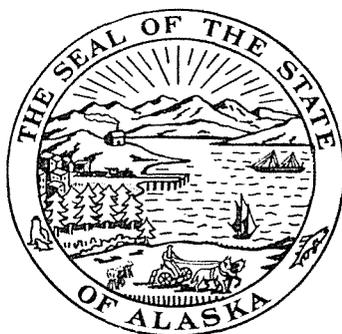


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STATE OF ALASKA

William A. Egan, Governor



ANNUAL REPORT OF PROGRESS, 1969 - 1970

FEDERAL AID IN FISH RESTORATION PROJECT F-9-2

SPORT FISH INVESTIGATIONS OF ALASKA

ALASKA DEPARTMENT OF FISH AND GAME

Wallace H. Noerenberg, Commissioner

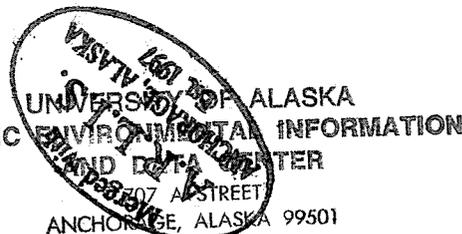
Alaska DIVISION OF SPORT FISH

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INTRODUCTION

This report of progress consists of Job Segment Reports from the State of Alaska, Federal Aid In Fish Restoration, Project F-9-2, "Sport Fish Investigations of Alaska".

The studies reported herein are investigations evaluating the sport fish resources of the state. Recreational and other impacts on the fishery resources necessitates a continuous endeavor of ascertaining facts and knowledge of the fisheries. The 24 jobs reported on are of a continuing nature. The investigations are composed of 11 projects involved with the inventory and cataloging of the sport fish waters of the state, sport fishery creel censuses, and access. Fish species that received special investigational effort include: Dolly Varden, anadromous fish, grayling, sheefish, whitefish, pike, char, and salmon. The information gathered from the combined studies provides necessary background data for a better understanding of management problems and constitutes a basis for necessary future investigations.

The subject matter contained in these reports is incomplete, and the findings and interpretations subject to re-evaluation as work progresses.

3. Adhere to the Alaska Department of Fish and Game's Bear Lake Management and Research Policy of June 26, 1968, which limits the production of red salmon.

OBJECTIVES

1. To collect and analyze biological data concerning the distribution, abundance, and timing of adult and outmigrant silver salmon smolts in the Resurrection Bay area.
2. To determine the age compositions of adult and juvenile silver salmon populations in the Resurrection Bay area.
3. To determine the sport harvest of silver salmon in Resurrection Bay and natural mortality in salt water.
4. To investigate the freshwater environmental characteristics limiting survival of juvenile silver salmon in the Resurrection Bay drainage, and mitigate freshwater mortality.
5. To determine the methods and means to increase or extend the freshwater spawning and rearing areas of the watershed.
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 silver salmon, Oncorhynchus kisutch, smolts and fry migrating out of Bear Lake were enumerated with a weir, located in Bear Creek, 1,750 feet downstream from Bear Lake. The downstream trapping facilities were comprised of a series of vertical screens which guide downstream migrants into a model "B" fishpass containing adjustable louvers to regulate waterflows into the trap. The timing and abundance of adult silver salmon into Bear Lake were measured by trapping facilities modified in 1969. Salmon and char gain access to the trap via an arched 29- x 18-inch "L" shaped culvert. The upstream migrant trap consists of a 5- x 10-foot concrete tank of which one-half is a "holding" area with a wooden-slatted "V" entrance behind a 24-inch wall of wooden stoplogs and vertically adjustable salmon-blocking gate. As the gate is raised, fish enter the trap by jumping over the stoplog wall into a brail inside the trap. When sufficient fish have entered the trap, the gate is closed and the brail raised by electric hoist. Trout and char fall through the 1 1/2-inch spacing of the wooden brail floor into the trap below. From the trap the fish either swim into an adjacent trout trap through a bar screen resting on a 24-inch stoplog wall or return downstream. One set of perforated plate screens and another set of 3/4-inch mesh screens retain all upstream migrants in or below the trout trap.

The age structure of silver salmon smolt and adult populations was determined by examining each fish for a finclip combination assigned when it was a young-of-the-year fingerling. The age composition of unmarked silver and red salmon, O. nerka, and steelhead trout, Salmo gairdneri, smolt and adult migrations were found by examining with a micro-projector scales pressed on 0.02-inch thick cellulose acetate. Random length and weight samples of salmon smolts were collected weekly at the weir after the fish had been anesthetized in a 1:20,000 solution of MS-222 (Tricaine Methanesulfonate). Stream temperatures and flows were recorded daily whenever weir modification construction permitted.

The salmon sport harvest and effort in Resurrection Bay were measured by a creel census conducted at the Seward small boat harbor. The sampling design and interview method were nearly the same as described by Logan (1966). Fishing mortality was determined by checking as many silver salmon as feasible during creel census interviews to ascertain the harvest of finclipped fish. An index to silver salmon escapement was

measured by conducting weekly foot surveys on seven index streams. All carcasses were checked for clipped fins, sexed, and mutilated to preclude recounting on subsequent surveys.

