvest</u>
1968	22,560	8,187	36.3
1969	15,040	5,150	34.2
1970	14,865	5,440	36.6
1971	20,595	9,488	46.1
1972	15,240	4,755	31.2

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 11:30AM to 10:00PM. These are presented in Table 3. Returning boats were not counted from 8:00 - 11:30 AM in 1972 because it was found that only 11.6 and 14.3% of weekend and weekday sport craft, respectively, 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. As in past years, the greatest number of boats returned between 3:00 - 6:30 PM. Sport fishing effort (man-days) was calculated by multiplying the total number of boats by the average number of anglers per boat. The average number of anglers per boat was as follows: weekdays - 3.19, weekends - 3.27, and salmon derby - 3.15.

TABLE 3 The Mean Number and Percentage of Sport Fishing Boats Returning to the Seward Small Boat Harbor During Each Sampling Period in 1972.

<u>Sampling Periods (hours)</u>	<u>Weekends</u>		<u>Weekdays</u>	
	<u>Mean Number of Boats</u>	<u>Percent</u>	<u>Mean Number of Boats</u>	<u>Percent</u>
8:00 AM- 11:30 AM*	13.8	11.6	6.4	14.3
11:30 AM- 3:00 PM	31.4	26.4	8.9	19.8
3:00 PM- 6:30 PM	44.5	37.4	20.1	44.8
6:30 PM- 10:00 PM	<u>29.2</u>	<u>24.6</u>	<u>9.5</u>	<u>21.1</u>
Total	118.9	100.0	44.9	100.0

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

Total sport fishing effort exerted for silver salmon was an estimated 30,125 man-days, the highest recorded for this fishery. A total of 30.1% of this effort was sampled during the creel census period. Fishing effort and mean catch per hour from 1968-1972 are summarized in Table 4. The fishing effort on weekdays and weekends, excluding the derby, was 9,640 and 7,635, respectively. Military personnel and dependents, angling from boats provided by the Army and Air Force recreation camps at Seward, contributed 19.8% (5,950 man-days) of the total effort.

TABLE 4 Derby and Total Sport Effort (Man-Days) Exerted for Silver Salmon, and Mean Catch per Hour in Resurrection Bay, 1968-1972.

<u>Year</u>	<u>Period of Census</u>	<u>Total Effort</u>	<u>Derby Effort</u>	<u>% Derby Effort</u>	<u>Catch Per Hour</u>
1968	7/ 5-9/10	25,350	11,590	45.7	0.15
1969	7/ 9-9/ 9	24,655	11,262	45.7	0.12
1970	7/ 3-9/ 8	27,125	14,955	55.1	0.08
1971	7/12-9/ 8	26,485	12,990	49.0	0.11
1972	7/ 4-9/10	30,125	12,850	42.7	0.07

The seasonal mean catch per hour was 0.07 silver salmon. Civilian anglers fishing during weekdays realized the highest catch per hour (0.13 fish) whereas the lowest catch rate (0.05 fish) occurred during the derby when effort was greatest. The average number of hours each angler fished per day was as follows: weekdays - 5.96, weekends - 6.11, and salmon derby - 7.00.

King, O. tshawytscha, and pink salmon, O. gorbuscha, were taken incidentally with silver salmon during the season. An estimated 1,638 king salmon were harvested during the census period at an average rate of 0.16 fish per boat. Though this catch rate is lower than the 0.27 king salmon

per boat average in 1971, it still was substantially higher than the 1968-1970 average (0.07 fish per boat) in Resurrection Bay. King salmon were most abundant in July when anglers averaged 0.37 fish per boat. Most king salmon taken appeared to be "feeders", or immature fish in their first and second ocean-years. The origins of these stocks are unknown since king salmon rarely ascend Resurrection Bay streams.

