REF 90292

The Resources Agency of California
Department of Fish and Game

ANNUAL REPORT
MOKELUMNE RIVER FISH INSTALLATION
FROM JANUARY 1, 1964 TO JUNE 30, 1965[1/]

FREDERICK H. GROH
Region 2, Inland Fisheries

SUMMARY

The period covered in this first annual report of the Mokelumne River Fish Installation extends from January 1, 1964 through June 30, 1965.

The first king salmon, Oncorhynchus tshawytscha, arrived at the installation on October 17, 1964 and the last one on December 5, 1964. The run consisted of 184 males and 178 females, for a total of 362 fish. Of this total, 120 fish were hauled from the Woodbridge counting station to the channels by tank truck.

An inclined plane trap was installed in the ladder to count the downstream migrants. A total of 73,540 king salmon fry was counted and released. The trap was removed on April 5, 1965.

No records have been kept on the steelhead, Salmo gairdneri gairdneri, population in the Mokelumne River; however, 15 adults entered the hatchery between January 1, 1964 and March 20, 1964. In order to provide enough eggs for the year's production, Nimbus Hatchery supplied 206 adult fish. A total of 436,276 eggs were taken.

During the 1965 spawning season, a total of 30 adult steelhead entered the hatchery and 55,300 eggs were taken. This amount was supplemented by 315,456 steelhead fry from Nimbus Hatchery.

From January 1, 1964 through June 30, 1965, a total of 255,805 steelhead was planted in the Mokelumne River, leaving a balance of 310,000 fish on hand at the end of the fiscal year.

#

1/ Submitted December, 1965
Inland Fisheries Administrative Report No. 65-21

INTRODUCTION

Effects of Camanche Dam

Before Camanche Dam was constructed on the Mokelumne River, salmon and steelhead were able to migrate from the Delta as far upstream as Pardee Dam. When East Bay Municipal Utility District completed Camanche Dam in 1963, about 12 miles of good spawning ground was lost. The few good spawning riffles which exist below the dam are not sufficient to accommodate the normal fall runs of king salmon and steelhead. In order to mitigate the loss of spawning grounds, the District constructed the Mokelumne River Fish Installation.

In the fall of 1960 the East Bay Municipal Utility District, with the cooperation of the Department of Fish and Game, built an experimental salmon spawning channel near Lancha Plana, which is upstream from the present installation. The success of this experiment resulted in the construction of the present spawning channel in lieu of a standard salmon hatchery. In conjunction with the channel, a hatchery facility was provided to accommodate the steelhead run. The East Bay Municipal Utility District paid for the construction of the installation and also pays the cost of operation. The channel and hatchery is managed and operated by the Department of Fish and Game.

Construction of the Channel

At the present time the Mokelumne River Fish Installation is among the largest artificial spawning channels in the world. It is located about 40 miles south east of Sacramento at the base of the Camanche Dam on the Mokelumne River (Figure 1).

The spawning channel consists of two loops, each containing spawning sections and resting pools. The resting pools, which are spaced 500 feet apart, provide a shelter for the fish until they are ready to spawn. Invert controls are located at 250 feet intervals in the spawning gravel and at the upstream and downstream ends of each pool. They serve to stabalize the gravel and could be modified to vary the velocity and depth of the water in the channel (Figure 2). A typical cross section of the channel is shown in Figures 3 and 4. Specifications used in constructing the spawning channel are shown in Figure 5.

Water for the channel is supplied from a low level outlet in Camanche Dam. It first enters an aerator which has a maximum capacity of 40 cfs. Additional water is supplied through a by-pass around the aerator. From here the water enters a concrete box for distribution to the channels. From the distribution box the water can be directed into either or both of the channels, or it can run directly into the ladder and by-pass the channels entirely. Water enters the head of each loop through a diffusion chamber under the channel bottom which reduces the velocity to 1/4 foot per second.

A V-trap type gate is installed at the fish entrance of each channel loop to prevent the adults from returning downstream.

Operation of the Spawning Channel

Salmon enter the fish ladder at the base of the dam and ascend to the sorting tank. A mechanical sweep and lift, elevates the fish and deposits them into an anesthetic tank for sorting and counting. From there the salmon enter the channel to spawn.

Fertilized eggs remain in the gravel for about 50 days before they hatch. After the young fry have absorbed their yolk sacs, they emerge from the gravel and return to the river.

King Salmon Spawning Operation

During the first year of operation, Camanche Reservoir did not have sufficient water in storage to provide a 60 cubic feet per second flow. On October 9, 1964, water was turned into the channel and a maximum flow of 38 cubic feet per second was obtained. As the elevation of the reservoir increased, the flow through the channels increased to a maximum of 53 cubic feet per second during the spawning season.

The first salmon entered the channels on October 17, 1964 and the last one on December 5, 1964. The number of fish entering the channel through the ladder amounted to 146 males and 96 females, for a total of 242 fish. Between November 24, and 28, 1964, 38 males and 82 females were hauled by truck from the Woodbridge counting station to the channels (Figure 6).

Dead salmon were collected at the lower end of the channel. All fish were measured and cut open for inspection, and any remaining eggs were counted. From the total of 178 female carcasses recovered, all except 3 fish spawned successfully.

Based on the fecundity of 4 females which were spawned artificially, an estimated 927,300 eggs were deposited (Figure 8). The average egg retention after spawning was 25 eggs per female. The first dead carcass was recovered on November 2, 1964 and the last one on December 17, 1964 (Figure 7). The redds were quite evenly distributed and all sections of the channel were utilized except a 500 foot area at the upper end on channel 2.

King Salmon Downstream Migrant Operation

At the end of the spawning season, the water in the channel was reduced to 30 cubic feet per second, and an inclined plane trap was installed at the outlet of the channel to trap the salmon migrants. The first migrants appeared on December 27, 1964 and the last ones on April 5, 1965. After the water was turned off, the resting pools were seined on 3 occasions and 780 salmon fry were rescued. A total of 73,540 salmon migrants, 8 percent of eggs deposited, was trapped during the season (Figure 9). We feel that this total figure is not a true picture of the spawning success for two reasons. First, as the trapping period progressed, a severe algae problem developed at the trap, making it necessary to by-pass part of the water from the channel directly into the ladder. It is quite possible that many salmon fry escaped through the by-pass. Secondly, a total of 5,100 yearling steelhead entered the channel with the adult salmon. The steelhead were trapped and counted along with the migrating salmon fry. The steelhead were periodically cut open and almost all stomachs contained salmon fry. A fish rack will be installed at the sorting tank and aerator next year, so that only salmon can enter the channel. Several redds were uncovered after the salmon season and only a few dead eggs were recovered.

STEELHEAD PROGRAM

Hatchery Operation

The steelhead migration in the Mokelumne River takes place during the months of January, February, and March. Steelhead ascend the fish ladder and enter the

holding tank, where they remain until they are ready to spawn. After the fish have been spawned artificially, the adults are returned to the river.

Steelhead fingerlings grow at irregular rates. They are graded and the smallest fingerlings disposed of by planting; only about 100,000 of the fastest growing fish are reared to yearling size. Fingerling planting is a by-product of the yearling program.

