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GUIDING SALMON FINGERLINGS WITH HORIZONTAL LOUVERS

by

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INTRODUCTION

The use of horizontal louvers at dams or other water-use projects for the purpose of guiding downstream migrants into safe bypasses may be more desirable in some instances than vertical louvers. From an economic viewpoint, the location of a fingerling bypass at or near the surface of the water, or the physical conformation of an existing dam, may indicate the need for guiding fish upwards rather than from side to side (horizontally) as is the case with vertical louvers.

If use of the louver principle is to be extended to include a wider range of environmental conditions, we need to know more of how and why fish respond to a louver array. The experiments reported here employed a horizontal-louver array with a bypass located at or near the surface. The objectives of this study were to examine the effect of light and louver color on the guiding efficiency of a horizontal-louver array.

EXPERIMENTAL SITE AND EQUIPMENT

All experiments were conducted in the Tanner Creek bypass, a special auxiliary channel providing discharges up to 60 cubic feet per second from the forebay to the tailrace of Bonneville Dam. The test area was located near the forebay entrance of the bypass. At this point, the channel is 17 feet deep and 10 feet wide. In order to create velocities sufficient for operation of the louver facility, the width of a 40-foot section of the main channel was reduced to 4 feet. The louver array and associated experimental equipment were installed in this area (fig. 1).

During initial experiments, the louvers consisted of black iron slats 1/8 inch thick, 2 inches wide, and 4 feet long. In the final experiment, the louvers were painted white. Individual slats were fitted into slotted channel irons at 90° to the direction of flow and were spaced 2-3/16 inches apart. Flow straightener vanes were installed at 1-foot intervals (fig. 2) and overlapped one another to give a continuous flow-straightening effect as described by Bates and Vinsonhaler (1957). The resulting louver array measured 4 feet wide by 10 feet long and was installed at an angle of 30° to the channel floor.

The fingerling bypass was located in a fixed position at the downstream end of the louver array (fig. 1) and operated either as a surface or a submerged collector depending on depth of water in the channel. Because of fluctuations in the forebay level, water depth varied between approximately 6 and 9.5 feet

