INTERNATIONAL PACIFIC SALMON
FISHERIES COMMISSION

PROGRESS REPORT

No. 35

PART I

INVESTIGATION OF THE PRESPAWNING MORTALITY OF SOCKEYE IN CHILKO RIVER IN 1971

BY

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PART II

INVESTIGATION OF THE USE OF ANTIBIOTICS TO CONTROL THE PRESPAWNING MORTALITY OF THE 1971 CHILKO POPULATION

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NEW WESTMINSTER, B. C.
CANADA
1977

PART II

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ABSTRACT

Investigations have shown that bacterial diseases can cause death of sockeye salmon prior to spawning (Colgrove and Wood 1966, Williams 1973). The use of antibiotics to control prespawning mortality was investigated. A subcutaneous injection of combiotic was administered to Chilko River sockeye which were held in a pen on the spawning grounds. The data suggest that enhancement of spawning success of sockeye populations which suffer prespawning losses would be possible with administration of a combiotic. However, the procedure used is not considered practical at this time for the Chilko population.

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INTRODUCTION

Investigations into the problem of prespawning mortalities among Fraser River sockeye salmon have been carried out since 1963. These investigations have established that gill damage caused by bacterial organisms on the spawning grounds is associated with premature mortality. In addition, warm water, i.e. maximum temperatures above 57° F, during spawning was associated with high mortalities.

An experiment was designed to examine the effect of cooling the water during spawning and the data indicated that cool water could reduce mortality (Colgrove and Wood 1966). Therefore a serious attempt was made to cool McKinley Creek during the spawning period of 1969. Although the water was for the most part below 57° F maximum, a serious mortality (65%) still occurred (Williams 1973). This prompted an investigation into other methods of reducing the prespawning loss. During 1970, a study was carried out to determine whether or not reduced mortality could be expected upon one or two treatment baths in 1 and 3 ppm Ni-furpirinol (P7138), a bacteriostatic agent which acts effectively against numerous fish diseases (Shimizu and Takase 1967; Amend and Ross 1970; Ross 1972). The data suggested control of some bacteria but the fish continued to die under the experimental conditions (Williams 1973).

Prespawning mortalities occurring in ripening ponds at the Cowlitz Hatchery in Washington have been attributed to kidney disease, furunculosis and columnaris disease. Tests carried out in 1968 and 1969 with subcutaneous injections of a combiotic, administered approximately every five to seven days were successful in reducing mortalities (DeCew 1969). Although the technical aspect of carrying out this kind of operation on natural sockeye spawners in rivers and streams is enormous, it was felt that a similar operation carried out on a population within a spawning channel could be feasible.

Therefore an experiemnt was set up using the 1971 early Chilko spawners. The objective was to determine if the combiotic used at Cowlitz fish hatchery would be effective against the prespawning mortality occurring on the Chilko spawning grounds.

DESCRIPTION OF 1971 SPAWNING

The first sockeye arrived at the Chilko spawning grounds on August 8. These fish, and fish arriving up to approximately August 20 to 25, passed over the spawning grounds and into Chilko Lake. Peak arrival was set at August 30, with virtually all of the run on the spawning grounds by October 8 (FIGURE 1). The first fish which migrated into the lake between August 10 to 20 are believed to have spawned on the east shore at the south end of Chilko Lake. This population, estimated at 15,700 fish, is considered separate from the river population based on scale pattern and fish size (Saito and Woodey, MS 1973). The first segment of the major spawning population probably spawned in the north end of Chilko Lake up to 5 miles from the outlet. The total population in this segment was estimated at 12,157 fish, with 7,659 females. These fish could not be isolated from the river fish by scale pattern or size. The remaining fish, totaling 91,807 females and 53,229 males, spawned in the Chilko River primarily from the lake outlet to one-half to 1 mile below the outlet, with some spawning occurring up to 5 miles below the lake outlet. Peak days of spawning occurred from September 24 to 28 in the river. First dead was recovered in the river on September 8, peak recovery was October 9 and dead recovery was terminated October 17 in the river (FIGURE 2). First dead in the north end of the lake were recovered September 13, with peak recovery on September 18 to 25 and final recovery October 11. There was only one dead recovery trip to the south end of Chilko Lake. This was carried out on September 18, with 32 females, 17 males and 5 jacks recovered. Recovery was terminated because of bad weather, however an estimated 300 sockeye were observed floating ventral side up in a moribund condition along several miles of the southeast shoreline.