The freshwater environmental characteristics limiting survival of juvenile silver salmon in Bear Lake were investigated by measuring the relative abundance of threespine stickleback, Gasterosteus aculeatus, in their downstream movement through the weir. The reinfestation rate of stickleback in Bear Lake was correlated with the abundance of silver salmon smolts resulting from prior fingerling plants in the lake to determine what effect the stickleback population increase had on smolt production.

FINDINGS

The findings presented are the result of the 1969 segment of this project. For a description of the Resurrection Bay area and past information collected on the project, see Dunn (1961) and Logan (1962 through 1969).

Bear Lake Project

The Bear Lake system was selected for study and enhancement of salmon populations because it is the largest body of water in the Resurrection Bay drainage and is accessible by road. This 445-acre lake offers the most stable rearing potential for silver salmon smolt production in the area since it is not subjected to the fluctuations in flows and temperatures characteristic of the drainage tributaries. The 1963 Bear Lake rehabilitation to eradicate competitor and predator species, subsequent annual stocking with marked young-of-the-year fingerlings, and their egg sources are reviewed by Logan (1969).

Bear Lake Silver Salmon Downstream Migration:

The downstream migrant trap was operated continuously from May 30 until July 20 when extremely low stream flows and the second phase of weir modification construction precluded trap operation. The trap was again operated periodically from September 11 until October 9 when very high stream flows necessitated removing several downstream migrant screens to prevent flooding of the weir facilities. Although 23 silver salmon smolts were collected on May 30, only a small portion of the migration was believed to have occurred before this date. From 1962 to 1968 (excluding 1965) an average of 2.1% of the seasonal smolt migration passed the weir before May 30.

The total migration during the period of weir operation was calculated at 17,525 silver salmon smolts. This run consisted of 4,035 (23.0%) Ad-LV clipped smolts, 4,914 (28.1%) Ad-RV clipped smolts, and 8,576 (48.9%) unmarked smolts. A total of 47,500 Ad clipped smolts of Eagle Creek, Oregon, stock were planted in Bear Creek from May 8 to May 13. One hundred forty-three of these smolts migrated upstream after being stocked and were later captured in the downstream trap. A total of 288 scale samples was collected from unmarked smolts between June 6 and July 6. The percentage and extrapolated number of smolts in each age class of the unmarked smolt migration were as follows: age I - 6.9% (592 fish), age II - 77.2% (6,621), and age III - 15.6% (1,338). One smolt (0.3% of the sample) was age IV with a fork length of 207 mm. The age I, II, and III smolts had mean fork lengths of 102.4, 120.9, and 152.7 mm, respectively (Table 1). Smolts having an Ad-LV or Ad-RV clip were age II because they were stocked in Bear Lake as marked young-of-the-year in 1967.

The 592 age I unmarked smolts resulted from the 1967 Bear Lake escapement of 2,661 males and 1,500 females of mixed Swanson River and Bear Lake stocks. No fingerlings were planted in Bear Lake during 1968 because of the lake's declining smolt production. The 6,621 age II smolts originated from the 1966 escapement of 1,494 males and 1,261 females, primarily of Swanson River and Dairy Creek origins. Fingerling

plants in 1967 were all marked fish. The 1,338 age III smolts resulted from the 1965 Bear Lake escapement of 127 males and 93 females of Swanson River stock from the 360,800 fingerlings planted in Bear Lake in 1966.

TABLE 1 Length Range and Mean Fork Length for Each Age Class of Unmarked Silver Salmon Smolts Captured at the Bear Creek Weir, 1969.

<u>Age Class</u>	<u>No. of Fish</u>	<u>Mean Length (mm)</u>	<u>Length Range (mm)</u>
I	20	102.4	70 - 118
II	223	120.9	90 - 180
III	45	152.7	122 - 193

The 4,035 Ad-LV and 4,914 Ad-RV clipped smolts resulted from 182,500 and 63,900 young-of-the-year, respectively, which were marked at Fire Lake Hatchery and stocked in Bear Lake during August, 1967. In 1968 the age I smolt production for the Ad-LV plant and the Ad-RV plant was 1.87 and 2.10%, respectively, or an average of 1.89% for both plants. With the 1969 age II smolt production of 2.21% for the Ad-LV plant and 7.69% for the Ad-RV plant, the total smolt yields thus far for both groups were 4.08 and 9.79%, respectively, or an average of 5.52% for both plants. The Ad-LV and Ad-RV fish originated from eggs taken at Big Creek, Oregon, and Pasagshak River on Kodiak Island, Alaska, respectively.

Abundance and timing of the silver salmon downstream migration are presented in Table 2. The highest daily count occurred on June 16, when 3,084 smolts (17.6% of the total run) were enumerated. The stream temperature at initiation of the smolt migration was 42°F with 93.1% of the migration occurring between 42 and 56°F from May 30 to June 29. No significant difference in migration timing was noted between smolts originating from Oregon and Alaskan stocks. Fifty percent of the smolts from each group migrated past the weir by the following dates: Oregon stock (Ad-LV fish) June 15, Kodiak stock (Ad-RV fish) June 16, and Bear Lake stock (unmarked fish) June 17. Silver salmon fry did not show any appreciable migration, with only 53 fry captured in the downstream trap from September 11 until it was closed on October 4. It is noted, however, that the downstream migrant trap was inoperative from July 20 until September 10 due to the weir modification construction.