The eggs are hatched in an incubator and when the fry reach the feeding stage they are transferred to hatchery troughs. The fingerlings remain there until large enough to be moved to the rearing ponds. There are 6 concrete rearing ponds, each one 10 feet wide, 3 feet deep, and 100 feet long. They are arranged in 2 series of 3 ponds each. The fish are raised for one year before they are released into the Mokelumne River. The hatchery facilities are capable of raising 100,000 yearling steelhead per year.

Steelhead Production

During the 1964 steelhead season, 15 adults were trapped and spawned. In order to provide enough eggs for the first year's production, Nimbus Hatchery supplied 91 males and 115 females. These were spawned with the Mokelumne River fish to make a total take of 436,276 eggs for the 1964 broodyear. From January 1, 1964 through June 30, 1965 a total of 92,525 yearlings and 163,280 fingerlings were released. During the 1965 season 30 adult steelhead entered the hatchery and produced 55,300 eggs. Nimbus Hatchery supplied 315,456 steelhead fry to supplement the 1965 broodyear production. A balance of 310,000 of these fingerlings remain on hand as of June 30, 1965.

PUBLIC RELATIONS

A 300 feet observation area was fenced off along one channel so that the public could have an opportunity to watch the salmon activity. From January 1, 1964 through June 30, 1965, a total of 25,220 people visited the installation.

APPENDIX

The appendix covers weather conditions, air and water temperatures, river and hatchery flow release, salmon taken and carcass recovery, daily downstream migrant release, and steelhead taken.

TABLE A-1
Mokelumne River Fish Installation
Weather and Water Recordings
Salmon and Steelhead Data
July 1964

Date	Weather	Temperature Air Max.	Temperature Air Min.	Temperature Water Max.	Temperature Water Min.	Flow - cfs River	Flow - cfs Hatchery	Adult Salmon	Carcass Recovery	Salmon Migrants	Steelhead
1	Clear	89	49	60	60	430	35				
2	Clear	87	48	60	60	335	35				
3	Clear	88	49	60	60	342	35				
4	Clear	84	46	61	61	337	35				
5	Clear	86	48	61	61	342	35				
6	Clear	90	48	61	61	337	35				
7	Clear	89	49	60	60	337	35				
8	Clear	86	49	60	60	323	35				
9	Clear	90	50	60	60	308	35				
10	Clear	96	50	60	60	320	5				
11	Cloudy	103	54	60	60	421	5				
12	Clear	100	55	60	60	325	5				
13	Clear	98	56	60	60	303	5				
14	Clear	97	60	61	60	303	5				
15	Clear	95	61	61	60	312	5				
16	Clear	96	64	62	61	342	5				
17	Clear	98	60	62	61	351	5				
18	Clear	92	57	62	61	370	5				
19	Clear	94	56	62	60	316	5				
20	Clear	94	60	62	61	291	5				
21	Clear	96	62	62	61	255	5				
22	Clear	94	58	62	61	320	5				
23	Clear	102	58	62	61	360	5				
24	Clear	103	62	62	61	340	5				
25	Clear	102	63	62	61	342	5				
26	Clear	97	69	63	61	342	5				
27	Cloudy	97	74	63	62	325	5				
28	Clear	104	70	64	62	310	5				
29	Clear	96	62	64	61	310	5				
30	Clear	88	62	62	60	315	5				
31	Clear	88	58	62	60	325	5				

All temperatures are in degrees Fahrenheit. Air and water temperatures recorded on thermograph at aerator.

TABLE A-2
Mokelumne River Fish Installation
Weather and Water Recordings
Salmon and Steelhead Data
August 1964

Date	Weather	Temperature Air Max.	Air Min.	Water Max.	Water Min.	Flow - cfs River	Flow - cfs Hatchery	Adult Salmon	Carcass Recovery	Salmon Migrants	Steelhead
1	Clear	87	54	62	60	325	5				
2	Clear	90	60	62	60	342	5				
3	Clear	94	57	61	60	342	5				
4	Clear	98	59	64	62	342	5				
5	Clear	102	62	64	62	342	5				
6	Clear	100	66	64	62	342	5				
7	Clear	100	66	64	62	342	5				
8	Clear	98	60	64	62	342	5				
9	Clear	100	60	64	62	342	5				
10	Clear	96	58	64	62	342	5				
11	Clear	98	58	64	62	342	5				
12	Clear	96	58	63	62	342	5				
13	Clear	92	58	62	61	342	5				
14	Clear	90	56	62	60	342	5				
15	Clear	96	56	62	60	342	5				
16	Clear	96	60	62	60	342	5				
17	Clear	98	63	62	60	342	5				
18	Clear	96	62	62	59	342	5				
19	Clear	99	60	62	59	342	5				
20	Clear	102	62	62	59	342	5				
21	Clear	95	66	62	59	342	15				
22	Clear	95	62	61	59	342	15				
23	Clear	96	62	61	59	342	15				
24	Clear	98	60	61	58	342	10				
25	Clear	96	58	61	58	342	10				
26	Clear	90	60	60	58	342	10				
27	Clear	90	57	60	58	342	10				
28	Clear	90	58	60	58	342	10				
29	Clear	95	56	60	58	342	10				
30	Clear	90	60	61	58	342	10				
31	Rain	62	52	58	58	342	10				

TABLE A-3
Mokelumne River Fish Installation
Weather and Water Recordings
Salmon and Steelhead Data
September 1964

Date	Weather	Temperature Air Max.	Temperature Air Min.	Temperature Water Max.	Temperature Water Min.	Flow - cfs River	Flow - cfs Hatchery	Adult Salmon	Carcass Recovery	Salmon Migrants	Steelhead
1	Cloudy	77	48	59	58	342	10				
2	Clear	86	50	60	58	295	10				
3	Clear	92	54	60	58	295	10				
4	Clear	94	53	60	58	295	10				
5	Clear	95	53	60	58	295	10				
6	Clear	82	50	60	58	295	10				
7	Clear	83	50	60	58	295	10				
8	Clear	80	48	59	57	295	10				
9	Clear	84	49	59	57	295	10				
10	Clear	90	53	60	57	295	10				
11	Clear	94	55	60	58	295	10				
12	Clear	86	50	60	57	275	10				
13	Clear	82	54	60	57	275	10				
14	Clear	88	52	60	57	275	10				
15	Clear	92	54	61	58	275	10				
16	Clear	94	59	61	58	275	10				
17	Clear	84	54	61	58	275	10				
18	Clear	88	51	62	59	275	10				
19	Clear	97	51	63	60	250	10				
20	Clear	93	54	63	60	250	10				
21	Clear	92	56	62	60	250	10				
22	Clear	93	56	62	59	250	10				
23	Clear	97	58	62	59	250	10				
24	Clear	100	63	62	59	250	10				
25	Clear	93	62	61	59	250	10				
26	Clear	80	56	60	58	250	10				
27	Clear	77	49	60	57	250	10				
28	Clear	78	50	60	57	250	10				
29	Clear	84	49	62	58	250	10				
30	Clear	86	51	62	60	250	10				

