H2OPE HYDROPOWER

AN ECOLOGICAL APPRAISAL OF FISH HABITAT ON THE RIVER RIBBLE IN SETTLE.

SCIENTIFIC REPORT

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1. INTRODUCTION

There is a widespread acknowledgement that renewable energy sources will need to be harnessed as part of an overall strategy to tackle climate change, and in line with this a number of small hydroelectric schemes within the northwest of England are expected over the next few years. One of these developments has been proposed for a small weir spanning the River Ribble at Settle in Yorkshire (**NGR: SD 817 641**). This site is considered suitable for such a project as the housing structure for a hydropower unit is partly in place in the form of an old disused water mill which is present on the east shores of the river.

2. SITE INFORMATION

The River Ribble is one of the primary arterial rivers in north-western England. Rising in the Yorkshire Dales, the River Ribble flows south and west through Lancashire becoming estuarial from Preston as it deposits into the Irish Sea. The Ribble Estuary is internationally recognised for its biodiversity and has scientific interest (SSSIs) and Ramsar designations. In addition, The EU Water Framework Directive aims to bring the Ribble up to 'good ecological status', with the river being used as a pilot for the national implementation of the Directive. In total, this watercourse is 120 km in length from source to sea (Figure 1).

Figure 1. Map showing the Location of the River Ribble

Settle in North Yorkshire, is the first town through which the River Ribble flows on its course to the Irish Sea. Settle has an industrial background dating back to the 19th century and there are a number of industrial installations located throughout the town, some of which are no longer operational. One such example is the weir and mill building to the north of the town which has been selected as a possible site for a hydro scheme construction.

3. OBJECTIVES

The overall objective of the survey was to perform a habitat mapping exercise with a view to understanding the current availability and juxtaposition of key habitat features at the site of the proposed hydropower scheme on the River Ribble at Settle, particularly assessing any potential effects on Annex II species (i.e. species protected under the European Habitats and Species Directive (92/43/EEC)).

3.1 Specific Objectives

- To identify and map fish habitat, particularly that used by Atlantic salmon (*Salmo salar* L.) and migratory trout (*Salmo trutta* L.).
- To quantify the availability of lamprey (*Lampetra)* and bullhead (*Cottus gobio*) habitat surrounding the proposed hydropower scheme north of Settle.
- To assess bankside and instream habitat with a view to identifying the presence of protected species, particularly otter (*Lutra lutra* L.).
- To briefly comment on whether there is any evidence that the proposed hydropower scheme is likely to compromise the passage of migratory salmonids.

4. METHODOLOGY

On the 3rd February 2009 an ecological walkover survey was conducted on the River Ribble north of Settle. The main aim of the survey was to map habitats preferred by migratory salmonids. However, habitat used by other conservation species, notably lamprey and bullhead were also recorded. A continuous ecological survey was also performed looking for field signs of other species such as otter.

4.1 Fish Habitat Walkover Survey

The fisheries section of the ecological walkover survey provided an overall picture of the quality, distribution and relative proportions of different fish habitat types throughout the study area. The methodology for the walkover survey followed that outlined in the Environment Agency's Fisheries Technical Manual 4 "Restoration of Riverine Salmon Habitats" (Hendry & Cragg-Hine 1997)[1].

[1] Environment Agency National R&D Project W2/i584 - EA R&D Technical report W44

The field mapping technique was based upon hand drawing onto a high-resolution map (OS 1 km tiles) at a scale of 1:10,000 [2]. The river outline and salient geographic location points were selected from a digital map and printed onto aquatrace (roughly 300-500m of river length per A3 sheet). These detailed maps enabled very accurate mapping of in-river habitat characteristics.

The habitat features noted along the stretch of the river were drawn directly onto the A3 maps, with the boundaries of the different habitat classifications indicated to represent their actual position within the river using a series of labelled symbols. The symbols were linked by a single pencil stroke to a line parallel with the riverbank delineating the linear extent of that particular habitat feature.

Other prominent features (e.g. obstructions to migration, macrophyte beds, footbridges etc.) were noted together with overhanging trees, electricity pylons and bridges to aid accurate location, the latter being confirmed via hand held GPS. This allowed exact representation of the areas of individual habitat types encountered. In this manner, a mosaic of the different habitat types was drawn along the whole section of the river (Figure 2).

