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STATE OF ALASKA

Walter J. Hickel, Governor

ANNUAL REPORT OF PROGRESS, 1966 - 1967

FEDERAL AID IN FISH RESTORATION PROJECT F-5-R-8

SPORT FISH INVESTIGATIONS OF ALASKA

ALASKA DEPARTMENT OF FISH AND GAME  
Urban C. Nelson, Commissioner

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[Alaska Department of Fish and Game] Sport Fish Division

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## INTRODUCTION

This report of progress consists of findings and work accomplished under the State of Alaska Federal Aid In Fish Restoration Project F-5-R-8, "Sport Fish Investigations of Alaska."

The project during this report period is composed of 20 separate studies. Some are specific to certain areas, species or fisheries, while others deal with a common need for information. Each job has been developed to meet the needs of various aspects of the State's recreational fishery resource. Seven jobs are designed to pursue the cataloging and inventory of the numerous State waters. These are divided into logical utilization areas and are jobs of a continuing nature. It will be many years before an index of the potential recreational fishing waters is completed. Six jobs are directed toward specific sport fish studies. These include special efforts toward the anadromous Dolly Varden of Southeastern Alaska, silver salmon in Resurrection Bay, king salmon stocks on the lower Kenai Peninsula, king and other salmon stocks in Upper Cook Inlet, and Arctic grayling and sheefish in Interior Alaska. Special reports have been prepared on specific phases of the Dolly Varden life history and appear in the Department's special "Research Report" series.

The Statewide access evaluation remains one of the most important jobs conducted under this Federal Aid Program. It provides the Department with a tool to recommend withdrawal of suitable access sites on potential recreational fisheries throughout the State.

The remaining jobs include creel census efforts on specific fisheries in high use areas of the State, an egg-take program directed toward locating suitable indigenous stocks, perfecting advanced techniques in taking, handling and rearing species that are not normally associated with standard fish cultural practices, and continuation of the evaluation of the Fire Lake System.

The material contained in this report is often fragmentary in nature. The findings, evaluations and interpretations contained herein are subject to re-evaluation as the work progresses and additional data are collected.

## RESEARCH PROJECT SEGMENT

STATE: ALASKA Name: Sport Fish Investigations of Alaska.  
Project No: F-5-R-8 Title: Silver Salmon Studies in the Resurrection Bay Area.  
Job No: 7-B-1

Period Covered: May 1, 1966 to June 30, 1967

## ABSTRACT

This report on silver salmon, Oncorhynchus kisutch, studies in the Resurrection Bay area is a continuation and expansion of prior studies initiated by Dunn (1960) and continued by Logan (1961, 1962, 1963, 1964, 1965).

A creel census for silver salmon was conducted at the Seward Small Boat Harbor from July 13 to September 13, 1966. It is estimated that 9,592 fish were taken in 14,195 man-days of effort. The mean catch per hour was 0.14. The 8-day Seward Silver Salmon Derby accounted for 45.1 and 49.7 percent of the total sport harvest and effort, respectively. An estimated 1,700 pink salmon O. gorbuscha, were taken from July 5 through August 10, with the catch per hour averaging 0.06.

The total minimum escapement for the seven index streams was 1,161 silver salmon with escapements being substantially improved in all streams except Dairy Creek. Information is presented on the abundance, sex ratios and timing of silver salmon in the index streams.

An estimated 38,456 silver salmon smolts were captured at the Bear Creek weir from May 24 through October 21. Of these, 4,597 were age II (Ad-RV clip), 19,341 were age I (Ad-LV clip) and 14,518 were age I (unmarked). The peak of the smolt migration occurred on June 14. The mean fork lengths, during the peak of migration, of the age II (Ad-RV), age I (Ad-LV) and age I (unmarked) smolts were 153.9, 107.0 and 104.1 mm, respectively. Silver salmon smolts decreased markedly in size from past years and possible reasons for this are discussed.

The adult upstream migration extended from August 1 to October 14 and consisted of 2,755 silver salmon of which 1,082 were age 2.1 (Ad-LV clip), 1,387 were age 1.1 (Ad-RV clip), and 286 were age 1.1 (unmarked). The peak of the run occurred on September 24. The marine survival of the Ad-RV and Ad-LV fish was 11.78 and 22.77 percent, respectively. The marked fish catch-to-escapement ratio was 0.26:1.

Information is presented on the timing of silver salmon smolts and adults as they pertain to stream flows and temperatures. The timing and abundance of other salmonoids in Bear Creek are included, as well as data on the small-mesh gill net and seine sampling in Bear Lake.

Detailed and additional data collected during this report segment are on file at the Seward Field Office.

## RECOMMENDATIONS

1. Retain the present objectives of the studies.
2. Further modify the Bear Creek weir to prevent fish from passing over it during high stream flows.
3. Limit the number of other salmonoids entering Bear Lake to enhance the rearing of juvenile silver salmon.

## OBJECTIVES

1. To collect and analyze biological data concerning the distribution, abundance and timing of adult and outmigrant silver salmon in the Resurrection Bay area.
2. To determine the age composition of adult and juvenile silver salmon.
3. To determine the sport harvest of silver salmon in Resurrection Bay and the natural and fishing mortality in salt water.
4. To investigate the freshwater environmental limitations of juvenile silver salmon 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 determine the rate of stickleback reinfestation in rehabilitated Bear Lake.
7. To determine species composition, relative abundance and growth of fishes and the limnology of the Seward Lagoon.
8. To provide recommendations for the management of silver salmon in these waters and direct the course of future studies.

## TECHNIQUES USED

Salmon sport harvest and effort in Resurrection Bay were determined by a creel census conducted at the Seward Small Boat Harbor. The sampling design and interview method employed were identical to that described by Logan (1965). The number of fin-clipped silver salmon taken in the fishery was determined by examining as many fish as possible when interviewing anglers who completed their daily fishing.

Silver salmon escapement was ascertained 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.

The abundance and timing of silver salmon smolts and fry migrating out of Bear Lake were measured with a concrete weir located 1,750 feet below the lake outlet. Fish were guided to a model "B" fishpass by a series of vertical screen panels having 13/64-inch openings with 60 percent of the screen's surface passing water (Figure 1). The fishpass contained adjustable louvers to regulate water flows. The timing and abundance of adult salmon were determined by a trap on the downstream side of the weir (Figure 2). Water was supplied to the trap by two 8-inch pipes with screened intakes which entered the trap through its base and created an "upwelling" effect. Additional water also had to be passed through the upstream end of the trap to provide sufficient flow to attract fish. Panels of 1/8-inch-thick aluminum slats placed 1/2-inch apart were laid on stringers at a 10-degree angle on the downstream side of the weir stop logs. Water falling through the slats prevents upstream migrants from passing over the weir except during very high stream flows (Figure 2). Stream flows and temperatures were recorded daily at the weir. Length and weight samples of upstream and downstream migrants were collected at the weir after the fish had been anesthetized in a 1:20,000 solution of M.S. 222 (Tricaine Methanesulfonate).

The population structure and growth rate of juvenile salmon in Bear Lake were determined by using 100 by 6-foot variable mesh gill nets having 20-foot panels of 1/2, 3/4, 7/8, 1 and 1-1/4-inch bar mesh. The rate of threespine stickleback reinfestation was measured by seining at beach index sites with a 1/2-inch stretch mesh 35 by 5-foot seine.

## FINDINGS

A description of the Resurrection Bay area and past information collected on this project are presented in Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Progress Reports by Dunn (1960) and Logan (1961, 1962, 1963, 1964, 1965).

