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December 27, 1960

Report No. 1610

THE DEVELOPMENT OF A METHOD FOR TESTING THE STAMINA OF TROUT

By

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The comparative fighting ability and stamina of hatchery-reared trout and wild trout have been discussed by anglers and fish culturists for many years. Certain questions have been asked repeatedly: Are hatchery trout as strong as wild trout? If not, could their strength be increased by a period of conditioning in swiftly flowing water? If their stamina could be increased, would this in turn increase survival? Do some species of trout reared in hatcheries have more stamina than others? Do various diets influence stamina of hatchery fish? Do trout at one hatchery have more stamina than trout of the same species at another hatchery? Does clipping fins of trout reduce their stamina? Answers to these and other questions have thus far been largely speculative, based on personal experience rather than scientific data. Obviously, a technique for accurately measuring the stamina of trout would be extremely useful.

Our efforts toward developing a method for testing the stamina of trout were undertaken during the summers of 1957 and 1958, principally at the Grayling Hatchery. Significant progress was made, although the time which could be given to the project was limited. No further work was done in 1959 and 1960, due to the lack of funds for providing assistance and to the reassignment of the junior author to a position outside the Grayling area. The purpose of the present report is to give a summary of the work which was done, to serve as a background for possible future work. The several items of equipment which are described are being stored at the Grayling Hatchery pending an opportunity to continue the project.

Development of equipment

Two methods for testing stamina have been described in the literature. A report in The Progressive Fish-Culturist[1] briefly described a "stamina tester" used by Norman Reimers at the Convict Creek (California) Experiment Station. This equipment consisted of a 20-foot metal trough, 20 inches wide and 14 inches deep, screened at both ends and set up as a flume in which water velocity could be regulated. Trout were placed in the trough, and the length of time which elapsed before they appeared exhausted at the lower screen was recorded. A rotating chamber[2] has also been employed, but it is more complicated in construction and less portable than the trough. Since Reimers' trough appeared to be effective and could easily be duplicated, this equipment was adopted, with some modifications.

The testing equipment first employed in the tests in the summer of 1957 was a discarded 10-foot length of hatchery trough, which we lined with sheet aluminum so that the junction of the sides and bottom was rounded instead of square (Fig. 1). This was done to prevent fish from seeking these slack-water corner areas to maintain their position (as they did in Reimers' experiments). Both ends of the trough were screened to prevent escape of test fish. The trough was designed for portability (to permit use at streamside and at different hatcheries) and for installation in hatchery raceways.

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[1] Vol. 18, No. 3, p. 112, 1956.

[2] F. E. J. Fry and J. S. Hart. The relation of temperature to oxygen consumption in the goldfish. Biol. Bull. 94, pp. 66-77. 1948.

Figure 1.--Trough used in early attempts to develop a method for testing the stamina of trout.

Figure 1

For preliminary tests, the trough was installed at the head end of a raceway of the State Fish Hatchery in Grayling, Michigan (Fig. 1). The upper end was fitted into the bulkhead for water supply, and the lower end was supported by a metal rod between two metal stakes, driven into the bottom of the raceway. Holes in the stakes spaced 2 inches apart permitted adjustment of the gradient of the trough for altering water velocity. Adjustments of the gradient could also be made by driving the supporting stakes deeper into the raceway bottom.

This trough proved to be too short for stamina tests because the area of fairly constant velocity (as measured with a Price Pigmy Current Meter) was very limited. Screens of various sizes were employed in the inlet and outlet in attempts to alter the flow but none was satisfactory. The head screen created a turbulence in which the fish could rest and the water gained speed towards the lower end of the trough so that the velocity varied widely from head to foot. Therefore, this trough was abandoned and a new one was designed.

The second trough was designed to operate on the ground rather than in a raceway (Fig. 2). It was made of wood, measured 18 feet long with an inside diameter of 7 inches, and was lined with aluminum to present a smooth surface and a U-shaped cross-section (to eliminate the right-angle junction of the sides and bottom, as in the first trough).

