# RESPONSE OF JUVENILE MIGRANTS TO FLOW ACCELERATIONS

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## INTRODUCTION

The collection of juvenile salmonid migrants is sometimes difficult after they have been deflected from the main portion of the stream by mechanical devices such as louvers, screens, or electrical impulses. Downstream-migrating salmonid juveniles at times are reluctant to accept the provided bypasses or confined openings (Brett, 1958; Bates, 1960).

A series of tests was carried out to determine the relationship of fish acceptance or non-acceptance to various acceleration ratios of the approach flow to the bypass flow. All tests were conducted at the Eagle Creek behavioral flume, near Estacada, Oregon, using a conventional louver array.

## EAGLE CREEK BEHAVIORAL FLUME

### The Flume

A flume designed for use in testing various fish guiding and collecting devices was constructed on Eagle Creek (Estacada, Oregon) during the fall of 1962. Placement of the flume in relation to Eagle Creek is shown in figure 1. Flow in excess of that required for flume operation can be diverted through control gate 2. A louver structure was installed just ahead of this control gate to guide the young migrants toward the test flume. The wooden flume, which measures 100 feet long, 6 feet wide, and 4 feet deep was so designed that the entire structure could be pivoted at the upstream end and sloped from the horizontal plane down to a maximum of $9^{\circ}$, providing a drop of 1.5 feet at the downstream end.

At the inlet end, control gate 1 provides security against flood flows as well as attraction to fish through use of high volume flows into the canal.

Two sections of clear plastic windows, measuring 8 feet long and 3 feet high, were installed on one side of the flume adjacent to the center and downstream end of the flume to allow observation of fish response.

A bypass was provided for fish guided by the test facility. A perforated plate screen, with 1/4-inch-diameter holes, attached to the downstream end of the flume carried all fish into a compartmented trap. Volume of flow was regulated with a steel gate (control gate 3) at the upstream end of the flume. Velocity control was secured through use of stoplogs positioned at the downstream end.