Mean fork lengths of marked silver salmon smolts sampled weekly at Bear Creek weir are shown in Table 3. The mean length of age II Ad-LV and Ad-RV smolts during the peak of their migration were 145.3 and 150.4 mm, respectively. These average fork lengths are comparable to those of age II smolts during Bear Lake's peak production following rehabilitation or to those of age III natural smolts (Table 1). Age II smolts from prior plants had the following mean fork lengths: 1965 - 167.5 mm, 1966 - 153.9 mm, 1967 - 128.2 mm, and 1968 - 114.6 mm. The average fork length of 148.3 mm for marked age II smolts in 1969 represents a 33.7 mm growth increase over marked age II smolts in 1968. That Bear Lake is now producing fewer but larger smolts with an increased availability of stickleback for forage would be a feasible explanation for their superior growth if unmarked age II smolts had shown a similar size increase. Unmarked age II smolts, however, averaged only 6.3 mm larger than the average length of 114.6 mm for unmarked age II smolts in 1968. Similarly, age III unmarked smolts showed a 2.4 mm increase in fork length over age III unmarked smolts in 1968. Unmarked age I smolts also showed a large increase in growth relative to unmarked age I smolts in 1968. Age I smolts averaged 74.3 mm in 1968 compared to 102.4 mm in 1969, for a 28.1 mm growth increase. The reason for the different growth rates between marked and unmarked age groups is not known at this time. Despite the foregoing irregularity of the declining smolt growth trend, other aspects of the 1969 smolt migration reveal Bear Lake's diminishing productivity. The abundance of

silver salmon smolts is approaching the pre-rehabilitation level and the 1969 red salmon smolt migration was the smallest recorded. The age structure of both red and silver salmon smolt populations has shifted from age I to age II dominance, resulting in an additional year of juvenile rearing mortality. Consequently, planted silver salmon fingerlings surviving to smolts have decreased substantially. Since 1967, the lake's stickleback population has attained pre-rehabilitation abundance. The above trends indicate the need to rehabilitate Bear Lake again to attain its former salmon production.

TABLE 2 Silver Salmon Smolts and Fry Enumerated Through Bear Creek Weir by Weekly Periods, 1969.

Weekly Period	Hatchery Origin		Natural Origin	
	1966 Brood (Ad-LV Clip)	1966 Brood (Ad-RV Clip)	1965-1967 Broods (Unclipped)	1968 Brood (Unclipped)
5/27-6/ 2	94	33	25	0
6/ 3-6/ 9	625	304	483	1
6/10-6/16	2,282	2,507	3,118	0
6/17-6/23	953	1,645	2,015	0
6/24-6/30	67	370	1,781	0
7/ 1-7/ 7	3	25	541	0
7/ 8-7/14	7	20	469	0
7/15-7/21*	3	8	114	0
7/22-9/ 8*	Downstream migrant trap inoperative 9/ 9-9/15			
9/ 9-9/15	1	2	5	12
9/16-9/22	0	0	0	0
9/23-9/29	0	0	11	19
9/30-10/6	0	0	14	22
Total	4,035	4,914	8,576	54

*This period occupied with weir modification construction.

TABLE 3 Mean Fork Lengths and Ranges (in mm) of Samples From Marked Silver Salmon Smolts Enumerated Through Bear Creek Weir by Weekly Periods, 1969.

Weekly Period	1966 Brood (Ad-LV Clip)			1966 Brood (Ad-RV Clip)		
	No.	Mean	Range	No.	Mean	Range
6/ 3-6/ 9	46	142.4	106 - 192	55	154.7	119 - 211
6/10-6/16	50	150.9	122 - 205	49	152.7	122 - 178
6/17-6/23	50	145.3	113 - 228	49	150.4	122 - 190
6/24-6/30	43	138.8	102 - 180	50	146.0	110 - 187
7/ 1-7/ 7	1	---	120	18	156.2	116 - 195
7/ 8-7/14	5	137.0	128 - 146	16	154.8	121 - 194

From September 28 to October 4, 12 landlocked silver salmon were captured in the downstream trap. Of the six fish sampled, five were males and all were sexually mature. Fork lengths ranged from 345 to 390 mm with a mean length of 355.5 mm. Seven fish had an Ad-RV clip and five were unmarked. The Ad-RV clipped silver salmon were remnants of the 43,000 young-of-the-year fingerlings planted in Bear Lake in 1964 and were age V in 1969. Sampling with gill nets in 1965 showed that landlocking probably had occurred to a segment of both the 1963 and 1964 fingerling plants.

Bear Lake Downstream Migration - Other Species:

A total of 486 Dolly Varden, Salvelinus malma, was captured between May 30 and October 4. The highest daily count occurred on June 17 when 57 fish (11.7% of the total run) were enumerated. Flood flows occurring in the fall of 1965, 1966, and 1967 allowed ingress of Dolly Varden over the Bear Creek weir. These char overwintered in Bear Lake during these years. However, since these char are anadromous, most of them migrated out of Bear Lake during the spring into Resurrection Bay.