TABLE A-4
Mokelumne River Fish Installation
Weather and Water Recordings
Salmon and Steelhead Data
October 1964

Date	Weather	Temperature				Flow - cfs		Adult Salmon	Carcass Recovery	Salmon Migrants	Steelhead
		Air		Water							
		Max.	Min.	Max.	Min.	River	Hatchery				
1	Clear	90	51	62	60	250	10				
2	Clear	95	58	62	60	250	10				
3	Clear	98	57	62	60	250	10				
4	Clear	97	58	62	60	250	10				
5	Clear	93	58	62	60	250	10				
6	Clear	95	58	62	59	240	10				
7	Clear	83	56	60	58	240	10				
8	Clear	84	50	60	58	240	10				
9	Clear	84	52	60	57	240	38				
10	Clear	84	49	60	57	240	38				
11	Clear	90	52	61	57	240	38				
12	Clear	88	51	61	58	240	38				
13	Clear	78	48	60	57	240	38				
14	Clear	80	48	60	57	240	38				
15	Clear	80	50	60	57	240	38				
16	Clear	76	49	60	57	240	38				
17	Clear	78	38	60	57	240	38	3			
18	Clear	82	40	60	57	240	38	0			
19	Clear	87	47	60	57	240	38	0			
20	Clear	88	48	60	57	240	38	2			
21	Clear	88	45	60	57	240	38	0			
22	Clear	84	44	60	56	240	50	1			
23	Clear	68	46	59	57	240	50	0			
24	Cloudy	68	44	59	57	240	50	0			
25	Cloudy	63	44	59	57	240	50	0			
26	Clear	69	45	59	57	240	50	8			
27	Clear	65	54	60	58	240	50	8			
28	Rain	71	60	62	58	240	50	11			
29	Rain	64	53	60	58	200	50	5			
30	Cloudy	70	50	60	58	200	50	15			
31	Cloudy	65	50	60	58	200	50	13			

TABLE A-5
Mokelumne River Fish Installation
Weather and Water Recordings
Salmon and Steelhead Data
November 1964

Date	Weather	Temperature Air Max.	Temperature Air Min.	Temperature Water Max.	Temperature Water Min.	Flow - cfs River	Flow - cfs Hatchery	Adult Salmon	Carcass Recovery	Salmon Migrants	Steelhead
1	Rain	58	54	60	58	200	50	20			
2	Rain	58	48	60	58	200	50	14	1		
3	P.Cloudy	62	46	60	58	150	50	4	0		
4	P.Cloudy	66	45	60	57	150	50	9	0		
5	Cloudy	66	44	61	57	150	50	0	0		
6	Cloudy	70	42	59	58	150	50	0	0		
7	Cloudy	64	49	58	58	150	50	2	0		
8	Rain	66	52	60	58	150	50	0	0		
9	Rain	64	46	58	56	150	50	3	1		
10	Rain	56	45	56	56	150	51	4	7		
11	Rain	52	47	56	55	150	52	8	4		
12	Rain	58	38	56	54	150	52	18	3		
13	P.Cloudy	55	33	56	54	150	52	15	8		
14	Clear	56	32	56	52	150	52	12	8		
15	Clear	54	32	54	52	150	52	4	4		
16	P.Cloudy	50	32	54	52	150	52	9	9		
17	Clear	56	28	54	51	150	52	5	10		
18	Clear	53	28	53	51	150	52	4	10		
19	Clear	58	30	53	50	150	52	3	12		
20	Clear	60	30	52	50	150	52	6	18		
21	Cloudy	59	30	52	50	150	52	3	10		
22	Clear	59	37	52	50	150	52	4	9		
23	Clear	59	38	52	50	150	52	7	15		
24	Clear	60	42	52	50	150	51	4-58 1/	12		
25	P.Cloudy	57	50	51	50	150	51	1-34 1/	22		
26	Cloudy	57	38	51	50	150	51	4-14 1/	11		
27	Clear	54	39	51	50	150	51	2- 7 1/	3		
28	Cloudy	57	43	52	50	150	51	2- 7 1/	7		
29	Cloudy	51	42	51	50	150	51	1	4		
30	Clear	50	43	51	50	150	51	2	6		

1/ hauled from Woodbirdge counting station to spawning channels

TABLE A-6
Mokelumne River Fish Installation
Weather and Water Recordings
Salmon and Steelhead Data
December 1964

Date	Weather	Temperature Air Max.	Temperature Air Min.	Temperature Water Max.	Temperature Water Min.	Flow - cfs River	Flow - cfs Hatchery	Adult Salmon	Carcass Recovery	Salmon Migrants	Steelhead
1	Cloudy	60	49	52	50	150	51	0	6		
2	P.Cloudy	62	50	52	50	150	51	2	10		
3	Rain	58	38	51	50	150	51	2	11		
4	P.Cloudy	52	35	51	50	150	51	1	3		
5	Clear	57	41	51	50	150	51	1	16		
6	Clear	60	36	51	50	150	51		13		
7	Clear	56	48	51	50	150	52		11		
8	Clear	61	43	52	50	150	52		12		
9	Clear	62	48	52	50	150	52		14		
10	P.Cloudy	56	48	51	50	150	52		13		
11	Clear	59	50	51	50	150	38		33		
12	Clear	58	34	51	50	150	38		2		
13	Clear	56	31	50	49	150	38		6		
14	Cloudy	46	35	50	49	150	38		3		
15	Cloudy	47	43	50	49	150	38		1		
16	Cloudy	48	44	50	49	150	38		0		
17	P.Cloudy	48	42	50	49	150	38		7		
18	Cloudy	48	36	50	49	150	53				
19	Rain	53	46	50	49	150	53				
20	Rain	60	54	50	50	150	53				
21	Rain	60	56	51	50	150	53				
22	Rain	62	56	52	51	150	53				
23	Rain	64	58	52	51	150	36				
24	Cloudy	64	54	52	51	150	37				
25	Cloudy	58	52	51	51	150	38				
26	Rain	54	46	51	50	150	37				
27	Rain	47	40	50	49	150	38			10	
28	Rain	45	39	50	49	150	35			17	
29	Rain	43	40	50	49	150	35			19	
30	Rain	47	40	50	49	676	35			24	
31	Rain	49	31	49	47	2,870	35			28	

TABLE A-7
Mokelumne River Fish Installation
Weather and Water Recordings
Salmon and Steelhead Data
January 1965