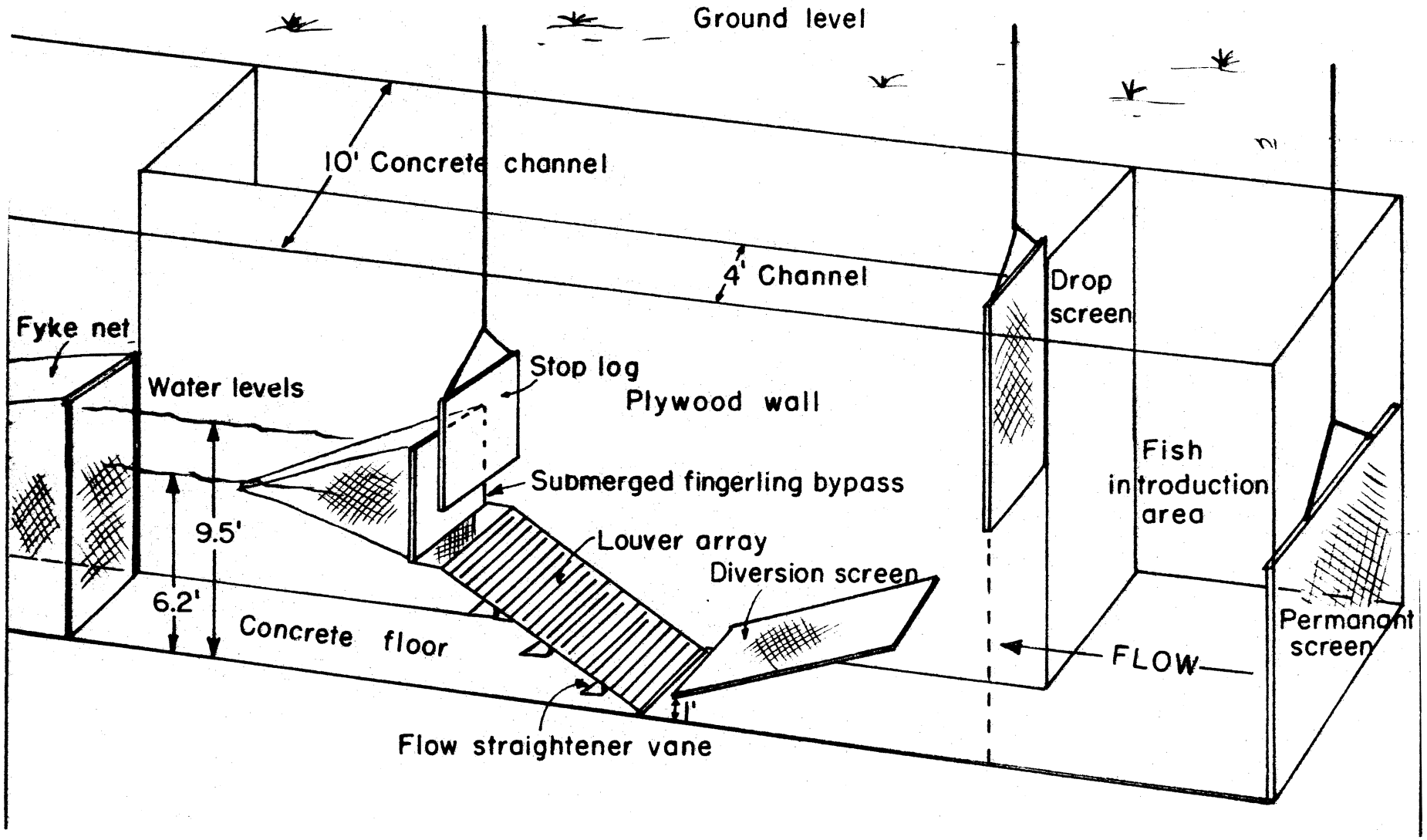

Figure 1.--Horizontal-louver test area showing experimental equipment.

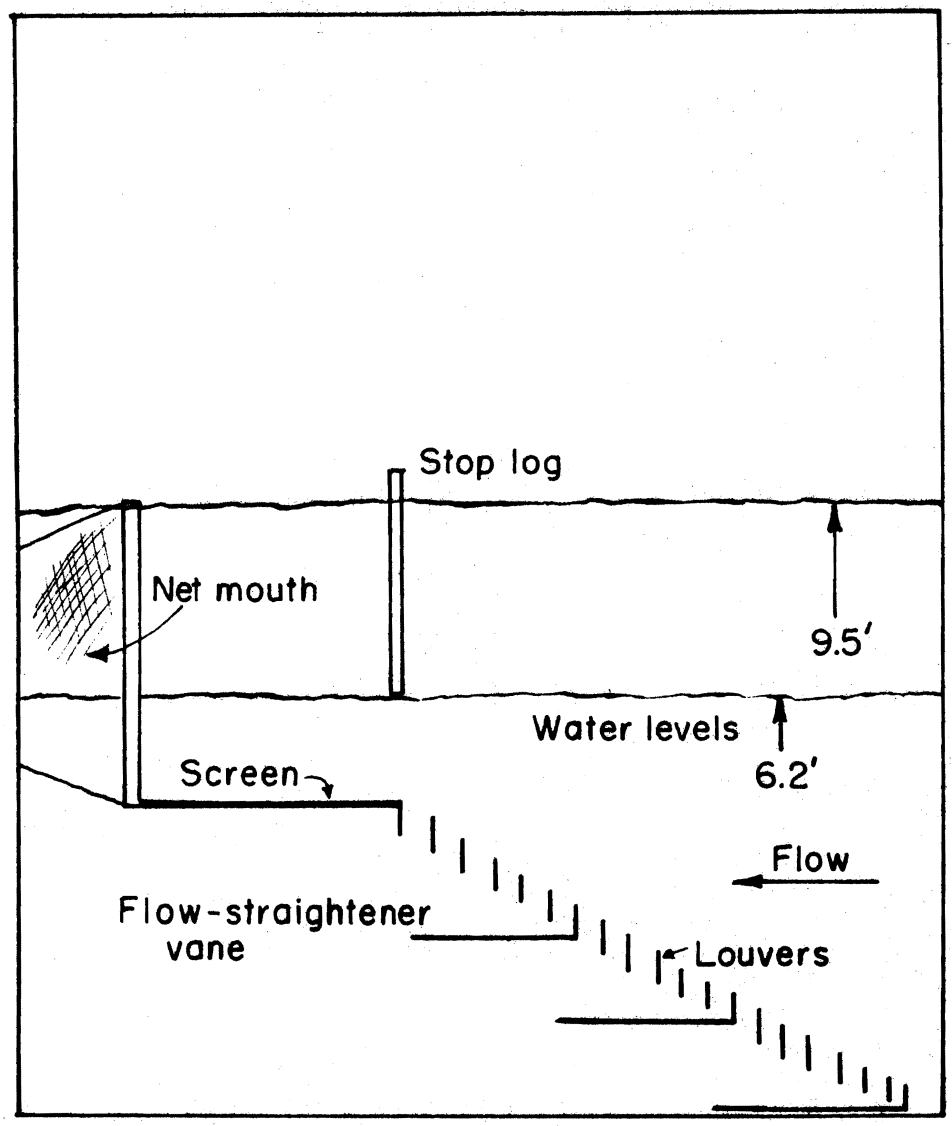

Figure 2.--Side view (diagrammatic) of horizontal-louver assembly showing flow-straightener vanes and appurtenant test facilities.

during the experiments. When the water was about 6 feet deep, the bypass was located at the surface. When the water depth exceeded 6 feet, a submerged bypass 1 foot high by 4 feet wide was created by insertion of a plywood panel. This panel was removed when the bypass operated as a surface collector.

