Modifications of Temperature Avoidance Troughs for Testing Small Fishes

Numerous studies have been conducted to establish temperature criteria required to protect ecosystems against thermal additions to the aquatic environment (Coutant 1977; Beltz et al. 1974; Raney and Menzel 1973). Temperature avoidance and preference tests are frequently conducted to establish these criteria in environmental impact studies (Gift 1977; Stauffer et al. 1975). The trough described here is a modification of designs presented by Meldrim and Gift (1971), Hill (1968), Sprague (1964), Jones (1952), and Shelford and Allee (1913). The design modification includes a turbulence-deflecting pool at each water inlet (to reduce the turbulence that may affect fish behavior) and a larger, more effective drainage system (to enable better maintenance of the temperature differentials that are required in avoidance testing).

A trough was constructed of 1.9-cm-thick exterior grade plywood (one board, 5.1 × 10.2 × 396 cm, was used as framing to secure the end and side panels of the apparatus), polyvinyl chloride (PVC) pipe fittings, hose clamps, and flexible plastic tubing. The trough had two levels (Figs. 1,2): one level, the support floor, provided structural support in addition to forming the bottom of inlet and center drain areas; the second level, the test floor, was placed on four blocks 30.5 cm long, 8.9 cm high, and 3.3 cm wide to form turbulence-deflecting pools at each inlet port. Two side drains, 1.4 cm in diameter, were positioned 3.8 cm above the test floor to drain the warmer, less dense water. A center drain area was created by two blocks cut at a 45° angle (Fig. 3) and recessed into the support floor. The shape of the blocks created a funnel effect which allowed the cooler, denser water to drain more rapidly than in previous designs.

Removable perforated baffle plates, which facilitated cleaning of the trough, were positioned at each end of the test floor to prevent the fish from entering the inlet pools. A perforated baffle plate fixed to the test floor covered the center drain area and nylon screening covered the two side drains. The water level was maintained by adjusting valve apertures on all drains. Temperature gradients were monitored by temperature-sensing probes spaced evenly throughout the trough.

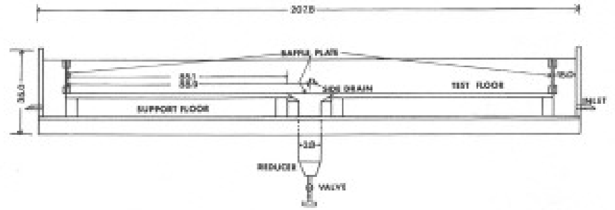

Fig. 1. Schematic diagram of avoidance trough (left side panel removed). All dimensions are in centimeters.

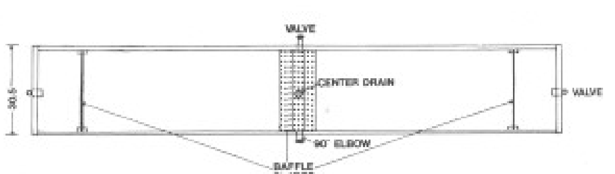

Fig. 2. Top view of avoidance trough.

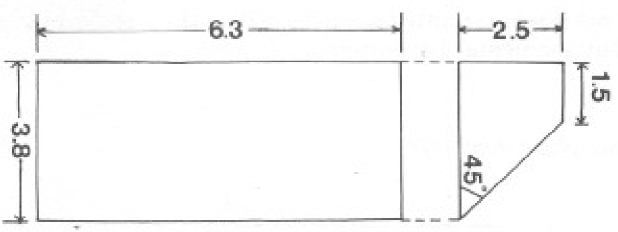

Fig. 3. Dimensions for wooden blocks used to create funnel effect of center drain area. Pieces are joined and sealed with epoxy paste.

We used plastic tubing and PVC pipe fittings to avoid introducing dissolved metals into the test water—as often occurs when water passes through metal fixtures. Adjustable stainless steel hose clamps sealed connections between tubing and fittings. Nontoxic epoxy paste was used where wood parts were joined. The trough and the steel perforated baffle plates were coated with nontoxic epoxy paint.

The modifications presented in this paper were thoroughly tested before this apparatus was used in experiments. Dye was injected into inlet lines to enable examination of flow patterns of water as it moved through the trough. Although substantial turbulence was apparent in the lower one-third of the inlet port area (due to the high water velocity required to maintain proper water levels), water in the test area exhibited laminar flow, indicating that the new design eliminated the turbulence associated with earlier designs (Fig. 4).

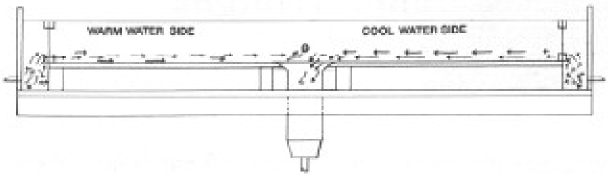

Fig. 4. Side view of trough, showing turbulence at inlet ports and laminar flow patterns of water in the testing area.

Personnel of the Appalachian Environmental Laboratory found it difficult to maintain temperature differentials when they used the modified trough of Meldrim and Gift (1971). The modifications presented here significantly reduced this difficulty. Dye tests and temperature monitoring indicated that colder, denser water was rapidly removed due to the funnel effect of the center drain, and that the side drains discharged the warmer, less dense water.

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