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An investigation into the effect of lights upon the descent of salmon smolts through the fishway at Cowie falls on the Mersey river, N. S.

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AN INVESTIGATION INTO THE EFFECT OF LIGHTS UPON THE DESCENT OF SALMON SMOLTS THROUGH THE FISHWAY AT COWIE FALLS ON THE MERSEY RIVER, N. S.

M. W. Smith

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The construction of dams for hydro-electric plants upon a number of Nova Scotian streams has complicated fish cultural endeavours directed toward the maintenance of salmon populations. Fishways in many instances provide quite efficient means of by-passing the ascending adult salmon, and also give an avenue of escape for the descending kelts and smolts. However, a much greater volume of water passes through the turbines than through the fishways, and thus it might be presumed that a majority of the descending smolts are swept through these turbines and possibly destroyed. Obviously the presumption rests upon the issues:(1) Do descending smolts pass through the turbines, and (2) if so, are they killed? At most of the power developments it is physically difficult to secure evidence in regard to either of the questions, due primarily to the great rush of water in the tailrace. Quantitative determinations of the numbers of fish that pass through the turbines, alive or dead, could scarcely be made. Qualitative evidence for dead fish could be obtained more easily, although even then much time and labour would be required to maintain suitable netting in the rapidly flowing water. Actually, we understand, some evidence was obtained for the Department of Fisheries that smolts did pass through the turbines and some, at least, were killed at the No. 3 Development of the Nova Scotia Power Commission on the Mersey river, N. S.

Assuming that descending smolts are killed by the turbines of various hydro-electric developments in Nova Scotia, it was suggested by Fisheries Inspector Buchanan that lights might be used at night to

attract smolts to the fishway, and thus reduce to a greater or less degree the number that passed through the turbines. The Department of Fisheries requested that the Fisheries Research Board investigate the possibilities of this suggestion, and accordingly the writer was assigned to the investigation.

The investigation was made at Cowie Falls (No. 6 Development of the N. S. Power Commission) on the Mersey river, N. S. Observations extended over the period from May 17 to 25, 1941.

THE LIGHTS

The positions of the lights in relation to the mouth of the fishway are shown in the accompanying sketch. (fig.1)

Four lights, each of 500 watts, with street-light reflectors, were employed. Two lights (1 and 2) were placed on a pole at the head of the fishway, with the reflectors so tilted that the light was reflected out over the pond above the dam. These lights were placed at 24 ft. 9 in. and 14 ft. 9 in. above the surface of the water when the level of this in the pond was 57 ft. above sea level. A third light was located 4 ft. above the surface of the water at the head of the fishway with its light reflected directly downward upon the water. A fourth was situated approximately 8 ft. below the third, placed in the same fashion, so that the water was illuminated as it poured into the fishway through the opening in the stop logs that regulated the flow.

The above arrangement of lights was such that fish would, if attracted toward light, move from a dimly to a brightly lighted zone in the water, and at the same time come more under the influence of the water current into the fishway. Before moving into a dark zone again the fish would be swept into the fishway proper.

THE TRAP

The fish were trapped by placing a wire screen of ¼ in. mesh across the fishway just back of the pier that divides the mouth of the fishway into two channels and immediately in front of the first concrete partition. (fig. 2) Since water entered the fishway through only one of the channels at the head, the backwater in the other provided an area of comparatively quiet water into which fish could move above the screen. To fish the trap the stop logs were placed in the mouth of the fishway, and when the water drained sufficiently low above the screen the fish were dipped with a small net.

PROCEDURE

The day and night were divided into the following periods:

6:00 A. M. to 6:00 P. M. ---- Day period.

6:00 P. M. to 9:00 P. M. ---- Evening twilight period.

9:00 P. M. to 12:00 M. ------ First Night period.

12:00 M. to 3:00 A. M. --- Second Night period.

3:00 A. M. to 6:00 A. M. ---- Morning twilight period.

On one date the lights were on for the first night period and off for the second. On the succeeding night the situation was reversed, and was carried on alternating the light periods. No lights were on during either the evening or morning twilight periods.

The above schedule was maintained from 6:00 A. M. May 17 to 6:00 P. M. May 24. The lights were on from 6:00 P. M. May 24 to 6:00 A. M. May 25, and were off during the same twelve hours of the night of May 25-26.

