A FUNNEL NET FOR RECOVERING FISH BELOW TURBINES

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INTRODUCTION

In order to investigate fingerling salmonid mortalities and explore the existence of safe passage routes through Kaplan turbines in Columbia River dams, it is necessary to collect downstream migrants as they exit from the draft tubes and to guide them into a protected area for examination. Equipment to accomplish this must be large enough to cover the draft tube exits of a turbine and strong enough to withstand water pressures and turbulences encountered in flows over 12,000 cubic feet per second.

Funnel nets to screen flows from turbines and collect downstream migrants have been used by Kramer and Donaldson (1964). These nets were constructed of multiple layers of netting and were used to strain turbine discharges of about 3,000 c.f.s. Although the technique is applicable, the construction of a multilayer net for use at large Kaplan units is not economically feasible. The cost estimates for a similar net to screen the entire turbine discharge at Bonneville Dam ranged from $80,000 to $110,000.

Advances in the field of net design (Alverson, 1962), however, provided a basis for constructing a funnel net at a much lower cost. This report gives a general description of a funnel net 82 feet wide, 32 feet deep at the mouth, about 230 feet long and tapering to a circular cod end 18 inches in diameter. This net, constructed for about $8,000, is being used at Bonneville Dam to collect fingerling salmonids from turbine discharge flows.

NET CONSTRUCTION

Basically, the net (Fig. 1) was constructed of a single layer of 3/4 and 1/2 inch stretch measure (s. m.), continuous filament, knotless nylon webbing. The 3/4-inch webbing, preshrunk to 5/8 inch s. m. and with a tensile strength of 80 pounds, was used for 80 feet of the front section from the mouth toward the cod end. Additional overlay webbing, 4-inch s. m. knotless nylon, was added to 80 feet of the left side of the net looking downstream for reinforcement against high velocities and turbulences occurring in that area. The remainder of the net was constructed of 1/2-inch s. m. nylon webbing having a tensile strength of 20 pounds.

Panels of netting of sufficient width to cover an entire side of the funnel net were obtained directly from the factory and cut to the desired shape. These panels were joined at the edges by gathering together three meshes from each panel and sewing them around longitudinal riblines with nylon net twine. The twine, used for all lashings in the net, exceeded the breaking strength of the netting by at least 10 percent.

At the mouth of the net, selvage meshes were evenly distributed. These meshes were rolled around a 1/2-inch galvanized steel wire rope encircling the mouth and lashed to it with nylon twine. No more than four lacings to a knotted hitch were used.

Various sizes of medium lay nylon rope were used throughout the net for strength during periods of unequal stress. Longitudinal riblines (Fig. 1) were of 1-1/4-inch medium lay nylon rope extending 100 feet downstream from the net mouth. From this point, 3/4-inch rope was spliced in and continued to the cod end.

Primary diagonal riblines (Fig. 1) of 1/2-inch nylon were installed in all four sides, and the webbing was attached incrementally to compensate for the changing lengths of the lines under different stress along the net. The increment varied from 30 percent (70 percent of the stretch measure) near the mouth to 20 percent near the cod end.

Secondary diagonal riblines were also provided for additional support. These lines, 3/8-inch in diameter, were lashed to the net at 5-foot intervals and seized to the primary riblines at points where they crossed. All diagonal lines were spliced to the longitudinal riblines.

NET OPERATION

A system of trolleys, cables and winches was devised to install and remove the funnel net from the draft tube opening and to control the body of the net in the turbulent tailrace flows.

