Advisory Visit

Porter Brook, South Yorkshire

13/09/11

Introduction

This report is the output of a site visit undertaken by Paul Gaskell of the Wild Trout Trust to the Porter Brook on 13th September, 2011. Comments in this report are based on observations on the day of the site visit and discussions with David Sorsby, local resident and conservationist.

Normal convention is applied throughout the report with respect to bank identification, i.e. the banks are designated left hand bank (LHB) or right hand bank (RHB) whilst looking downstream.

1.0 Catchment / Fishery Overview

The Porter Brook is part of the River Don catchment in South Yorkshire, rising as a spring on the moorland at Clough Hollow. Local geology is dominated by millstone grit and coal measures. From its source just inside the Peak District National Park, the stream becomes steadily more urbanised and modified along its course – particularly from the B6069 road bridge onwards. Although a relatively small and narrow stream, its steep gradient (falling approx. 300m over a 6.5-km course) made it an ideal source of water power. Historically, some 21 mill dams have been constructed along its length, and there are additional barriers to fish migration produced by engineering modifications to the channel. The most extensive of such modifications include the below-ground culverting of the stream in Sheffield city centre. In fact, the Porter Brook and the River Sheaf have their subterranean confluence directly beneath Sheffield Midland Railway station.

There are no angling club interests on the heavily urbanised 800-m section of the Porter Brook (Fig. 1). However, the presence of a number of wild trout noted during the visit highlights its importance as a habitat for wild self-sustaining populations. The urban development surrounding the brook means that there are numerous surface water drains feeding into the river from areas of largely impermeable material. Even so, the “day-to-day” water quality is sufficiently good to support hatches of aquatic invertebrate such as *Ephemera danica* (known to be sensitive to organic pollution). Episodic pollution is, however, a known risk – with an example noted in 2009 just upstream of the inspected reach (maintenance works were thought to have breached a foul sewer).

Under the Water Framework Directive legislation, the Humber River Basin Management Plan lists the Porter Brook as a single water body from source to confluence with the River Sheaf (reference number: GB104027057760). As a heavily modified watercourse, it has been assessed as currently having "Good Ecological Potential" and is rated as "Good" for both fish and invertebrates.