A total of 302 red salmon smolts was captured on May 30 indicating some fish had migrated before the downstream trap was installed. During the three years the downstream trap was operated prior to any red salmon smolts migrating, the portion of the seasonal smolt run before May 30 averaged only 3.8%. The total red salmon smolt run was 11,007 fish, with the last smolt captured on September 11. The highest daily count occurred on June 9 when 2,250 fish (20.4% of the run) were enumerated with the mean stream temperature being 45.5°F. The migration was comprised of 36.4% age I, 55.5% age II, and 8.1% age III smolts as determined by a sample of 110 scales collected periodically throughout the migration. Average fork lengths of the age I, II, and III smolts were 75.5, 97.5, and 133.3 mm, respectively. Fork lengths of 51 smolts measured during the peak of migration ranged from 65 to 125 mm, with a mean length of 93.5 mm.

A total of 2,564 threespine stickleback was captured throughout the period of downstream trap operation. Their greatest abundance was observed from September 7 until October 4, when 1,925 stickleback (75.0% of the migration) were enumerated. A great number of stickleback became trapped and died against the diagonal row of downstream migrant screens and the three permanent screens above the trout trap. These fish, however, were mixed with accumulated debris on the screens and were not sorted for enumeration during screen cleaning. The number of stickleback counted each month were as follows: May - 12, June - 461, July - 166, and September - 1,390, and October - 535.

Thirty-five steelhead trout, Salmo gairdneri, smolts were enumerated from June 17 to July 3. Fork lengths for 26 smolts ranged from 170.0 to 242.0 mm with a mean length of 200.2 mm. This small migration was comprised of 79.2% age III and 20.8% age IV smolts as determined by 24 scale samples. Mean fork lengths for age III and IV smolts were 193.1 and 224.2 mm, respectively. Stream temperatures ranged from 50 to 60°F when migration occurred.

Bear Lake Silver Salmon Upstream Migration:

The upstream migrant trap was operated continuously from May 27 until July 27 when construction of an electrically operated brail began. The first adult silver salmon was captured on September 2, although six fish were removed from the trap and passed upstream in late August by weir construction workers. On the first day of brail operation, September 11, 33 silver salmon were removed from the trap. The last silver salmon was taken on October 28, and after determining that no fish remained in Bear Creek, the adult migrant trap was closed on October 31. A total of 1,139 silver salmon was enumerated, and the highest daily count of 186 fish (16.3% of the run) occurred on October 4. The percentages of finclipped and unmarked silver salmon were 76.2 and 23.8, respectively. The various age classes and finclip combinations were as follows: 16 age 2.1 fish (1965 brood year) with an LV-RV clip, 9 age 1.1 fish (1966 brood year) with an Ad-LV clip, 2 age 1.1 fish (1966 brood year) with an Ad-RV clip, 841 age 2.1 fish (1965 brood year) with an Ad clip, and 217 age 2.1 fish (1965 brood year) which were unmarked. The LV-RV clipped silver salmon originated from the 1966 plant of 360,800 fingerlings of Swanson River stock, from which an estimated 35,679 (9.9% of the plant) age I smolts migrated in 1967. These fish did not have typical "smolt" characteristics when they passed through the weir, but had the appearance of rearing juveniles with a mean fork length of 69.9 mm. Swanson River silver salmon rear in both lakes and streams and migrate chiefly as age II smolts (Engel, 1966). Therefore, a portion of the LV-RV smolt migration did not go to sea in 1967 but reared an additional year in fresh water below the weir to attain growth to smolt size. The Ad-LV and Ad-RV clipped silver salmon resulted from the 1967 fingerling plants of Oregon and Kodiak stocks, respectively, which migrated to sea as age I smolts in 1968. The Ad clipped silver salmon resulted primarily from the

aforementioned 1966 plant of Swanson River fingerlings and secondarily from natural production in Bear Lake. A total of 11,961 age II smolts (90.0% of the unmarked run) and 1,236 age III smolts (9.3% of the unmarked run) produced by the 1965 and 1964 brood years, respectively, were Ad clipped and released in 1968. The unmarked silver salmon adults are the result of natural production below the weir from the 1965 Bear Creek escapement since only 67 smolts were released unmarked in 1968. The sex ratio of males to females in 1969 was 1.09:1. Males predominated the first segment of the migration with the sex ratio becoming similar during the latter part of the run.

The timing and abundance of the various silver salmon age and finclip groups through Bear Creek weir are presented in Table 4. Timing of the 1969 migration was slightly later than in 1968, due to peak stream flows delaying the latter part of the run in October. Each group of returning adults was examined to determine if the migration timing of stocked fish differed with those produced naturally. By October 4, 50% of all marked and unmarked fish had passed the weir, indicating no difference in their timing. The stream temperature at the beginning of the upstream migration was 62°F on August 31, gradually dropping to 36°F by October 28 when the run terminated. Most of the migration (84.4%) occurred when stream temperatures ranged from 52 to 44°F between September 15 and October 11.

TABLE 4 Adult Silver Salmon Enumerated Through Bear Creek Weir by Weekly Periods, 1969.