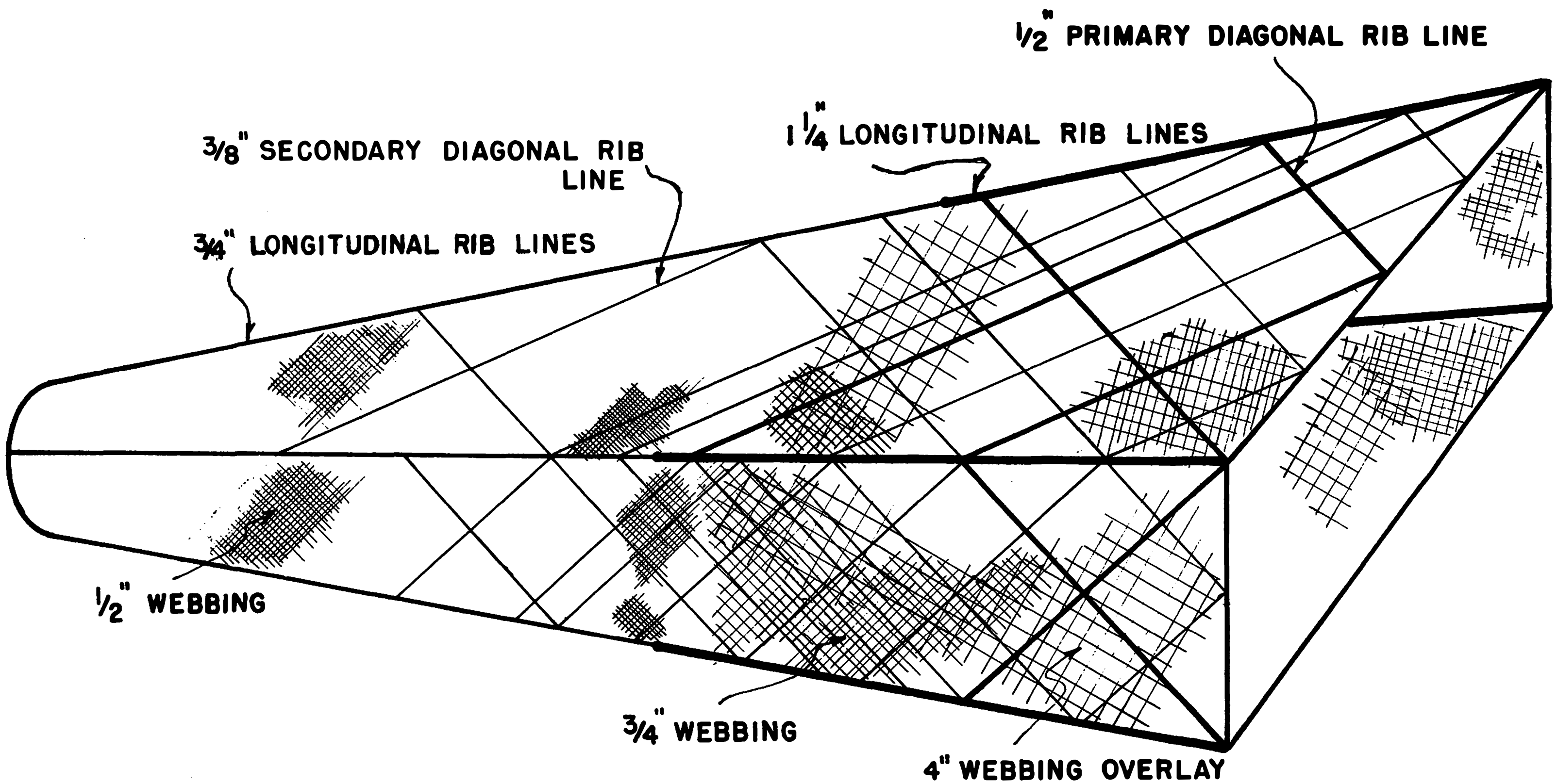

Figure 1.--Funnel net construction (diagrammatic).

The mouth of the net was attached to twelve 4-wheel trolleys mounted on vertical H-beams fastened to the sides of the draft tube exit and extending to the bottom from the turbine intake deck. The top of these beams conformed to the profile of the overhanging wall. The trolleys were connected, by a system of cables, pulleys, and sheaves, to a double drum winch. In operation, the mouth of the net attached to the trolleys was closed vertically and lowered toward the water surface. When sufficient distance was obtained, the trolleys were separated downward by braking the winch until the net mouth was extended. The entire unit was then lowered into the water until the bottom trolley reached the bottom of the draft tube. At this time, cables to the upper trolleys were tightened to insure full vertical extension of the mouth.

A system for installing and removing the body of the net without loss of the control utilized a moving double block (Fig. 2). Cables were extended from a deck winch through the block and returned to the two uppermost trolleys on the out H-beams. As the winch was slackened, the block moved downstream and the cables between the block and the trolleys formed overhead suspension lines to which the net was attached. Proper tension on these suspension cables was maintained by a connection between the block and a shore mounted winch. The net was suspended by shackles between the upper longitudinal riblines and the cables.