In order to maintain control over the movement of fish in the test area, several screens (number 4 wire mesh) were installed. A diversion screen was positioned so that all fish were presented to the foot of the louver. This made it necessary for each fish to avoid virtually the entire length of the louver array to reach the fingerling bypass. A drop screen at the head of the test channel was used to prevent fish from entering the test area at the conclusion of each test. A permanent screen was installed at the channel entrance in conjunction with tests using introduced hatchery fish to prevent the fish from moving upstream into the forebay. The screen also served to keep predatory fish from moving downstream into the test area where their presence was considered detrimental to the experiment.

Two fyke nets were used to measure the guiding efficiency of the louver array--(1) a net to catch all fish that passed through the louvers and (2) a net to trap fish bypassing the louvers.

The velocity at the fingerling bypass, measured in the center of the 1- by 4-foot opening, ranged from 2 to 2.8 feet per second (f.p.s.). Approach velocities measured 5 feet upstream from the louver array varied from 1 to 1.5 f.p.s.

Turbidity of the water decreased from a Secchi disk reading of 1.1 feet in May to 6.6 feet in August. Water temperatures ranged from 50° F. in May to 68° F. in August.

METHODS AND PROCEDURES

Four experiments were conducted from May to August 1962. Each experiment consisted of eight or more tests of 9½ hours duration (4:30 p.m. to 8 a.m. the following morning). Guiding efficiency is expressed as the number of fish diverted by the louvers as a percentage of the total number of fish recovered in both nets. The two conditions of lighting were usually alternated every other test night. The brighter the illumination included naturally occurring light and some reflected artificial light. In the alternate condition light was decreased by covering the entire test area with plywood to prevent all overhead light from reaching the louver array (fig. 3).