Weekly Period	Brood Year and Fin Mark					Male	Female	Total
	1964 & 1965 (Ad)	1966 (Ad-LV)	1966 (Ad-RV)	1965 (LV-RV)	1965 (Unclipped)			
9/ 2- 9/ 8	1						1	1
9/ 9- 9/15	107	1		1	37	89	57	146
9/16- 9/22	105			3	24	80	52	132
9/23- 9/29	97	2			22	68	53	121
9/30-10/ 6	387	5	1	11	146	265	285	550
10/ 7-10/13	107	1			34	68	74	142
10/14-10/20	28		1	1	8	23	15	38
10/21-10/27	8					1	7	8
10/28-11/ 3	1					1		1
Totals	841	9	2	16	271	595	544	1,139

Bear Lake stocks were used as a source of silver salmon eggs for the Fire Lake Hatchery in 1969 since the lake is tentatively scheduled to be rehabilitated in 1971. Since only a small number of the progeny of the 1969 escapement would result in age I smolts migrating in 1971, most of the juvenile silver salmon produced would be eliminated during rehabilitation. A total of 301 females was held in the weir's new holding tank for artificial spawning, allowing an escapement of 245 females to spawn naturally in the tributaries of Bear Lake. Fish were held for varying lengths of time from September 16 to October 27 with stream temperatures ranging from 50 to 36°F. The female holding mortality was 41.0% which was due mainly to a fish loss on October 14 when 86 females died as a result of an intake pump failure. A total of 172 females was spawned, yielding an estimated 445,200 eggs. Approximately one male was used to fertilize eggs from every three females. The spawned fish were of Bear Lake and Swanson River stocks.

The average fork lengths of female silver salmon used for spawning were as follows: LV-RV fish - 594 mm, Ad fish - 605.0 mm, and unmarked fish - 620.6 mm. Average fork lengths of males were: Ad fish - 623.4 mm and unmarked fish - 638.8 mm. Since insufficient numbers of fish returned representing the male LV-RV, Ad-LV, and Ad-RV finclip groups, their mean lengths are not presented. No size selection was made of larger females for spawning because the magnitude of the escapement was unknown when artificial spawning was initiated. Larger males, however, were retained for spawning. The mean fork lengths and ranges.

as well as sample sizes of males and females by finclip group measured at the weir, are shown in Table 5. Naturally produced Bear Lake silver salmon adults averaged larger in size than those of Swanson River origin.

Bear Lake Upstream Migration - Other Species:

The first adult red salmon was caught at the weir on May 27 and the last one was taken on July 20. A total of 21,205 fish was enumerated with the highest daily count of 1,558 red salmon (7.3% of the run) occurring on June 30. The migration consisted of 8,949 males, 12,210 females, and 46 "jack" salmon. The male-to-female sex ratio was 0.73:1. A sample of 432 scales was collected periodically during the Resurrection Bay commercial fishery and at Bear Creek weir throughout the migration period. The average adult age structure was comprised of 1.6% age 1.2, 10.6% age 2.2, 87.1% age 1.3, and 0.7% age 2.3 fish. The age 1.3 fish measured at the weir had a mean length of 600 mm and an average weight of 5.2 pounds compared to means of 524 mm and 4.0 pounds for age 1.2 fish in 1968. The 1.2 age group comprising 99.5% of the 58,964 red salmon escapement into Bear Lake in 1968 was produced by an escapement of 4,500 fish which spawned in the rehabilitated lake in 1964. This same escapement also produced the 1969 return of age 1.3 adults. The commercially caught red salmon had an average weight of 6.05 pounds, compared to 4.60 pounds in 1968 for age 1.2 fish. Water temperatures during the spawning migration ranged from 40 to 60°F, with 88.7% of the run occurring when stream temperatures ranged from 42 to 58°F.

An estimated 99,074 and 885 red salmon were taken in the Resurrection Bay commercial and subsistence fisheries, respectively, according to fish tickets and 107 subsistence permit returns. The commercial season was open continuously from May 27 to June 12 and during regular fishing periods from June 13 until June 18 when the fishery was closed by emergency regulation to obtain the desired escapement into Bear Lake. Nearly all fish were taken by drift gill nets. The bulk of the fishery occurred from June 1 to June 14 when fishermen caught 71.0% of the total harvest, averaging 132 fish per boat landing. A total of 108 boats participated in the fishery. The total run including Bear Lake escapement was estimated at 121,164 red salmon.

Red salmon from Bear Lake were artificially spawned again in 1969 to satisfy a request for eyed eggs by the Japan Salmon Resources Preservation Association. An attempt to hold red salmon adults at the weir until maturity was thwarted by stream temperatures above 60°F and excessive fungusing which resulted in an 81.2% holding mortality. Consequently, mature fish were captured by gill nets near Inlet No. 3 in Bear Lake and spawned on location. Fifty-nine females were spawned from July 25 to August 8, yielding an estimated 205,500 eggs with a mean of 3,483 eggs per female.

Two adult steelhead, both partially spent females, were captured in the upstream trap on May 27. Two juvenile rainbow trout were taken in the upstream trap on June 19 and 21.

All Dolly Varden were held below the weir in 1969. Due to the 1 1/2-inch spaces in the brail floor, all but the largest char fell through into the adult trap as the brail was raised. From this trap the char either moved immediately upstream into the trout trap or descended the fish pass culvert to remain below the weir.