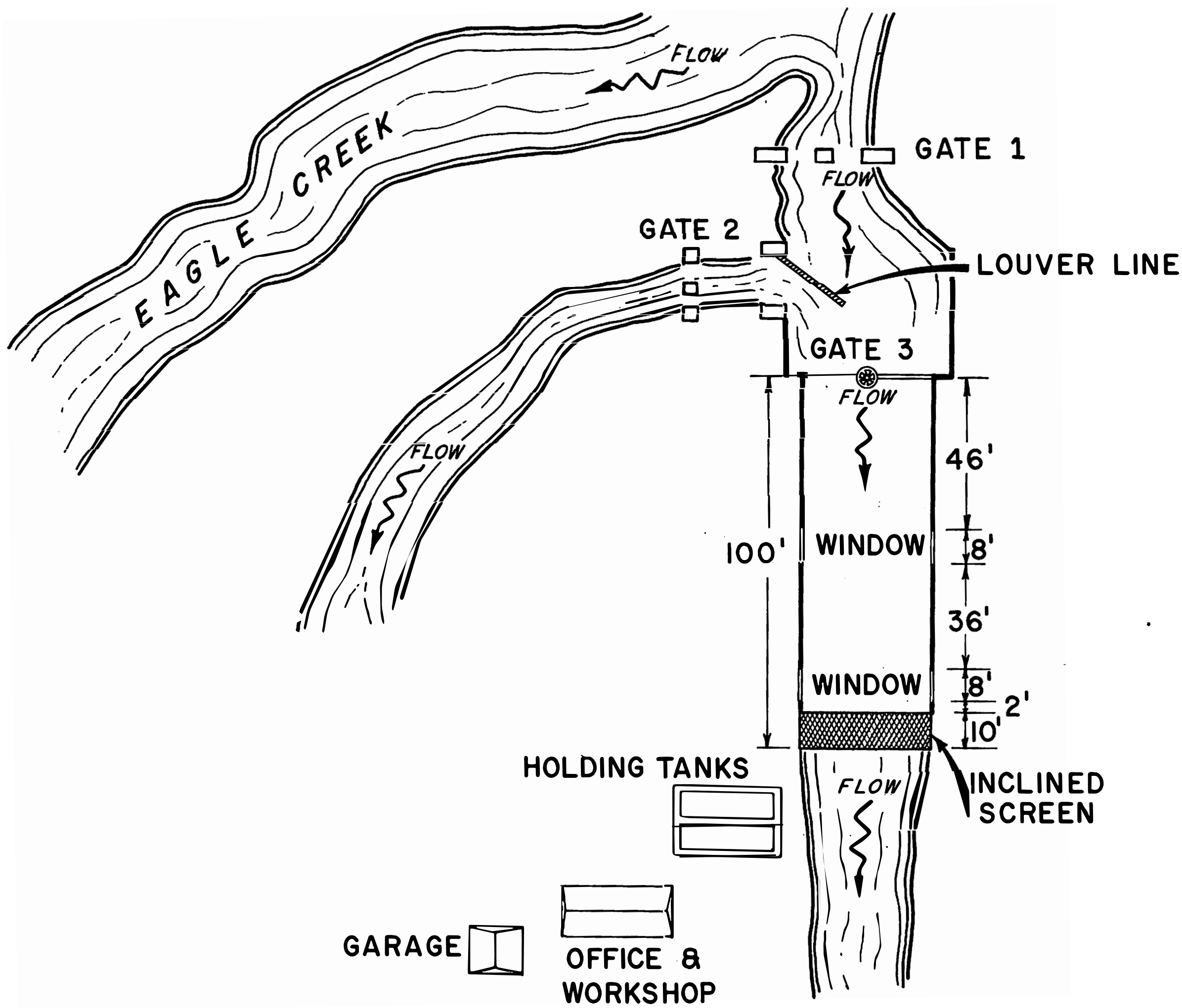


Figure 1.--Plan view of test flume area showing physical relationship of Eagle Creek, control gates, louver shunt, flume, and fish holding tanks.

## Water Supply

Eagle Creek, a tributary to the Clackamas River, flows by way of the Willamette River into the Columbia River. It is capable of fluctuating rapidly in volume as a factor of precipitation within the Pacific slope of the Cascades, ranging from a maximum of several thousand second feet to as little as several hundred. At times, particularly during flood periods, the water becomes turbid, but this condition seldom lasts more than several days. During the low-water periods of summer, the main stream is completely channelized into the test flume to provide sufficient volume of flow.

# EQUIPMENT AND PROCEDURE

A 2.5-foot-deep, 20-foot-long louver line angled at 20 degrees to the flow was installed in the flume. This louver terminated in an 8-inch-wide, 8-foot-long bypass (fig. 2). The transition from louver line to bypass was situated opposite a view window. Placing the test structure at the lower end of the flume took full advantage of the increased velocities created by the water spilling out of the flume and through the inclined screen. The flume gradient was adjusted to 1 percent (1-foot drop in 100 feet) to produce a higher head differential. Stoplogs at the lower end provided additional flow control.

A series of tests was conducted at approach velocities of 1, 2, 3, and 4 feet per second. For each specific approach velocity there was in turn a respective series of bypass velocities that was lower than, equal to, or higher than the initial approach velocity value.

A short pretest study of the characteristics of flow approaching the louver line and bypass showed there was no appreciable change in mean velocity values until the flows approached to within 6 feet or less of the bypass entrance (fig. 3). The flow then increased up to the bypass mouth and beyond.

Acceleration is the ratio of the mean approach velocity to the bypass velocity. The mean approach velocity was determined by averaging all measurements from the head of the louver to the point where a marked increase began. The bypass velocity used to calculate acceleration was that value measured at the mouth of the bypass. The relationship of the mean approach velocity to the bypass velocity was expressed as a percentage of approach velocity.