The lower end of the trough was suspended on a loop of chain hung from a standard (Fig. 3). Gross adjustments in level could be made by changing links in the chain and fine adjustments by turning the nuts on the eye bolts that held the chain. The lower end of the trough was fitted with slots so that screens of various sizes, or other devices to regulate water escapement, could be inserted. It was found that sheet-iron plates with a single round opening were more satisfactory for restraining water and maintaining a desired flow than were simple dams of various heights. Plates with a large hole produced

Figure 2.--General view of equipment developed for testing stamina of trout.

Figure 2

Figure 3.--Standard for supporting the lower end of the trough used for testing trout stamina. The length of the chain determined the inclination of the trough, and thus controlled the velocity of the water.

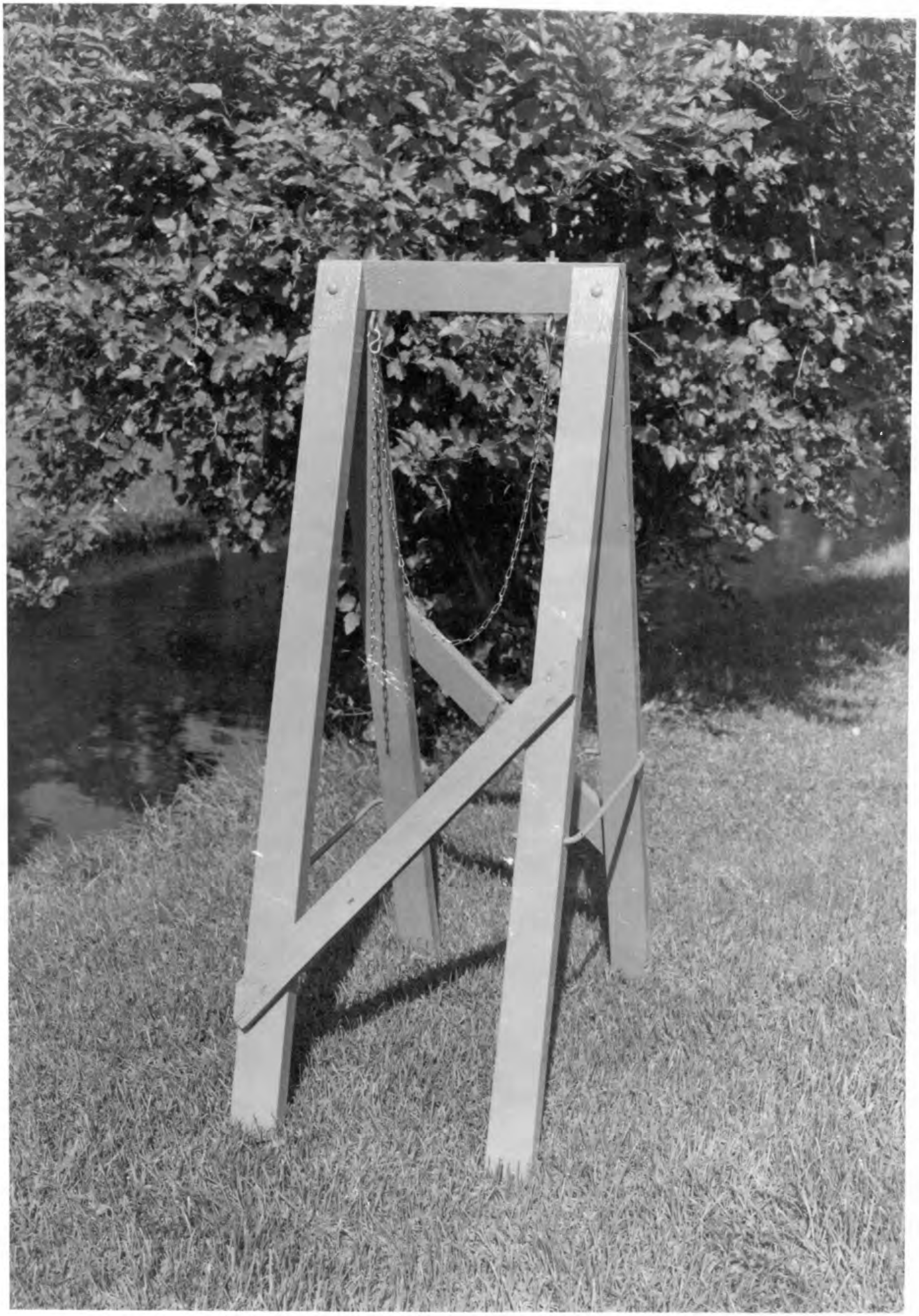


Figure 3

a higher water velocity in the trough than plates with a smaller hole, so three plates were made, each with a different-sized hole. This was done to enable the velocity to be changed from one rate to another without the necessity of adjusting the inclination of the trough. (To obtain a more critical adjustment of velocity, cuts were made in the border of each hole to make tabs that could be turned down to gradually enlarge the hole; this refinement did not give satisfactory results, however, so it was discarded.)

The upper end of the trough was closed at first with a flat end which admitted a round 4-inch pipe from the water supply tank. However, water entering the trough through this pipe caused a strong current that extended some distance down the trough and created undesirable turbulence in the test area. Therefore, the 11-inch length of pipe connecting the trough with the supply tank[3] was modified so that it flared from a 4-inch diameter at the tank to a width of 7 inches (the width of the trough) at the trough (see Fig. 2). This modification greatly reduced turbulence in the test area. The upper end of the trough rested on a frame of fixed height, which also supported the water supply tank (Fig. 