Adult Silver Salmon Timing and Abundance in Index Streams

The relative timing and abundance of adult silver salmon in the Resurrection Bay area have been measured each year since 1961 by foot surveys in selected index areas of seven clear streams near the road system. The timing of the 1969 escapement was somewhat later than in past years due to very high stream flows during October. The various runs peaked from October 25 to November 5 in most index streams. Minimum silver salmon escapements for each index stream since 1965 are shown in Table 6. The period from 1965 to 1969 encompasses one complete life cycle which is chiefly four years for Resurrection Bay silver salmon. The 1969 combined escapement of 553 fish is the lowest recorded since 1965 which was also a "poor"

TABLE 5 Length Range and Mean Fork Length (in mm) of Adult Silver Salmon Measured at the Bear Creek Weir, 1969.

	Unmarked Fish			Ad Fish			LV-RV Fish		
	<u>No.</u>	<u>Mean</u>	<u>Range</u>	<u>No.</u>	<u>Mean</u>	<u>Range</u>	<u>No.</u>	<u>Mean</u>	<u>Range</u>
Males (holding mortality)	6	555-640	592	8	550-675	609			
Males selected for Spawning	10	590-760	667	14	540-695	631	1		595
Females--holding mortality and spawned fish*	78	545-730	621	183	500-735	605	7	545-640	594

*Females were not selected for size and therefore represent a random sample.

year. The minimum total escapement for these streams in 1965 was 536 silver salmon. The Dairy Creek escapement of 115 fish showed the only substantial increase in 1969. No straying of marked Bear Lake fish was noted in any of the index streams.

TABLE 6 Minimum Silver Salmon Escapements in Seven Index Streams in the Resurrection Bay Area, 1965-1969.

<u>Stream</u>	<u>Minimum Escapement</u>					<u>Mean</u>
	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	
Airport Creek	50	127	55	67	36	67
Clear Creek	56	171	227	364	59	175
Dairy Creek	48	30	99	98	115	78
Grouse Creek	106	236	174	378	182	215
Jap Creek	86	228	172	229	78	159
Mayor Creek	16	135	66	41	64	64
Salmon Creek	<u>174</u>	<u>234</u>	<u>329</u>	<u>1,037</u>	<u>19</u>	<u>359</u>
Total	536	1,161	1,122	2,214	553	1,117

Silver salmon sex ratios for each index stream were determined by sexing carcasses on weekly foot surveys. The ratio of males to females in the 1969 migrations ranged from 0.7:1 in Grouse Creek to 1.5:1 in Clear Creek, with a mean of 1.0:1 for all index streams. Sex ratio determinations of escapements in these streams are summarized from 1965 to 1969 in Table 7.

Resurrection Bay Salmon Harvest and Effort

The creel census to determine the salmon sport harvest and effort in Resurrection Bay was initiated on July 9 and terminated on September 9. As in past years, the census was conducted at the Seward small boat harbor which has the only docking and boat launching facilities for salmon anglers. Two 3.5-hour periods on weekend days and three weekdays, based on a Latin Square design, were sampled each week with only completed anglers being interviewed. The total silver salmon harvest was estimated at 15,040 fish. This estimate was extrapolated from interviews with 9,317 anglers harvesting 5,296 silver salmon. The peak of the harvest occurred on August 9, the first day of the Seward Silver Salmon Derby, when an estimated 1,133 fish (7.5% of the season's catch) were taken. A substantial portion of the season's harvest occurs during the derby which extended from August 9 to August 17. The estimated catch of 5,150 fish taken during the derby comprised 34.2% of the total sport harvest. The derby and total sport harvests are summarized for 1965 through 1969 in Table 8. Resurrection Bay has been closed to commercial fishing for silver salmon since 1965.

The total sport fishing effort exerted for silver salmon was estimated at 24,655 man-days with 37.8% of the anglers being interviewed. This effort was similar to that effort exerted in 1968 despite 1969 being a less productive year. Effort during the nine-day derby was estimated at 11,265 man-days (45.7% of the total effort) with 2,515 derby tickets sold. The fishing effort on weekdays and weekends, excluding the derby, was 6,390 and 7,000 man-days, respectively. Military personnel angling from boats provided by the

Army and Air Force recreation camps at Seward comprised 18.1% of the effort (4,465 man-days). The average silver salmon catch per hour was 0.12. Civilian anglers fishing during weekdays realized the highest catch per hour of 0.14 whereas the lowest rate (0.06) occurred during the derby. Fishing effort and mean catch per hour since 1965 are summarized in Table 9.

TABLE 7 Ratio of Male to Female Silver Salmon in Seven Index Streams in the Resurrection Bay Area, 1965-1969. (Number of fish examined in parentheses.)

<u>Stream</u>	<u>Year</u>					<u>Mean</u>
	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	
Airport Creek	0.8:1 (10)	1.0:1 (40)	0.9:1 (39)	1.0:1 (22)	1.1:1 (19)	1.0:1
Clear Creek	0.5:1 (20)	1.2:1 (57)	1.1:1 (31)	1.3:1 (35)	1.5:1 (5)	1.1:1
Dairy Creek	1.4:1 (33)	1.0:1 (16)	1.0:1 (66)	0.9:1 (89)	1.1:1 (84)	1.1:1
Grouse Creek	1.1:1 (34)	1.0:1 (65)	1.1:1 (68)	1.1:1 (60)	0.7:1 (29)	1.0:1
Jap Creek	1.2:1 (28)	0.9:1 (90)	1.0:1 (22)	1.0:1 (31)	0.8:1 (31)	1.0:1
Mayor Creek	0.8:1 (7)	0.9:1 (49)	1.1:1 (15)	1.0:1 (18)	1.0:1 (10)	1.0:1
Salmon Creek	1.0:1 (22)	1.2:1 (41)	1.0:1 (41)	1.1:1 (122)	1.0:1 (6)	1.1:1

TABLE 8 Derby and Total Sport Harvest of Silver Salmon in Resurrection Bay, 1965-1969.