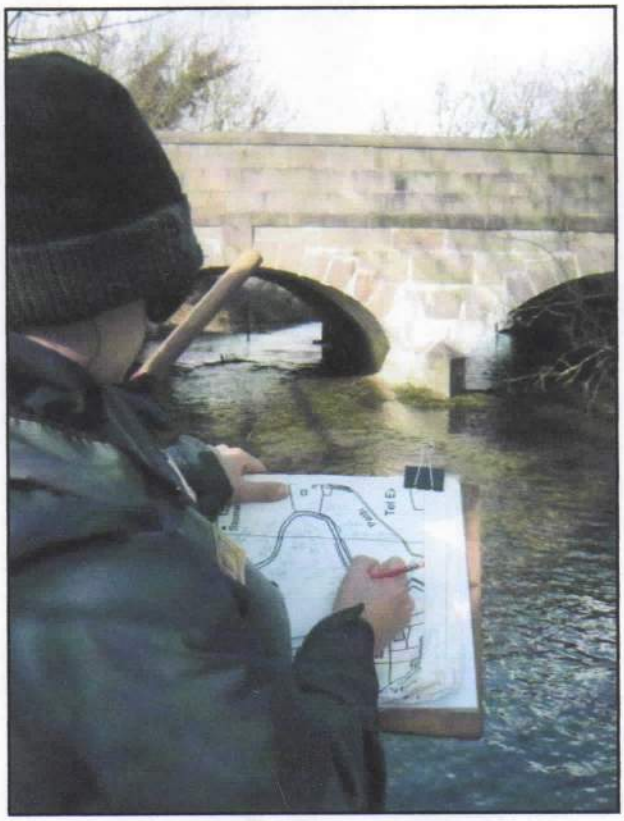

Figure 2: APEM scientist recording information during an ecological walkover survey

[2] Minimum resolution. Resolution down to 2,500 or 1:1,250 in some areas may be available (source OS Land-line ™)

On return to the laboratory the data (including photographic records), were transcribed into GIS (ArcMap) for visual representation as well as facilitating detailed spatial analysis and quantification of habitat types. These digital data were then analysed in a number of ways, which allowed:

- Calculation of available juvenile and spawning habitat and its proximity to other habitat types.
- Location of sensitive habitats used by conservation species.
- Identification of the placement of obstructions and the type and quantity of inaccessible habitat for migratory fish.

4.1.1 Salmonid Habitat Requirements

The principal instream physical habitat characteristics that determined suitability for juvenile salmonids are: water depth, water velocity, streambed substratum and cover (Heggenes 1990). Preferred spawning sites are often within the transitional area between pool and riffle where the flow is accelerating and the depth decreasing. Gravel of suitable coarseness is also required with interstices as the voids between gravel particles are cleaned by the current or by up welling water (Petersen 1978, Bjorn and Reiser 1991).

Salmon fry and parr occupy shallow, fast-flowing water, with a moderately coarse substrate with cover (Symons and Heland 1978, Bagliniere and Champigneulle 1986). Deep or slow moving water, particularly when associated with a sand or silt substrate, however, does not support resident juvenile salmonids (Wankowski and Thorpe 1979, Bagliniere and Champigneulle 1986).

Suitable cover for juveniles includes areas of with surface turbulence, loose substrate, large rocks and other submerged obstructions, undercut banks, overhanging vegetation, woody debris lodged in the channel and aquatic vegetation (Heggenes 1990, Bjorn and Reiser 1991, Haury *et al.* 1995).

The relative position of habitat types was also of importance. For instance, the proximity of juvenile habitat to spawning gravels may be significant to their utilisation. In addition, adults will require holding pools immediately downstream of spawning gravels in which they can congregate prior to spawning.

Salmonid habitat types recorded during the walkover survey were as follows (a definition of each of is given in Table 1):

- Spawning gravel
- Fry (0+) habitat
- Mixed juvenile (0+ & $\geq$1+) habitat
- Parr ($\geq$1+) habitat
- Riffles
- Glides
- Pools

Table 1. Habitat classification system (after Hendry & Cragg-Hine 1997).