The prespawning mortality of these populations varied considerably. The fish sampled from the south end of Chilko Lake, based on one day's dead recovery, had a prespawning mortality of 5.5% (TABLE 1). The fish spawning in the north end of Chilko Lake were sampled from September 13 to October 11. Based on a sample total of 669 fresh-dead females, the prespawning mortality ranged from 83.3% in the early samples to 0% in the last fish sampled with an average of 30.1% (FIGURE 2).

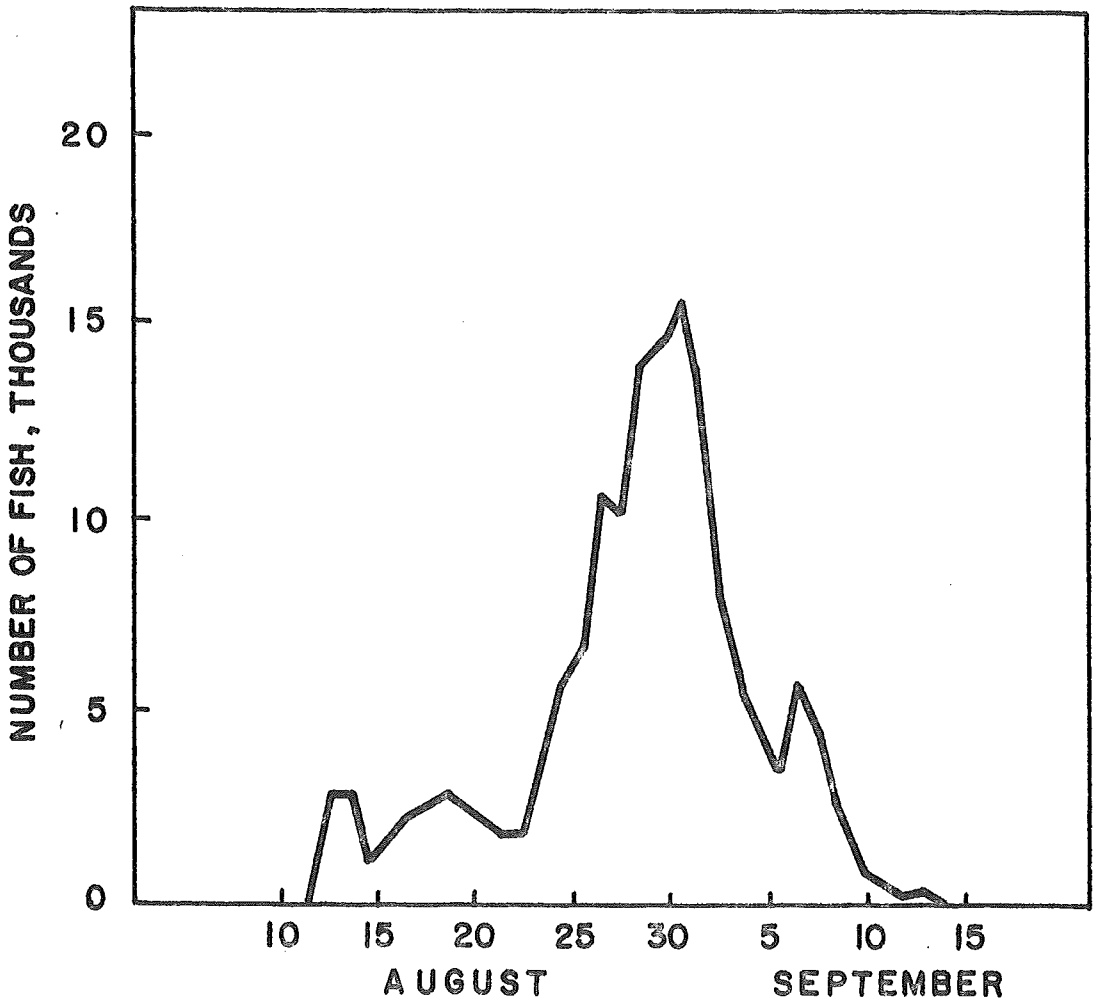

FIGURE 1 - 1971 Chilko sockeye arrival at the spawning grounds, based on tower counts at Lingfield Creek.