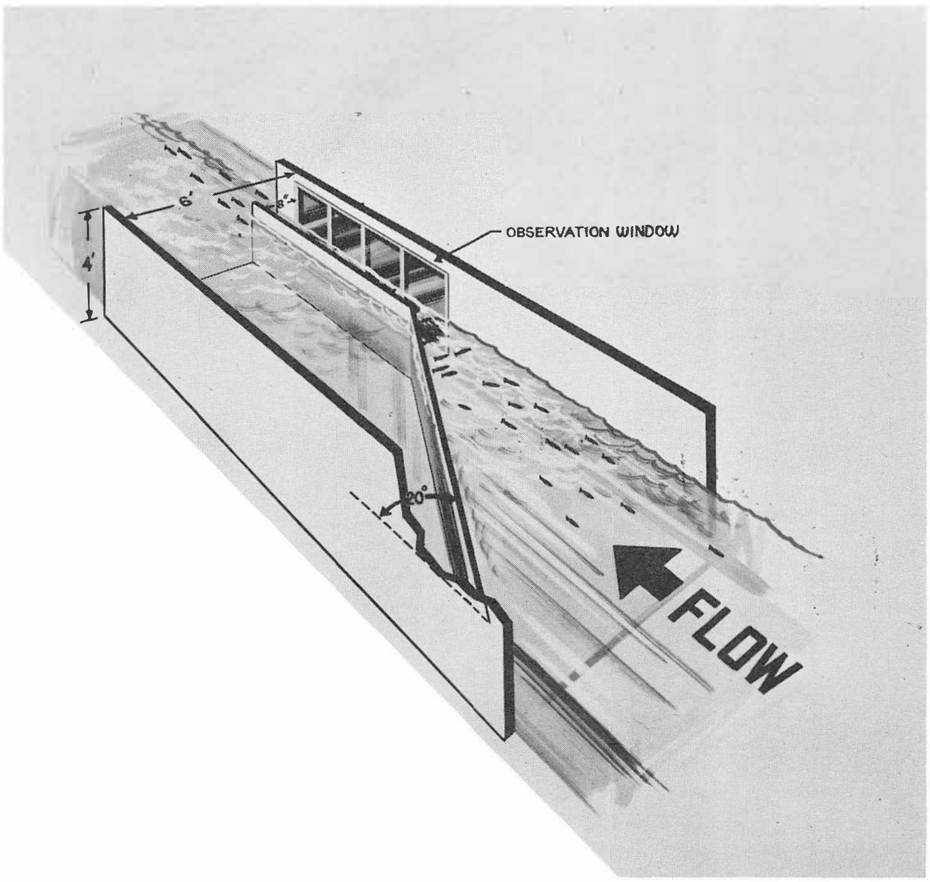


Figure 2.--Details of louver and bypass used in acceleration tests.

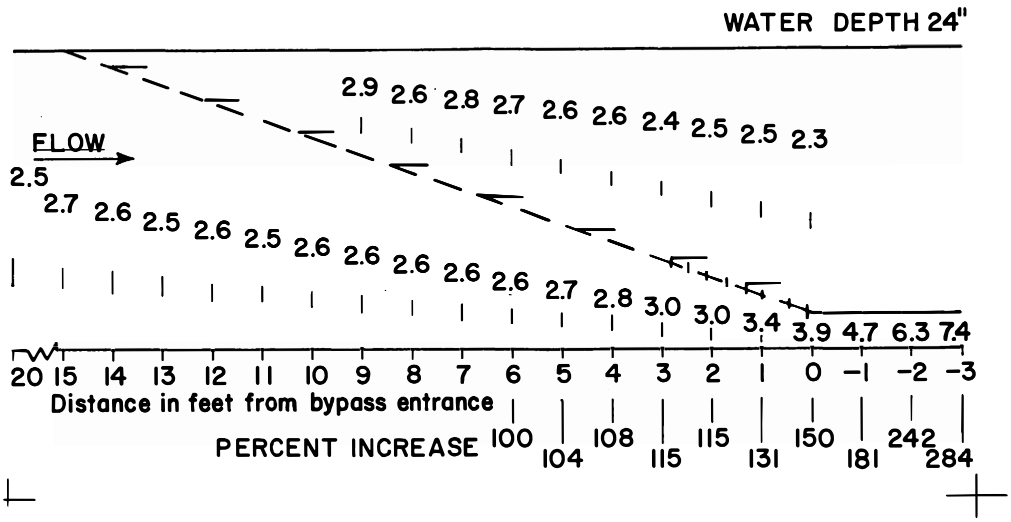


Figure 3.--Approach velocity to bypass velocity ratio of 150 percent (1:1.5) showing velocities measured at 1-foot intervals. Bypass velocity is measured at mouth of bypass (3.9 f.p.s. at 0-foot mark). Acceleration is ratio of mean approach velocity (2.6 f.p.s.) to bypass velocity (3.9 f.p.s.).

