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A NEW TWO-WAY FISH TRAP FOR STREAMS

By

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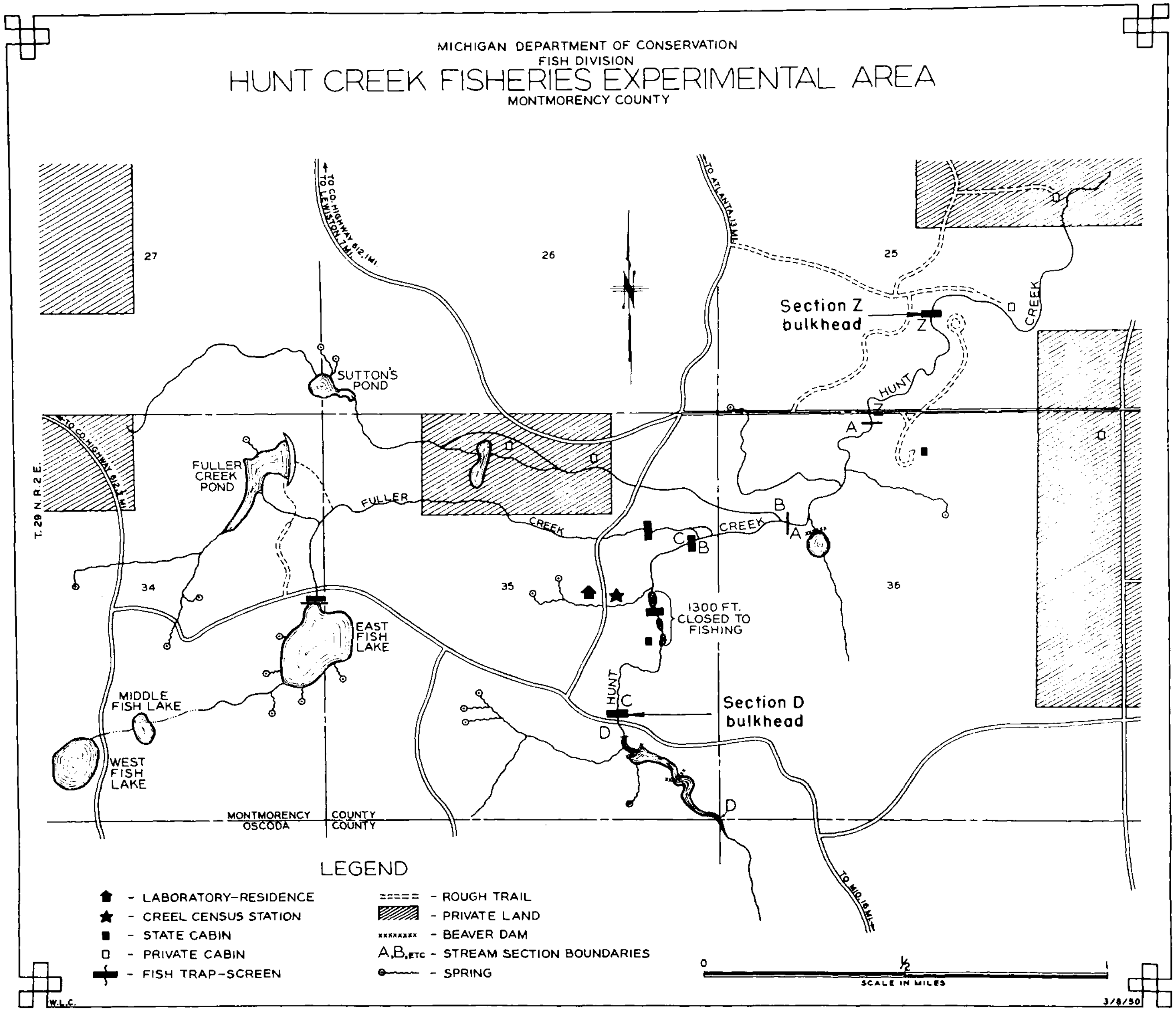
Any stream trap that successfully captures and holds migrant fish is a useful tool in fishery research and management. Shetter (1938), Carbine and Shetter (1945), Wolf (1951), and Reid (1953) have enumerated the value of fish traps in studying diverse fishery problems. A new type of two-way fish trap has been developed at the Hunt Creek Fisheries Experiment Station. Its primary function is to temporarily confine migrating brook trout to enable the staff to accurately follow the annual movements of these fish in the stream.