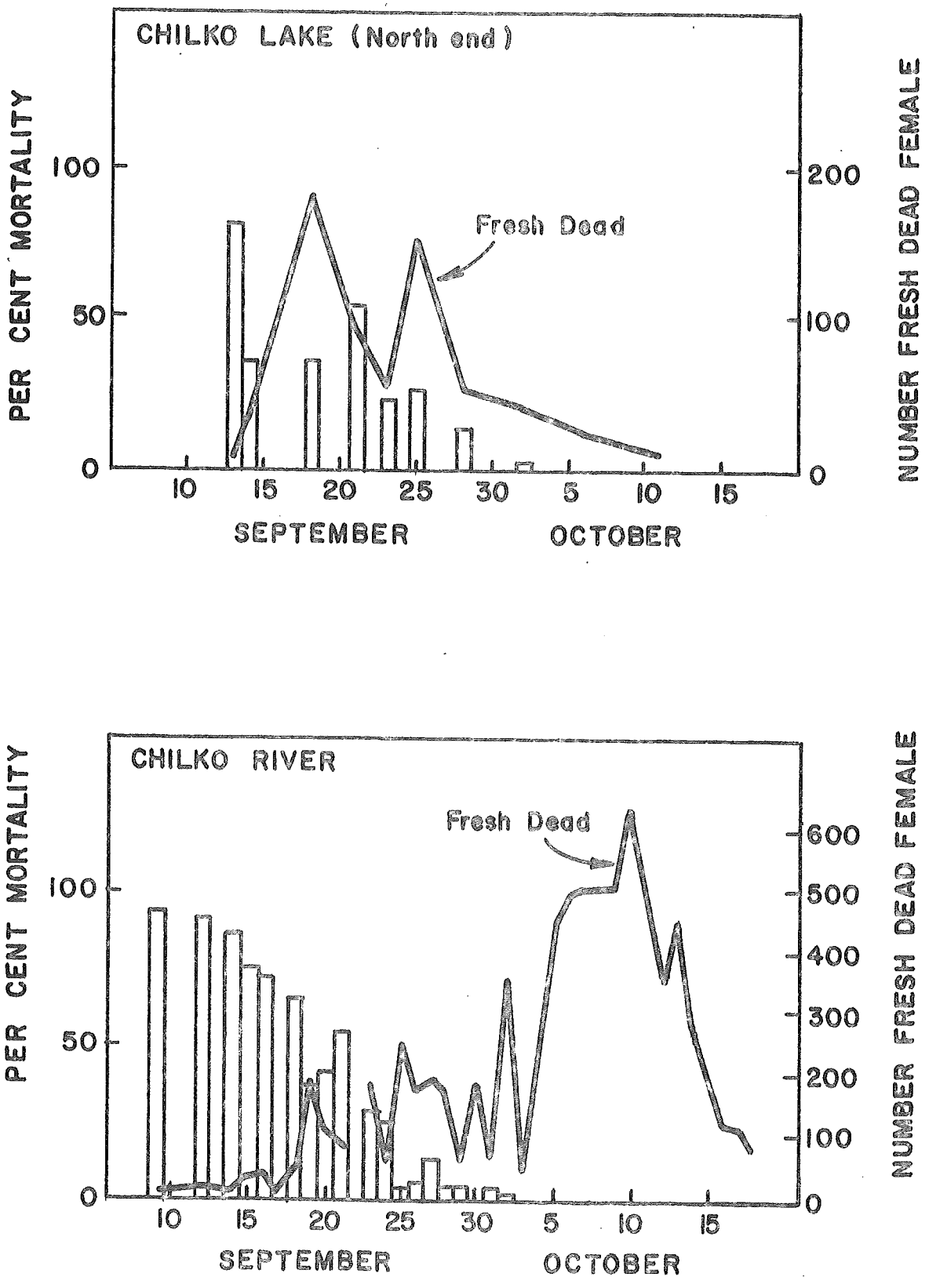

FIGURE 2 - Dead recovery and percent mortality of the Chilko Lake (north) and Chilko River fish.

TABLE 1 - Fresh-dead female sockeye sampled for percent prespawning mortality.

Sample	Recovery Dates	Total Sample Size	Peak Dead Recovery	Percent Prespawning Mortality
Lake (south)	Sept. 19	32	Sept. 19*	5.5
Lake (north)	Sept. 13-Oct. 11	669	Sept. 18 and 25	30.1
River	Sept. 8-Oct. 17	7,141	Oct. 9	6.1

* Only sample date

The total prespawning mortality for fish sampled in the river was 6.1% ranging from 92.9% for the first dead down to 0% for dead recovered between October 6 and 17 (FIGURE 2).

METHODS

Fish Capture and Holding

Eighty-nine males and 118 females from the early part of the Chilko population were captured with a seine approximately one-quarter mile downstream from the lake outlet. Fifty-five percent of the total fish captured were classed as the north lake (early river) population, while 45% were classed as south lake population (TABLE 2).

TABLE 2 - Summary of fish capture and treatment.

Date	Treated ♂	Treated ♀	Control ♂	Control ♀	Total	Percent Lake (South) Population
Aug. 13	1	6	-	-	7	0.0
Aug. 14	1	3	-	6	10	33.0
Aug. 17	9	15	26	28	78	52.0
Aug. 18	14	29	20	31	94	48.8
Aug. 19	8	-	-	-	8	33.0
Aug. 20	10	-	-	-	10	0.0
Total	43	53	46	65	207	45.0

Upon capture the fish were immediately placed in 5-gallon plastic cans containing a 1:4,200 solution of 2 phenoxy ethanol and water. The fish were then taken by barge to the holding pen approximately 300 yd upstream.

The pen was constructed in approximately 4.5 ft of water, with chainlink fencing supported on iron stakes. It measured approximately 38 x 40 ft and was divided down the middle to give two compartments 38 x 20 ft.

Fish were tagged, measured and sexed and then either placed in the control pen or injected with antibiotic and placed in the pen for treated fish (TABLE 2). The treated fish were loaded at a density of one female per 1.6 sq yd and the control fish at one female per 1.3 sq yd. The optimum density at Chilko is calculated at one female per 1.5 sq yd (Int. Pac. Salmon Fish. Comm. 1964).

Treatment of Fish

Fish were treated with a mixture containing 50% penicillin-streptomycin and 50% oxytetracycline. The antibiotics were administered by a subcutaneous injection inserted just ahead of the dorsal fin, approximately 3/4 inch below the dorsal surface of the fish. The treated fish were injected on the day of their capture and given a second injection September 1, 10 to 18 days after the first injection.

Fish were observed daily for spawning activity and mortalities. The dead were retrieved, and date, tag number, physical measurements, and stage of maturity, including percent spawned, were recorded for each fish. In addition, some histological samples were taken from moribund fish and preserved in Bouin's fluid.