Pink salmon abundance was lower than expected during their normally dominant, even-year cycle. Anglers averaged only 0.12 pink salmon per boat for the 1972 season. This catch rate was slightly higher than the 0.09 fish per boat averaged in 1971, a typically "weak" odd-year cycle, though considerably lower than the 0.61 and 0.38 pink salmon per boat averaged in 1968 and 1970, respectively. The main cause for this poor adult return probably was due to the extremely cold winter temperatures prevailing prior to sufficient snow cover during the 1970-71 winter. This apparently resulted in poor egg-to-alevin survival in Southcentral Alaska's coastal streams (unpublished; Alaska Department of Fish and Game, Informational Leaflet 155, 1971). The total pink salmon sport harvest in 1972 was estimated at 1,458 fish. This species was most abundant in the sport fishery through July.

Bear Lake Upstream Migration

Silver Salmon:

The upstream migrant trap was operated continuously from May 16 to November 21. Silver salmon first entered the trap on September 2 and the last one was captured October 31. A stream survey on November 5 disclosed that 12 silver salmon were spawning below the weir in lower Bear Creek.

A total of 188 silver salmon (including 39 precocious males, or "jacks") were enumerated through the trap. Abundance and timing of the adult silver salmon migration are shown in Table 5. Approximately half the migration occurred within the October 14-20 weekly period when Bear Creek flows increased from 42 to 63 cfs as a result of heavy fall rains.

TABLE 5 Adult Silver Salmon Enumerated Through Bear Creek Weir by Weekly Periods, 1972.

Weekly Periods	Brood Year and Fin Mark		σ	♀	Total
	1969 Ad	1968 - 1969 (Unmarked)			
9/ 2- 9/ 8		3	1	2	3
9/ 9- 9/15		14	7	7	14
9/16- 9/22	6	3	6	3	9
9/23- 9/29					
9/30- 10/6	10	12	17	5	22
10/ 7-10/13	7	9	9	7	16
10/14-10/20	23	52	43	32	75
10/21-10/27	2	7	8	1	9
10/28-11/ 3	—	<u>1</u>	<u>1</u>	—	<u>1</u>
Total	48	101	92	57	149

The highest daily count of 38 fish (20.2% of the run), including 16 "jacks", occurred on October 16. The stream temperature at the beginning of migration was 15.1°C (59°F) and gradually lowered to 1.7°C (35°F) when the run terminated. Most of the migration (75.8%) occurred from September 20 to October 20 when Bear Creek temperatures ranged from 3.9° to 9.0°C (39° - 48°F) and flows, from 33 to 63 cfs.

No difference in migration timing was noted nor expected between Ad marked (hatchery-reared to smolts) and unmarked (wild) fish since both groups were of Bear Lake origin. The percentages of marked and unmarked adults were 32.3 and 67.8%, respectively. Thirty-eight of the 39 "jacks" were Ad marked, and returned from the May, 1972 Bear Creek smolt release. "Jacks" comprised 20.7% of the total migration.

The 48 Ad marked age 1.1 adults resulted from the 1971 release of 51,100 marked age 1.0 smolts (1969 brood, Bear Lake stock) in Bear Creek below the weir. Marine survival of this smolt plant was extremely low (0.09%) , and is discussed later in this report.

Unmarked adults were the result of natural production in Bear Lake tributaries and Bear Creek from the 1968 and 1969 brood years. Scale samples from 70 fish (69.3% of the wild adult escapement) disclosed that 24.3% were age 1.1 (1969 brood year) and 75.7% age 2.1 (1968 brood year). No age 3.1 (1967 brood year) fish were detected in the sample. Sampling of the Resurrection Bay silver salmon sport catch, however, showed a higher percentage of age 1.1 fish and the presence of age 3.1 adults in the total population. Age compositions of these samples are compared in Table 6. The only unmarked "jack" observed in the Bear Creek upstream migration was age 2.0.

TABLE 6 Age Compositions of Bear Lake and Resurrection Bay Wild Adult Silver Salmon Population Samples, 1972.

Location	Number Fish Sampled	Age Group (%)			
		3.1	2.1	1.1	Total
Bear Lake	70		75.7	24.3	100.0
Resurrection Bay	179	6.1	59.2	34.7	100.0

Age composition of the 1971 smolt outmigration (1,866 smolts) which produced the 1972 Bear Lake escapement was 10.5% age 1.0, 83.3% age 2.0, and 6.2% age 3.0. Marine survival of the 1,751 age 1.0 and 2.0 smolts released past the weir averaged 5.8%.