<u>Year</u>	<u>Total Sport Harvest</u>	<u>Derby Harvest</u>	<u>% of Total Harvest</u>
1965	4,020	2,298	57.1
1966	9,590	4,326	45.1
1967	17,380	6,289	36.2
1968	22,560	8,187	36.3
1969	15,040	5,150	34.2

The average number and percentage of completed anglers returning to the Seward small boat harbor were determined for each of the 3.5-hour sampling periods extending from 1130 to 2200 hours. The period from 0800 to 1130 hours was not sampled because information collected from 1964 through 1966 showed that only 11.6 and 14.3% of weekend and weekday fishermen, respectively, had completed fishing during this period. The mean number of anglers who terminated fishing during this period was added to the total for the three periods sampled to determine total daily effort. The greatest number of weekend and weekday fishermen terminated fishing between 1500 and 1830 hours (40.7%) and 1130 to 1500 hours (37.7%),

respectively. The number and percentage of anglers returning during each sampling period are summarized in Table 10. The mean number of hours each angler fished per day was as follows: weekdays - 6.02, weekends - 6.43, salmon derby - 7.34. The average number of anglers per boat was as follows: weekdays - 3.06, weekends - 3.15, salmon derby - 3.13.

TABLE 9 Derby and Total Sport Harvest (Man-Days) for Silver Salmon and Mean Catch Per Hour in Resurrection Bay, 1965-1969.

<u>Year</u>	<u>Period of Census</u>	<u>Total Effort</u>	<u>Derby Effort</u>	<u>% Derby Effort</u>	<u>Catch/ Hour</u>
1965	7/14-8/27*	13,380	8,900	66.5	0.05
1966	7/13-9/13	14,195	7,055	49.7	0.14
1967	7/12-9/12	20,100	8,505	42.3	0.15
1968	7/ 6-9/10	25,350	11,590	45.7	0.15
1969	7/ 9-9/ 9	24,655	11,265	45.7	0.12

*Sport fishing was closed by emergency regulation on August 27.

TABLE 10 The Average Number and Percentage of Completed Silver Salmon Anglers Returning to the Seward Small Boat Harbor for Each Sampling Period on Weekends and Weekdays, 1969.

<u>Sampling Period</u>	<u>Weekends</u>		<u>Weekdays</u>	
	<u>Mean No. of Anglers</u>	<u>%</u>	<u>Mean No. of Anglers</u>	<u>%</u>
0800-1130 hours*	15.5	11.6	4.9	14.3
1130-1500 hours	38.0	28.4	10.0	29.4
1500-1830 hours	54.5	40.7	12.9	37.7
1830-2200 hours	25.8	19.3	6.3	18.6
Total	133.8	100.0	34.1	100.0

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

King salmon, *O. tshawytscha*, and pink salmon, *O. gorbuscha*, were incidentally caught with silver salmon, although the creel census did not entirely encompass their period of availability. King salmon were observed caught infrequently during June and early July prior to creel census. An estimated 595 king salmon were taken by boat anglers during the census period at an average catch rate of 0.07 fish per boat. Pink salmon were taken sporadically from the first day of census, July 9, until the end of August. The sport harvest of pink salmon peaked from July 23 until August 5, with a mean catch per boat of 0.32 fish observed during the two-week period. The total pink salmon harvest throughout the census period was estimated at 450 fish.

Marked Silver Salmon Analysis

Finclipped adult silver salmon harvested in the Resurrection Bay fishery and passed through Bear Creek weir originated from the 1968 Bear Lake smolt migration. The only exception to this was the small return of LV-RV clipped fish, which migrated as age I "smolts" in 1967 but remained in fresh water for an additional

year. The 1968 smolt migration after trap mortality was comprised of 3,331 age I fish with an Ad-LV clip, 1,330 age I fish with an Ad-RV clip, and 13,206 age II fish marked at the weir with an Ad clip. The number of adult silver salmon returning to Bear Creek weir after 14 to 17 months of ocean life was as follows: 16 age 2.1 fish with an LV-RV clip, 9 age 1.1 fish with an Ad-LV clip, 2 age 1.1 fish with an Ad-RV clip, 841 age 2.1 fish with an Ad clip, and 271 age 2.1 unmarked fish. The marine survival, defined as the survival of smolts released through the weir to adults returning to the weir, was 0.27% for the Ad-LV smolts ($9/3,331 \times 100$), 0.15% for the Ad-RV smolts ($2/1,330 \times 100$) and 6.37% for the Ad smolts ($841/13,206 \times 100$). The marine survival for the unmarked smolts is unknown since only 67 unclipped smolts were released through the weir in 1968. These fish, therefore, are the result of natural production in Bear Creek weir below the weir. The marine survival of the LV-RV smolts can only be supposed since the number of age II smolts that finally migrated to sea in 1968 after migrating past the weir in 1967 is unknown. However, the 0.42% marine survival determined for the LV-RV smolts which did migrate to sea in 1967, with the 16 fish returning in 1969, yields a total survival of 0.46%, or 0.04% for the age II LV-RV clipped smolts.