Date	Weather	Temperature Air Max.	Temperature Air Min.	Temperature Water Max.	Temperature Water Min.	Flow - cfs River	Flow - cfs Hatchery	Adult Salmon	Carcass Recovery	Salmon Migrants	Steelhead
1	Clear	46	26	48	47	2,870	35			26	
2	Rain	49	39	49	48	2,870	35			29	4
3	Rain	50	44	48	48	2,870	35			50	
4	Rain	54	48	49	48	2,814	35			42	
5	Rain	54	50	50	49	2,870	35			47	
6	Rain	56	36	49	48	2,400	35			0	4
7	P.Cloudy	51	27	48	46	2,400	35			40	
8	Clear	50	28	48	46	1,500	35			0	
9	Clear	54	35	48	46	2,000	35			23	
10	Clear	53	37	47	46	48	35			55	
11	Cloudy	48	42	48	46	2,000	35			100	
12	Clear	55	38	47	46	1,500	35			29	
13	P.Cloudy	55	34	47	44	1,500	35			57	1
14	Fog	42	34	45	44	1,500	35			74	
15	Fog	42	38	45	44	1,500	35			56	2
16	Fog	44	39	45	45	1,500	35			31	
17	Fog	46	42	45	45	1,500	35			53	
18	Fog	46	40	45	45	2,000	36			62	
19	Rain	48	42	45	45	2,000	36			114	
20	P.Cloudy	50	44	45	45	2,000	36			157	
21	P.Cloudy	49	42	45	45	2,000	36			401	
22	P.Cloudy	58	44	45	45	2,000	20			980	
23	Rain	58	43	45	45	2,000	20			630	
24	Clear	58	34	48	46	2,000	20			1,580	
25	P.Cloudy	48	34	47	46	2,000	15			978	
26	Clear	56	36	47	46	2,770	15			1,700	
27	Clear	56	36	47	45	2,750	15			1,275	
28	P.Cloudy	50	34	46	45	2,750	15			1,785	
29	Cloudy	55	42	46	45	2,750	15			1,275	
30	Cloudy	48	36	48	46	1,500	32			1,700	
31	Cloudy	45	33	45	45	1,500	32			935	

TABLE A-8
Mokelumne River Fish Installation
Weather and Water Recordings
Salmon and Steelhead Data
February 1965

Date	Weather	Temperature Air Max.	Temperature Air Min.	Temperature Water Max.	Temperature Water Min.	Flow - cfs River	Flow - cfs Hatchery	Adult Salmon	Carcass Recovery	Salmon Migrants	Steelhead
1	Cloudy	45	42	45	45	1,500	34			1,485	
2	Fog	45	42	45	45	750	34			1,020	
3	Fog	45	42	45	45	750	42			1,190	
4	Fog	48	42	45	45	750	40			1,360	1
5	Rain	54	46	45	45	750	40			1,870	
6	P.Cloudy	57	40	45	45	750	20			2,200	2
7	Clear	64	40	45	45	2,200	35			2,140	
8	Clear	57	39	45	45	2,000	35			2,550	
9	Clear	54	33	45	45	1,750	36			2,175	
10	Clear	60	30	45	45	1,250	36			2,040	
11	Clear	56	32	45	45	750	36			1,275	
12	Clear	61	33	45	45	500	36			3,315	
13	Cloudy	56	42	45	45	1,000	36			1,505	
14	Clear	61	42	45	45	1,500	36			425	3
15	Clear	56	32	45	45	610	38			1,065	
16	Clear	63	34	45	45	1,586	38			845	2
17	Clear	65	34	45	45	1,200	32			2,635	1
18	Clear	67	34	45	45	337	32			1,645	
19	P.Cloudy	68	36	45	45	680	32			2,550	
20	P.Cloudy	66	37	45	45	625	32			1,023	
21	Clear	70	40	45	45	500	32			1,085	
22	Clear	62	36	45	45	400	32			2,550	
23	Clear	60	35	45	45	1,200	32			810	
24	Clear	65	34	45	45	1,187	32			850	
25	Clear	67	33	45	45	325	32			935	
26	P.Cloudy	65	36	45	45	535	32			765	
27	Rain	60	40	45	45	535	32			1,275	
28	Clear	64	36	47	44	535	32			1,190	

TABLE A-9
Mokelumne River Fish Installation
Weather and Water Recordings
Salmon and Steelhead Data
March 1965

Date	Weather	Temperature Air Max.	Temperature Air Min.	Temperature Water Max.	Temperature Water Min.	Flow - cfs River	Flow - cfs Hatchery	Adult Salmon	Carcass Recovery	Salmon Migrants	Steelhead
1	Clear	64	32	47	44	650	32			1,275	
2	Clear	66	36	48	44	750	32			1,360	1
3	Clear	68	40	47	44	800	32			1,360	2
4	Cloudy	68	44	47	45	928	32			1,000	
5	Rain	60	46	46	45	903	32			1,615	
6	Cloudy	59	42	46	44	900	32			1,000	
7	Clear	65	37	46	44	900	32			1,405	1
8	P.Cloudy	65	38	47	44	708	32			930	
9	Cloudy	54	38	46	44	657	32			1,020	
10	P.Cloudy	59	44	46	45	796	32			850	
11	P.Cloudy	58	38	46	44	667	32			935	
12	Rain	47	45	45	45	810	32			350	
13	P.Cloudy	64	44	46	44	855	32			455	
14	P.Cloudy	71	42	47	45	1,033	32			300	
15	P.Cloudy	66	36	46	44	1,050	30			295	
16	P.Cloudy	67	40	46	44	450	30			170	
17	P.Cloudy	68	40	46	44	250	30			85	
18	P.Cloudy	60	35	46	44	250	30			85	
19	Clear	66	34	46	44	250	33			45[1]	
20	Clear	70	40	46	44	250	33				
21	Clear	74	36	46	44	250	33				
22	Clear	75	44	46	46	250	33				
23	Clear	61	45	46	46	250	33				
24	Cloudy	54	45	46	46	250	33				2
25	Cloudy	61	43	46	46	250	33				
26	Rain	58	45	46	46	250	33				
27	Rain	61	42	46	46	894	33				
28	P.Cloudy	65	36	46	44	1,560	33				
29	Cloudy	63	39	47	45	1,600	33			8[2]	
30	Cloudy	66	43	47	46	1,469	33			9	
31	Rain	60	48	47	46	918	33			11	

1/ live car removed from trap
2/ live car replaced at trap

TABLE A-10
Mokelumne River Fish Installation
Weather and Water Recordings
Salmon and Steelhead Data
April 1965

Date	Weather	Temperature Air Max.	Temperature Air Min.	Temperature Water Max.	Temperature Water Min.	Flow - cfs River	Flow - cfs Hatchery	Adult Salmon	Carcass Recovery	Salmon Migrants	Steelhead
1	Cloudy	62	43	47	45	1,000	33			6	
2	Rain	52	44	46	45	1,104	33			2	4
3	Clear	66	40	48	46	1,313	33			4	
4	Cloudy	62	37	47	46	1,500	33			5	
5	Cloudy	56	46	46	46	1,500	3			25[1/]	
6	Rain	57	44	46	46	500	3				
7	Cloudy	53	42	46	46	1,152	3				
8	Rain	52	44	46	46	1,550	3				
9	Rain	48	40	46	46	1,000	3			100[2/]	
10	Rain	51	42	47	47	1,860	3				
11	P.Cloudy	60	37	47	47	2,050	3				
12	Cloudy	58	48	48	47	2,050	3			330[2/]	
13	Rain	60	46	48	48	1,475	3				
14	Rain	62	48	49	48	1,444	3				
15	Cloudy	64	52	49	48	1,527	3				
16	Rain	66	47	48	47	1,600	3			350[2/]	
17	Cloudy	64	42	48	48	1,600	3				
18	Rain	69	48	49	48	1,600	3				
19	P.Cloudy	76	50	49	48	1,600	3				
20	Rain	65	53	49	48	1,600	.1				
21	Cloudy	74	51	49	48	1,721	.1				
22	Clear	72	42	49	48	1,992	.1				
23	Clear	77	42	49	48	2,219	.1				
24	Clear	84	47	49	48	2,479	.1				
25	Clear	84	39	50	48	2,500	.1				
26	Clear	86	48	50	48	2,500	.1				
27	Clear	89	56	50	48	2,500	.1				
28	Clear	84	54	50	48	2,500	.1				
29	P.Cloudy	82	50	50	48	2,500	5				
30	Clear	77	48	50	48	2,271	5				