4). The tank was made from a 55-gallon steel drum from which one end had been cleanly removed. Its outlet was located 4 inches from the top of the drum. Maintenance of a constant head of water above the outlet was necessary to provide an even flow of water into the trough, so a section of metal 5 inches wide and 2 inches deep was cut from the top of the barrel as an overflow. (This was later modified to a section 11 inches wide and 1 inch deep.) A steel box with a drain and hose was attached below the overflow to collect the excess water and conduct it away from the working area. (See Fig. 5; drain box had not been installed on tank as shown in Fig. 4.) The steel drum was further modified by installing baffles to alter the flow of

[3] Connection of the tank and trough was accomplished by the use of modified stove pipes. One short length of stove pipe was permanently fastened to the trough and a second to the tank. In assembling the apparatus, the two sections were fitted together and then sealed by strapping a section of rubber innertube around the junction. This connecting unit could be readily dismantled when necessary.

Figure 4.--Tank, platform and pump used in tests of trout stamina.

Figure 4

water from the pumps (Figs. 5, 6). Without the baffles, the flow through the inlet hoses caused a boiling turbulence that resulted in an uneven flow through the outlet into the trough. The baffles eliminated this fluctuation.

When fish were placed in the trough, many of them crowded into the turbulent water immediately behind the upper screen. It was necessary to keep the fish out of this area because velocity of the water here could not be measured and it was desirable to keep the fish in a steady current. To accomplish this, a cloth cover 10 feet long was placed over the test compartment, leaving the 2 linear feet of trough nearest each screen uncovered. The fish remained beneath the cover during the tests, until they were exhausted and dropped down to the lower end of the trough. Occasionally one would move up into the turbulence at the head end, but the observer could easily induce it to move back under the cover by touching it with a stick.

