AN ATTEMPT TO SEGREGATE A SPECIFIC RACE OF CHINOOK SALMON (Oncorhynchus tshawytscha) BASED UPON RESPONSE TO HOMESTREAM WATER

by

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INTRODUCTION

The construction of dams on the Columbia River and its tributaries has often resulted in physical and environmental changes detrimental to specific races of anadromous fishes. Not infrequently, relocation or artificial propagation programs are required to perpetuate these races. One of the basic problems encountered in such programs is that of fish collection. In some instances, this is merely a matter of trapping the fish as they arrive at the dam, and in others, several races may be involved. Some of these races may be destined for unaffected spawning areas, whereas others may be bound for areas that would be cut off from production. Thus, the problem of segregation arises.

The specific race or races must be identified and collected while the others are permitted to continue upstream. Although time of arrival and external physical characteristics can be used to differentiate races in some instances, more precise methods may be necessary with the increasing complexity of the "fish vs. dam" problem. The object of this study was to investigate the possibility of segregating races of migrating salmon based upon response to homestream water. Chinook salmon (Oncorhynchus tshawytscha) were used in the study.

METHODS AND MATERIALS

Our approach was based upon the hypothesis that chinook salmon "home" upon some distinctive quality in the water imparted from their parent stream. If presented with a choice of flows of differing quality, they would select the one having the greater concentration of their homestream water. In these experiments, we examined the response of a specific race of chinook salmon to such a choice. The chinook race studied was the one destined for Spring Creek Hatchery, approximately 25 miles above Bonneville Dam.

Two types of experiments were planned. In the first type, fish ascending the Washington-shore fish ladder were routed through the laboratory where they were offered a choice of entering one of five channels. During control tests, the flow velocity and composition of the water in the channels were identical. Under the test condition, a relatively small quantity of Spring Creek water was introduced into one of the channels. Since the racial composition of these fish was unknown, the response of the Spring Creek fish to the choice condition had to be determined by a tag-recovery method. After making a choice, all fish were tagged and released; the response of the Spring Creek fish to the choice array was determined from the tagged fish arriving at the hatchery.

The second type of experiment utilized only Spring Creek fish and was conducted after the foregoing series was completed. In these tests, surplus male salmon were transported directly from Spring Creek Hatchery in tank trucks, subjected to the choice array, and then returned to the hatchery.

The experimental area of the laboratory consisted of a choice area, 11.5 feet wide by 31.5 feet long--terminating at the upstream end into five identical channels, each 27 inches wide and 20 feet long (fig. 1). Channel walls were thoroughly sealed to prevent seepage into or from adjoining areas. Each channel led to a 40-foot long holding pen. Water was introduced at the upstream end of the laboratory, passed through the holding area, and then flowed over weirs into each channel. The water was approximately 2.5 feet deep in the holding pens and 1.8 feet deep in the channels and choice area. Velocities in the channels and choice area were approximately 1 foot per second; flow in each channel was approximately 3.6 cubic feet per second.

Spring Creek water was transported from the hatchery in two 1,000-gallon tank trucks. Water from the trucks entered the laboratory by gravity flow through a 1½-inch plastic pipe. Flows were introduced into the test channel (either #3 or #4, fig. 1) through a length of perforated pipe extending across the width of the channel just above the water surface. The spray from the pipe was directed into the weir overfall to provide thorough mixing with the river water entering the channel (fig. 1). Spring Creek water was metered into the channel at a rate of 10 to 11 gallons per minute, which was the maximum sustained flow that could be maintained with two trucks in operation (one truck on the road while the other was discharging at the laboratory). At Spring Creek, the discharge from the hatchery is approximately 10 c.f.s. Assuming this water is thoroughly mixed with the Columbia River (90,000 c.f.s.) water when it reaches Bonneville Dam, the above metering rate would provide a concentration of Spring Creek water in the test channel over 65 times that in the other channels.

Fish were introduced into the system individually, each fish being allowed to select a channel and enter the holding pen before another one was released. The holding pens were covered with floating panels, and the surrounding area was darkened to keep the fish in a quiescent state until they were tagged at the end of the day. A drop screen at the downstream end of each holding pen prevented fish from falling back downstream into the channels. These screens were raised momentarily as the fish ascended from the channels to the holding pen (fig. 1).