1/ live car removed from trap

2/ rescued from channel resting pools after water was turned off

TABLE A-11
Mokelumne River Fish Installation
Weather and Water Recordings
Salmon and Steelhead Data
May 1965

Date	Weather	Temperature Air Max.	Temperature Air Min.	Temperature Water Max.	Temperature Water Min.	Flow - cfs River	Flow - cfs Hatchery	Adult Salmon	Carcass Recovery	Salmon Migrants	Steelhead
1	Clear	72	39	49	48	2,021	5				
2	Cloudy	70	50	49	48	2,000	5				
3	Clear	77	40	50	48	2,000	5				
4	P.Cloudy	69	43	50	49	2,000	5				
5	Clear	67	37	49	48	2,000	5				
6	Clear	64	36	49	48	2,000	5				
7	Clear	76	38	50	48	2,000	5				
8	Clear	76	41	50	49	2,000	5				
9	Clear	84	42	51	49	2,000	5				
10	Clear	86	44	52	50	2,000	5				
11	Clear	88	47	52	50	2,000	5				
12	Clear	88	48	51	50	2,000	5				
13	P.Cloudy	72	44	49	49	2,000	5				
14	Clear	81	43	50	49	2,000	5				
15	Clear	86	45	50	50	2,000	5				
16	Clear	88	46	51	50	2,000	5				
17	Clear	85	47	52	50	2,000	5				
18	P.Cloudy	83	47	52	50	2,000	5				
19	Cloudy	75	50	51	50	2,000	5				
20	Cloudy	68	50	51	50	2,000	5				
21	Rain	65	49	50	50	2,000	5				
22	Rain	74	48	51	50	2,000	5				
23	Clear	80	45	52	50	2,000	5				
24	Clear	78	46	52	50	2,000	5				
25	Clear	85	45	52	50	1,583	5				
26	Clear	89	48	52	50	1,500	5				
27	Clear	90	52	52	50	1,500	5				
28	Clear	92	52	52	51	1,500	5				
29	Clear	90	52	52	51	1,500	5				
30	Clear	83	52	52	51	1,500	5				
31	Cloudy	70	47	51	51	1,500	5				

TABLE A-12
Mokelumne River Fish Installation
Weather and Water Recordings
Salmon and Steelhead Data
June 1965

Date	Weather	Temperature Air Max.	Temperature Air Min.	Temperature Water Max.	Temperature Water Min.	Flow - cfs River	Flow - cfs Hatchery	Adult Salmon	Carcass Recovery	Salmon Migrants	Steelhead
1	Cloudy	71	46	51	51	1,500	5				
2	Cloudy	78	48	52	51	1,500	5				
3	Cloudy	80	49	52	51	1,958	5				
4	Cloudy	79	49	52	51	2,000	5				
5	Cloudy	79	48	52	51	2,292	5				
6	Cloudy	73	49	53	51	2,500	5				
7	Cloudy	70	51	53	51	2,500	5				
8	Clear	69	45	52	50	2,500	5				
9	Clear	78	45	52	50	2,500	5				
10	Clear	87	50	53	51	2,500	5				
11	Clear	88	52	53	51	2,500	5				
12	Clear	82	47	53	51	2,375	5				
13	P.Cloudy	80	54	55	52	2,500	5				
14	P.Cloudy	71	52	54	52	2,490	5				
15	Clear	78	44	54	52	2,126	5				
16	Cloudy	83	50	55	53	2,500	5				
17	Cloudy	76	56	54	53	2,225	5				
18	Clear	86	52	56	53	2,017	5				
19	Clear	90	56	56	54	2,000	5				
20	Clear	88	56	56	54	2,000	5				
21	P.Cloudy	82	54	56	54	2,000	5				
22	Clear	80	53	56	54	1,776	5				
23	P.Cloudy	79	52	56	54	1,750	5				
24	P.Cloudy	78	50	56	53	1,750	5				
25	Clear	68	48	55	53	1,750	5				
26	Clear	74	48	54	52	1,172	5				
27	Clear	88	48	55	52	757	5				
28	Clear	94	52	56	52	383	5				
29	Clear	94	47	56	53	203	5				
30	Clear	76	53	54	52	703	5				