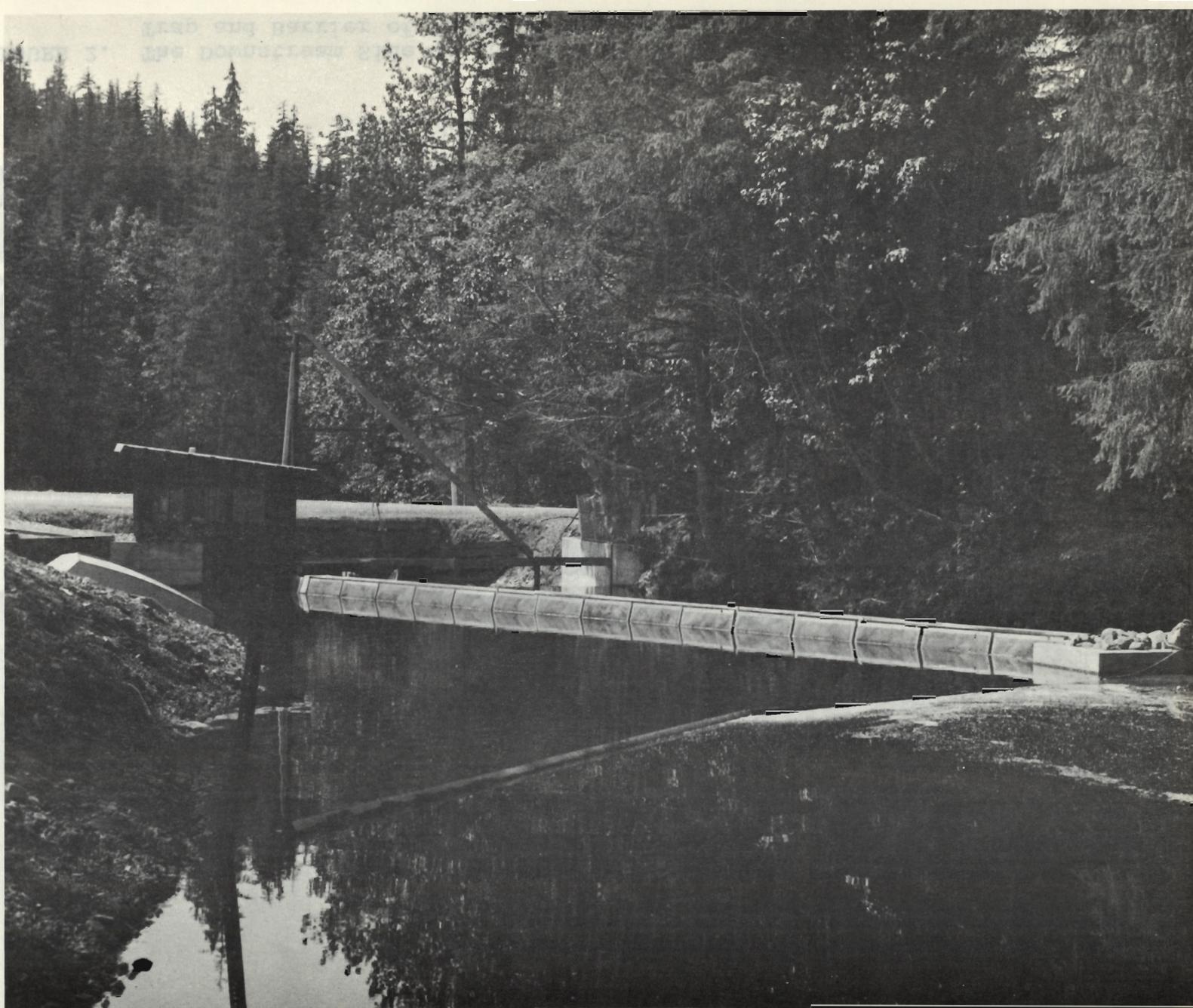


FIGURE 1. The Upstream Side of the Bear Creek Weir Showing the Screen Panels which Guide Fish to the Downstream Migrant Trap Located under the Weir House.

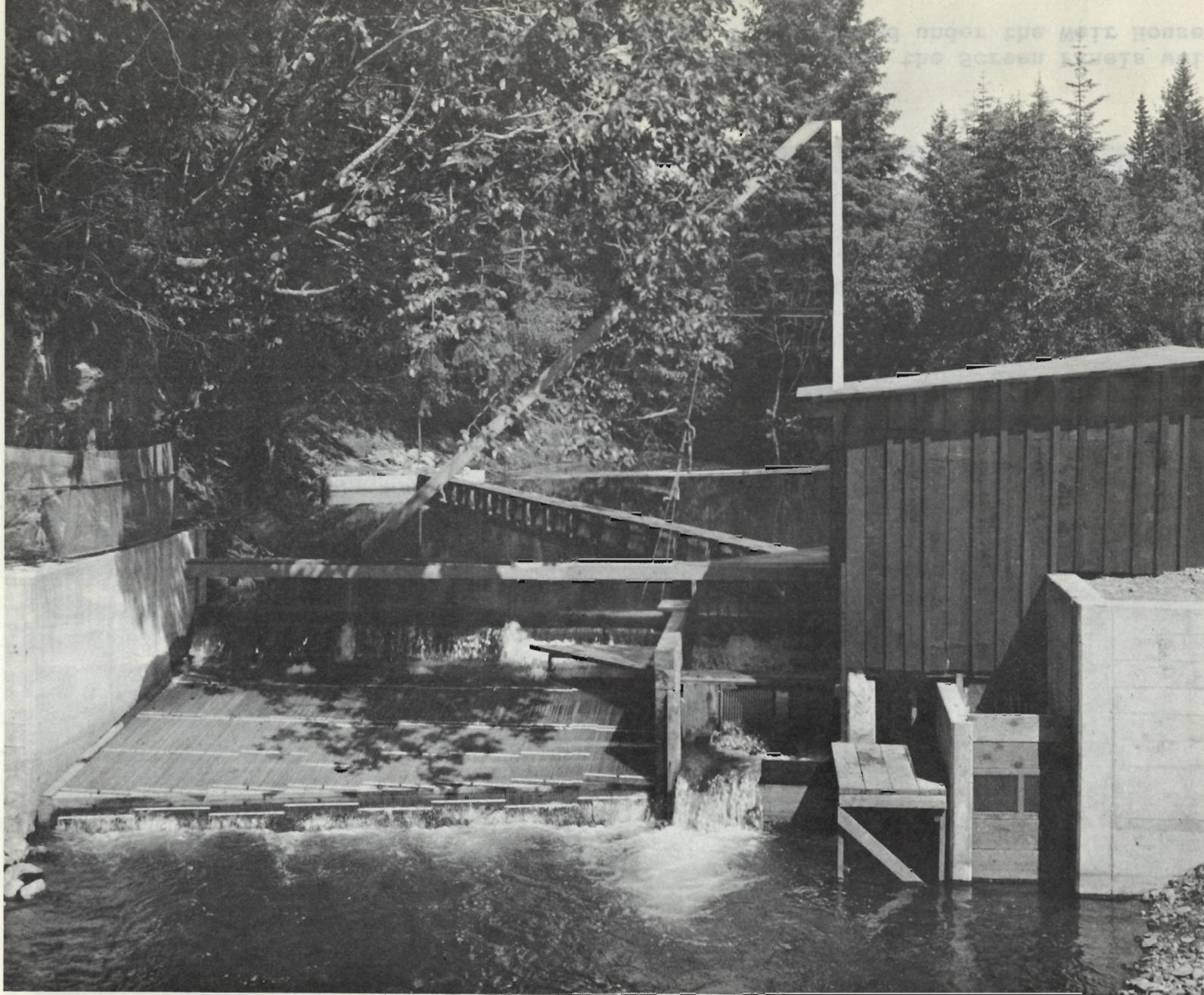


FIGURE 2. The Downstream Side of the Bear Creek Weir Showing the Upstream Migrant Trap and Barrier of Aluminum Slat Panels.