Mean fork lengths of adult silver salmon measured at Bear Creek weir are shown in Table 7. No appreciable size difference was noted overall between wild and marked fish, although wild females averaged 26 mm larger than Ad females. Mean lengths of the sampled Resurrection Bay fish are given in Table 8.

TABLE 7 Mean Fork Length and Range (mm) of Adult Silver Salmon Measured at Bear Creek Weir, 1972

	<u>Wild Fish</u>			<u>Ad Fish</u>		
	<u>No.</u>	<u>Range</u>	<u>Mean</u>	<u>No.</u>	<u>Range</u>	<u>Mean</u>
Males	44	464-713	615	24	477-734	616
Females	26	451-736	632	19	468-736	607
Total	70	451-736	622	43	468-736	612

TABLE 8 Mean Fork Length and Range (mm) of Wild Adult Silver Salmon Sampled from the 1972 Resurrection Bay Sport Fishery.

	<u>Number</u>	<u>Range</u>	<u>Mean</u>
Males	114	496-763	651
Females	103	499-745	637
Total	217	496-763	645

The male-to-female sex ratio, excluding "jacks", in the Bear Lake escapement was 1.6:1, whereas a 1.1:1 sex ratio was observed in the Resurrection Bay sample.

Most (78.9%) Bear Lake female silver salmon were retained at Bear Creek weir for artificial spawning. These fish were artificially spawned to acquire the maximum number of fingerling for restocking Bear Lake in 1973. Forty-five females and 21 males were held to ripen for varying lengths of time between September 30 and November 21. Stream temperatures ranged from 0° to 10.1°C (32° - 50°F) during this period. Male and female holding mortalities were 28.6 and 4.4%, respectively. Forty females were artificially spawned, yielding an estimated 144,000 eggs.

Average fecundity was 3,600 eggs per female. Approximately one male was used to fertilize eggs from three females. Dead egg loss after shocking at Fire Lake Hatchery was about 3%.

Other Species:

The first adult red salmon, O. nerka, was captured in the upstream trap on June 12 and the last, on September 20. A total of 724 fish were enumerated, with the highest daily count of 34 (4.7% of the run) occurring on June 24. The migration consisted of 331 males, 391 females, and 2 "jacks". The male-to-female sex ratio was 0.85:1. A sample of 543 scale samples collected periodically at Bear Creek weir disclosed that the adult age structure was 2.9% age 1.2, 4.4% age 2.2, 29.3% age 1.3, and 63.0% age 2.3. Age 1.1 and 2.1 "jacks" comprised 0.4% of the upstream migration. Mean fork lengths for ages 1.2, 2.2, 1.3, and 2.3 fish were 473, 499, 590, and 592 mm, respectively. Bear Creek water temperatures during the upstream migration ranged from 5.6° to 17.9°C (42° - 64°F) and flows, from 17 to 60 cfs.

The Resurrection Bay commercial fishery harvested only 89 red salmon according to cannery fish tickets. The commercial fishing season was open continuously from May 15 until June 17, when it was closed by emergency order due to an obviously weak run. Adjusting the commercial harvest by the ratio of Grouse and Bear lakes' adult escapements (93:722 fish), an estimated 79 (88.6%) red salmon caught were of Bear Lake stock. Therefore, the total estimated Bear Lake adult production was 801 red salmon.

Upstream migrant Dolly Varden, Salvelinus malma, ascended to the weir in mid-June and continued moving in and out of the trap intermittently throughout the remaining field season. Mature pink salmon arrived in the upstream trap on July 22 and eventually moved downstream to spawn below the weir. One female king salmon (840 mm) was recorded in the trap on August 1. No chum salmon, O. keta, were observed in the trap, although four spawned in lower Bear Creek in late August. All fish other than red or silver salmon were retained below the weir.

Adult Silver Salmon Timing and Abundance in Index Streams

The relative timing and abundance of Resurrection Bay area silver salmon escapements have been measured each year since 1961. Selected index areas of seven clear streams near the road system were foot surveyed weekly throughout immigration until peak of spawning had terminated. Timing of the 1972 escapement was generally in late October, and peak of spawning occurred within the following two weeks in most index streams. Minimum silver salmon escapements in each stream index area since 1968 are presented in Table 9. The period from 1968 to 1972 encompasses one complete life cycle, which is typically four years for Resurrection Bay silver salmon.