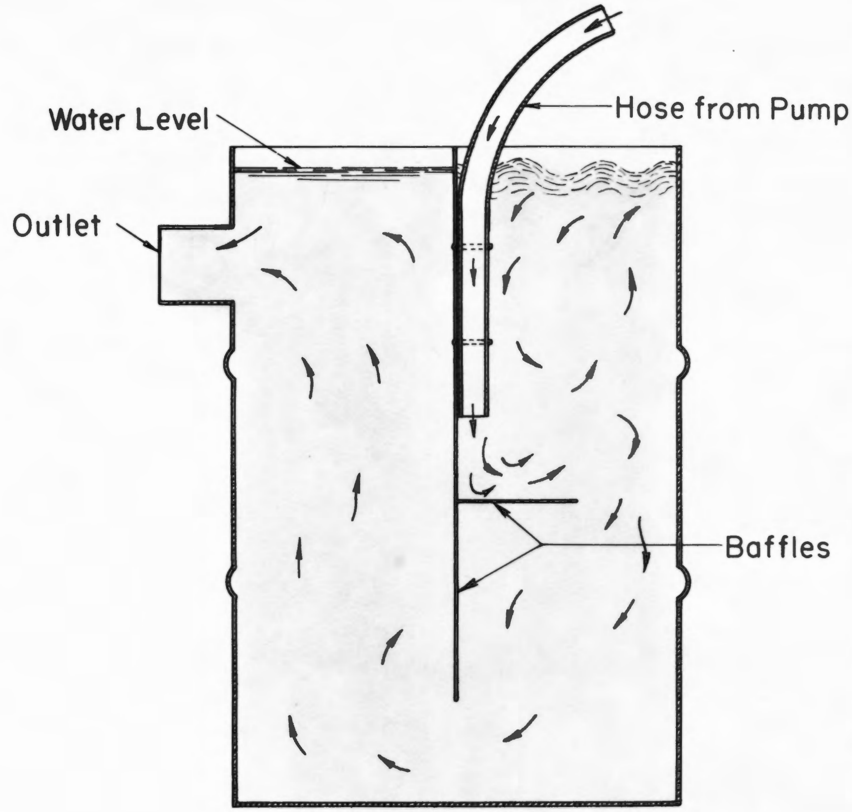
A number of preliminary tests were made with rainbow trout using various gradients to find a water velocity in which the fish could maintain themselves for about one-half hour before they were exhausted. This length of time would permit many tests during one day and be long enough to permit fish to overcome any initial shock resulting from any sudden change from low to comparatively high water velocity. After an apparently suitable water velocity had been established by several trials, measurements were made with a Price Pigmy Current Meter at 1-foot intervals beginning 3 feet from the head end. It was found that the velocity was not constant but increased from 1.6 feet per second at a point 3 feet from the head screen to 2.2 feet per second at 17 feet from the head screen. The area of least change in velocity was chosen for the testing area. The cloth cover mentioned above encouraged the fish to remain in this area.

Because the unit was to be portable, and would have to be dismantled and set up again in other locations, it would be desirable to do so without the

Figure 5.--Top and side views of final version of tank used to provide constant water supply for trout stamina tests.

Figure 5

Figure 6.--Diagrammatic longitudinal cross-section (above) and cut-away view (below) of water-supply tank used for trout stamina tests. Arrows in the upper sketch show directions of water movement.


Water Level
Hose from Pump
Outlet
Baffles

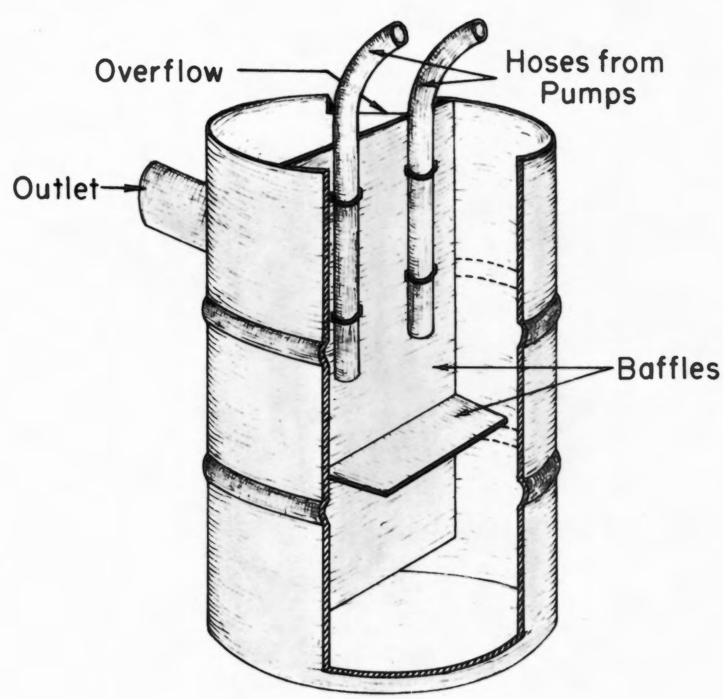

Overflow
Hoses from Pumps
Outlet
Baffles

Figure 6

necessity of making new velocity readings with the meter. In an attempt to make this possible, a spirit level was held against the side of the trough after the water velocities were determined, adjusted to a level position and fastened securely in place. Later tests suggested, however, that the level was not sensitive enough to insure reproduction of identical water velocities when the unit was moved.