### Resurrection Bay Salmon Harvest and Effort

The creel census to measure silver salmon harvest and effort was initiated on July 13 and terminated on September 13. The total silver salmon sport harvest was estimated at 9,592 fish. This estimate was based on interviews with 3,740 anglers who had completed fishing and captured 2,450 silver salmon. The silver salmon harvest since 1961 is shown in Table 1. The peak of the catch occurred on August 13 and 14 which was the first week-end of the Seward Silver Salmon Derby. The Derby was scheduled from August 13 through August 21. However, it was cancelled on August 21 due to high winds. The harvest of 4,323 silver salmon during the 8-day Derby comprised 45.1 percent of the total catch.

TABLE 1 - Sport and Commercial Harvests of Silver Salmon in Resurrection Bay, 1961-66.

<u>Year</u>	<u>Sport Harvest</u>	<u>Commercial Harvest</u>	<u>Total Harvest</u>
1961	5,504	1,332	6,836
1962	14,482	3,923	18,405
1963	7,293	2,250	9,543
1964	2,971	656	3,627
1965	4,022	No Fishery	4,022
1966	9,592	No Fishery	9,592

Pink salmon were taken concomitant with silver salmon; however, the census period did not completely cover their period of availability. Spot checks of anglers showed pink salmon first occurred about July 5. By August 10 they had generally disappeared from the catch and accounted for only 0.01 percent of the salmon taken during the Derby. From July 5 through August 10 an estimated 1,700 pink salmon were taken. The mean catch of pink salmon per hour was 0.06.

The total silver salmon fishing effort was calculated at 14,195 man-days with 26.3 percent of the fishermen being interviewed. Fishing from shore, chiefly at the Lowell Point beaches, comprised 3.2 percent of the total effort. The estimated 7,055 man-days expended during the Seward Silver Salmon Derby constituted 49.7 percent of the total angling pressure. The mean catch per hour for the entire fishery was 0.14 which is the second highest recorded. The total and Derby effort, mean catch per hour, and period of census since 1961 are presented in Table 2. The number of Derby tickets sold in 1966 was 2,400. Ticket sales, which provide a very gross index to Derby size, declined 17.8 percent from the 1965 record high of 2,920 (Table 3).

TABLE 2 - Silver Salmon Sport Effort, Catch per Hour and Length of Census in Resurrection Bay, 1961-66.

<u>Year</u>	<u>Total Effort (man-days)</u>	<u>Derby Effort (man-days)</u>	<u>Catch per Hour</u>	<u>Period of Census</u>
1961	6,000	2,870	0.10	7/11 - 9/9
1962	11,380	5,435	0.19	7/7 - 9/7
1963	15,430	7,480	0.07	7/17 - 9/10
1964	7,540	4,150	0.07	7/18 - 9/11
1965	13,380	8,900	0.05	7/14 - 8/27
1966	14,195	7,055	0.14	7/13 - 9/13

TABLE 3 - Number of Tickets Sold and Length in Days for the Seward Silver Salmon Derby, 1956-66.

<u>Year</u>	<u>Number of Tickets</u>	<u>Number of Days</u>
1956	1,100	4
1957	1,400	4
1958	1,560	4
1959	2,275	4
1960	1,700	10
1961	2,200	4
1962	2,400	4
1963	2,625	5
1964	2,105	9
1965	2,920	12
1966	2,400	8

The number of completed fishermen returning to the Seward Small Boat Harbor was determined for each of the four 3.5-hour sampling periods which were conducted between 0800 and 2200 hours. The percentage of anglers returning by period was as follows: 0800-1130 hours, 8.8; 1130-1500 hours, 20.1; 1500-1830 hours, 50.7; 1830-2200 hours, 20.4. This past season, the mean number of hours fished per day was as follows: weekdays, 4.32; weekends, 5.42; Salmon Derby, 6.96. The average number of anglers per boat was as follows: weekdays, 2.56; weekends, 2.64; Salmon Derby, 2.76. The average number of hours fished per day and mean number of fishermen per boat since 1961 are presented in Table 4. These data show there were more anglers per boat and they fished longest during the Salmon Derby, followed by weekends and weekdays, respectively. More hours are fished during the Derby chiefly because of the incentive provided by prizes totaling \$10,000. Weekend anglers also fish longer because the majority of them are from the Anchorage area, 128 miles north of Seward, and costs and travel time are greater to participate in the fishery. Information from 15 charter boat trips showed that charter boats averaged 3.33 anglers per trip. Their silver salmon catch per hour of 0.30 is over twice that of the average angler.

#### Silver Salmon Escapement

The relative annual abundance of silver salmon in the Resurrection Bay drainages has been determined by foot surveying seven index streams since 1961. The largest producer in the area is the Resurrection River; however, its size and glacial water preclude the usual direct survey methods. The total minimum relative escapement for the index streams was 1,161 silver salmon (Table 5).

TABLE 5 - Minimum Silver Salmon Escapements in Seven Index Streams in the Resurrection Bay Area, 1961-66.

<u>Name of Stream</u>	<u>Minimum Escapements</u>					
	<u>1961</u>	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>
Airport Creek	162	55	42	52	50	127
Clear Creek	96	78	40	217	56	171
Dairy Creek	249	603	188	245	48	30
Grouse Creek	24	210	76	294	106	236
Jap Creek	91	92	72	152	86	228
Mayor Creek	21	30	15	95	16	135
Salmon Creek	90	212	175	79	174	234
TOTAL	733	1,280	608	1,134	536	1,161

TABLE 4 - The Mean Number of Hours Fished Per Day and Mean Number of Anglers Per Boat During Weekdays, Weekends, and the Salmon Derby on Resurrection Bay, 1961-1966.

Year	Weekdays		Weekends		Salmon Derby	
	Mean No. of Hrs. Fished Per Day	Mean No. of Anglers Per Boat	Mean No. of Hrs. Fished Per Day	Mean No. of Anglers Per Boat	Mean No. of Hrs. Fished Per Day	Mean No. of Anglers Per Boat
1961	5.11	2.28	6.02	2.57	8.37	2.65
1962	6.21	2.74	6.51	2.80	7.99	2.90
1963	5.71	2.76	5.96	3.02	7.57	2.86
1964	4.45	2.60	5.52	2.71	6.76	2.70
1965	4.43	2.57	5.94	2.60	7.15	2.73
1966	4.32	2.56	5.42	2.64	6.96	2.76
MEAN	5.04	2.59	5.90	2.72	7.47	2.77

Since the majority of silver salmon return in their fourth year of life at age 2.1, the present total escapement is similar to the 1,280 fish escapement of the 1962 parent year. With the exception of Dairy Creek, all streams showed an improved escapement over 1962. The progeny of silver salmon spawning in Dairy Creek utilize primarily the 10.2-acre brackish-water Seward Lagoon as a rearing area. The dyke separating the lagoon from the ocean was destroyed by the 1964, March 27 earthquake. This resulted in the lagoon becoming inundated with pure salt water and going nearly dry during low tides. The magnitude of the damage is evinced by the present escapement of only 30 fish which are mainly the progeny of a parent run of 603 silver salmon.