Fish used in these experiments were hatchery-reared chinook and coho salmon fingerlings 3 to 5 inches in fork length. One-hundred fish were released in each test at the upper end of the channel above the louver line and their behavior was recorded during passage through the observation area. Most tests were conducted during daytime hours, as no difference could be detected between day and night testing. Bypass efficiency was expressed as the percentage of fish accepting the bypass in relation to the total number of fish presented to the louver array.

## RESULTS

The willingness or reluctance of fish to enter the louver bypass was related to both the approach and bypass velocity patterns (fig. 4). At the lowest approach velocity (1 f.p.s.), a ratio of 1. to 2.6 was necessary to achieve an acceptable bypass efficiency, whereas at an approach velocity of 4 f.p.s. a reasonably good bypass efficiency was achieved at a ratio of 1 to 1. In all cases, chinook fingerling evinced a virtually complete rejection of the bypass when bypass velocities were less than approach velocities.

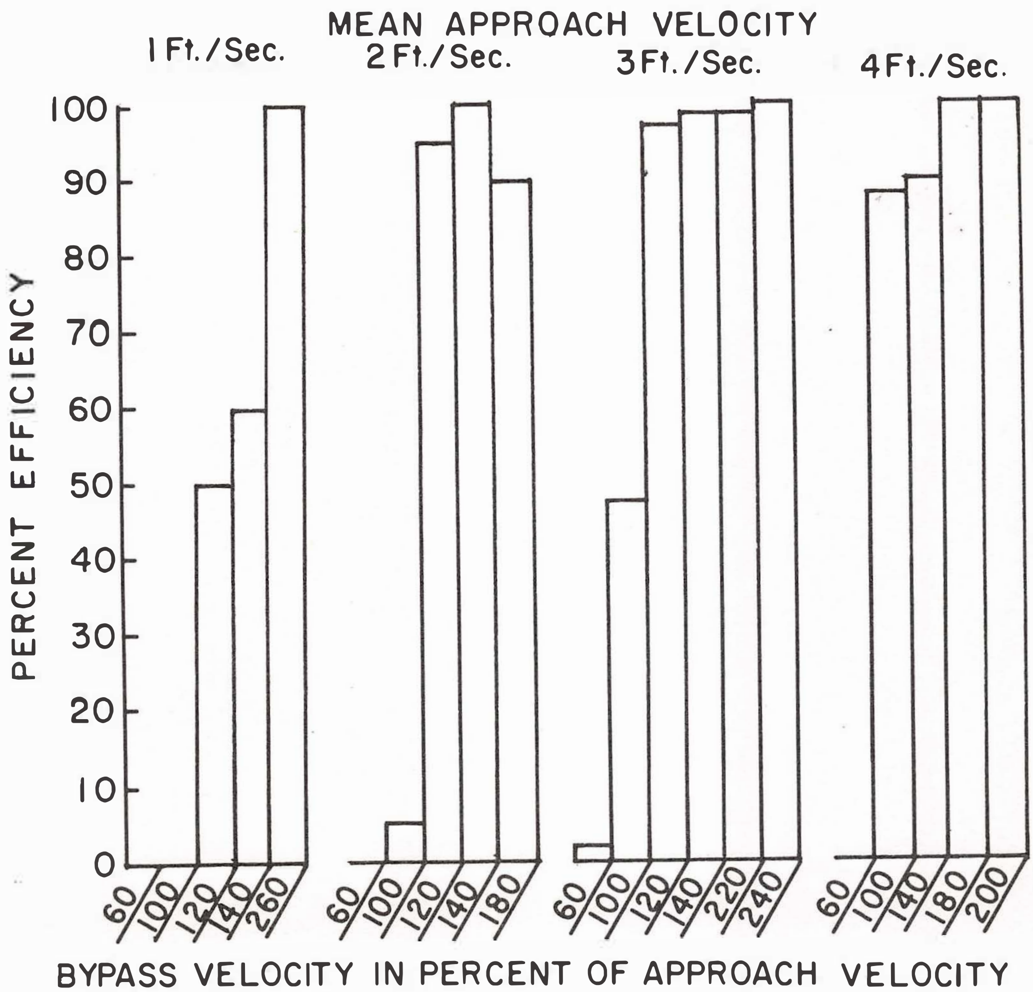


Figure 4.--Bypass efficiency in relation to bypass and approach velocities.