TABLE 9 Minimum Silver Salmon Escapement in Seven Index Streams in the Resurrection Bay Area, 1968-1972.

<u>Name of Stream</u>	<u>Minimum Escapement</u>					<u>Mean 1968-71</u>
	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	
Airport	67	36	26	13	15	36
Clear	364	59	91	93	55	152
Dairy	98	115	66	46*	49*	81
Grouse	378	168	131	150**	42	207
Jap	229	78	79	79	68	116
Mayor	41	64	38	19	22	41
Salmon	<u>1,037</u>	<u>19</u>	<u>105</u>	<u>62**</u>	<u>90</u>	<u>306</u>
Total	2,214	539	536	462	341	939

*Does not include marked "jacks" or adults returning from hatchery-reared smolts released in 1970 and 1971.

**Escapements were partially eliminated by toxic outflows from Bear Lake, but estimated by 1969-70 means to maintain continuity.

Total combined escapements since 1968 have markedly declined. Those observed in 1971 and 1972 are the lowest recorded since surveys were initiated in 1961. The factors responsible for this reduced production are not yet understood, although future analysis of past local weather records (temperature and precipitation) may show some relationship. Though a low adult return was produced in 1971 by a relatively high parent brood escapement (1,122 fish) in 1967, it was even lower in 1972. The 1968 parent brood escapement was nearly twice that of 1967, although its dominant age 2.1 cycle production was apparently only 37% as great. Environmental factors, particularly those of air temperature and precipitation as they affect adult spawning and juvenile rearing requirements (water temperature and stream flow), are believed to be partially responsible and will receive further study.

Insufficient spawned carcasses were examined during the stream surveys to present any valid sex ratios for these index area escapements.

Silver Salmon Smolt Stocking Evaluation

A total of 222,000 age 1.0 Ad marked silver salmon smolts were released in Bear Creek and Seward Lagoon from May 15 to 31, 1972. These fish resulted from eggs obtained by artificially spawning Lake Miam, Kodiak brood stock in 1970. Of the total smolt plant, 155,500 smolts averaging 14.8 per pound were released below the Bear Creek weir to offset the lack of Bear Lake smolt production due to the 1971 rehabilitation. Considerable downstream smolt mortality from extensive seagull predation is believed to have occurred after each of the three plants.

A total of 66,500 smolts averaging 16.8 per pound were planted in Seward Lagoon on May 31. Two 100 x 6-foot variable mesh ($\frac{1}{2}$ " - $1\frac{1}{4}$ " stretch measure) nylon gillnets, fished for 42 hours on July 21 and 22, caught 85 marked and 19 wild fish. Mean lengths of the marked and wild silver salmon were 110.8 and 100.7 mm, respectively. The smaller stocked fish apparently remain in the lagoon system until acquiring sufficient size to "smolt". This may occur either later in the same season or by the following spring.

Marked smolts from the May, 1969 lagoon plant were recovered in an April, 1970 population sample taken in Dairy Creek, its main inlet. Most marked smolts in 1972 probably emigrated within two weeks after being stocked, according to periodic observations made along Seward Lagoon and its outlet.

An estimated 852 marked juveniles (smolts and "jacks") were harvested during the Resurrection Bay sport fishery as a result of 1972 smolt plants. An additional 150 marked "jacks" returning to Seward Lagoon were estimated taken during the popular shore fishery near the outlet culvert in Resurrection Bay. "jack" escapements in Dairy and Bear Creeks were an estimated 30 and 38 fish, respectively.

Marked adults surviving from the 62,000 age 1.0 (1969 brood, Bear Lake origin) smolts released in Bear Creek and Seward Lagoon in May, 1971, contributed 8.1% (1,237 fish) to the 1972 Resurrection Bay sport fishery. Of the total 1971 plant, 51,000 marked smolts were stocked in Bear Creek. As in 1972, seagull predation was evident after each release and probably resulted in high freshwater mortality. Only 48 marked adults returned to Bear Creek weir in the 1972 escapement for 0.09% marine survival of the plant.