DATA

1. Salmon smolts.

From May 16 to 26, 141 smolts were taken from the trap. From 6:00 A. M., May 17, to 6:00 P. M., May 24, there were 123. The numbers for the periods of the above schedule were as follows:

Day	77.8 hours	53 fish	0.7 per hour
Twilight	36.8 "	45 "	1.2 " "
Night-Lights on	20.0 "	13 "	0.6(5)" "
Night-Lights off	20.2 "	12 "	0.6 " "

From 3:30 P. M. to 8:00 A. M., May 16-17, before the lights were installed, 8 smolts entered the fishway. With lights on from 6:00 P. M. to 6:00 A. M., May 24-25, there were 5 smolts, while on the following night (same period) with no lights, 3 smolts were taken from the trap.

The average number per hour for the various periods is shown graphically in figure 3.

2. Other fish.

The following species (and number) were also takne in the trap:

White perch (Morone americana)	--	157
Sucker (Catostomus commersonnii)	--	57 jv., 4 adult.
Golden shiner (Notemigonus crysoleucas)	--	16
Eel (Anguilla rostrata)	--	12
Catfish (Ameiurus nebulosus)		11
Yellow perch (Perca Flavscens)	--	8
Killifish (Fundulus diaphanus)	--	1
Fallfish (Leucosomus corporalis)	--	1
Brook trout (Salvelinus fontinalis)	--	1
Land-locked salmon	--	1

The white perch entered the trap as follows (May 17-24):

Day	77.8 hours	10 fish	0.1 per hour
Twilight	36.8 "	42 "	1.1 " "
Night-Lights on	20.0 "	13 "	0.6(5)" "
Night-Lights off	20.2 "	65 "	3.2 " "

During the same period 45 young and 3 adult suckers ran into the fishway. Of these, 42 came in the twilight hours, 5 during the day, and only 1 at night (lights on).

DISCUSSION

When operations were begun on May 17, few smolts were entering the fishway, and on subsequent days the numbers remained small. Information received from residents indicated that smolts descend the Mersey river early. It was stated that smolts begin to leave the river in late April, and the largest run occurs in early May. Definitely smolts were in the fishway on May 4 and 9. It is probable, therefore, that the smolts which were observed during the period of h the investigation were only stragglers of a larger and earlier migration.

The number of smolts that entered the fishway was small, and, accordingly, not much reliance can be placed upon the data to demonstrate the effect of light upon the smolts' movements. Only certain provisional deductions may be made:

(1) As many smolts entered the fishway at night with the lights off as with them on. The lights had no apparent attraction to the descending smolts.

(2) As many smolts entered the fishway per unit of time during daylight as at night, with lights on or off.

(3) The largest number of smolts per unit of time entered the fishway during the twilight hours (6-9 P. M., 3-6 A. M.), particularly the morning twilight period (fig.3).

(The number of smolts did not permit a closer analysis of the time that the fish seemed most inclined to run during the twilight periods.)

In the investigation of the effect of light upon descending smolts, certain considerations should be borne in mind, some of them pertinent only to the situation at Cowie Falls (No. 6 Development).

(1) Qualitative evidence (specimens) that descending smolts are killed by the turbines is apparently lacking for the development at Cowie Falls.

(2) Early each Sunday morning the level of the headpond at Cowie Falls is lowered, and, on many occasions, so low that water does not flow out the fishway. By late Sunday afternoon, however, the level is again raised, and if the river is at all in spate, much water escapes over the spillways of the dam. This escapement of water over the dam (15 in. on May 25) creates considerable surface current in the headpond, and provides a more efficient avenue of descent for the smolts than the fishway.

(3) The head of the fishway at Cowie Falls is situated well to one side in a small bay, the mouth of which is partially obstructed by a rocky islet.

(4) The intakes for the turbines at Cowie Falls are at a considerable depth. If smolts move in the surface strata of water, the danger to them of being swept into the turbines in much reduced. Smolts may be seen playing or feeding at the surface in the headpond, which provides evidence, in some measure, that they do remain near the surface. Qualitative evidence indicated in (1) is needed.

(5) It is suggested that the downward migration of smolts in an obstructed river as the Mersey is quite different to that in an open stream. It is possible that smolts remain for

some time in the headponds, particularly if these are quite large, and run out in small numbers over a considerable period of time through fishways, or escape in large numbers intermittently when water is permitted to flow over dams. If water flows to a considerable extent over dams, large amounts on certain days or continuously, possibly most of the smolts descend with this water rather then down the fishway, or through the turbines.