RESULTS

Physical Measurements

The physical measurements of the female experimental fish classed as river fish were fairly consistent throughout the groups, with lengths averaging approximately 58 to 59 cm, and weights averaging 1,900 to 2,000 gm. The lake population was considerably smaller at 55.4 cm fork length, weighing approximately 1,600 gm. The fecundities of the lake fish were also smaller averaging 2,657 compared with 3,292 for the control females classed as river

TABLE 3 - Physical measurements of experimental and river spawners.

	Group	No.	Fork Length cm	Total Wt gm	Body Wt gm	Viscera Wt gm	Gonad Wt 0% Spawned	Gonad Wt 100% Spawned	Fecundity
Female Treated	River	8	59.3	1,883	1,709	89.66	209.1	36.2	2,680
	Lake	6	55.1	1,477	1,391	75.1	-	11.4	-
Control	River	7	59.2	2,025	1,687	90.6	243.6	-	3,292
	Lake	14	55.5	1,661	1,357	75.2	222.6	-	2,657
Male Treated	River	12	61.5	2,357	2,186	116.9	68.3	17.4	-
	Lake	4	56.1	1,868	1,730	94.7	51.9	22.4	-
Control	River	7	60.0	2,204	2,047	97.7	49.1	-	-
	Lake	11	57.6	1,984	1,818	95.5	52.0	-	-

fish (TABLE 3). The fecundities of the treated female river fish averaged 2,680, however many of these were very loose and could have begun spawning or simply lost eggs during holding and processing.

The male experimental fish had the same pattern as the female. The treated and control river fish were similar 60.0 to 61.5 cm long and approximately 2,300 gm in weight, while the lake fish were considerably smaller averaging 57.2 cm fork length and 1,953 gm total weight (TABLE 3).

Fish Condition

Forty-nine percent of the female and 33% of the male experimental fish had gill lesions upon arrival. The control fish had a large increase in the prevalence of gill lesions during the holding period. The prevalence of gill lesions in female control fish increased from 39 to 86%, while in the males it increased from 33 to 82%. There was little evidence of healing of lesions among the control fish. The prevalence of gill lesions among the treated fish which did not spawn successfully remained at the same level of approximately 50% for the female and 25% for the male to death. There was evidence of successful healing among 38% of the females with lesions and 33% of the males with lesions. However, there was a somewhat similar rate of new lesions forming among 33% of the unspawned female without lesions and 18% of the unspawned male without lesions.

The prevalence of gill lesions decreased from 54.2 to 12.5% during holding among the treated females which spawned successfully. This was a result of no clean fish developing lesions, and 77% of the fish with lesions at arrival, healing during the holding period. The pattern of gill lesions prevalence among the treated male which spawned successfully was similar to the treated unspawned male with perhaps a slight increase in the healing rate (TABLE 4). The data was broken down into lake and river fish and there appeared to be no obvious differences in the prevalence pattern of gill lesions. That is, in both cases the treated fish showed a greater rate of healing and fewer lesions at death (TABLES 5 and 6).

The river spawners generally had a lower prevalence of gill lesions than either the control or treated fish. The one exception was a higher prevalence of gill lesions (25%) among the river female which spawned successfully (TABLE 7).

TABLE 4 - Percent of unspawned (0%) and spawned (100%) experimental fish with gill lesions at arrival and death.

Gill Condition	Female				Male			
	Control		Treated		Control		Treated	
	0%	100%	0%	100%	0%	100%	0%	100%
Percent with lesions at arrival	39.3	-	64.0	54.2	33.3	-	21.4	36.8
Percent dead with lesions that healed	4.5	-	37.5	76.9	13.3	-	33.3	42.9
Percent without lesions that showed lesions at death	79.4	-	33.3	0.0	80.0	-	18.2	16.7
Percent with lesions at death	85.7	-	52.0	12.5	82.2	-	28.6	31.5

TABLE 5 - Prevalence of gill lesions among unspawned (0%) and spawned (100%) experimental lake fish.