The sex ratios of silver salmon, determined by examination of the carcasses, in the index streams are summarized in Table 6. The ratio of males to females in the present run ranged from 0.9:1 in Jap and Mayor Creeks to 1.2:1 in Clear and Salmon Creeks. Examination of Table 6 shows that sex ratios vary extensively from year to year within the same stream.

#### Silver Salmon Timing

Since 1961, the timing of the silver salmon runs into the index streams has been determined by weekly foot surveys. These surveys showed that fish usually appeared shortly after September 20. The initial entrance to the streams of the present escapement could not be accurately measured due to high and turbid water conditions. The dates of the peak escapements for each index stream ranged from October 11 to November 8. The escapement peaks of the past runs have occurred between September 28 and November 19. The timing of the annual escapement peaks for each stream except Salmon Creek are presented graphically in Figure 3. Figure 3 shows that the dates of the greatest escapement counts vary considerably for each stream but that they generally occur between October 10 and November 10.

#### Bear Lake Silver Salmon Studies

The Bear Lake system was selected for intensive study and the enhancement of silver salmon populations because it is the largest accessible body of water in the Resurrection Bay area. This 445-acre lake was rehabilitated with rotenone in August of 1963 in an effort to mitigate freshwater mortality and increase its rearing potential for juvenile silver salmon (Logan, 1963). Bear Lake has been stocked annually with young-of-the-year silver salmon since the rehabilitation (Table 7). Most of the fry stocked originated from egg takes conducted on the Swanson River, a tributary to Cook Inlet, situated in the northwestern portion of the Kenai Peninsula. These fish are chiefly age 2.1 and rear in both streams and lakes (Engel, 1965). In 1966, 360,800 fry were planted of which 164,300 were stocked on July 11 at a mean size of 544 per pound, 183,400 were stocked on July 12 at a mean size of 700 per pound and 13,100 were stocked on August 9 at a mean size of 267 per pound. The effect of the Bear Lake rehabilitation on the growth rate and survival of the various fry plants was determined by measuring the size and number of silver salmon smolts passing the Bear Creek weir.

TABLE 7 - Number and Size of Young-of-the-Year Silver Salmon Stocked in Bear Lake, 1963-66.

<u>Date of Plant</u>	<u>Number of Fry</u>	<u>Number per Pound</u>	<u>Total Plant</u>	<u>Origin of Eggs</u>
11/13-12/8/63 (15 trips)	148,000	Mean of 88	148,000	Bear and Dairy Creeks, Swanson River
9/16/64	43,000	168	43,000	Swanson River, Ketchikan streams
8/25/65	30,800	102	69,800	Swanson River
9/3/65	39,000	90		
7/11/66	164,300	544	360,800	Swanson River
7/12/66	183,400	700		
8/9/66	13,100	267		

TABLE 6 - Ratio of Male to Female Silver Salmon in Seven Index Streams in the Resurrection Bay Area, 1961-66. (Number of Fish Examined in Parentheses.)

Name of Stream	Year						Average
	1961	1962	1963	1964	1965	1966	
Airport Creek	1.1:1 (58)	1.2:1 (38)	1.1:1 (32)	1.2:1 (11)	0.8:1 (10)	1.0:1 (40)	1.1:1
Clear Creek	0.8:1 (7)	1.1:1 (47)	1.0:1 (29)	1.4:1 (39)	0.5:1 (20)	1.2:1 (57)	1.0:1
Dairy Creek	1.7:1 (229)	1.0:1 (593)	1.2:1 (69)	0.8:1 (208)	1.4:1 (33)	1.0:1 (16)	1.2:1
Grouse Creek		1.1:1 (70)	1.3:1 (39)	1.5:1 (70)	1.1:1 (34)	1.0:1 (65)	1.2:1
Jap Creek	1.0:1 (38)	0.9:1 (52)	1.0:1 (41)	1.2:1 (107)	1.2:1 (28)	0.9:1 (90)	1.0:1
Mayor Creek				0.9:1 (27)	0.8:1 (7)	0.9:1 (49)	0.9:1
Salmon Creek	1.0:1 (10)	0.9:1 (94)	1.0:1 (45)	1.0:1 (10)	1.0:1 (22)	1.2:1 (41)	1.0:1

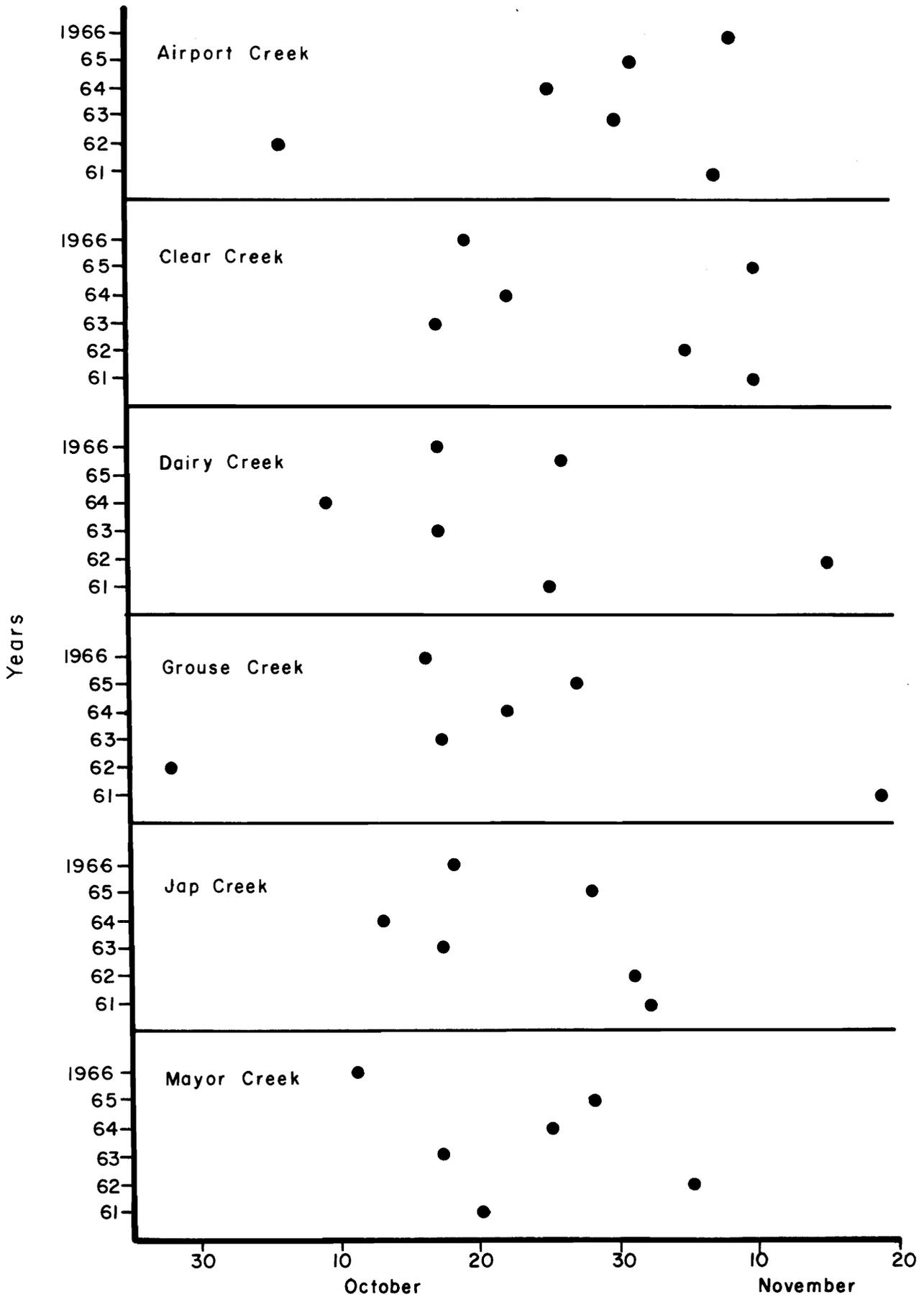


Figure 3. The Timing of the Highest Silver Salmon Escapement Counts in the Resurrection Bay Index Streams, 1961-1966.