? Terminal concrete weirs are located on Hunt Creek (Fig. 1) at the lower ends of sections Z and D, approximately 1.99 miles apart. The lower bulkhead, at section Z (Fig. 2), is the one we are concerned with in this paper. At the section Z bulkhead, Hunt Creek is 37.5 feet wide and has an average depth of 1.2 feet. The bulkhead retains a normal head of 2.5 feet of water. The bottom type below the bulkhead is gravel and sand; and that above is mostly sand, which, for the most part, has been carried in and deposited by the deceleration of the water as it nears the bulkhead. According to measurements made by the U.S.G.S. (data for the period from April, 1949 to April, 1950),

FIGURE 1.--Map of Hunt Creek experimental area. Section Z bulkhead is at the north end of section Z.


MICHIGAN DEPARTMENT OF CONSERVATION
FISH DIVISION
HUNT CREEK FISHERIES EXPERIMENTAL AREA
MONTMORENCY COUNTY
27
26
25
34
35
36
TO CO. HIGHWAY 612, 1 MI.
TO LEWISTON, 7 MI.
TO ATLANTA, 13 MI.
TO CO. HIGHWAY 612, 3 MI.
T. 29 N. R. 2 E.
SUTTON'S POND
FULLER CREEK POND
FULLER
CREEK
CREEK
HUNT
CREEK
HUNT
Section Z bulkhead
Z
A
B
A
C
B
1300 FT. CLOSED TO FISHING
EAST FISH LAKE
MIDDLE FISH LAKE
WEST FISH LAKE
Section D bulkhead
C
D
D
MONTMORENCY COUNTY
OSCODA COUNTY
TO MIO, 18 MI.
LEGEND
- LABORATORY-RESIDENCE
- CREEL CENSUS STATION
- STATE CABIN
- PRIVATE CABIN
- FISH TRAP-SCREEN
- ROUGH TRAIL
- PRIVATE LAND
- BEAVER DAM
A, B, ETC - STREAM SECTION BOUNDARIES
- SPRING
0
½
1
SCALE IN MILES
W.L.C.
3/8/50

the annual average discharge through the Z bulkhead is about 23.2 c.f.s., with a range from 15 c.f.s. to 55 c.f.s. A flow in excess of 80 c.f.s. through the Z bulkhead will cause the traps to overflow and allow fish to escape, even though all screens are kept clean.

The present operation setup at the Z bulkhead (Fig. 2) consists of a self-cleaning rotary screen at either side, four Wolf traps to capture fish moving downstream, and, directly in the center, the newly devised trap for taking fish moving either up- or downstream. Further information and construction plans for any of the above devices may be obtained by writing to the Michigan Department of Conservation, Institute for Fisheries Research, University Museums Annex, Ann Arbor, Michigan.

The self-cleaning rotary screen is expensive to maintain. The Wolf trap has the important limitation of handling only a small water flow, so that flood water over-tops the trap, with a loss of fish. Also, both the rotary screen (when not operating) and the Wolf trap retard the current sufficiently to allow an undesirable deposition of sand, silt, vegetation, and detritus just above the bulkhead. Prior to the development of the new two-way trap, upstream-migrating fish were caught in a V-shaped up-trap which type is still used at the section D bulkhead (Figs. 3 and 4), but which is believed to retard the free migration of fish. The new two-way trap was devised to overcome the limitation of the rotary screen, the Wolf trap, and the V-shaped up-trap, i.e., to pass more water downstream without overtopping, to retain all migrating fish, to allow less-restricted migration of fish, and to avoid the deposition of sand, detritus, etc.