Habitat Type	Description
Spawning gravel	Ideally stable but not compacted, with a mean grain size 25 mm or less for trout, but up to 80 mm for salmon. 'Fines' (< 2 mm grain size) to be less than 20% by weight.
Fry (0+) habitat	Shallow, < 20 cm deep, fast flowing (> 30 cm/s), with surface turbulence and a gravel and cobble substrate.
Parr (≥1+) habitat	20 - 30 cm deep, fast flowing (>30 cm/s), surface turbulent, with gravel / cobble / boulder substrate.
Riffles	Shallow (< 30 cm deep), fast-flowing (> 50 cm/s), surface turbulent, gravel / cobble / boulder substrate.
Glides	= or > 30 cm deep, moderate velocity in range 10-30 cm/sec, surface smooth and unbroken, relatively even substrate of cobbles with finer material
Pools	= or > 40 cm deep, slow-flowing (< 10 cm/s), surface unbroken, substrate with a high proportion of sand and silt.

Other categories used during habitat mapping were:

- Bedrock: native or consolidated rock (offering little or no fish habitat)
- Cascade: series of small waterfalls caused by boulder / bedrock outcrops
- Chute: an inclined shallow passage often over bedrock / man made substrate (offering little or no fish habitat)
- Run: generally fast flowing with a broken surface (commonly used by migratory fish as passageway)

4.2 Further Observations

4.2.1 Evidence of otter activity

Otters are protected in England, Wales and Scotland under Schedule 5 and 6 of The Wildlife and Countryside Act 1981, making it an offence to kill, trap or disturb their breeding areas (EA 1999). This protection extends throughout Europe. The otter is also classified as a species requiring special protection under the EU Habitats Directive (43/93/EEC).

As such, an otter survey was performed as part of the overall ecological walkover survey by examining 500 m stretches up and downstream of the proposed hydropower site in settle. Any evidence of otter tracks or spraint / faeces were recorded in order to establish the extent of use and the number of individuals using the site. Particular attention was paid to areas typically used by otter for sprainting such as bridge ledges, tree saddles and riverside rocks. Other riparian habitat was also investigated for potential lying up places and breeding holts.

5. RESULTS

5.1 Fish Habitat Walkover Survey

Interactive habitat maps illustrating the results of the walkover survey on the River Ribble are provided on the accompanying CD using ArcMap – Appendix I. The foldout layout shown in Figure A1 summarises the finding of the walkover survey.

The percentage cover of different types of aquatic habitat in the River Ribble study area, north of Settle is presented in Table 1. The habitat is diverse and changeable throughout the survey reach and is regularly interspersed with bedrock and boulder outcrops, particularly in the region immediately downstream of the weir structure in Settle. Notably the first 20 m downstream of the weir is essentially devoid of any fish habitat, particularly that preferred by species of conservation interest, due to bedrock outcrops thought to be sandstone (millstone grit), (Figure 3). In addition, the bedrock just downstream of the weir has given rise to areas of shallow and very fast flowing chute habitat, which in low flows may cause obstruction to migratory fish.

Figure 3. Sandstone bedrock at the foot of the weir in Settle.

Table 1 and Figure 4 indicate that run and glide are the dominant habitat types in the study area. These habitats provide essential routes of passage for migratory salmonids. A large percentage of this habitat is located upstream of the weir due to the impoundment of water caused by the structure which extends approximately 200 m upstream of the weir.

Forty metres downstream of the weir, deep run and pool habitats prevail which provide essential holding areas for fish waiting to utilise the fish pass on the south east corner of the weir.

Table 1. Area and percentage abundance of aquatic habitat in the Ribble study area.

Habitat Type	Area (m^2)	% Contribution
Fry	1419.2	9.3
Riffle	664.7	4.3
Mixed Juvenile	2758.7	18.0
Parr	540.9	3.5
Run	4655.2	30.4
Glide	4823.3	31.5
Pool	455.6	3.0
Total	**15317.7**	**100.0**

The habitat downstream of Settle Bridge is generally shallower and faster flowing giving rise to pockets of mixed juvenile habitat with a cobble and pebble substrate. Whilst mixed juvenile habitat contributes 18 % of the overall habitat types present, it is commonly broken up by areas of bedrock and boulder cascade and bedrock outcrops. Although juvenile salmonid habitat was widespread throughout the survey reach, optimal salmonid spawning habitat was absent from the reach.

