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COMPARATIVE RESPONSE OF BLINDED AND NON-BLINDED FINGERLING SALMON TO A LOUVER BARRIER AND TO A SHARP INCREASE IN WATER VELOCITY

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INTRODUCTION

Louvers were developed as a promising fish-guiding device by Bates (1956) at the Tracy-Mendota Canal in California. In these experiments, and in literature extant at the time (Wunder, 1950), pressure wave sensing seemed to account for the response young fish exhibited toward the louvers. Tests conducted by Larsen[1/] at Bonneville Dam showed a higher degree of response to white louvers than to dark louvers when visible light was excluded as much as possible. Such differences indicated that sight, too, must have a role in the response of fish to louvers. The experiments described here compared the response of blinded and non-blinded fingerling salmon to a louver barrier and to a sharp increase in water velocity.

EQUIPMENT AND PROCEDURE

Populations of blinded and non-blinded fish were used in this experiment. Hatchery-reared spring chinook (<u>Oncorhynchus tshawytscha</u>) and coho salmon (<u>O</u>. <u>kisutch</u>) were blinded with an electric soldering iron and allowed a 1-week period of acclimatization to visual occlusion prior to testing for (1) their reactions to a louvered barrier, and (2) their reactions to a rapid increase in water velocity. The technique used to blind fingerlings for this experiment did not destroy their sensitivity nor capacity to detect and respond to a change in water velocity.

A cedar plank flume, 50 feet long, 6 feet wide and 4 feet high, was the facility in which the vertical louver was erected and into which a small box was affixed to create rapid water velocity increase. The experiment described here was conducted at Carson National Fish Hatchery, Carson, Washington, in January 1963.

The vertical louver consisted of a 24-inch-high black iron frame containing 1/8-inch-thick by 3-inch-wide black iron slats spaced 2 inches apart. The louver, on a 20° angle across the flume with the slats seated at 90° to flow, terminated at a 6-inch bypass. Water depth during the obstacle detection test was approximately 18 inches; the approach velocity to the louver was 1.5 feet per second, with an approach-to-bypass velocity ratio of 1:1.4 f.p.s.

1/ (See "Guiding salmon fingerlings with horizontal louvers," Larsen, vol. 4, Review of Progress, Fish-Passage Research Program.)

The flow accelerator (fig. 1) in which the velocity perception test was conducted was a plywood box, 60 inches long, 8 inches wide, and 12 inches high, with 0.5-inch metal mesh at the upstream end to retain the fish. Two triangular wood wedges, each forming an angle of 28° to the flow of water were nailed inside the box 6 inches from the downstream end. The 4.75-inch-long, 2.5-inch-wide, 12-inch-high wedges provided a 3.0-inch constriction within which the sudden increase in velocity occurred. Water approached the wedges at 1.3 feet per second, but increased at a high ratio between the wedges. Water depth remained quite consistent despite the almost 300 percent increase in velocity. Terminal velocity was 3.8 f.p.s.

In the obstacle detection test, water was introduced into the flume at a constant head, and the depth and velocity in the flume were controlled manually by stoplogs across the downstream end of the flume. Velocity was measured in the mid-approach area, approximately 10 feet upstream from the louver, and also measured at the bypass entrance.

Fingerling salmon were released into the approach area as individuals, by twos and threes, and by groups of approximately 15 or 20. Their response toward the louvers was observed. The test fish were recovered in a trap section of the inclined screen attached to the foot of the flume.

In the flow perception test, the accelerator device (fig. 1) was fastened to the flume floor and braced firmly to prevent the sides from bulging outward from the internal pressure. Vertical panels, angled across the flume and fitted tightly against each side of the upstream end of the accelerator, created a constant head that fed a consistent volume of water into the plywood box. Volume of water (and the subsequent velocity in the box) was controlled by allowing a sufficient amount of water to enter the flume.

Fish with vision as well as blind fingerlings were introduced by hand--one fish at a time--into the already flowing water. Their reactions, induced by the rapid increase in velocity, were observed.