Group	Female				Male			
	Control		Treated		Control		Treated	
	0%	100%	0%	100%	0%	100%	0%	100%
Percent with lesions on arrival	14.3 (2)*	-	100.0 (1)	40.0 (2)	45.4 (5)	-	100.0 (1)	66.7 (2)
Percent with lesions that healed	0.0	-	0.0	100.0 (2)	0.0	-	100.0 (1)	50.0 (1)
Percent clean fish developing lesions	100.0 (12)	-	0.0	0.0	83.3 (5)	-	0.0	0.0
Percent with lesions at death	100.0 (14)	-	100.0 (1)	0.0	90.9 (10)	-	0.0	33.3 (1)

( ) * Number fish in sample.

TABLE 6 - Prevalence of gill lesions among unspawned (0%) and spawned (100%) experimental river fish.

Group	Female				Male			
	Control		Treated		Control		Treated	
	0%	100%	0%	100%	0%	100%	0%	100%
Percent with lesions on arrival	429.0 (3)*	-	50.0 (2)	50.0 (2)	0.0	-	0.0	25.0 (25)
Percent with lesions that healed	0.0	-	25.0 (1)	100.0 (2)	0.0	-	0.0	100.0 (2)
Percent clean fish developing lesions	100.0 (4)	-	25.0 (1)	0.0	66.7 (4)	-	40.0 (2)	12.4 (1)
Percent with lesions at death	100.0 (7)	-	50.0 (2)	0.0	66.7 (4)	-	40.0 (2)	12.5 (1)

( )* Number fish in sample.

TABLE 7 - Percent prevalence of gill lesions among 0%, 50% and 100% spawned fresh dead Chilko River fish.

Recovery Date	Male			Female		
	0%	50%	100%	0%	50%	100%
Sept. 17-18	-	-	-	25	25	33
Sept. 25	17	13	33	29	33	14
Sept. 26	-	-	-	0	5	27
Oct. 2	0	0	0	-	0	17
Total	15 (20)	8 (12)	5 (21)	11 (124)	15 (46)	25 (187)

( )* Number fish in sample.

There was only one other obvious difference in the condition of the treated and control fish. Five (15%) injected males developed a very obvious liver condition which was exclusive to treated male fish (FIGURE 3).

One treated unspawned female fish probably died from a ruptured spleen and internal bleeding. There were no other abnormalities observed upon examination of the dead.

Life Span and Success of Spawning

The male control fish had an average life span of 19 days, approximately five days longer than the average life span of the female control fish. The life span of males classed as river fish averaged approximately three days longer than the life span of males classed as lake fish. There was very little difference in the life span of river and lake females. There was 100% prespawning mortality among both the male and female control fish. In addition, there was no indication that the fish began digging. The life span of the treated fish (male 17.2 and female 15.8) which did not spawn successfully was very similar to the average life span of the control fish (male 19 and female 13.9). The one exception, the unspawned-treated female lake fish had a life span of 28 days as opposed to 15.2 days for the controls. The life span of 28 days is only based on one fish and therefore does not contribute to the comparison. The rate of dying, however, was much slower in the unspawned injected fish compared with the control fish (FIGURE 4).

The average life span of the fish which spawned successfully was considerably longer at approximately 38 to 46 days, than the unspawned-treated, or control fish at 15.8 to 22.1 days. The spawned-out male fish had an average life span of three to five days shorter than the comparable group of female fish, with the total males averaging 37.7 days while the total females averaged 42 days (TABLE 8).

The spawning success of the treated group varied from male to female and from lake fish to river fish. The male lake fish appeared to have poorer spawning success than river males. However, the female lake fish appeared to have a much higher spawning success than the female river fish. The numbers of fish identifiable as river or lake are relatively small, making interpretation concerning significance difficult (TABLE 8).