Other unsuccessful attempts to make a suitable velocity "meter" included construction of a Pitot tube, a Darcy tube, and a plastic paddle wheel connected to a bicycle speedometer. None of these were sensitive enough to accurately measure the velocities employed in these tests.

Near the close of experimentation in September, 1958, a device was tested that demonstrated promise in helping to obtain nearly identical gradients each time the unit is reassembled. It consisted of two burettes from which the petcocks had been removed, connected by 16 feet of hose of the same diameter as the burettes. The burettes were fastened to the outside of the trough at points 15 feet apart, and water was added to the device until both burettes were half-full. If the burettes were permanently secured to the trough, it was observed that slight changes in inclination of the trough could be detected by reading the water levels in the two burettes. During earlier tests we found that a difference in the level of the upper and lower ends of the trough of less than 1/4 inch altered the water velocity appreciably. The burette device is capable of measuring differences in level of this magnitude. Nevertheless, in future studies, a Pigmy Meter should be used to check water velocity every time the unit is assembled on a new location. Approximate level can be determined first by the burettes and exact velocity obtained with the aid of the meter. Any changes during the tests after the meter has been read, such as might occur due to sinking of the unit in soft soil, can be detected by examination of the burettes.

Preliminary stamina tests

Most of the early stamina tests were made with rainbow trout as test fish and with a water velocity of about 2 feet per second. The fish were selected for length within limits of 2 inches (e.g., 7.0-8.9 inches) and the length of each was recorded at the time it became exhausted and was removed from the unit. Elapsed time, water temperature and lengths of the fish remaining at the close of a given trial (after half or more had become exhausted) were also recorded. Five fish were tested at one time during the early trials, but since there was ample space in the unit, 10 were employed in later tests. A stop watch was used to measure the length of time the fish remained swimming before they became exhausted.

In the first series of trials, timing was continued until all fish were exhausted. Individual fish varied widely, however, and sometimes when 8 or 9 fish became exhausted within 30 minutes, one or two would not appear to be affected, even after 2 hours. On the advice of Dr. D. W. Hayne, Institute Biometrician, subsequent trials were made with 11 fish per test, and timing continued only until 6 were exhausted.

In several preliminary tests that we made, rainbow trout which had been captured in the raceway by hand net became exhausted in a much shorter time than fish held in a live crate overnight. The hand-net method of capture may have selected weaker fish or the fish may have been fatigued by struggling and excitement in attempting to escape capture. No further study of that reaction was made and all subsequent tests were made with fish held overnight in live crates.

Our preliminary trials with fish were run primarily to test the apparatus and to find a suitable means of measuring water velocity. Since the water velocities varied during the various tests, they are not reproducible, and the data have not been further analyzed.

Present status of the stamina tests for trout

A trough for a testing chamber and a suitable arrangement for water supply was developed. The entire unit can be transported with a trailer and station wagon and can be assembled and operated at a hatchery or at streamside. A device was made to obtain approximate trough inclination when the unit is assembled and to indicate any change in slope during tests. A water velocity of 2 feet per second was found to be adequate to test hatchery rainbow trout. The unit can accommodate 11 fish for each test.

Suggestions for conducting future tests

A Price Pigmy Current Meter should be employed to check the water velocity for each test.

It will be important to avoid bias in selecting samples of fish when future stamina tests are conducted. Fish which are selected by a random-sampling procedure should not be fed for one day prior to testing and should be held in live crates overnight before testing.

Care should be exercised to avoid exciting the fish immediately before any test. Experiments should be conducted to determine the degree of difference between tests with fish removed from the raceway immediately before the trial and fish held overnight in live crates.

If the study is continued, adequate assistance should be provided for at least six consecutive weeks.

Acknowledgments

The cooperation of the staff of the State Fish Hatchery, Grayling, where most of the work was done, and at the Harrietta and Wolverine stations, was excellent. Water velocity measurements for many of the tests were made by Horace Failing and Robert Larson of the Grayling office of the U. S. Geological Survey.

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Typed by M. S. McClure