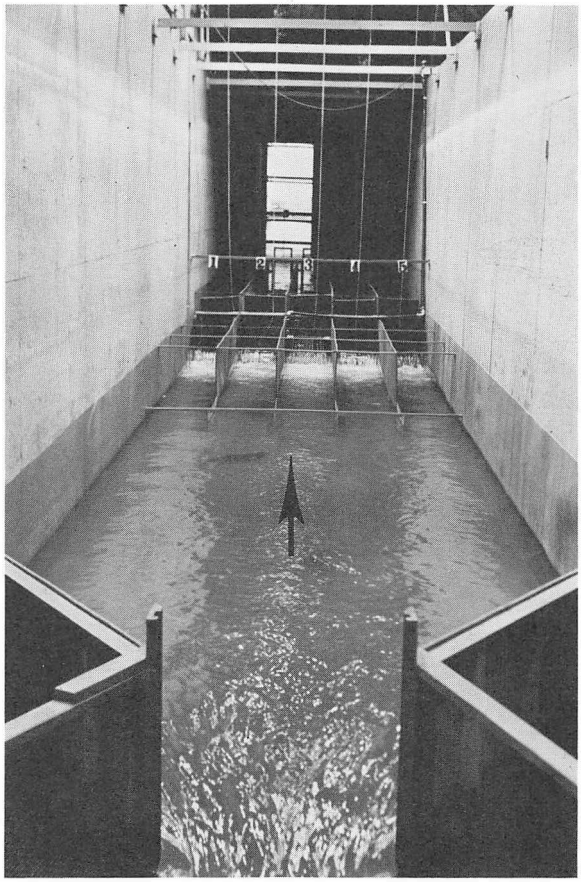

Figure 1.--View of choice area, channels, and holding pens (in darkened area) with Spring Creek water being introduced into channel #3. Note chinook salmon just below entrance to channel #2. Vertical ropes in background are used to operate drop screens at entrance to holding compartment.

Tagging was generally done with a four-man crew (fig. 2). One man crowded the fish from the holding pen into the tagging box; another held the fish while it was being tagged, and two men performed the tagging alternately. Fish were tagged with a small nylon-dart and vinyl-tubing tag approximately 2-3/4 inches long (fig. 3). The tag was inserted with a stainless steel applicator on the right side of the fish just below the dorsal fin; tag penetration was controlled by a set screw on the plastic handle holding the applicator.

Handling of fish during tagging was kept to a minimum by use of the tagging box and submersible holding trough. The tagging box was suspended from tracks and could be moved from pen to pen. In operation, the foam-padded trough was lowered to the bottom of the box, the holding pen gate was opened, and the fish was forced to swim into the box. The gate was then closed, and the trough holding the fish was raised out of the water by use of rope tackle and suspended from hooks while the fish was tagged. Trough and fish were then lowered back into the water, the upstream gate of the tagging box was opened, and the fish swam out and was free to leave the laboratory and continue its migration. Each fish was generally out of the water no more than 15 to 16 seconds.

RESULTS AND CONCLUSIONS

A total of 13 tests were conducted. Spring Creek water was added to channel #3 in four tests and to channel #4 in four tests. The remaining five tests were control trials in which no Spring Creek water was added. A total of 565 chinook were subjected to the choice condition and subsequently tagged and released. Approximately 25 percent (143) of the tags were recovered (table 1). The three major recovery sites were: (1) Spring Creek Hatchery, (2) the Indian fishery between Bonneville Dam and The Dalles, and (3) the Oxbow Hatchery (Fish Commission of Oregon). The most distant recoveries were the two fish recovered at Oxbow Dam on the Snake River. One of these had traveled the 450 miles in 23 days at an average rate of 19.6 miles per day. Another fish recovered at Rocky Reach Dam on the Columbia River, had traveled approximately 330 miles in 22 days--an average rate of 15 miles per day.

Of the 42 fish recovered at Spring Creek Hatchery, 17 were tagged during control tests, 15 were tagged during tests in which Spring Creek water was introduced into channel #3, and 10 were tagged when the test water was introduced into channel #4. A comparison of the response of the fish during test and control

Figure 2.--Tagging chinook salmon at the upstream end of the holding pen. Man in holding pen (extreme left) crowds fish into tagging trough after it is submersed in the box.