The evolution of the two-way trap began with attempts to improve on the V-shaped up-trap. Mr. Proshek reasoned that a screen laid horizontally in the bulkhead would handle much more water than would a vertical screen because

FIGURE 2.--Section Z bulkhead. The concrete weir containing the rotary screens, Wolf traps, and the new two-way fish trap. Each bulkhead slot measures 48 inches from wall to wall.

the horizontal screen would present a larger surface area for water passage. In August of 1950, he built into the bulkhead a horizontal screen as seen in Fig. 5, B. At that time neither an upstream stop-screen nor a holding box for migrant fish was included. This setup was a big improvement over a vertical screen. It did pass much more water. It had one serious fault: the horizontal screen became plugged with dirt and debris too much to be dependable. One day, when Mr. Proshek closed the structure for cleaning, he observed the effect when the inlet flow was restricted--the water rushed rapidly over the screen, picked up the dirt and debris and carried it away. With that, the basic design for the new trap was established. This horizontal screen with its rushing, turbulent water had one serious fault--it killed fish.

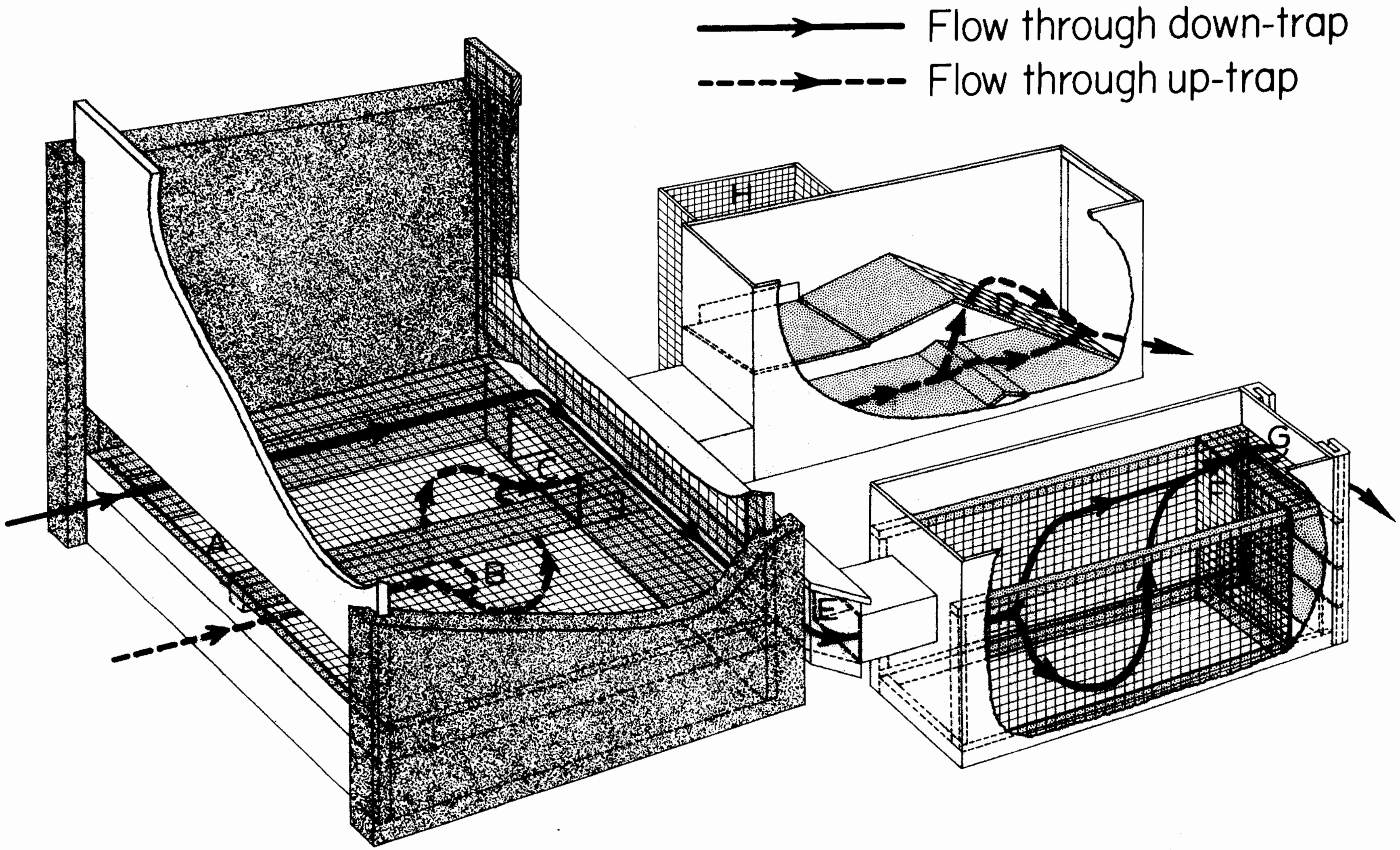
To overcome the fish-killing character of the trap, a "calm"box was installed in the horizontal screen. This rectangular box, about one foot deep and fourteen inches on the sides, was built directly into the horizontal screen to provide a resting place for fish that entered the trap, and as a place for dirt and debris to settle. With this improvement, the trap functioned well, but still a few fish were being killed because the debris filled the calm box and prevented the fish from entering the protected water. A larger calm box was needed. This fault was remedied by constructing a chute at the downstream end of the horizontal screen to direct the water, fish, and debris into a large holding box on the downstream side of the bulkhead. In Fig. 2, this is the box to the left occupying the center slot of the bulkhead, and in Fig. 5 it is in the right foreground. This holding box is essentially two boxes, a wire screen box contained within a wooden box, being held apart by wooden braces.