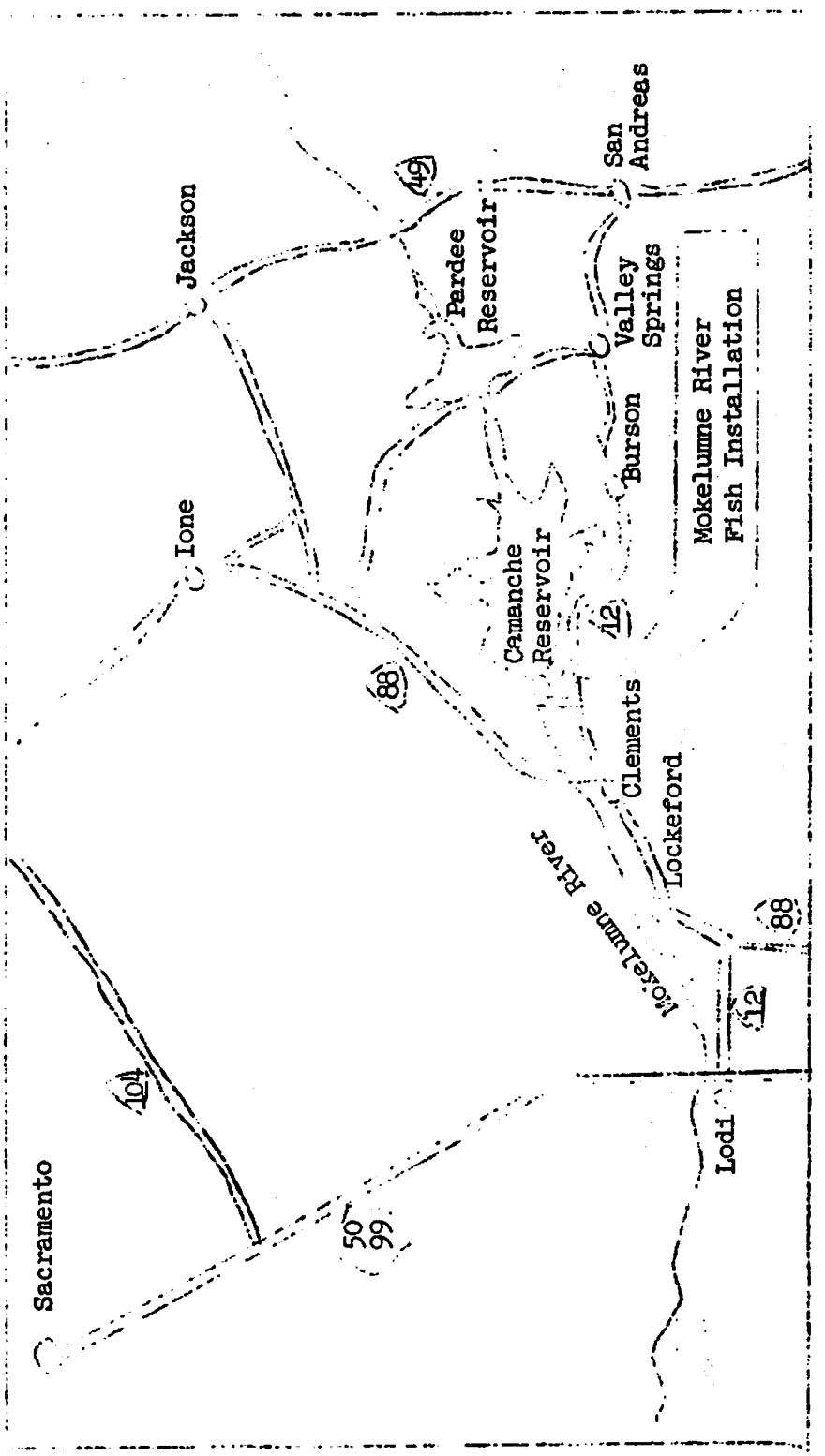


FIGURE A-1. Mokelumne River Fish Installation location map

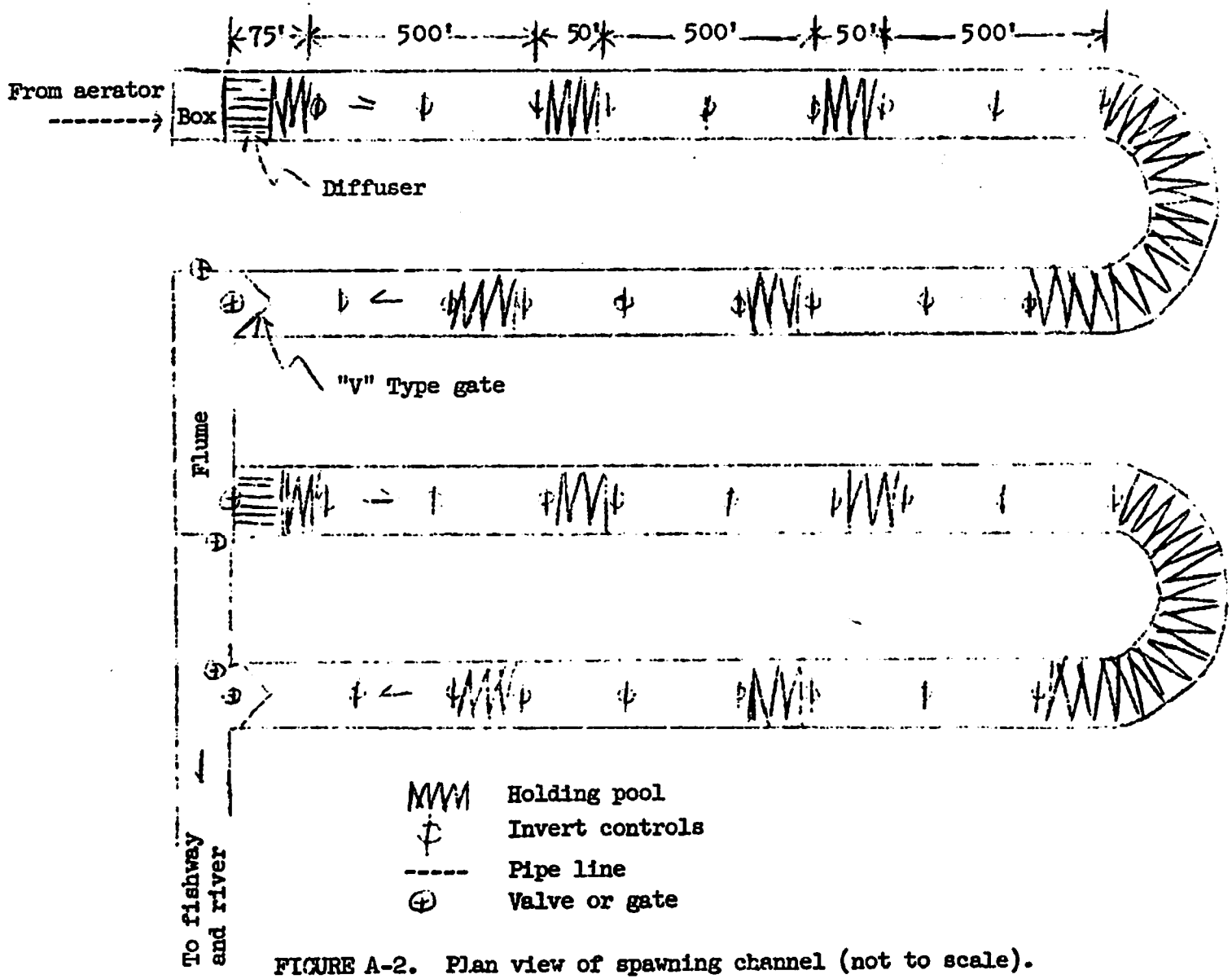


FIGURE A-2. Plan view of spawning channel (not to scale).

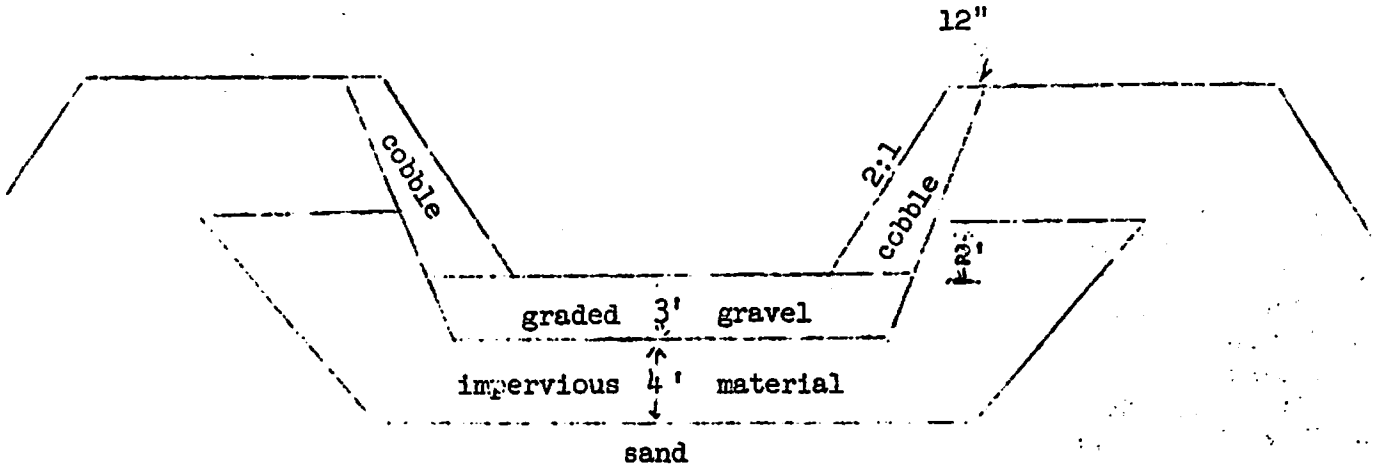


FIGURE A-3. Typical cross section of channel.