(6) At Cowie Falls considerable water passes through the log chute when pulp wood is being passed downstream. The entrance to the chute is mid-stream, and, although there would be activity to frighten fish away while the water is flowing into this outlet, it still remains possible that smolts descend by this means as well.

The white perch entered the fishway in greater numbers per unit of time at night with the lights off. The data suggest that these fish become more active at the surface as it becomes dark and are inadvertently swept into the fishway. Light, by some means, appears to help them avoid the fishway, perhaps by driving them to deeper water.

Suckers were found in the trap mostly after the twilight hours. In the half-light, the young fish probably enter more shoal water to feed, and, as with the white perch, are swept into the fishway accidentally. It is unlikely that either white perch or suckers (jv) seek to run downstream.

The data secured for the white perch and suckers would seem to have no pertinence to the question whether salmon smolts are attracted by lights or not.

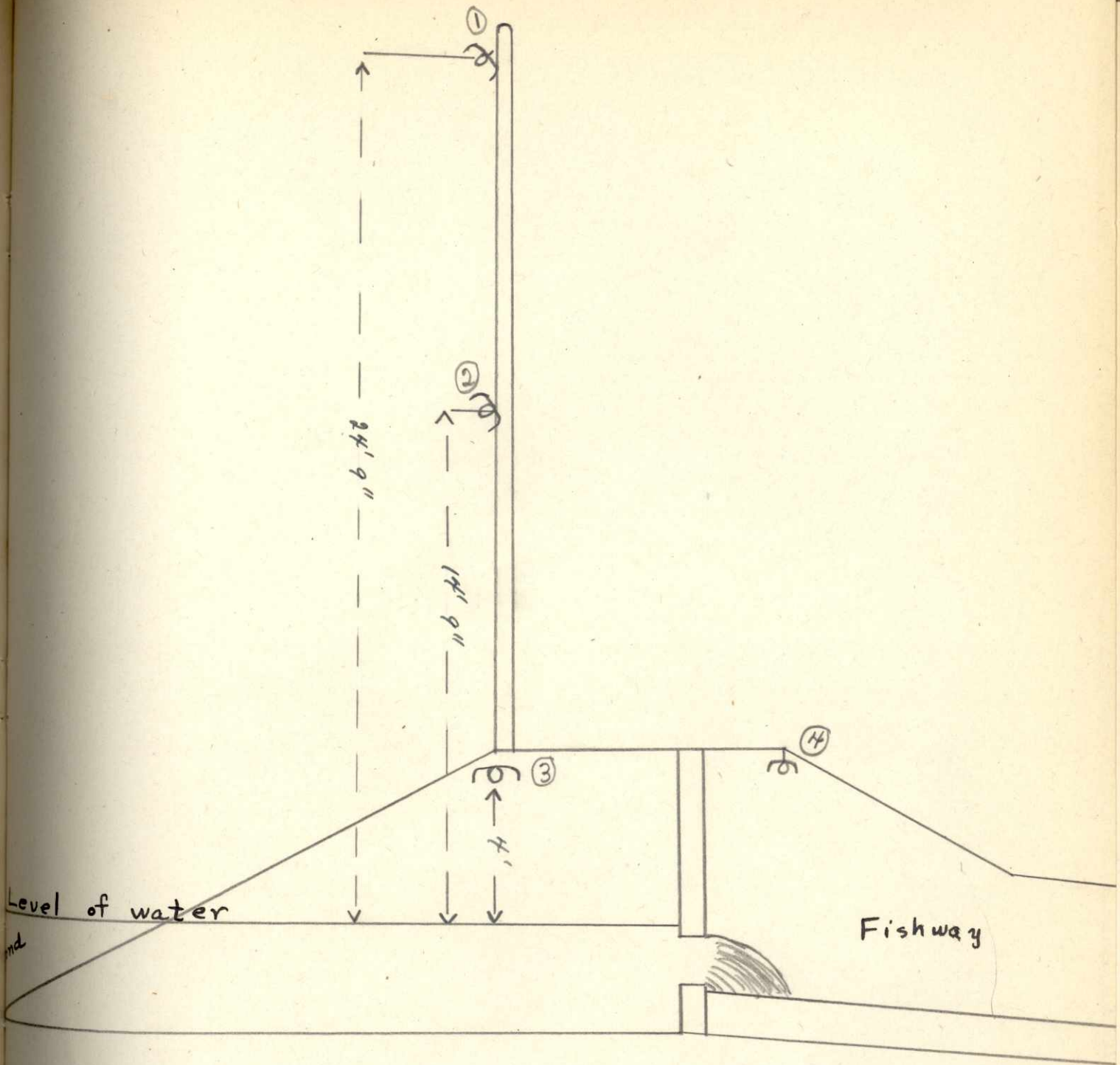

Fig. 1. Position of Lights at Head of Fishway

Cowie Falls, Mersey river, N.S.

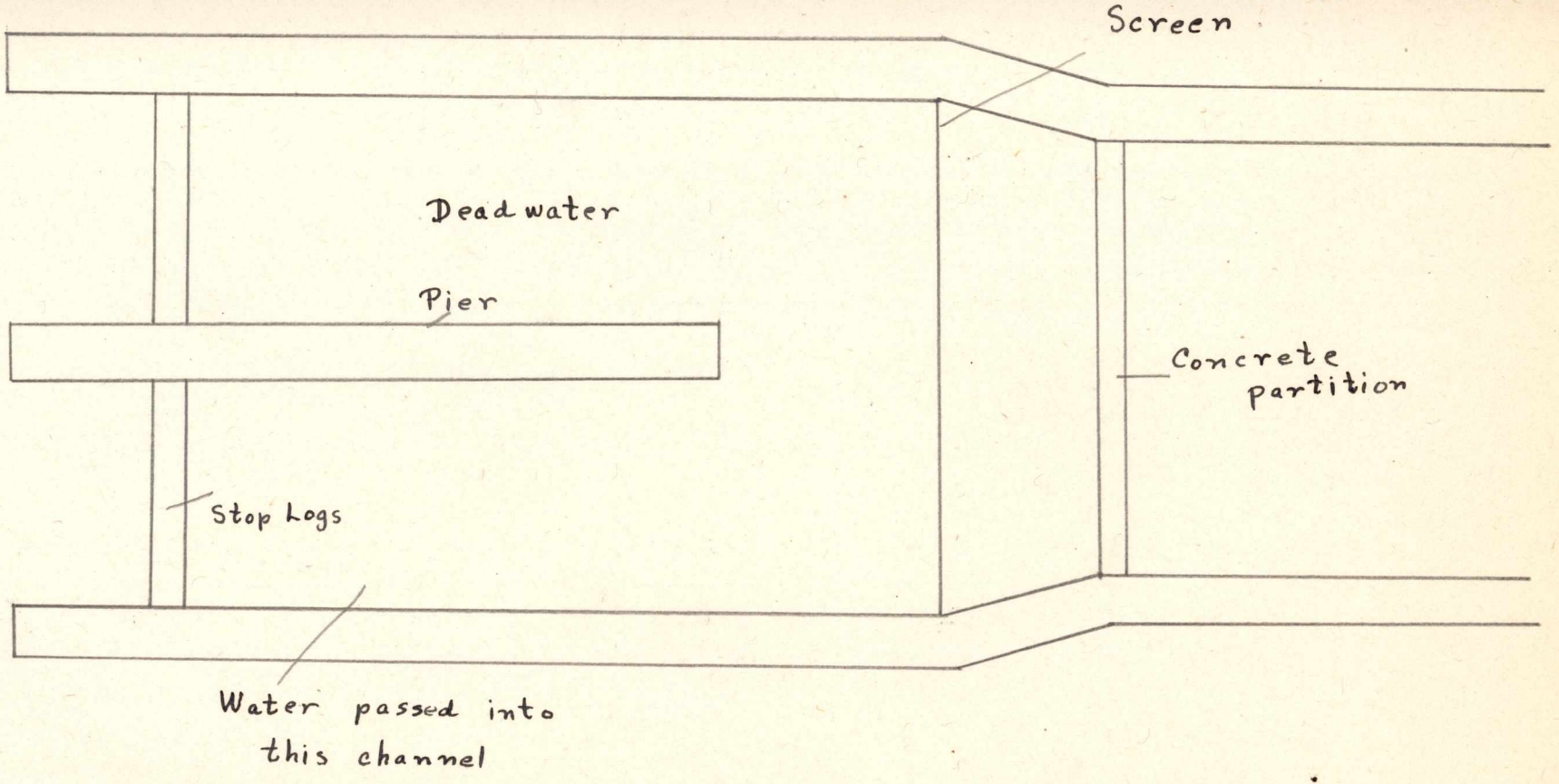

Fig. 2.