### Bear Creek Silver Salmon Downstream Migration

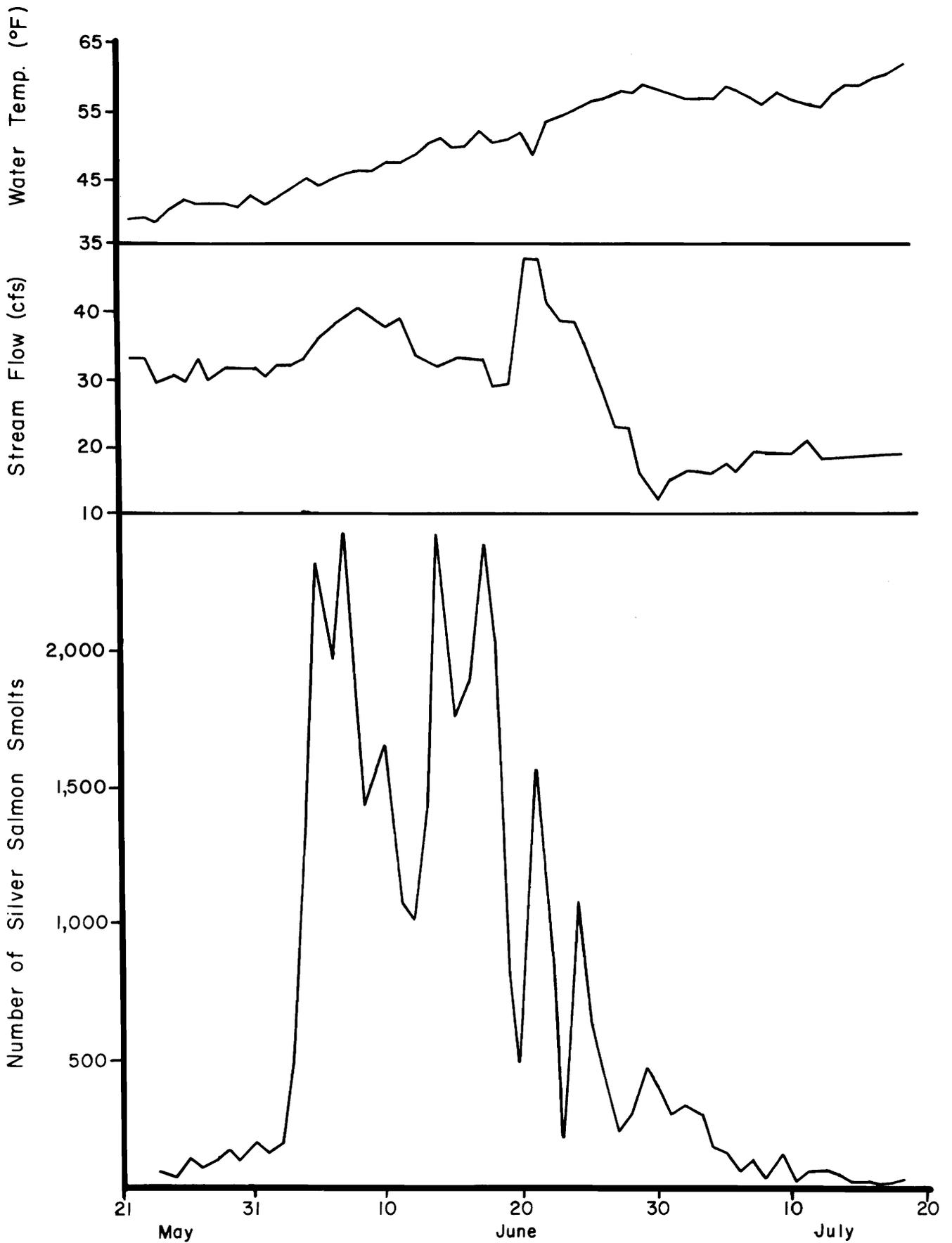
The downstream migrant trap on the Bear Creek weir was operated from May 24 through October 21. Eighty-one silver salmon smolts were captured the first day of weir operation. It is unlikely that any appreciable migration of smolts occurred prior to May 24 because the temperature of Bear Creek did not rise to 39° F. until May 19. Data obtained at Bear Creek from 1962 through 1965 evinces that very few smolts migrate prior to stream temperatures attaining 39° F. (Logan, 1965).

The total silver salmon smolt migration was calculated at 38,456 fish. A hole in one of the downstream screens permitted an estimated 3,816 smolts to pass through it before it was repaired. The smolt migration was composed of 4,597 age II fish with an adipose and right ventral clip (Ad-RV), 19,341 age I fish with an adipose and left ventral clip (Ad-LV) and 14,518 age I unmarked fish. The Ad-RV smolts are a segment of the 1964 plant of 43,000 fry (Table 7). In 1965, an estimated 12,423 fish from this plant migrated as age I smolts. The combined 1965 and 1966 migration of 17,020 fish represents an Ad-RV smolt production from the original plant of 39.6 percent. The total Ad-RV smolt migration was comprised of 73.0 percent age I fish and 27.0 percent age II fish. The 19,341 Ad-LV smolts enumerated resulted from the 1965 plant of 69,800 fry and represents an age I smolt production of 27.7 percent. This is similar to the 28.9 percent production of age I smolts from the 1964 plant. No age III smolts from the 1963 plant were observed. The 14,518 unmarked smolts were primarily age I and resulted from the 1964 escapement of 593 males and 316 females.

The timing and abundance of the silver salmon smolt migration by weekly periods are shown in Table 8. A total of 1,436 smolts (3.7 percent of the total run) was killed due to crowding in the trap or from handling while they were being processed. The greatest number of smolts captured in one day was 2,711 on June 14 (7.1 percent of the total run), when the water temperature was 49.5° F. This is similar to the peak migration dates and water temperatures for past years (Table 9). Daily silver salmon smolt counts, mean stream flows and water temperatures are presented graphically in Figure 4. This graph shows that the bulk of the smolt migration occurred during a period when water temperatures were gradually rising from 44 to 52° F. The migration had two peaks, with the first occurring when stream flows were rising and the second while stream flows were comparatively stable (Figure 4).

TABLE 8 - Wild and Hatchery-Reared Silver Salmon Smolts Checked Through the Bear Creek Weir by Weekly Periods During 1966.