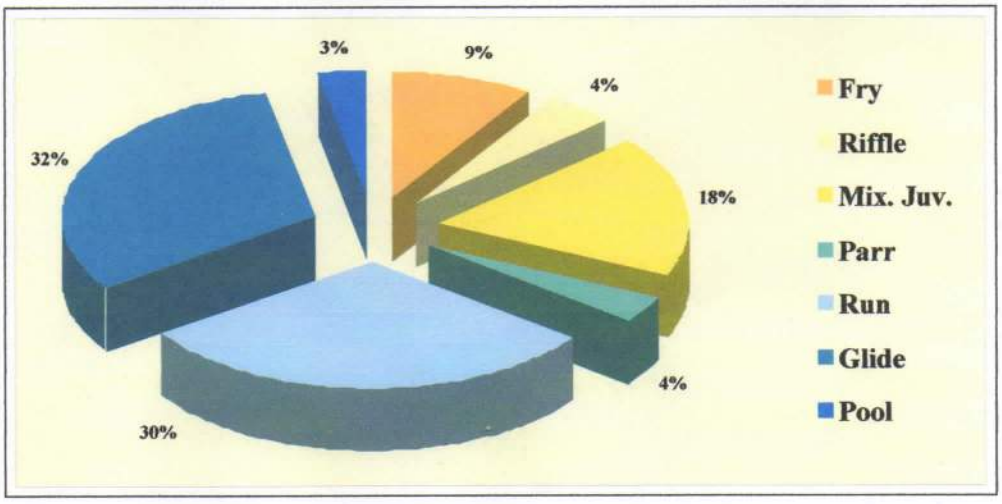

Figure 4. Percentage contributions of aquatic habitat categories in the Ribble study area

Further downstream (adjacent to Mill Close), further bedrock outcrops have produced cascades which have little habitat value and would be impassable during low flow periods. Similar areas comprising bedrock and boulder substrate contribute over 50 % of the total area (Figure 5). In all the total area with minimal or no fisheries habitat

value, including cascades, bedrock chutes (Figure 6) and torrents is 2133.4 m^2, representing 14 % of the mapped area.

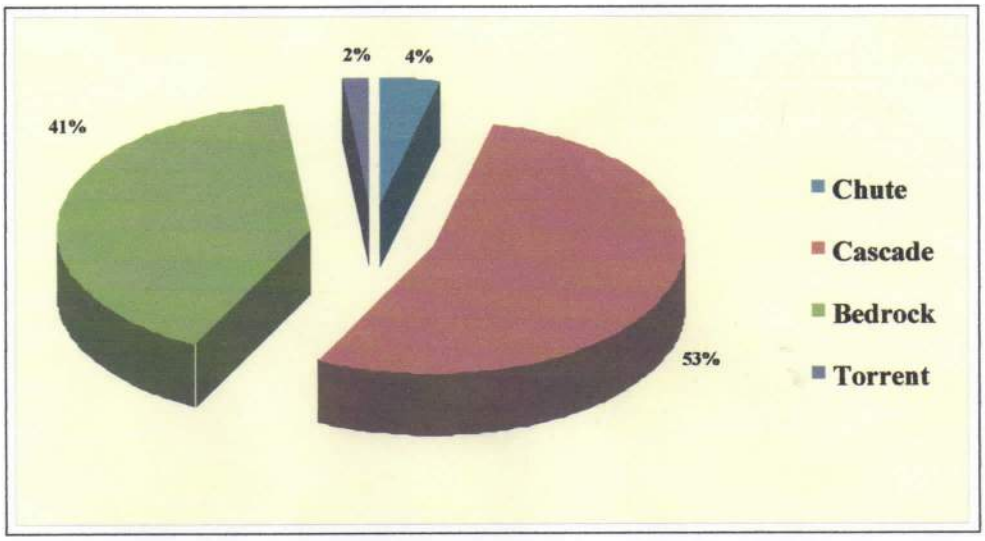

Figure 5. Areas with minimal or no fisheries habitat value in the Ribble study area.