Sketch - Head of Fishway showing position of Screen.

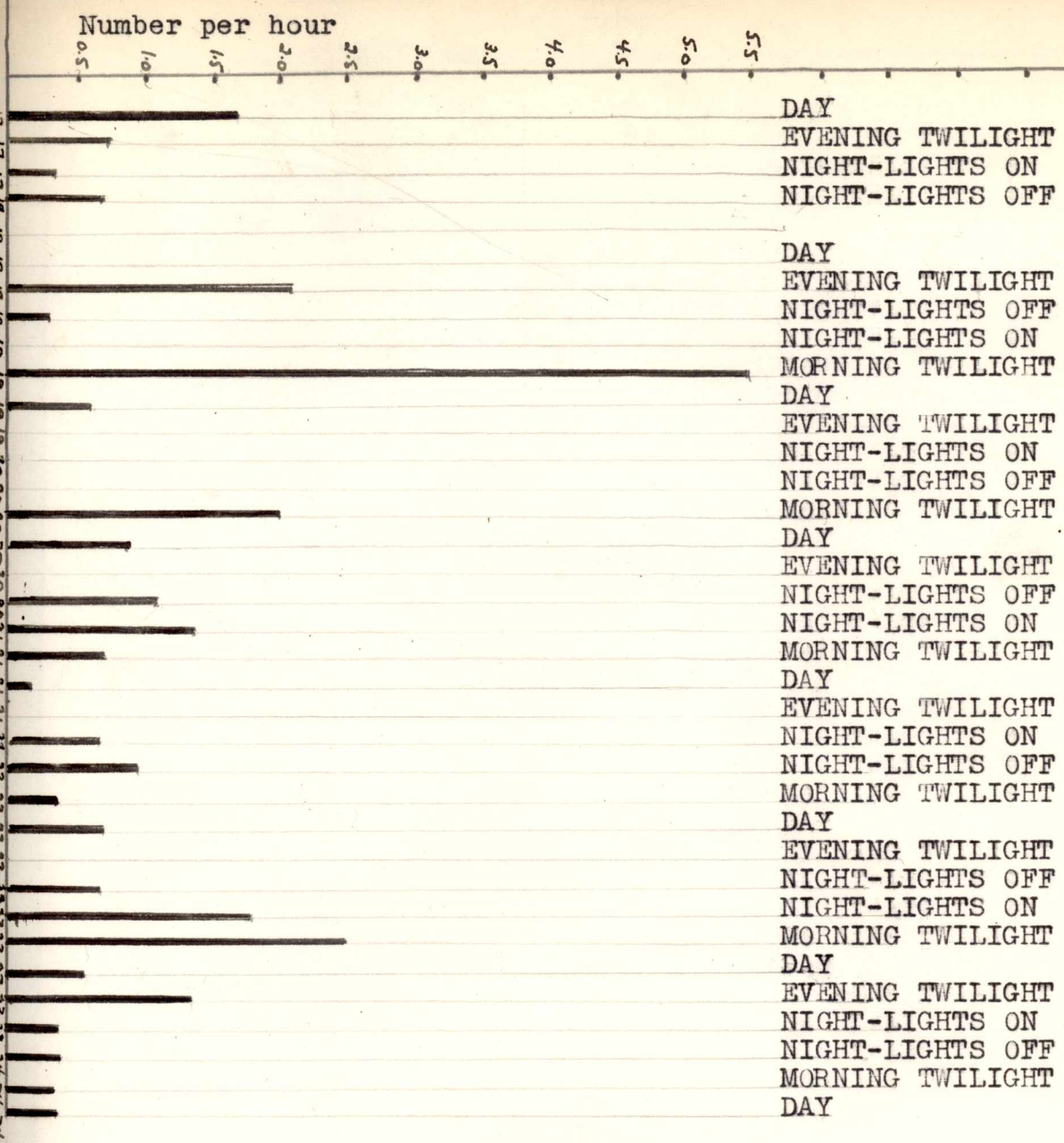

Fig 3.

Number of Salmon Smolts through fishway - Cowie Falls