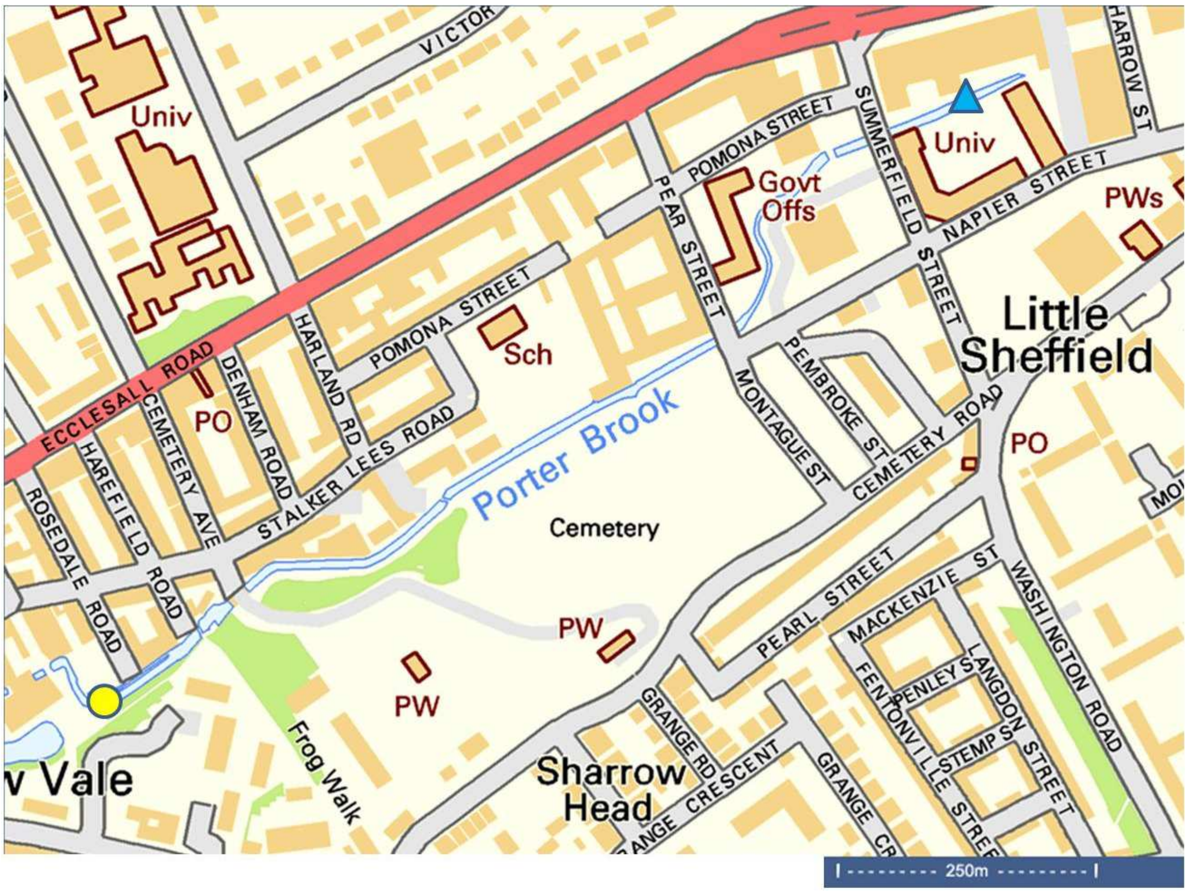

Figure 1: Map of inspected reach from downstream limit at SK34525 86310 (blue triangle) to upstream limit at SK33919 85853 (yellow circle)

2.0 Habitat Assessment

The first feature visited at the downstream limit (indicated in Fig. 1) showed an example of the multiple barriers to fish movement on the Porter Brook (Fig. 2). However, the pool habitat downstream of this weir had some excellent and varied submerged stone structure as well as varied native riparian (river-bank) vegetation. A number of adult fish were observed making use of this habitat during the visit. In addition to the native vegetation, the invasive non-native Himalayan balsam (*Impatiens glandulifera*) was also present. Over time, balsam is likely to come to dominate the river corridor flora and reduce the diversity of both the native plants and their dependent fauna. For this reason, a programme of removal is highly recommended. Eradication efforts must begin by identifying the upstream limit of this invasive species. Once the source stand of balsam is located, removal (via hand pulling of plants just prior to seed setting - usually in June) should proceed in a downstream direction. This is because seeds are washed downstream from source populations – so eradication success will be limited until such upstream sources are removed. Seeds of Himalayan balsam are known to remain viable for only ~3 years (compared to the many decades of native flora). This means that control can be established within only a few years following the above protocol.

Figure 2: Pool habitat below weir with good native flora and good submerged structural shelter for fish and a range of invertebrates. A few Himalayan balsam plants were evident here – and it would be a shame to lose the currently good native plant diversity evident on the RHB.

Surprisingly, the impounding effect on the water upstream of this weir is relatively limited. This is due, no doubt, to the steep gradient of the Porter Brook and its resultant capacity to mobilise stream bed material. As a consequence the watercourse has been able to reproduce some natural features of a meandering channel - even within the confines of the retaining walls (Fig. 3). Although undoubtedly still following a straighter path than would be the case in a completely unmodified system, the formation of marginal berms of gravel and cobble provides a nice variety of microhabitats for plants, invertebrates and some life-stages of flow-loving fish like trout.

Figure 3: Reformation of a slightly meandering path via deposition of stream bed material transported from upstream reaches during spate flows. The valuable presence of marginal vegetation also owes its existence to this process. It is unusual to find this type of briskly flowing watercourse immediately upstream of a weir – and is a product of the steep gradient and relatively narrow confines of the channel.

The cobble and small boulder-strewn run shown in Figure 3 is a high quality nursery area for trout. A relatively shallow average depth, presence of flow-disrupting rocks, low overhanging vegetation and stems of emergent aquatic plants are ideal for young fish. However, opportunities for both spawning and holding areas for adult fish are very limited. This highlights one of the primary problems facing the Porter Brook more generally (as well as specifically on this reach): the obstructions to fish passage. In order for the adult fish below the weir to reach upstream spawning habitat, and subsequently for their offspring to thrive in the nursery areas (typified by Fig.3), the multiple barriers to fish passage must be tackled. Solutions to this problem need not always consist of very formal "fish ladder" installations. Some suggestions are provided in the "Recommendations" section of this report.