Figure 6. Bedrock chute habitat immediately downstream of the fish pass in Settle.

In areas in which bedrock and boulder outcrops were absent, the substrate type in the survey reach was generally pebble, cobble with occasional small patches of gravel and coarse sand. No notable accumulations of fine grained material such as silt were recorded. This was likely due to continual sediment transfer away from the site with the high flows.

5.2 Further observations

At the foot of the fish pass on the weir at Settle a number of fresh otter spraint (Figure 7), with trampling evident in the nearby vegetation. This clearly indicated frequent use of the area around the weir by otter for passageway and for potential fishing grounds in the deeper water. Examination of habitat further inland provided no evidence of otter holts or lying up locations.

Figure 7. Otter spraint observed at the foot of the fish pass at the weir in Settle.

6. DISCUSSION

The only river reaches which may potentially be impacted by possible changes in flow regimes caused by the hydropower scheme at Settle are the regions in the immediate proximity of the weir. These areas, particularly downstream of the weir, are of minimal value to fish due to the abundance of bedrock substrate. This is particularly the case for juvenile salmonids, bullhead (the habitat preferences for which are similar to those of salmon juveniles) and juvenile lamprey which require fine grained, organic rich deposits in which to create their burrows. This is unlikely to change as a result of the hydro development.

However, in areas devoid of bedrock and boulder outcrops high quality juvenile salmonid habitat was widespread. Cover for juvenile fish was provided by a combination of overhanging trees, broken water surfaces and abundant cavities between pebble, cobble and boulder substrates. While these habitats are prevalent throughout the reach they are continually interspersed by features unsuitable for fish, notably bedrock cascades. This is particularly the case in the region between the weir and Settle Bridge.

During the survey conducted on the 3rd of February 2009 the river levels were low. These low water levels had followed a number of cold days where snow had fallen but had not yet melted. Despite this, it was apparent that the fish pass was providing an effective passageway for migratory salmonids. Importantly, however, a short distance downstream of the plunge pool at the foot of the pass there was a ten metre stretch of very shallow bedrock chute which could potentially impede the passage of fish under low flows.

Consequently, it is considered that successful movement of fish from the holding pool downstream of the weir to the first chamber of the fish pass would be dependent upon the water depth over the surrounding bedrock chute and cascade. It is predicted that an increase in water depth of at least 0.3 m (sufficient to cover the backs of adult salmon) would be required to attract fish out of the holding pool towards the fish pass. Under these conditions it is predicted that the fish pass would be passable even with the forecasted abstraction to the turbine. In addition, as the outflow from the hydropower turbine is predicted to be upstream of the bedrock chute, increased discharge in this area is likely to attract fish towards the fish pass. It would be desirable for the turbine tailrace to share a common opening with the entrance to the fish pass to maximise the benefit of this attractive flow.

The signs of recent otter activity during the survey should be considered, particularly during the construction phase of the hydroscheme at Settle. However, it is thought that long-term implications for otter populations in the area would be negligible, particularly given the absence of any lying up / breeding sites within the surveyed reach.

7. REFERENCES

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APPENDIX

APPENDIX I – CD of GIS Outputs

Instructions

- All habitat types will be automatically selected as themes upon opening the ArcMap file. To view habitats individually deselect any unwanted themes by clicking the appropriate arrow to the off position.

- Images captured during the walkover survey of the study area are hyperlinked to corresponding points along each of the river reaches. To view the images simply click on the dot in the yellow square.

A1: Fish Habitat Of The River Ribble In North Settle

A1: Fish Habitat Of The Ribble In North Settle

Key

- Dipper
- King Fisher
- Overhanging Vegetation
- Image
- Fry
- Riffle
- Mixed Juvenile
- Parr
- Run
- Glide
- Pool
- Shingle Bank
- Chute
- Boulder Cascade
- Bedrock Cascade
- Bedrock
- Torrent

80 40 0 80 Meters