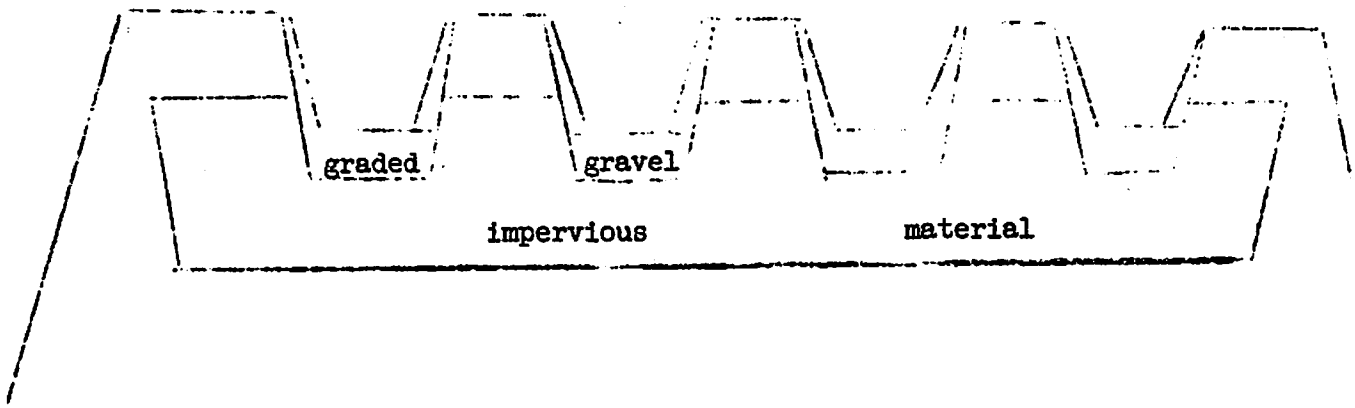


FIGURE A-4. Cross section of entire channel.

1. Two loops, each made up of 3,000 lineal feet of riffle and 400 lineal feet of holding pool, (Figure 2).
2. Sides of channel and bottom of holding pools are cobble, largest that could be found in the project area, most of which ranged from 3 to 6 inches.
3. Spawning gravel size:

Sieve size	Percent passing by weight
4"	100
3"	86-92
2"	66-78
1½"	47-61
1"	27-47
3/4	0

4.	Total length of channel	6,800 feet
5.	Total length of each loop	3,400 feet
6.	Total drop for full length of channel	5.70 feet
7.	Depth of impervious clay material	4 feet 1/
8.	Bottom width	20 feet
9.	Side slope	2 to 1
10.	Channel gradient	0.0008 (8/10,000)
11.	Side slope in pools	1½ to 1
12.	End slope in pools	4 to 1
13.	Depth of water in holding pools	5 feet
14.	Depth of spawning gravel	3 feet
15.	Spawning flow	69 cfs
16.	Average velocity at 69 cfs	2 fps
17.	Average depth at 69 cfs	1.5 feet
18.	Spawning gravel area	120,000 sq. feet
19.	King salmon spawning capacity	4,700 (2,000 females)
20.	Width of flume	11 feet
21.	Length of flume	144 feet

1/ A one-foot sand filter layer was to have been placed under the impervious fill. This was not added, with the exeption of one small area, because the graded bed contained a natural filter layer. This space was filled instead with an additional one foot of clay material, making four feet of impervious fill instead of the three feet originally specified.

FIGURE A-5. Mokelumne River Fish Installation spawning channel specifications

Mokelumne River Fish Installation

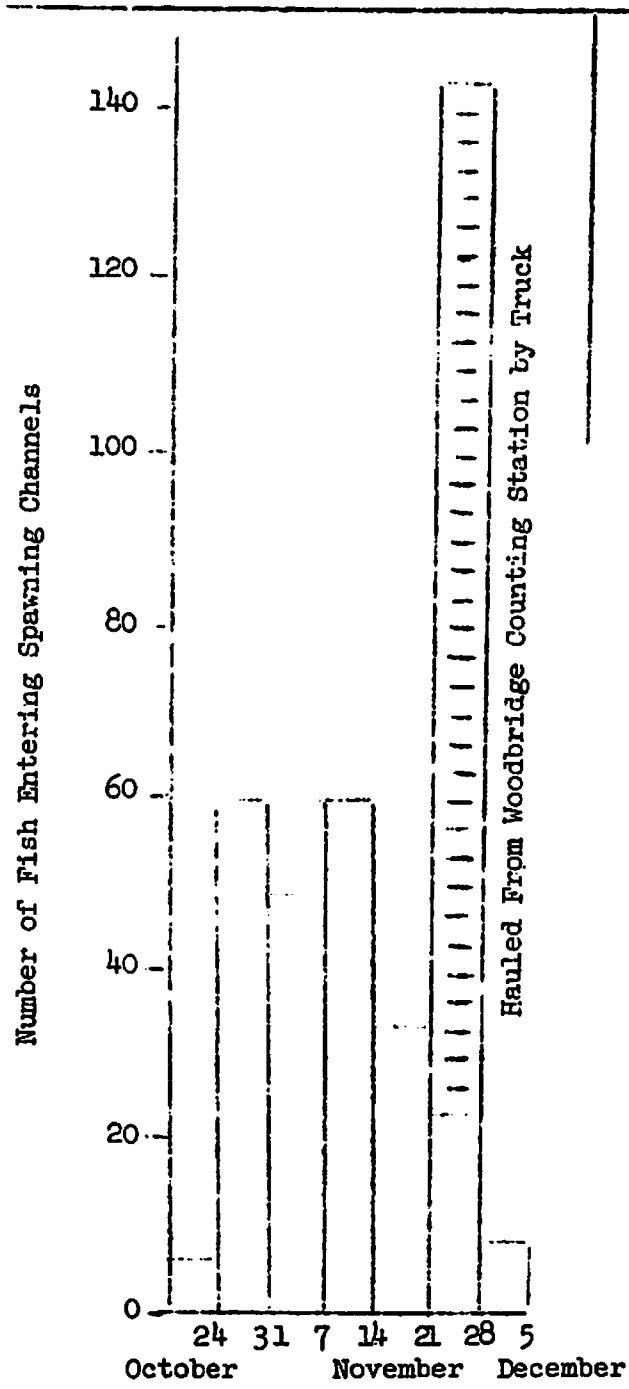


FIGURE A-6. Adult king salmon taken fall of 1964.