Weekly Periods	Wild Smolts		Hatchery-Reared Smolts		Total
	1964 Brood (no clip)	1963 Brood (Ad-RV)	1964 Brood (Ad-LV)		
5/20-5/26	24	210	53		287
5/27-6/2	166	432	486		1,084
6/3-6/9	6,428	1,107	4,220		11,755
6/10-6/16	4,131	1,901	5,374		11,406
6/17-6/23	2,817	778	4,781		8,376
6/24-6/30	739	162	2,606		3,507
7/1-7/7	146	7	1,284		1,437
7/8-7/14	37	0	480		517
7/15-7/21	13	0	19		32
7/22-7/28	10	0	22		32
7/29-8/4	7	0	7		14
8/5-8/11	0	0	2		2
8/12-8/18	0	0	0		0
8/19-8/25	0	0	0		0
8/26-9/1	0	0	7		7
9/2-9/8	0	0	0		0
TOTAL	14,518	4,597	19,341		38,456
No. Dead	715	90	631		1,436
No. Released	13,803	4,507	18,710		37,020



**Figure 4. Relationship Between Water Temperature, Stream Flow and Silver Salmon Smolt Migration at Bear Creek, 1966.**

TABLE 9 - The Date of Peak Migration, its Percentage of the Total Migration and Mean Water Temperature During the Migration Peak for Silver Salmon Smolts in Bear Creek, 1962-66.

<u>Year</u>	<u>Date of Peak Migration</u>	<u>Percentage of Total Migration</u>	<u>Mean Water Temperature (°F)</u>
1962	June 7	13.9	44.5
1963	June 7	19.6	49.0
1964	June 22	48.6	49.0
1965	June 5	5.1	41.0
1966	June 14	7.1	49.5
MEAN	June 11	18.9	46.6

Smolts of different rearing backgrounds and age classes did not exhibit the same migration timing. Fifty percent of the various smolt groups had migrated by the following dates: age II planted fish (Ad-RV clip), June 12; age I planted fish (Ad-LV clip), June 16; age I wild fish, June 10.

The mean fork lengths and sample size of silver salmon smolts checked through the Bear Creek weir by weekly periods are presented in Table 10. The average length of the Ad-RV smolts (age II) during the peak of their migration was 153.9 mm. A portion of these fish which migrated as age I smolts in 1965 had a mean length of 116.4 mm. The Ad-LV and unmarked wild smolts (age I) had mean fork lengths of 107.0 and 104.1 mm, respectively, during the peaks of their migrations. Silver salmon fry planted from August 25 to September 3, 1965, at a mean size of 95 per pound migrated at a slightly greater length as age I smolts than did the naturally produced fish of the same year (Table 10).

TABLE 10 - The Mean Fork Lengths (mm) of Samples from Wild and Hatchery-Reared Smolts Checked Through the Bear Creek Weir by Weekly Periods During 1966.

<u>Weekly Periods</u>	<u>Wild Smolts</u>		<u>Hatchery-Reared Smolts</u>			
	<u>1964 Brood (no clip)</u>		<u>1963 Brood (Ad-RV)</u>		<u>1964 Brood (Ad-LV)</u>	
	<u>No.</u>	<u>Mean Length</u>	<u>No.</u>	<u>Mean Length</u>	<u>No.</u>	<u>Mean Length</u>
5/20-5/26	21	95.4	50	155.5	52	101.0
5/27-6/2	27	94.3	50	158.1	50	98.7
6/3-6/9	50	104.1	50	154.9	50	105.0
6/10-6/16	50	101.6	50	153.9	50	107.0
6/17-6/23	48	114.9	48	155.0	48	116.3
6/24-6/30	50	113.2	22	158.5	50	116.6
7/1-7/7	50	118.3	--	-----	50	118.9
7/8-7/14	12	126.4	--	-----	50	121.5

Silver salmon fry were not captured in the downstream trap until July 14, three days after the first fry plant in Bear Lake. The numbers of fry captured by month were as follows: July--229, August--5,277, September--412. It is doubtful if large numbers of wild silver salmon fry were included because the escapement during the fall of 1965 was only 93 females. All fry captured at the weir were returned to Bear Lake because the survival to returning adults of fry which migrate to sea is almost nonexistent. The mean fork lengths of a 100 fish sample of the July 11 plant of 360,800 fry and the July 12 plant of 164,300 fry were 43.4 and 42.1 mm, respectively. The growth rate of these stocked fry, determined by periodically measuring the fork lengths of a 50 fish sample, were as follows: July 30, 51.6 mm; August 11, 57.6 mm; August 20, 58.2 mm; August 26, 61.7 mm; August 30, 64.2 mm.

### Downstream Migration--Other Species

Nineteen Dolly Varden *Salvelinus malma*, were captured the first day of weir operation, indicating that some of these fish migrated out of Bear Lake before May 24. Two hundred forty-five Dolly Varden were enumerated between May 24 and June 20 with the peak of the outmigration occurring on May 27. High stream flows during the fall of 1965 negated the weir as a fish barrier and these fish were able to ascend to Bear Lake where they remained during the winter.

Four threespine sticklebacks *Gasterosteus aculeatus*, were taken in the downstream trap on June 10 and 21 and on July 8 and 28.

The red salmon *Oncorhynchus nerka*, smolt migration extended from the first day of weir operation until August 12 with the bulk of the run occurring from May 29 through June 13. The total number of smolts could not be determined because of a hole in one of the screens during the peak of the migration, but it is entirely possible that a minimum of 100,000 fish migrated downstream. Also, 123,760 smolts were trapped at the weir and stocked in western Kenai Peninsula lakes in an attempt to establish kokanee populations. The escapement that produced these smolts was not measured because it occurred when the present weir was being constructed.

The mean fork lengths of a 50-fish sample collected weekly throughout the migration were as follows: May 24, 89.6 mm; May 30, 86.3 mm; June 6, 80.6 mm; June 13, 79.1 mm; June 20, 81.8 mm; June 27, 79.2 mm. The smolts were primarily age I (Logan, 1965). In 1962 and 1963, prior to the Bear Lake rehabilitation, the mean fork lengths of red salmon smolts during the peaks of their migrations were 65.7 and 68.7 mm, respectively. The lake rehabilitation in 1963 destroyed the 1964 smolt run. The 1965 migration consisted of 12,253 smolts having an average length of 116.4 mm during the peak of the run. The mean smolt fork length of 80.6 mm during the peak of the current migration is still greater than that of pre-rehabilitation smolts but is a 30.8 percent decrease in mean size from the 1965 post-rehabilitation smolts. The size decrease is probably due to intraspecific competition because the current smolt population is nearly 20 times that of the previous year. Water temperatures in Bear Lake were similar both years.

The average size of silver salmon smolts in the present run also declined. Age I planted smolts migrated at a mean fork length of 107.0 mm while the mean length of the 1965 age I planted smolts was 116.4 mm. Age II planted smolts had a mean fork length of 153.9 mm compared to the 1965 average length of 167.5 mm for age II planted smolts. Based on stocking records and the age composition of the smolt migrations, the 1965 population of silver salmon rearing in Bear Lake was from one to two times greater than the 1964 population. Even though the population of silver salmon rearing in the lake was greater when the 1966 age I and age II smolts were rearing, intraspecific competition may not be the only factor that affected smolt size. Although no food habit studies have been conducted, beach seining near the Bear Lake inlets indicates that red and silver salmon fry occupy the same part of the lake until about mid-July. Since the population of red salmon juveniles rearing in the lake during 1965 was over 20 times greater than the previous year, intraspecific competition resulting in a decline in silver salmon smolt size cannot be discounted.