The contribution of Bear Lake smolts to the Resurrection Bay fishery was determined by examining the sport catch for marked fish during creel census interviews. Finclipped fish reported by anglers other than during creel census periods were not considered in the analysis. A total of 3,448 silver salmon was examined with the following clipped fish observed: Ad clip - 107, Ad-LV clip - 6, Ad-RV clip - 4, and LV-RV clip - 2. The percentage of marked silver salmon projected for the total harvest of 15,040 silver salmon yielded an estimated catch of 519 marked Bear Lake fish. The observed and calculated harvests of finclipped silver salmon, since 1965, are summarized in Table 11. The percentages of the Ad and LV-RV finclip groups taken in the fishery and enumerated at Bear Creek weir were similar, with Ad fish comprising 68.3% of the marked fish taken in the fishery, and 73.8% of those observed at the weir.

TABLE 11 Observed and Calculated Recoveries of Marked Bear Creek Silver Salmon in the Resurrection Bay Sport Fishery, 1965-1969.

<u>Year of Recovery</u>	<u>No. of Fish Sampled</u>	<u>Est. Total Catch</u>	<u>% of Catch Sampled</u>	<u>No. of Marked Fish Recovered</u>	<u>Cal. No. of Marked Fish</u>
1965	1,454	4,020	36.2	63	174
1966	2,357	9,590	24.6	159	647
1967	4,029	17,380	23.2	286	1,233
1968	4,995	22,560	22.1	65	294
1969	3,448	15,040	22.9	119	519

The efficiency of the sport fishery in harvesting Resurrection Bay silver salmon stocks was measured by relating the estimated harvest of marked silver salmon to those returning to Bear Creek weir. The catch-to-escapement ratio of 0.60:1 (519/868), twice that of 1968 (0.30:1), indicates the 1969 run was relatively heavily exploited. Past catch-to-escapement ratios are summarized from 1965 to 1969 in Table 12.

The number of unmarked silver salmon taken in the fishery was calculated by multiplying the catch-to-escapement ratio of marked fish by the unmarked escapement at the weir. This method assumes both groups of fish were captured at the same rate. The number of unmarked fish harvested was estimated at 163 (271×0.60). The total production from Bear Lake, with a calculated harvest of 682 fish and an escapement of 1,139 fish, was estimated at 1,808 silver salmon.

Seward Lagoon Silver Salmon Stocking Evaluation

The 10.2-acre Seward Lagoon was planted with 42,200 age I silver salmon smolts from April 18 to

April 22, 1968. These smolts were the result of eyed eggs from Big Creek, Oregon, incubated at Fire Lake Hatchery, and reared in the Ft. Richardson cooling pond. All fish were marked with an Ad clip. The purpose of the experimental stocking was to determine the feasibility of planting smolts as a means to increase the number of adults returning in 1969, which was expected to be a "weak" year. In the fall of 1969, each silver salmon carcass was examined for the Ad clip, although none was observed during the normal spawning run of Dairy Creek fish. By November 11, no live silver salmon remained and all carcasses had been examined. On January 2, 1970, eight live silver salmon were observed in Lagoon Creek, tributary to Seward Lagoon, with an Ad clip seen on three fish. Stream flow was minimal and the water temperature was 34^oF. One week later no silver salmon remained in the tributary, but 15 fish were observed under the ice in Seward Lagoon. Those near enough for close observation were Ad clipped fish. Only three carcasses were retrieved on February 7 of which two were Ad clipped and one unmarked. One of the Ad clipped fish was a "jack" that returned from the 1969 plant of 21,000 silver salmon smolts of Eagle Creek, Oregon stock made from May 6 to May 13. Few of the smolts remained in the Seward Lagoon by July. Sixty-five gill-net hours captured only nine silver salmon smolts on July 2 and July 8 with a mean fork length of 101.4 mm. Other fish caught were starry flounder, Platichthys stellatus; staghorn sculpin, Leptocottus armatus; Dolly Varden; and adult red salmon.

TABLE 12 The Catch-to-Escapement Ratio of Bear Creek Marked Silver Salmon in the Resurrection Bay Area, 1965-1969.

<u>Year of Recovery</u>	<u>Cal. No. Taken in Fishery</u>	<u>No. of Adults Returning to Weir</u>	<u>Total Adults</u>	<u>Catch-to-Escapement Ratio</u>
1965	174	212	386	0.82:1
1966	647	2,469	3,116	0.26:1
1967	1,233	3,547	4,780	0.35:1
1968	294	969	1,263	0.30:1
1969	519	868	1,387	0.50:1

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SAMPLING RED SALMON SMOLTS IN THE KENAI RIVER HAS PROVIDED BIOLOGISTS WITH INFORMATION ON THE FISHERY MANAGEMENT OF THE RUSSIAN RIVER A MAJOR SPAWNING TRIBUTARY AND SPORT FISHERY,