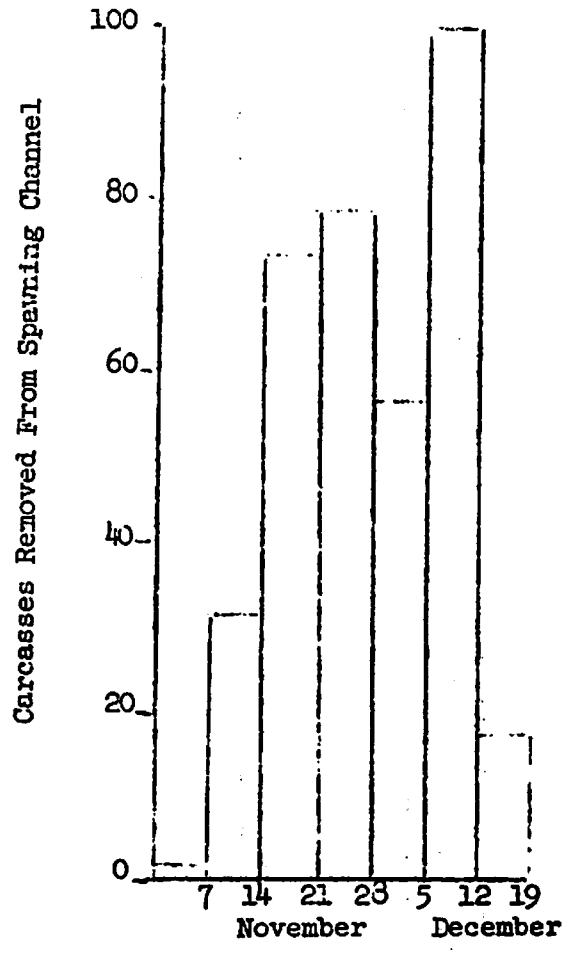
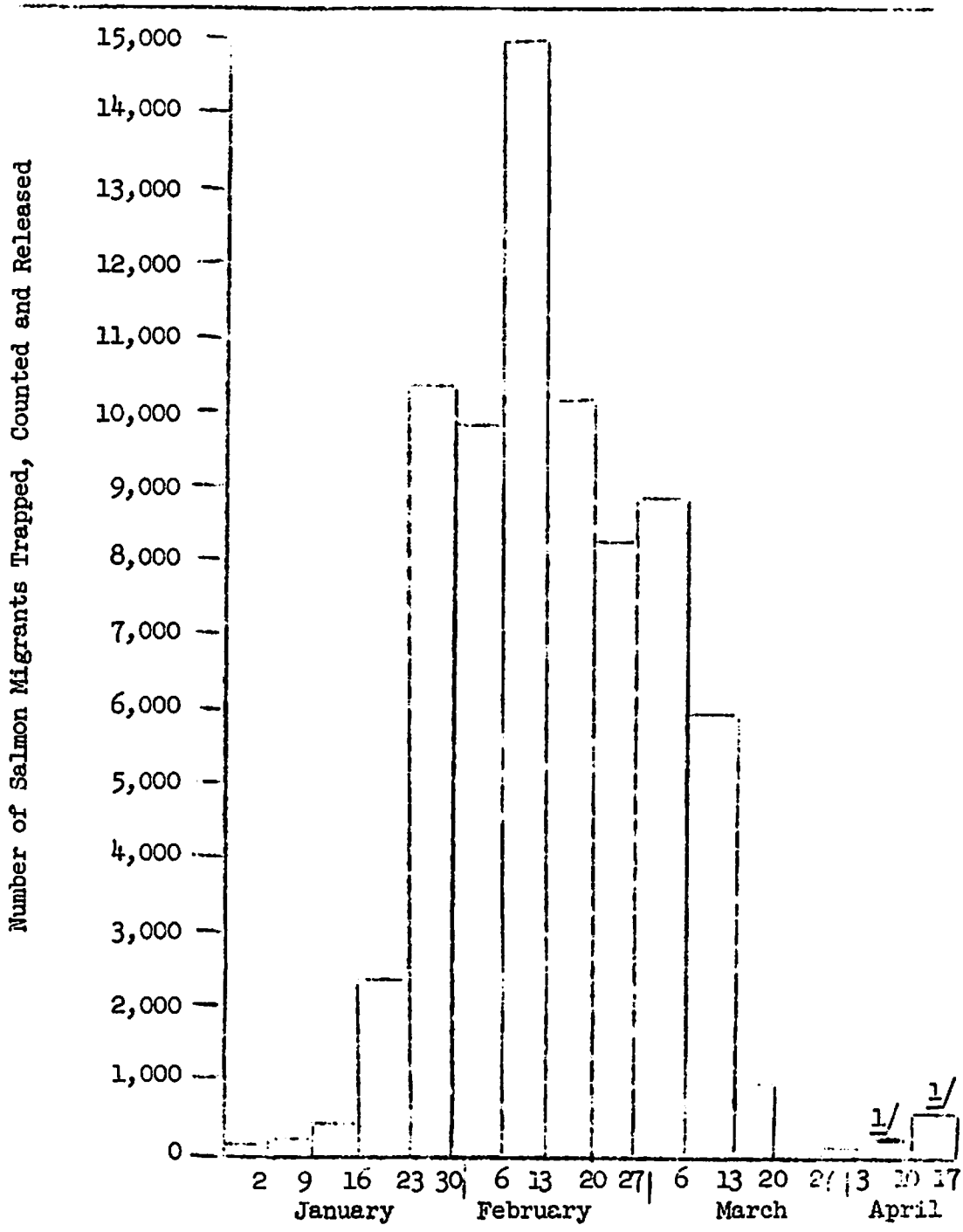


FIGURE A-7. King salmon carcass recovery fall of 1964.

Date	Water Max.	Water Min.	Number females	Length	Ounces eggs	Number per ounce	Total eggs	Egg loss	Percent fertility
23	52	50	1	33"	70	87	6,090	1,208	80.2
28	52	50	1	33"	79	85	6,715	1,893	71.8
28	52	50	1	27"	39	86	3,354	306	91.3
29	51	50	1	28"	45	97	4,365	317	92.7

Two ounces of Malachite Green stock solution was used twice a week until the eggs were in the advanced eyed stage.
Eggs were hatched in a Heath Incubator and each lot was kept in a separate tray.
Swim-up fry were transferred to hatchery troughs.

FIGURE A-8. Mokelumne River Fish Installation king salmon artificial spawning November, 1964



1/ Seined from resting pools in channels

FIGURE A-9. Mokelumne River Fish Installation, king salmon downstream migrant count, January through April, 1965.