

**PERFORMANCE OF FISH LIFT RECENTLY BUILT AT THE
TOUVEDO DAM ON THE LIMA RIVER, PORTUGAL**

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Introduction and main goals

From March 1998 to February 1999, upstream fish passage was continuously monitored by video tape analysis at the Touvedo Dam on the Lima River in northern Portugal. The fish lift was monitored with an automatic video recording system to test its efficiency, to acquire data on migratory patterns of the different species, as well as to validate some design criteria of such a fish facility. While being lifted, fish passage was recorded on videotape for later detailed analysis.

Site description

The fish lift is provided with three entrances, located in the tailrace area of the powerhouse (Figure 1). The attraction towards the entrances is achieved by discharging a flow of maximum 4,5 m³/s, which is equally distributed between the entrances. Approximately 1/3 of this flow is gravity water from the above

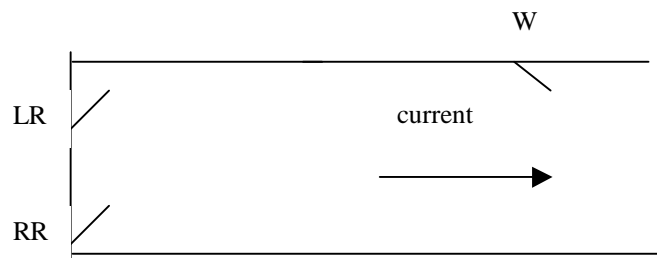
reservoir, and the remaining 2/3 is pumped from the tailrace area by means of two submerged pumps. The current creates a flow in the attraction circuit (channel), against which the migrating fish swim. Once in the circuit, the fish swim towards and eventually into the lift cage. After being lifted, the cage puts the fish into the upper channel where, swimming against the current that circulates there, they reach the reservoir and are able to continue their migration further upstream.

Materials and methods

Two video cameras and an automatic video recorder system were installed in an observatory room established near the transfer canal leading to the reservoir.

Analysis of the number of individuals and the percentage abundance was undertaken for each fish species that used the fish lift. One-way analysis of variance (ANOVA) was used to test for significant differences on a catch-per-unit-effort, CPUE (ind day⁻¹) basis for each fish species, between all months. Mann-Whitney Rank Sum Test (Zar, 1996) was used to detect significant differences between diurnal and nocturnal number of individuals per cycle.

The effect of water temperature, head- and tailwater level, air temperature, precipitation and river discharge at the dam on fish numbers in the fish lift, was tested by a forward stepwise multiple regression procedure (Zar, 1996).



-Location of the entrances in the tailrace area. LR- left rear entrance, RR- right rear entrance, W- wing entrance.

Results

A total of 1206 individuals of 7 species were transferred by the fish lift. Cyprinids were the dominant group captured, in which nase *Chondrostoma polylepis* (31,8%) was the most abundant specie, followed by barbel *Barbus bocagei* (21,1%), dace *Leuciscus carolitertii* (19,2%) and roach *Rutilus arcasi* (7,1%). Brown trout *Salmo trutta* and European eel *Anguilla anguilla* accounted for around 10%, whereas Atlantic salmon *Salmo salar* was very rarely captured.

Most seasonal movements of cyprinid fishes were observed in spring and were reproductive migrations. The timing of the run varies and its commencement appears to be mainly dependent on water temperature (Table 1). Similar results were also reported by other authors (Rodriguez-Ruiz & Granado-Lorencio, 1992) in other Iberian river.

Roach, dace and nase began migration in mid-April till the end of summer. Movements of barbel began in mid-May due to the later warming of the water. Salmonids migrated in June-July and autumn. Significant differences were not found at all in species hourly activity, except for nase and barbel, in June and July, respectively.

Water velocities in the three entrances were generally within the range of critical swimming speeds for fish, although 2,4 m/s, the upper limit of the range for best water velocities at the fishway entrances (Larinier, 1992) achieved when the station was running on, is more suitable for trout than for cyprinids.

Velocities within the attraction circuit were according to the minimum range of critical speeds (0,3-0,6 m/s) that leads to the appearance of fish orientation against the current (Travade *et al.*, 1992). Although in sections 2 and 3, water velocities seemed to be more suitable for fish orientation towards the lift cage, they didn't reach 1,0 m/s, which is considered to be the optimum value to avoid disturbance on fish behaviour (Clay, 1995).

Table 1. - Variables entered in the model of the forward stepwise regression analysis explaining species frequencies in the fish lift. Six different factors were analysed, but only those with significant values ($p < 0,05$) are included in the table.

Variable	F	r ²
Nase		
Water temperature	12,5**	0,18
Precipitation	9,15*	0,07
Both		0,25
Barbel		
Water temperature	7,24**	0,14
Dace		
River flow	11,5**	0,20
Trout		
Air temperature	6,31*	0,10
European eel		
Water temperature	11,51***	0,20
Air temperature	8,8**	0,08
Headwater level	9,4**	0,11
All three factors		0,40

* $p < 0,05$, ** $p < 0,01$, *** $p < 0,001$

Conclusions

The relative efficiency of the fishlift permitted cyprinids, salmonids and eels, a species with lesser swimming abilities, to pass upstream. All of them were found to occur downstream Touvedo dam in similar proportions, whereas diadromous species were not found either these areas or in the fishlift. Water velocities in the entrances appeared to encourage fish to enter in the attraction circuit, although for cyprinids and eels, they were somewhat high, occurring at the same time as the station was running on.

However, the lower-velocity in the attraction circuit may not be sufficient for producing the best orientation towards the cage and therefore causing the return of fish to the river.

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