The 1971 Seward Lagoon release of 10,900 marked smolts realized fair survival to returning adults, according to creel census estimates of the shore fishery near the lagoon outlet. An estimated 300 marked adults were taken by shore anglers from early August to late September. An additional 111 marked adults (1.0% marine survival of the plant) were estimated in the Seward Lagoon escapement.

Increasing or Extending Silver Salmon Spawning and Rearing Areas

Natural Rearing Ponds:

A 4.4-acre flooded borrow pit, excavated for Seward Airport runway material in the 1950's, was converted into a natural rearing pond for juvenile silver salmon in 1971. This pond was landlocked except for infrequent flooding

from the adjacent Resurrection River on high water years. Its source is from river water percolating through the porous substrate and from ground water springs. The pond's basin includes four depressions ranging from 5 to 9 feet deep, which provide sufficient depth for survival of overwintering fish. About half the pond is 2.5 feet deep or less. Estimated total water volume ranges between 15 and 20 acre-feet, depending upon the height of Resurrection River.

During the fall of 1969 Resurrection River flooded the pond as a result of three weeks heavy rain. Fingerling silver salmon, displaced from upstream niches, washed into the pond and most attained smolt size by 1971. An existing flood channel from the pond to Resurrection River was deepened to create a shallow outlet with a flow control weir emplaced in its mouth. Silver salmon smolts were observed emigrating as soon as the pond-river connection was completed. Shortly thereafter Resurrection River raised and backed into the pond, creating an inlet of glacial water. Though this was detrimental to the pond's water quality, many fingerling silver salmon from the river were naturally restocked in the pond. This phenomenon also occurred in July, 1972 after the outlet channel was excavated about 16 inches deeper for fish migration access in a lower water year. A few juvenile Dolly Varden char were also noted immigrating into the pond during high water periods, though their numbers were small compared to silver salmon fingerling. A sparse population of threespine stickleback, Gasterosteus aculeatus, also inhabits the pond.

The outlet channel is unique in that it allows fish migration only during Resurrection River's high water stages. Generally, these periods correspond to the spring runoff and early fall rains. The former is thought to be the most critical period because it is then that the normal smolt outmigration occurs, as well as when newly-emerged fingerling are most easily displaced downstream in the system. It is believed that if sufficient natural rearing ponds of similar design were available to attract even a small percentage of the "downstream drift", a significant step would be made in mitigating freshwater mortality of juvenile silver salmon in the Resurrection Bay drainage.

LITERATURE CITED

- Alaska Department of Fish and Game. 1971. A Summary of Preliminary 1972 Forecasts for Alaskan Salmon Fisheries. Informational Leaflet 155. 42p.
- Dunn, Jean R. 1961. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1960-1961, Project F-5-R-2, 2:289-303.
- Engel, Larry J. 1971. Evaluation of Sport Fish Stocking on the Kenai Peninsula - Cook Inlet Areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1970-1971, Project F-9-3, 12: 1-35
- Logan, Sidney M. 1962. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1961-1962, Project F-5-R-3, 3:57-74.
- _____. 1963. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1962-1963, Project F-5-R-4, 4:175-194.
- _____. 1964. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1963-1964, Project F-5-R-5, 5:133-151.
- _____. 1965. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1964-1965, Project F-5-R-6, 6:129-145.
- _____. 1966. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1965-1966, Project F-5-R-7, 7:79-99.
- _____. 1967. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1966-1967, Project F-5-R-8, 8:83-102.

_____. 1968. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1967-1968, Project F-5-R-9, 9:117-134.

_____. 1969. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1968-1969, Project F-9-1, 10:131-149.

McHenry, Edward T. 1970. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1969-1970, Project F-9-2, 11:75-89.

_____. 1971. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1970-1971, Project F-9-3, 12:1, 1-20.

_____, 1972. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1971-1972, Project F-9-4, 13: 1-20.

Prepared by:

Edward T. McHenry
Fishery Biologist

Approved by:

/s/ Howard E. Metsker

D-J Coordinator

/s/ Rupert E. Andrews

Division of Sport Fish