

MIGRATION OF LOWLAND RIVER FISHES

THROUGH FISH PASSES

– THE THREE P’S: PITS, PASSES AND POTAMODROMY

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Background

There is increasing recognition that in lowland rivers many non-salmonid freshwater fish species exhibit potamodromous migratory behaviour (e.g. Lucas & Batley, 1996; Northcote, 1998). European rheophilic cyprinids such as barbel *Barbus barbus* and chub *Leuciscus cephalus* usually move upstream in spring to find appropriate spawning habitat. In winter many fish, including juveniles, move downstream to seek refuge and subsequently move upstream in spring. Increasingly fish passage facilities are being provided for lowland river fishes, but we still have a poor understanding of their migratory behaviour and little information on the efficiency of these fish passes.

Passive integrated transponder (PIT) tags of c. 0.1 g enable attachment to fish of less than 5 g. Each tag contains a microchip but no battery, and is energised by a low frequency magnetic field emitted by the detector, triggering the tag to transmit its unique identity code. The technique, therefore, has great potential for simultaneous study of the behaviour of a wide range of sizes and species of fish that typically occur in lowland rivers. In this study an automated flat-bed passive integrated transponder (PIT) detector array was used to examine the behaviour of fish at a baffled flume pass on the Yorkshire Derwent, North East England.

Methods

The study site was a fish pass at Stamford Bridge weir on the Yorkshire Derwent, NE England (53° 59' N, 0° 55' W). This reach of the river is impounded, with weirs 5 km below and 3 km above Stamford Bridge. The fish community is dominated by riverine cyprinids, including chub and dace, which are lithophilic spawners. These, and other species, aggregate and spawn in the weir pool in spring, but prior to the building of a fish pass in 1996 they could not move further upstream. The pass at Stamford Bridge was built for the Environment Agency in 1996 and is the only route for passage past the weir under all but exceptional flood conditions. The fish pass is of a Denil-type baffled flume design, 10 m long, 0.9 m wide and with a gradient of 1:5.

The PIT detector array followed the principle of Castro-Santos *et al.* (1996), with detectors at the entrance and exit of the pass, and was based upon the flat-bed design of Armstrong *et al.* (1996). The flat-bed design, using a coil embedded in a 2 cm thick plate, is capable of detecting small commercially available low-range PIT tags across the whole width of a typical baffled fish pass and operates at 125 kHz. Tags used were Trovan ID100 (11.7 mm x 1.9 mm, 0.10 g in air). Nominal peak range of detection in water of a typical tag over a single antenna, 0.90 m wide, was 0.18 m, occurring in the midline near each of the ends. In order to improve interrogation of the whole water column, pairs of detectors, vertically spaced by 0.30 m, were used (see Lucas *et al.*, 1999 for further information). Each detector was attached to a power supply and high-sensitivity decoder unit (UKID single point decoder). Records were stored by memory chips and were periodically downloaded onto a portable laptop computer. A coarse screen at the upstream exit prevented large debris entering the pass.

Efficiency of the upstream detectors measured using 20 PIT-tagged brown trout (*Salmo trutta*), observed to swim past the detectors was recorded as 100%. Efficiency of detection measured using PIT tags mounted on poles was in excess of 95% throughout the study. Between 22 May 1998 and 9 April 1999 a total of 401 fish, comprising 11 species with a combined length range of 9-104 cm, were PIT tagged and released downstream of the fish pass. Of these, 241 wild fish were obtained from downstream of the weir, 58 wild fish were displaced from upstream of the weir and 102 were of hatchery origin.

Results

Near-continuous recording between 23 May 1998 and 31 May 1999 demonstrated the effectiveness of the PIT array at this site for recording entry to, and successful exit, of fishes from the pass.

A total of 1271 records from 90 individual fish were recorded at the downstream detectors, and 20 tagged fish were recorded successfully exiting from the top of the pass, giving a pass efficiency of 22.2 %, based on the proportion of different fish which ascended. Fish larger than 20 cm which entered the pass were significantly more successful in ascending it. Overall 22.4 % of tagged fish entered the pass, comprising chub, dace, roach *Rutilus rutilus*, bleak *Alburnus alburnus*, perch *Perca fluviatilis*, pike *Esox lucius* and brown trout, with highest numbers in May and June. There were significant differences in the proportions of different treatment groups of fish entering the pass; the highest value of 43.1% occurred for displaced wild fish and is suggestive of a homing response.

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