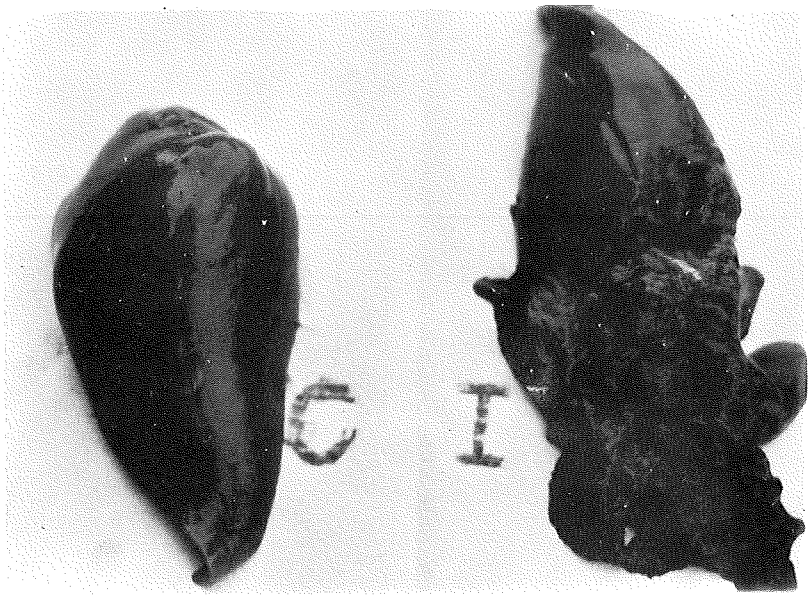

FIGURE 3 - Livers from a control fish and an injected ♂ fish exhibiting gross liver damage.