### Bear Creek Silver Salmon Upstream Migration

The first adult silver salmon was captured at the Bear Creek weir on August 1, nearly three weeks earlier than in past years. The last fish was checked through the weir on October 14, although the weir was in operation until October 31. A total of 2,755 silver salmon was enumerated with the peak of the migration occurring during the end of August. The highest daily count was 146 fish (5.3 percent of the run) on September 24. The migration consisted of the following fin-clip and age groups: 1,082 Ad-LV planted fish, age 2.1 (1962 brood year); 1,387 Ad-RV planted fish, age 1.1 (1963 brood year); 286 unmarked wild fish, primarily age 1.1 (1963 brood year). The sex ratio of males to females was 1.2:1. The timing of the various age groups by weekly periods is presented in Table 11. The run occurred earlier than in past years despite a similarity in stream temperatures. Daily weir counts, stream flows and water temperatures are shown graphically in Figure 5. The water temperature at the inception of the migration was 60.5° F., dropping gradually to 41.5° F. at the cessation of the run, with the bulk of the fish migrating between 54 and 48° F. Stream flows ranged from 23 to 101 cfs during the migration period.

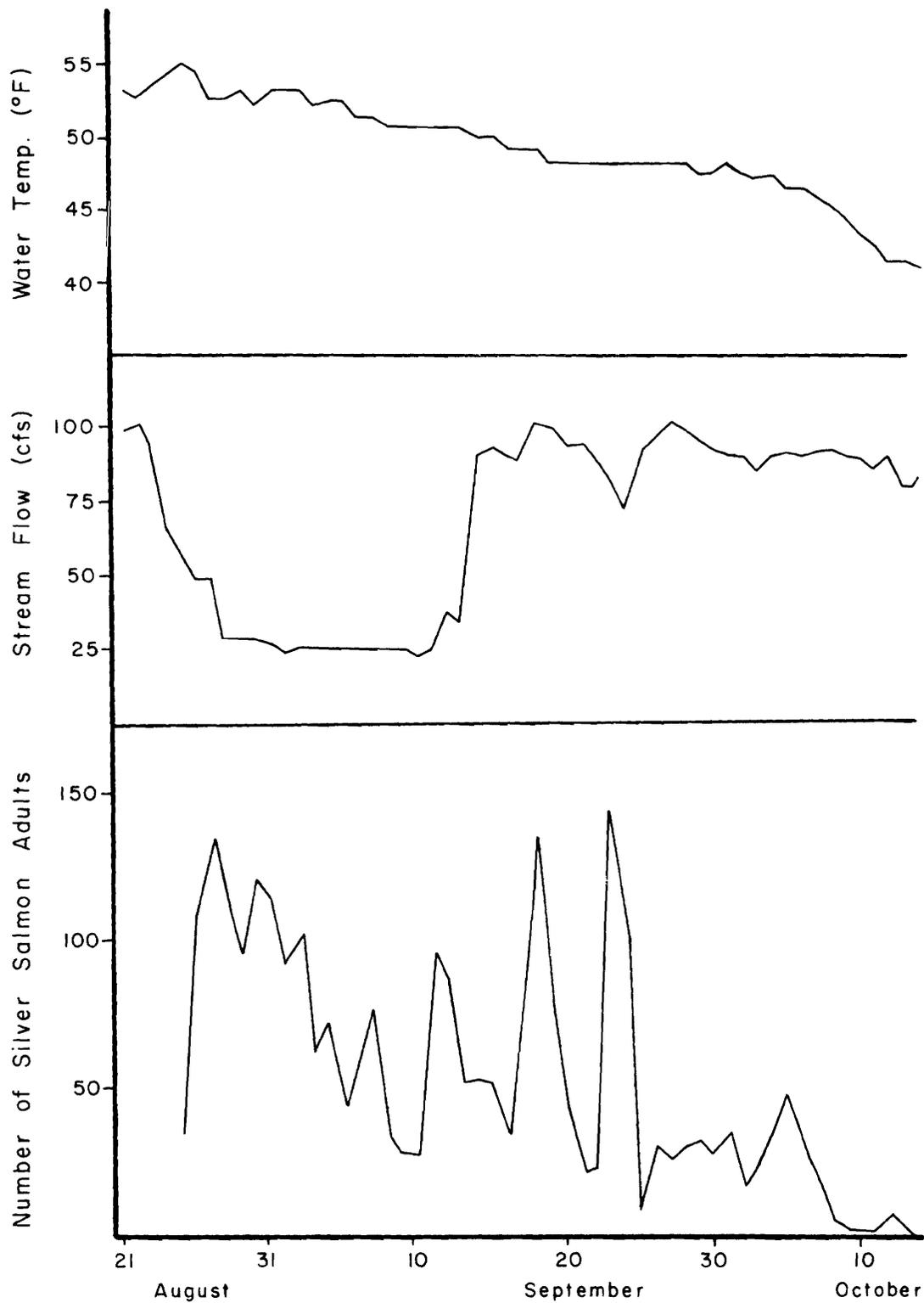


Figure 5. Relationship Between Water Temperature, Stream Flow and Adult Silver Salmon Migration at Bear Creek, 1966.

Silver salmon originating from different geographical areas did not exhibit the same migration timing. Fifty percent of the Ad-RV adults originating from Swanson River stocks had passed the weir by September 8 while half of the Ad-LV and unmarked fish originating from Bear and Dairy Creeks stocks were not checked through the weir until September 15 and 12, respectively.

TABLE 11 - Adult Silver Salmon Checked Through the Bear Creek Weir by Weekly Periods During 1966.

Weekly Period	1962 Brood (Ad-LV clip)	1963 Brood (Ad-RV clip)	1963 Brood (unmarked)	Males	Females	Total
7/29-8/4	0	3	0	3	0	3
8/5-8/11	3	1	0	4	0	4
8/12-8/18	0	0	0	0	0	0
8/19-8/25	0	1	0	1	0	1
8/26-9/1	232	409	83	380	344	724
9/2-9/8	179	290	43	306	206	512
9/9-9/15	153	206	39	221	157	378
9/16-9/22	227	217	38	260	222	482
9/23-9/29	187	137	43	193	174	367
9/30-10/6	94	95	32	95	126	221
10/7-10/13	21	24	6	20	31	51
10/14-10/20	6	4	2	11	1	12
TOTAL	1,082	1,387	286	1,494	1,261	2,755

There appeared to be no close relationship between the mean size of the smolts of a given brood year and the returning adults of the same brood year. The Ad-LV smolts (1962 brood year) migrated at a mean fork length of 167.5 mm and returned as adults at a mean length of 643 mm (n = 43) while the Ad-RV smolts (1963 brood year) migrated at a mean length of 116.4 mm and returned as adults at an average size of 620 mm (n = 50).

#### Upstream Migration--Other Species

The adult red salmon upstream migration commenced on June 6 and terminated on July 28 with 1,860 fish being passed over the weir. The peak of the migration was June 22 when 229 fish (12.3 percent of the run) were counted. The peak occurred when the water temperature was 53° F. and stream flows were at a high (50 cfs) for that time period.

Adult pink salmon first appeared at the weir on July 26 and were very abundant until the end of August. There is very limited spawning area above the weir that pink salmon will utilize so it was deemed advisable not to pass these fish over the weir. The current run was not surveyed, but it appeared to be greater than the 1964 migration of 6,500 fish. Because there was insufficient spawning area in Bear Creek for the size of the population, a large number of these fish congregated below the weir. In an effort to relieve what had become an increasing public relations problem 2,001 pinks were passed upstream between July 26 and August 9. Within the next 5 to 15 days nearly all these fish drifted downstream against the weir screens in a moribund condition and subsequently died without spawning. The large number of dead fish on the weir screens further complicated weir operation and created additional public relations problem. Hopefully, this problem should not occur again until 1968 and perhaps, by then, a solution can be found.