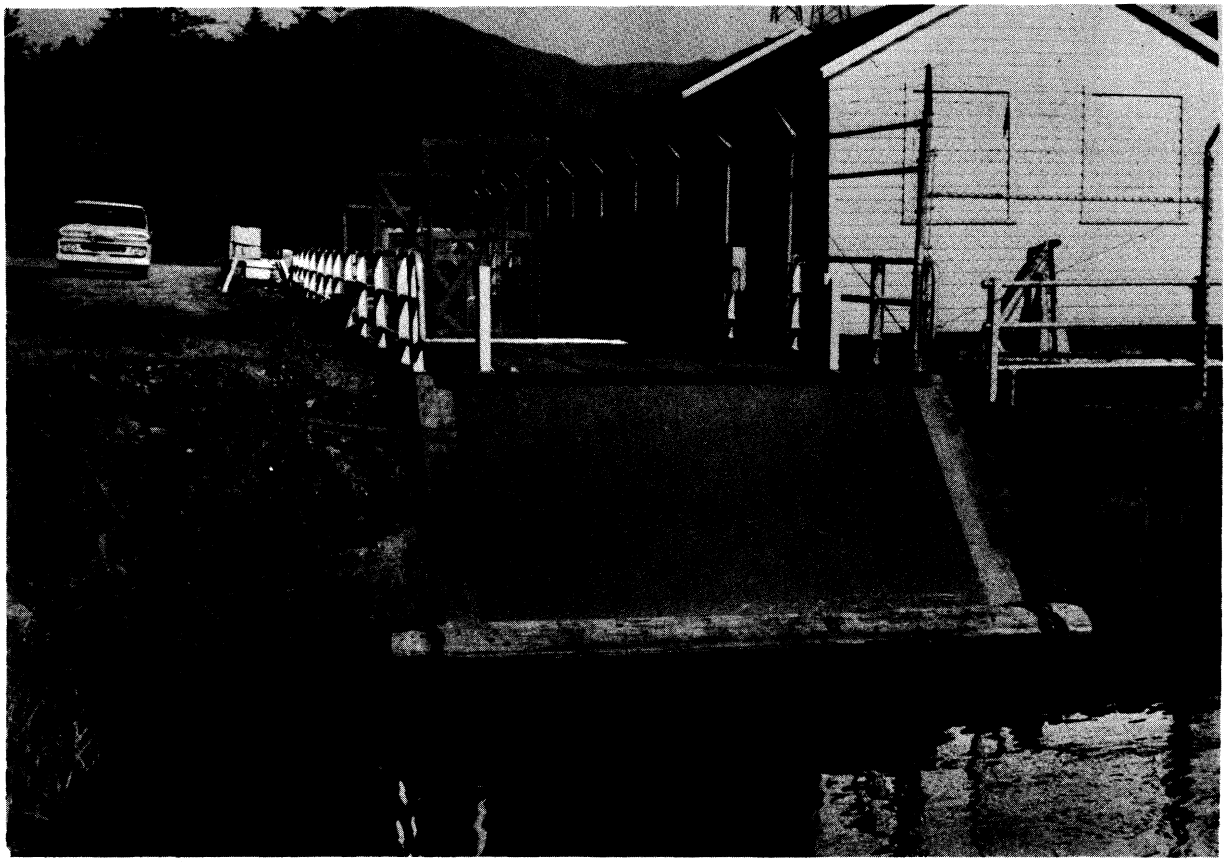

Figure 3.--Test area darkened, showing plywood cover in place.

At night, a limited amount of reflected light from mercury vapor lamps on Bonneville Dam reached the test area. The value of natural and artificial reflected light over the louver array at ground level on a clear night was approximately .15 foot-candle. Since the water surface in the channel was from 7.5 to 11 feet below ground level, light on the water surface above the louver array was undoubtedly less than that measured at ground level. In the dark condition, observations under the plywood covering indicated there was insufficient light to register in the human eye.

During experiments I and II, the water depth in the channel varied between 7.0 and 9.5 feet and the bypass was submerged from about 1 foot to about 3.5 feet. In experiments III and IV, water depth varied from 6.2 to 6.6 feet and the bypass was operated on the surface. Chinook salmon (*Oncorhynchus tshawytscha*) fingerlings migrating down the Columbia River were used in experiment I, and marked hatchery-reared coho salmon (*O. kisutch*) were used for experiments II, III and IV. In experiment I, migrants were allowed to enter and pass through the test area on their own volition. These consisted of wild migrants and fish released from hatcheries above Bonneville Dam. Total lengths of the fish ranged from 60 to 75 mm. In the remaining experiments a permanent screen was installed, and fish (120 to 140 mm. total length) were transported from nearby hatchery ponds to the test area where they were marked with an identifying fin clip and released into the area between the drop screen and the permanent screen. Fish were marked and released approximately 2 hours before the start of each test. A different fin clip was used in each test to determine if there was a holdover of fish from one test to another. Over 92 percent of the hatchery fish entered the test area on the day they were released.

In all experiments, the drop screen was raised at 4:30 p.m. to start a test and lowered at 8 a.m. on the following day to end the test. Fish were then removed from the two fyke nets, identified, and counted. The fyke net below the louvers returned to fishing position after inspection to prevent the entry of resident species (bass, squawfish, etc.) into the test area from the downstream end. The drop screen remained down until the start of the next test to prevent entry of fish into the test area from upstream.

RESULTS

Louver Efficiency Under Light and Dark Conditions

Experiments I and II were conducted to measure the effect of light on the guiding efficiency of black horizontal louvers in conjunction with a submerged fingerling bypass. Results of these experiments are given in table 1. In both experiments the fish were guided most efficiently under the lighted condition.

Guiding Efficiency, Black vs. White Louvers

Because the first two experiments showed guiding efficiency to be much greater when surface lighting prevailed, it was believed that vision might be an important factor in the reaction of fingerlings to louvers and that the visibility of the louvers could be increased by painting them white. At the time the latter experiments were carried out, the water level in the test site had dropped, making a surface bypass necessary. This permitted an evaluation of the two light conditions on the guiding efficiency of black and white horizontal louvers in conjunction with a surface bypass for fingerlings.

Referring again to table 1, a marked improvement in guiding efficiency resulted from use of white louvers under the darkened condition.

CONCLUSIONS

The experiments indicate the importance of vision in the response of salmon fingerling louvers. The guiding efficiency of black iron louvers was markedly reduced in the absence of overhead light. Conversely, efficiency increased under reduced illumination when louvers were painted white.

LITERATURE CITED

Bates, Daniel W., and Russell Vinsonhaler.
1957. Use of louvers for guiding fish. Transactions of the American Fisheries Society, vol. 86, p. 38-57.

Table 1.--Percentage of salmon fingerlings guided with a horizontal louver array under various operational conditions.

Experiment number	Bypass condition	Louver color	Turbidity (range of Secchi disc readings)	Guiding efficiency by light condition: Light	Guiding efficiency by light condition: Dark	Fish in sample
			Feet	Percent	Percent	Number
I	Submerged	Black	1.1 to 2.8	83	35	282
II		Black	2.5 to 4.6	92	34	940
III	Surface	Black	4.0 to 5.0	91	64	914
IV		White	4.5 to 6.6	95	94	940