Although no detailed study has been made of the physical principles which contribute to the success of the new two-way trap, casual observations lead

FIGURE 3.--Section D bulkhead looking upstream. The center slot contains the V-shaped up-trap, here in operation.

FIGURE 4.--Section D bulkhead looking downstream. The V-shaped funnel leads into the V-shaped up-trap. The water has been shut off.

FIGURE 5.--Drawing of the new two-way fish trap.



Flow through down-trap
Flow through up-trap
A
B
C
D
E
F
G
H

us to believe that the down-trap functions in the following manner: Water enters the trap inlet (Fig. 5, A) with considerable velocity due to the weight and velocity of the water above the inlet. This produces a horizontal force across the screen which tumbles debris and fish to the rear of the trap. Although the bulk of the water passing through the inlet drops through the horizontal screen and passes through the outlet (Fig. 5, C) and into the up-trap, a small volume of water carries the fish and debris across the horizontal screen, into the chute (Fig. 5, E), and into the down-trap holding box, where the water passes through the screen (Fig. 5, F) and out of the wooden box over the spillway (Fig. 5, G). The fish and debris are retained in the box.

Once the fish have entered the down-trap they cannot leave, as they are unable to swim through the rushing water passing over the horizontal screen. This trap, when set up correctly, does not kill fish. Our observations lead us to believe that the fish enter this trap voluntarily and are not "sucked" in.

There is a slight vertical oscillation of the horizontal screen produced by a constant fluctuation in the outlet flow. When the space under the horizontal screen (Fig. 6) completely fills with water, the shearing force of the horizontal movement of water over the face of the screen produces a slight vertical lift on the water under the screen (Bernoulli's effect). This vertical lift quickly ceases when a slight drop occurs in the water level below the screen, and water again drops through the screen to fill the void. The cycle of up and down movements of the screen and the water plus the horizontal movement of the water over the screen combine to keep the screen free of debris. The volume of water entering the trap must equal the volume of water leaving the trap to maintain the above condition. The flow is regulated by adjusting the stop-screen.