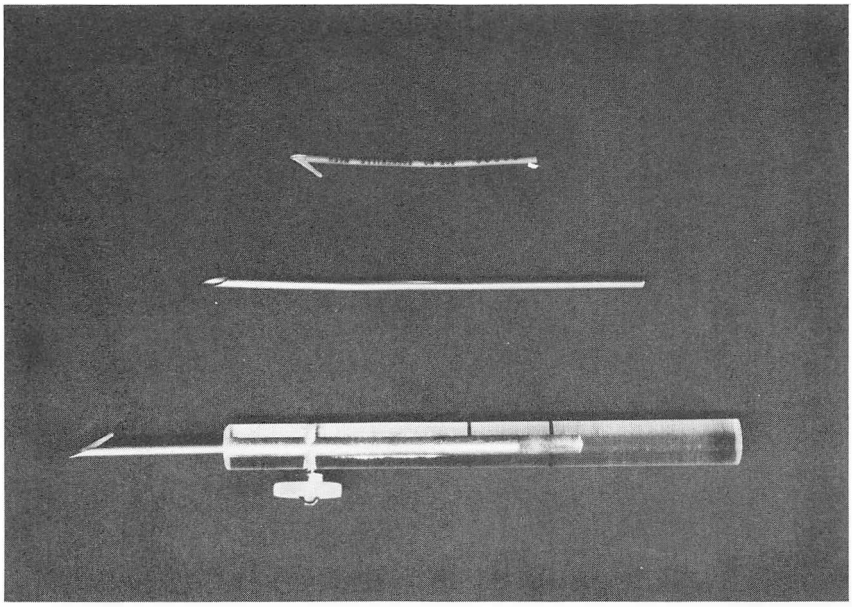

Figure 3.--Photograph of tagging equipment. From bottom to top are: Dart tag, applicator, and the two inserted into the plastic handle. Distance between the two marks on the plastic handle is 1 inch.

Table 1.--Daily record of chinook salmon tagged from August 31 to September 12 at Bonneville Dam and number recovered from each day's tagging.

Location of recovery	Aug. 31	Sept. 1	2	3	4	5	6	7	8	9	10	11	12	Total
						Number tagged								
	27	23	30	47	35	48	53	42	49	49	34	65	63	565
						Number recovered								
Spring Creek Hatchery		2	3	2	5	1	5	5	3	3	3	3	7	42**
Indian Fishery*	1		1	2	1	3	3	3	6	4	2	1	6	33
Oxbow Hatchery		1	1	1	1	6	4	2	4	2	1	6	2	31
Priest Rapids Dam	2			2		1	2	1			1			9
Klickitat Hatchery-River			1		2		1			1	1	1	2	9
Little White Hatchery				3	1					1		1	1	7
Cascade Hatchery								1					3	4
McNary Dam					1	1								2
Oxbow Dam				1									1	2
Big White Salmon River			1											1
Deschutes River								1						1
Rocky Reach Dam							1							1
Total	3	3	7	11	11	12	16	13	13	11	8	12	22	142

* Between Bonneville Dam and The Dalles.

** Does not include one fish that was sighted but not recovered.

conditions (fig. 4) indicates that Spring Creek chinook salmon were not attracted to either channel #3 or #4 when Spring Creek water was introduced at the rate of 10 to 11 g.p.m.

The results of these tests do not necessarily discount the possibility that racial segregation can be accomplished at some point below the spawning grounds by attraction to homestream water. Several factors may have contributed to the inconclusive results of this exploratory study. Among these are the concentration of source water used, the effect of hauling and piping on the quality of the test water, and the specific origin of the test water. The water supply for Spring Creek Hatchery is a composite of at least five springs in the same general area. Water used in these experiments (with the exception of one test) was obtained only from the largest spring, which furnishes a significant proportion (possibly 50 percent) of the hatchery supply. This source was utilized because it afforded a convenient supply of gravity-fed water which would remain of uniform quality (unaffected by the odors which might be imparted by fish-handling procedures at the hatchery) throughout the series of experiments. Although it appears unlikely, it is possible that the homing quality of the Spring Creek water may be imparted by one or several of the smaller springs and thus was not contained in the water utilized in the experiments.

In the tests with surplus male salmon from Spring Creek Hatchery, an effort was made to compare the response of Spring Creek fish to (1) water taken from the entrance of the hatchery pond (mixture of all water sources) and to (2) water from the large spring utilized in the previous tests. These tests were, however, largely unsuccessful due to the reluctance of the fish to enter the choice area and channels after being transported from the hatchery. With the few fish tested, there did not seem to be an apparent difference in the response to the two water sources.