Two adult steelhead Salmo gairdneri, were captured on July 28 and August 13 and passed over the weir.

Beginning about September 15, an undetermined number of Dolly Varden were able to swim over the weir when stream flows greater than 90 cfs flooded the aluminum slat barrier. These fish will spend the winter in Bear Lake and then migrate to sea during June of 1967.

### Fin-Clipped Silver Salmon Recoveries

The fin-clipped silver salmon taken in the Resurrection Bay fishery and checked through the Bear Creek weir originated from the 1965 Bear Lake smolt migration. This run consisted of an estimated 11,778 age I smolts (1963 brood) with an Ad-RV clip and 4,752 age II smolts (1962 brood) with an Ad-LV clip. A total of 1,387 Ad-RV and 1,082 Ad-LV adults returned to the weir after about 15 to 18 months of ocean life. The marine survival, which is defined as the survival of smolts released at the weir to adults returning to the weir, was 11.78 percent for the Ad-RV fish (1,387/11,778 x 100) and 22.77 percent for the Ad-LV fish (1,082/4,752 x 100). It is recognized that the marine survival rates presented here are higher than have been recorded for other areas. This may be due, in part, to the following: (1) the a priori assumption that these fish do not enter substantially into a commercial fishery; (2) errors in estimating the 1965 smolt migration during a three-day period of high stream flows when the number of smolts could not be directly enumerated.

The contribution that Bear Lake smolts made to the Resurrection Bay sport fishery was determined by examining the catch for fin-clipped fish concomitant with creel census. A total of 2,357 fish was examined from July 13 through September 13 of which 159 (6.75 percent) were fin-clipped. The observed marked catch was comprised of 82 Ad-RV and 77 Ad-LV silver salmon which, expanded for the total harvest of 9,592 fish, yield an estimated catch of 334 Ad-RV and 313 Ad-LV marked fish. The observed and calculated recoveries of fin-clipped silver salmon from Bear Lake since 1963 are presented in Table 12.

TABLE 12 - Observed and Calculated Recoveries of Silver Salmon Smolts, Marked at Bear Creek, in the Sport and Commercial Fisheries in Resurrection Bay, 1963-66.

<u>Year of Recovery</u>	<u>Number of Fish Sampled</u>	<u>Estimated Total Catch</u>	<u>Percentage of Catch Sampled</u>	<u>Number of Marked Fish Recovered</u>	<u>Calculated Number of Marked Fish</u>
1963	1,260	9,543	13.2	6	45
1964	630	3,627	17.4	27	155
1965	1,454	4,022	36.2	63	174
1966	2,357	9,592	24.6	159	647

The total survival rate of marked smolts to returning adults (harvest plus escapement) was 14.61 percent (1,721/11,778 x 100) for the Ad-RV and 29.35 percent (1,395/4,752 x 100) for the Ad-LV silver salmon. The higher survival rate of the Ad-LV adults is probably due to the following: (1) the Ad-LV fish originated from local Resurrection Bay stocks while the Ad-RV are chiefly from other areas of the state; (2) the Ad-LV fish migrated as age II smolts having a 30.5 percent greater mean fork length than the Ad-RV smolts which migrated at age I.

The efficiency of the sport fishery in harvesting Resurrection Bay silver salmon stocks was measured by comparing the catch-to-escapement ratio of returning fin-clipped adults. This ratio was 0.26:1 for the present migration and is the lowest recorded for the fishery. The catch-to-escapement ratios, presented in Table 13, are substantially lower in "even" years when silver salmon populations are generally greater.

TABLE 13 - The Catch-to-Escapement Ratio of Silver Salmon Marked at Bear Creek, 1963-66.

<u>Year of Recovery</u>	<u>Calculated Number Taken in Fishery</u>	<u>Number of Adults Returning to Weir</u>	<u>Total Adults</u>	<u>Catch to Escapement ratio</u>
1963	45	30	75	1.50:1
1964	155	436	591	0.36:1
1965	174	212	386	0.82:1
1966	647	2,469	3,116	0.26:1

### Bear Lake Population Sampling

During the summer the south shore area of Bear Lake was sampled periodically with three small-mesh gillnets. The nets were set perpendicular to the shore in 10 to 15 feet of water. The purpose of the net sampling was to determine if substantial "landlocking" of silver salmon occurred as was indicated in the 1964 and 1965 samples. The results of the test fishing are shown in Table 14. Although the age I wild and planted silver salmon captured were of a sufficient size to migrate to sea (Table 10), no Ad-LV fish from the 1963 plant or Ad-RV fish from the 1964 plant were taken indicating "landlocking" has not occurred. The cessation of "landlocking" may be due to the larger populations of silver and red salmon juveniles rearing in the lake.

Two seine samples were collected in Bear Lake off the terminus of Inlet No. 3 to determine the rate of threespine stickleback reinfestation. The first seine haul on July 1 captured 5 age I wild silver salmon ranging in length from 79 to 104 mm with a mean of 89.8, 6 age I planted silver salmon (Ad-LV clip) ranging from 79 to 101 mm with a mean of 90.3, 38 red salmon juveniles ranging from 68 to 110 mm with a mean of 78.9 and 18 Dolly Varden juveniles ranging from 74 to 104 mm with a mean of 87.8. The second seine sample on August 10 produced 44 silver salmon fry ranging in length from 37 to 67 mm with a mean of 57.4, 1 Dolly Varden 74 mm in length, and 1 threespine stickleback. The seine samples and catches in the downstream trap of the weir show that the threespine stickleback population is still at a low level of abundance and at this time cannot be considered a serious competitor to rearing silver salmon.

### Incubation Channel Water Supply Evaluation

A stream gauging station was established at Inlet No. 3 of Bear Lake in cooperation with the U. S. Geological Survey to determine stream flow fluctuations. One 45-day Ryan thermograph was installed in the stream to record water temperatures. A second thermograph was buried in gravel approximately 20 to 30 inches below the stream bed to record subsurface water temperatures. Data are also being collected on subsurface dissolved oxygen levels by the use of standpipes. The data collected will be used to evaluate Inlet No. 3 as a source of water for an artificial incubation channel for silver salmon. This will be reported in the next job completion report segment.

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TABLE 14 - Summary of Test Fishing in Bear Lake During 1966 Using Three 100 by 6-Foot, 1/2 to 1-1/4-inch Stretch Mesh, Gillnets Per Sample.

Sampling Date	Fish Species	Number Caught	F.L. Range (mm)	Mean Length	Catch Per Net-Hour
June 23	Wild SS <sup>1</sup>	9	95 - 109	103.1	0.13
	Planted SS <sup>2</sup>	54	95 - 125	110.8	0.78
	DV <sup>3</sup>	3	112 - 270	---	0.04
	RS <sup>4</sup>	1	260	---	0.01
July 6	Wild SS	4	94 - 114	103.3	0.06
	Planted SS	20	87 - 128	103.7	0.30
	DV	3	229 - 292	---	0.04
	RS	6	74 - 121	107.2	0.09
July 21	Wild SS	11	97 - 115	105.1	0.15
	Planted SS	36	99 - 122	109.1	0.50
August 3	Wild SS	7	103 - 116	108.1	0.10
	Planted SS	38	98 - 126	110.6	0.55

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<sup>1</sup> Wild silver salmon, age I, unmarked  
<sup>2</sup> Planted silver salmon, age I (Ad-LV clip)  
<sup>3</sup> Dolly Varden  
<sup>4</sup> Red Salmon

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