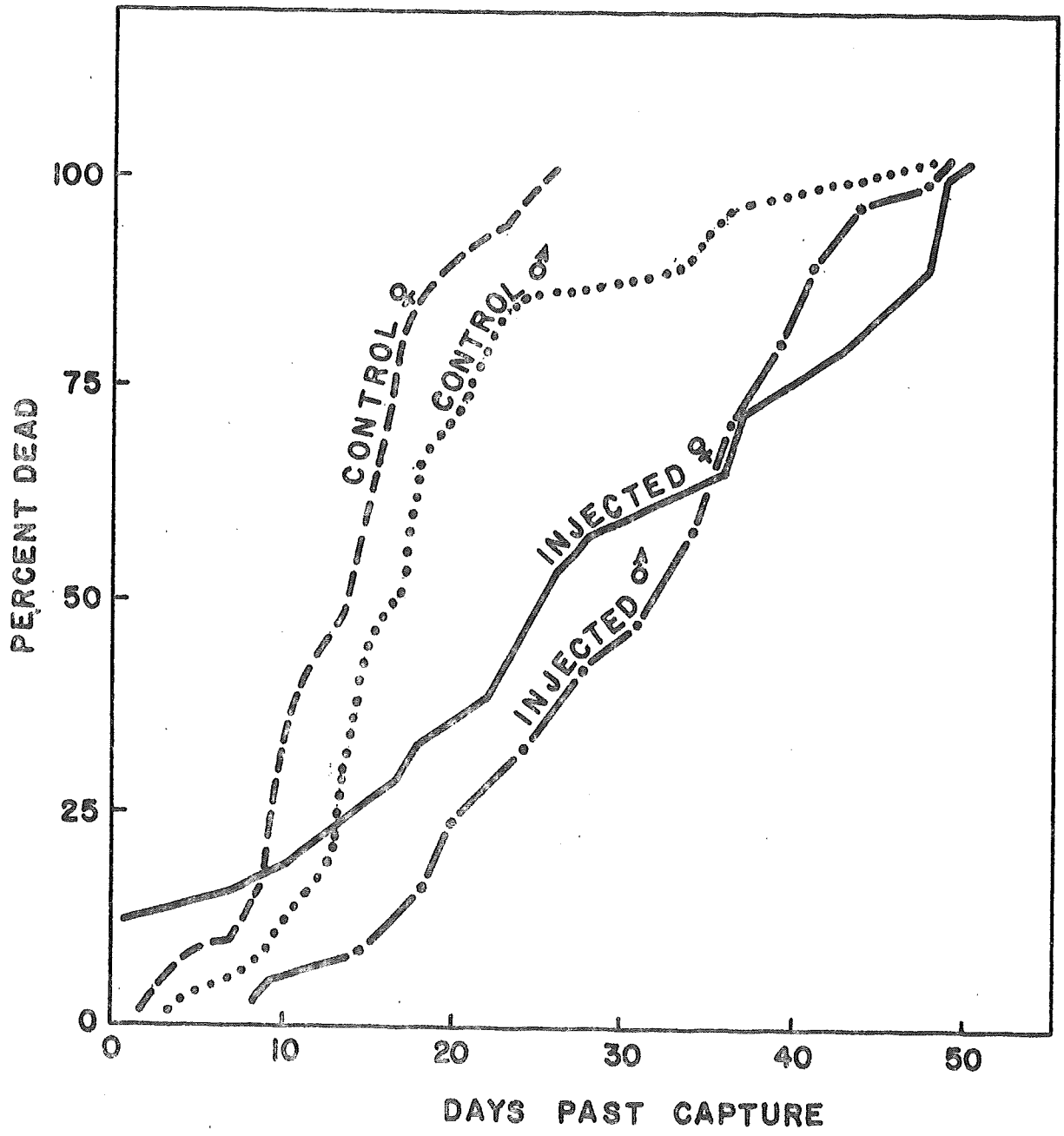

FIGURE 4 - Death rates of experimental Chilko sockeye.

TABLE 8 - Life span of unspawned (0%) and spawned out (100%) fish and percent prespawning mortality for 1971 experimental Chilko fish.

Sample	Sex	Population	No. Fish	Average Life Span (Days) 0%	100%	Spawning Success
Experimental injected	♂	River	13	17.5	39.2	59.6
		Lake	4	18.0	41.0	50.0
		Total*	38	17.2	37.7	57.9
	♀	River	12	18.7	42.9	50.0
		Lake	7	28.0	46.2	85.7
		Total*	57	15.8	42.0	47.4
Experimental control	♂	River	7	22.1	-	0.0
		Lake	10	17.3	-	0.0
		Total*	46	19.0	-	0.0
	♀	River	7	16.0	-	0.0
		Lake	14	15.2	-	0.0
		Total*	56	15.5	-	0.0
Spawning population early Chilko (north end of lake)	♀	Total	669	-	-	69.9
(south end of lake)	♀	Total	32	-	-	94.5

* Includes fish which could not be positively identified as either river or lake fish.

The total treated male spawning success was somewhat higher at 59.6% than the treated female at 47.4%. The spawning success of the female sockeye from the north and south lake populations was 10 to 20% higher than either of the comparable experimental groups (TABLE 8).

DISCUSSION

Although the experimental fish that were treated did not spawn as successfully as the equivalent fish spawning naturally, there was some indication of a beneficial effect from the injection of the combiotic. From the very poor spawning success (0%) among the control group, it is obvious that very little additional stress is required to initiate premature death among the early Chilko sockeye. Under the experimental conditions the administration of the combiotic promoted healing of gill lesions among 33 to 77% of the fish arriving with lesions, compared with only 4.5 and 13.3% healing in the control fish. Spawning success was increased from 0% in the control fish to 50% for the river fish and 85.7% for the lake fish. These data illustrate the differences in susceptibility that can occur among two different populations encountering similar environments. The data also suggest that enhancement of the spawning success of river populations may be possible with administration of a combiotic. However, one very large problem encountered in field operations is the difficulty of administering a series of injections. To obtain the most effective results, injections of the combiotic should be administered approximately every five days, although antibiotics may provide some control of necessitating access to the treated fish in the river or stream.

Therefore, such treatment is not considered practical at this time for the Chilko population.

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