Summarizing, Spring Creek chinook salmon were not attracted to a supply of source water that was transported and discharged at dilute concentrations into a test area some 25 miles downstream of the spawning area. If additional studies of this design are proposed, special consideration should be given to techniques used and also to the effect of water temperature.

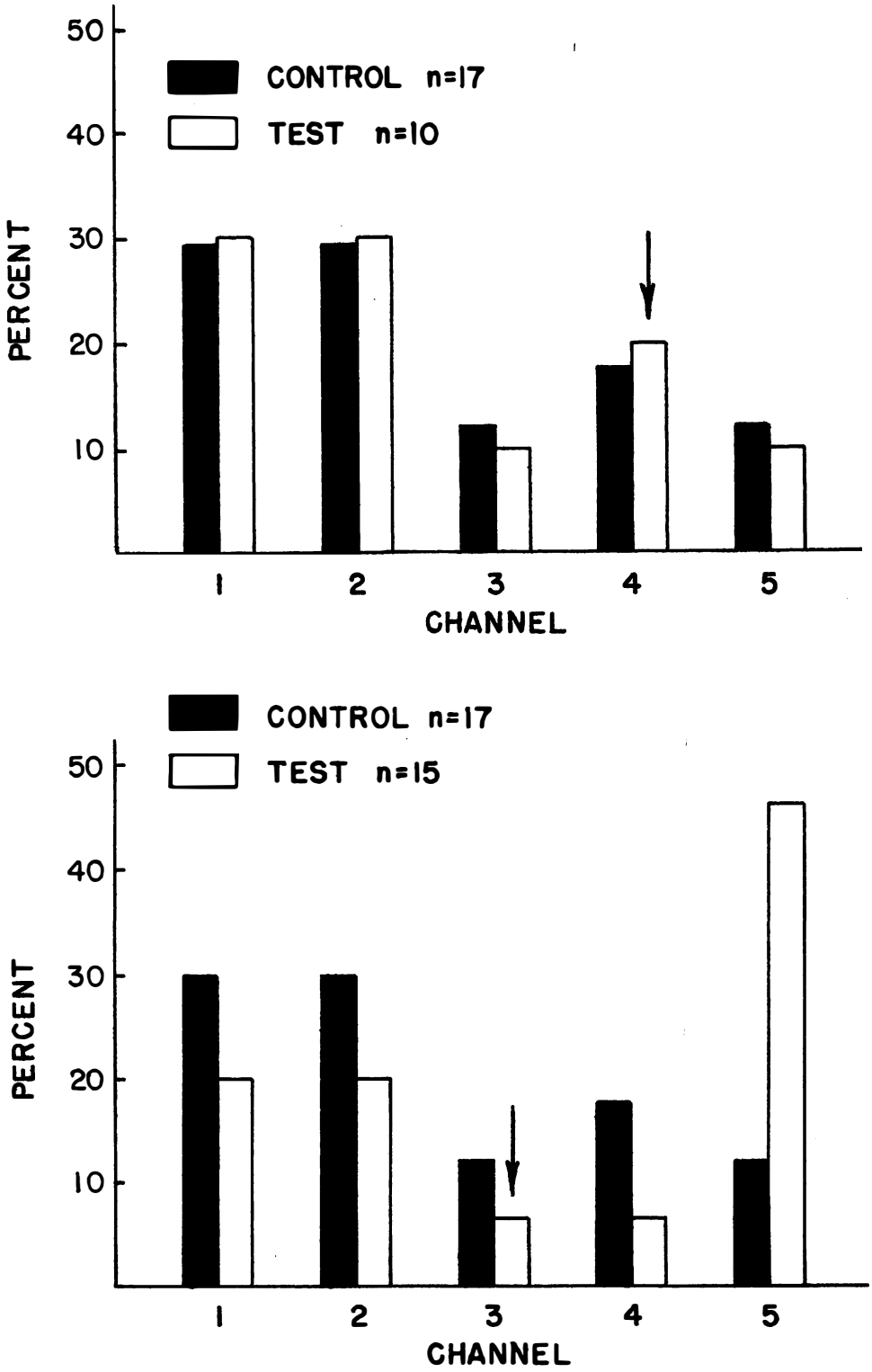

Figure 4.-- Results of tests at Bonneville on the response (proportions entering each channel) of Spring Creek chinook salmon to home stream water. Arrows indicate channel carrying added amounts of Spring Creek water under test conditions.