EVALUATION

The funnel net and the operational system, tested at Bonneville Dam, satisfactorily withstood the varying degrees of velocity and turbulence associated with discharges up to 12, 518 cubic feet per second and was easily installed and removed. The net was subsequently employed to capture fish from turbine No. 9 at Bonneville Dam.

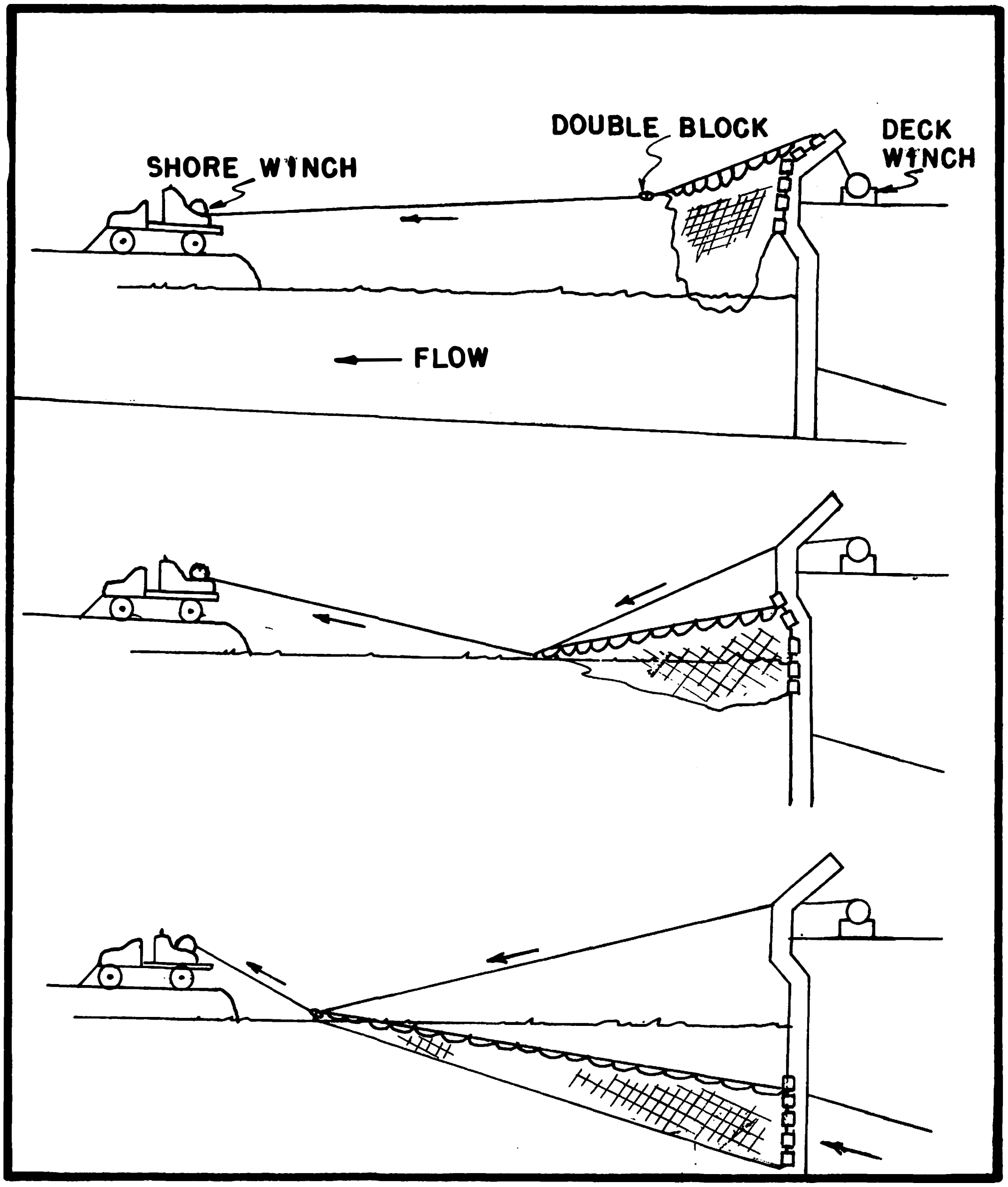

Figure 2.--Installation of funnel net (diagrammatic).

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