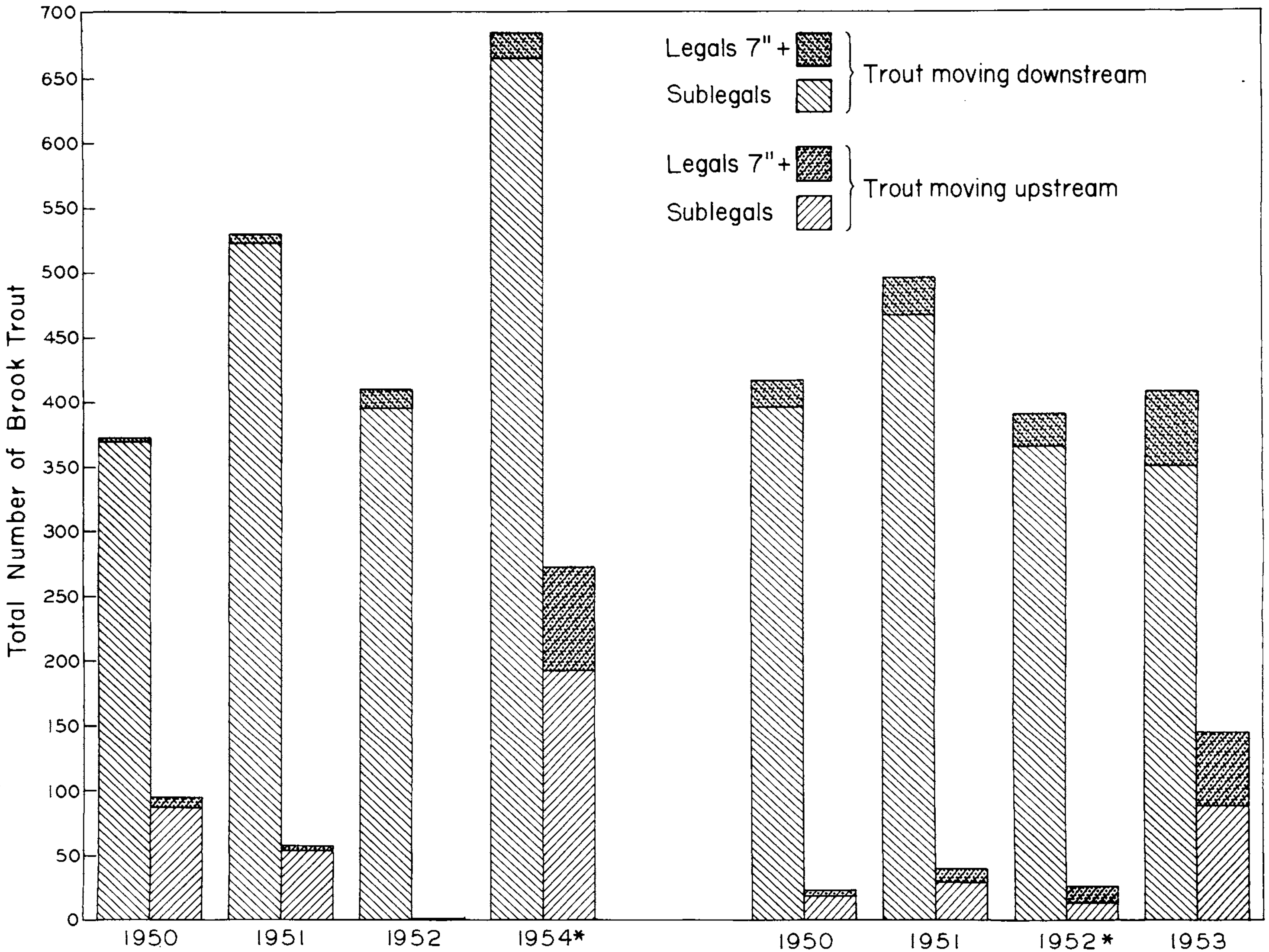
FIGURE 6.--Section Z bulkhead. The horizontal screen normally resting on the 2" by 4" legs seen along the right wall has been removed to show the outlet chute at the lower left leading to the up-trap, and the outlet chute at the center reaching almost entirely across the distant wall leading to the down-trap holding box. The white area to the right in the upper chute marks the entrance into the holding box.

The new down-trap has had little effect on the number of fish moving downstream (Fig. 7). Nor has there been any detectable change in the size composition of the fish moving downstream. The fluctuation in the number of fish moving downstream is believed to be caused by factors other than the down-trap, such as success of spawning and climatic variations. The new down-trap did help to stabilize the volume of water passing through the Z bulkhead and it did help to keep the stream area above the trap from filling in with sand and debris. Once installed, this trap has required little maintenance. After the down-trap was made to function satisfactorily, our attention was focused on devising an upstream trap to work in conjunction with the down-trap.

One of the reasons the V-shaped up-trap failed to function at the Z bulkhead was the lack of a concentrated volume of water flowing through the trap. Most of the water was passing through the Wolf traps and not through the up-trap; thus, the upstream-moving fish were attracted to the impassable Wolf traps. When the new down-trap was constructed, the outlet (Fig. 5, C) for the water passing through the horizontal screen was restricted to a 25" x 16" opening. The water passing through this opening was noted to attract fish. Fish were seen swimming up the outlet. They did not swim through the water, but on the surface with the lower part of their bodies submerged, or they simply leaped. This observation gave rise to the possibility of devising a trap which would hold these fish.