RESULTS AND DISCUSSION

Behavioral patterns exhibited by chinook and coho during all phases of this experiment were quite pronounced, and very few individuals reacted differently from their class norm. Because both species behaved alike, no further reference to species is made.

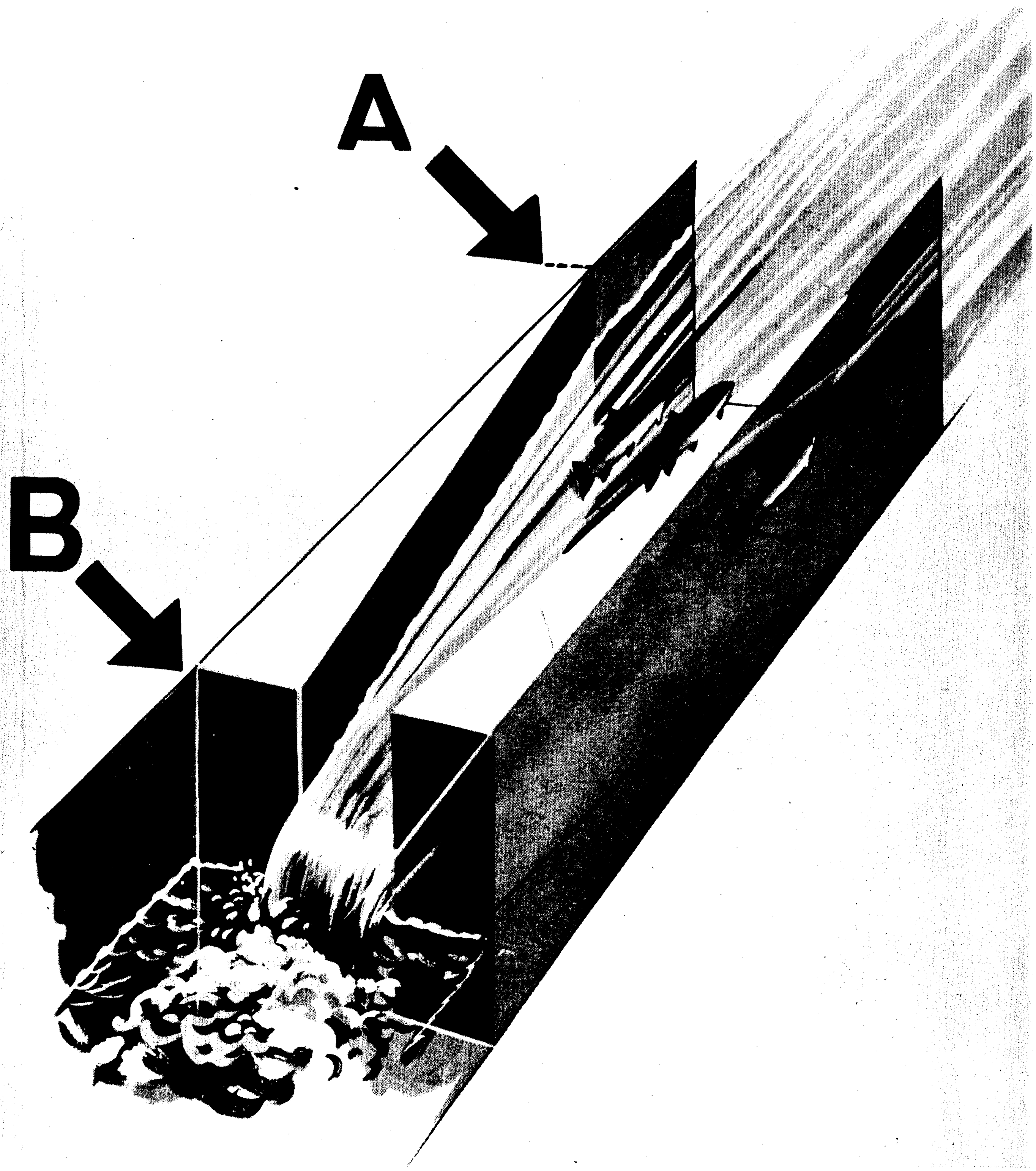

Figure 1.--Flow accelerator, a device in which blinded and non-blinded fingerling salmon were tested for their reactions to a sudden increase in water velocity. "A" indicates the mouth of the accelerator and "B" the throat. The box is 60 inches long, 12 inches high, and 8 inches wide. The constriction is 3.0 inches wide; A and B are 4.75 inches apart.

Obstacle Detection Test

During normal migration downstream, juvenile salmon generally approach a vertical louver system tailfirst, head oriented upstream against the flow of water. To avoid colliding against a louver, downstream migrants either deflect laterally without altering the linear position of their bodies, or in certain specific instances of relatively high velocity, turn as much as 90^{o} in relation to the line of the louvers and continue downstream retaining their position until they reach the bypass (Bates, 1956).

In these experiments the behavior pattern of the fish in possession of sight was one of lateral deflection away from the louvered barrier--without linear alteration of their bodies. They came downstream tailfirst, shunned the barrier, and guided into the bypass.

The blinded fingerlings reacted quite differently toward the louver. Although these fish still passed tailfirst downstream they displayed no awareness of the louver until their caudal fins came in contact with the angular obstruction. They did not deflect laterally, or in any obvious degree, alter the linear position of their bodies as an indication of awareness.

Unlike the normal behavior of fish in possession of sight, the blinded fingerlings did one of two things in the obstacle detection test: (1) Swimming passively, they went tailfirst downstream as expected, but very frequently slipped without resistance through the 2-inch spacings between the louver slats or (2) as a consequence of physical contact against the louver, they darted immediately back upstream. The presence of the louver exerted no guiding influence upon the blinded fish unless they touched some part of the barrier.

Velocity Perception Test