Consequently, in August of 1952, a shallow U-shaped trough (not shown) of one-half-inch mesh galvanized metal screen was partially submerged at the upper part of the down-trap outlet, and the trough inclined at such an angle that any fish swimming or jumping the outlet would fall into the inclined trough and slide down into a wooden holding box. The trap did capture fish

FIGURE 7.--The spring and fall movement of brook trout through the section Z bulkhead.



SPRING
May + June + July
* May, June, and 21 days of July

FALL
Sept + Oct + Nov
* Crude up-trap in operation

but not much better than the V-shaped trap. It was recorded, however, that the jump trap took a larger percentage of legal fish (larger than 7 inches) than did the V-shaped trap (Fig. 7, 1952, up).

In an attempt to improve upon the crude jump trap, the present jump trap as seen in Figs. 5 and 2 (the box to the right in the center slot) was built and installed during August of 1953. The new up-trap is basically a low falls (Figs. 5, 8, and 9). The only difference being that the fish, after swimming or jumping up the falls, land on a series of inclined wooden boards that direct the fish into an escape-proof holding box (Fig. 5, H). The water that passes through the up-trap is supplied from that which passes down through the horizontal screen in the bulkhead.

The new up-trap has been significantly more efficient (than previous traps) in allowing the upstream movement of fish. Fig. 7 shows the increase in upstream movement that occurred in the autumn of 1953 when this trap was first installed, and a repetition of the increase again in the spring of 1954. The new up-trap has taken brook and rainbow trout ranging from 3.4 to 12.6 inches, white suckers from 3.1 to 14.1 inches, and common shiners, creek chubs, and blacknose dace from 3.5 to 4.8 inches--the normal size range of fish in the experimental area. No rough fish or forage fish were ever taken in the V-shaped up-trap.

There are several possible refinements that can be made on the new two-way trap. For one, the up-trap and the down-trap holding boxes could be combined into one box to save lumber and labor. Another, the outflow from the downstream holding box could be made to pass through the up-trap to further increase the volume of fish-attracting water passing through the trap. Also, the level of the horizontal screen above the base of the bulkhead could be varied to determine the level at which the most water would be passed without

FIGURE 8.--Section Z bulkhead. A close-up of the downstream side of the down-trap holding box (left center) and the falls created by the new up-trap (right center).

FIGURE 9.--Section Z bulkhead. Looking down on the new up-trap showing the inclined boards which direct the fish into the small holding box at the lower center of the picture. The down-trap holding box is at the upper right, and a portion of a Wolf trap is at lower left.

deterring the movement of fish. Also, a better horizontal screen-to-bulkhead sealing device could be made that would eliminate the necessity of cleaning the inclined screen (Fig. 5, D) on the up-trap.

The dimensions for the new two-way fish trap given herein are those which were used at the section Z bulkhead. The dimensions will necessarily have to be altered if the trap is installed in a weir which differs in construction or water discharge. The slot between the concrete piers at the bulkhead (Fig. 5) is 4 feet wide, 8 feet long, and 4 feet deep. The horizontal screen is 6 feet 10 inches long and 4 feet wide, and is supported 14 inches off the bottom by a frame of 2" x 4" boards. The downstream holding box is 4 feet long, 3 feet deep, and 2 feet wide. The upstream trap is 5 feet long, 3 feet deep, and 2 feet wide. The tops of the upstream trap and the downstream holding box are on the same level; they are 1 foot above the level of the horizontal screen. The lumber used in building the trap consisted of 2" x 4" and 1" x 6" fir lumber. The screens were constructed of galvanized hardware cloth having six openings to the inch.

Literature Cited

Carbine, W. F., and David S. Shetter

1945. Examples of the use of two-way fish weirs in Michigan. Trans. Am. Fish. Soc. 73 (1943): 70-89.

Reid, Kenneth

1953. Stream secrets. Anglers' Club Bull. 32 (1): 3-9.

Shetter, David S.

1938. A two-way fish trap for use in studying stream-fish migrations. Trans. Third N. Am. Wildlife Conf.: 331-338.

Wolf, Philip

1951. A trap for the capture of fish and other organisms moving downstream. Trans. Am. Fish. Soc. 80 (1950): 41-45.

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