Young salmon swimming downstream tailfirst often evidence unwillingness to enter areas in which there is a sudden increase in water velocity. Instead, the fish will either shear off or refuse to enter the area of accelerating velocity. Behavior of this sort is common to fluvial fish and was again demonstrated in the velocity perception test.

The majority of fish with vision responded actively to the barrier as their tails entered the inlet to the wedges (Point A, fig. 1). Most fish either swam immediately back upstream, or after only a slight pause, continued downstream into the throat of the wedge. Rejection of the barrier velocity was most pronounced at the terminal slot (Point B, fig. 1). At Point B, the fingerlings either continued on downstream and out of the box because they could not overcome the 3.8 f.p.s. velocity, or they darted back upstream toward the retaining screen.

Blinded fish also approached the wedges tailfirst, and the majority darted back upstream after contact with the area of increased velocity. In the main, the responses of these fish were no different from those of fish in possession of sight. The pronounced rejection of the sharp velocity increase was similar to the type of response the blinded fish exhibited when their caudal fins contacted the vertical louver during trials in the obstacle detection test. In the velocity perception test, the blinded fish reacted to flow acceleration as though coming into contact with a solid object.

CONCLUSIONS

Blinded fingerlings, when approaching or within proximity of an obstruction, seemingly cannot detect the object. Results of this experiment suggest that fingerlings in possession of sight may not respond to objects which they cannot see, and therefore are unlikely to be affected by fish diverters wherein the function depends entirely upon the fish maintaining a visual fix.

The behavior of blinded fingerlings toward the louvers demonstrates that the response of fish to obstacles is predominantly a function of sight.

In the event vision is denied fingerling salmon (even for reasons other than physical impairment), the sense of touch apparently assumes the dominant role in the guiding mechanism. Since fingerlings can detect changing velocities very readily, a controlled sharp increase in water velocity may very well be effective in the guiding of young salmon. Tests of a device keyed to the principle of velocity rejection would appear worth exploring.

LITERATURE CITED

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