In contrast to the good quality nursery habitat that has arisen in the relatively steep and narrow sections of the brook, some sections are both too wide and of insufficient gradient to recover from being straightened (Fig. 4)

Figure 4: Overwide straightened section. There is a severe lack of overhead cover from predation here - along with a lack of deeper pool habitat. Both features would be required by adult fish. Deposition of fine sediments is also favoured from bank to bank. Such uniform deposition tends to reduce the variety of available microhabitats for both flora and fauna (although the presence of a variety of larger rocks is a valuable mitigating feature).

Overwide and straightened sections of rivers lack variety in depth and flow velocity and also tend to lack pool habitat (due to the flow being too diffuse to produce the necessary bed-scour). The overwide and straightened sections of the Porter Brook also lacked vegetation, cover from predation and gravel spawning substrate (Fig. 4). Desirable priority actions in such reaches are the provision of low overhanging cover (i.e. <30cm above water surface at normal flow) and creation of variety in depth and flow velocity. If opportunities to improve fish passage are limited (or only viable over a long timescale), it may be appropriate to import and stabilise gravel spawning substrate. Possible means of generating the above three characteristics are given in the Recommendations section.

A pair of weirs (one mid-frame and one beneath the arch; Fig 5) again exemplify the issue of blockages to accessing the varied habitat components that trout require to complete their lifecycle. In addition, the more typical impoundment effect of a weir (cf. Fig. 1) is clearly visible in figure 5. The obstruction produces a pond-like character of nearly static water that tends to produce a uniform habitat. However, the riparian vegetation is nicely varied and appears to lack significant incursions of invasive, non-native species.

Figure 5: Facing downstream towards a pair of weirs installed within a short reach. Opportunities exist to improve the in-channel conditions that are currently impacted by the impounding effect of the weir. Conversely, the good quality of the riparian vegetation is notable here – especially along the LHB

There may be opportunities to improve the variety of microhabitats in this reach via introducing a small notch in the weir towards the RHB (Fig. 5). This should be combined with redistribution of stream bed material to create additional variety (see Recommendations).

The final feature visited during the visit was the bend pool that marks the upstream limit of this reach (yellow circle; Fig. 1). Here the presence of a bend in the river has promoted the formation of a fantastic lateral scour pool

(Fig. 6). In other words, the outer edge of the bend has been deepened by the faster flow, whilst a "point bar" of stream bed material has been deposited by the slower flows at the inside of the bend – great habitat for a range of species. There is also quite an extensive riverside corridor of mature woodland vegetation. In this instance, the slight shading effect of

Figure 6: Fantastic lateral scour pool and mature woodland habitat at the upstream limit of the inspected reach

the short section of woodland will provide a crucial refuge from high summer temperature/low flow conditions. Brown trout, for instance, find water temperatures sub-optimal above around 19°C, with a lethal range of around 24°C to 29°C. This temperature refuge is especially important given the relatively un-shaded conditions in the adjacent sections of river (and will also provide a valuable passive cooling effect for surrounding human populations). Efforts to preserve the riparian vegetation here are well worthwhile and tree management should only be undertaken when there is a clear threat of damage to surrounding property by falling timber.

3.0 Recommendations

It is a legal requirement that all the works to the river require written Environment Agency (EA) consent prior to undertaking any works, either in-channel or within 8 metres of the bank. In addition, the permission of all relevant stakeholders (including, but not limited to, riparian landowners) will also be an absolute requirement.

For details on Himalayan balsam control, please see section 3.1.1 of the Urban Rivers restoration guidelines:
(http://www.wildtrout.org/images/PDFs/Urban_Manual/urban_section3_habitat%20projects%20on%20your%20river.pdf)

With respect to weirs, it must be noted that by far the best option for both the upstream habitat quality and for ease of fish passage is removal of the weir. This can be expensive and must be undertaken with great care in developed areas. If permissions can be gained, it is advisable to remove a weir gradually in stages separated by periods of months that allows the river to adjust. Where removal is impossible, a variety of techniques exist for the production of relatively cheap easements to fish passage (especially when undertaken by volunteer groups). Often these can be achieved for just the cost of the materials (a few hundred pounds) when compared to the many hundreds of thousands of pounds that a typical "formal" fish pass requires. Two examples are given below and over the page (all modifications to weirs require permission from structure owners):

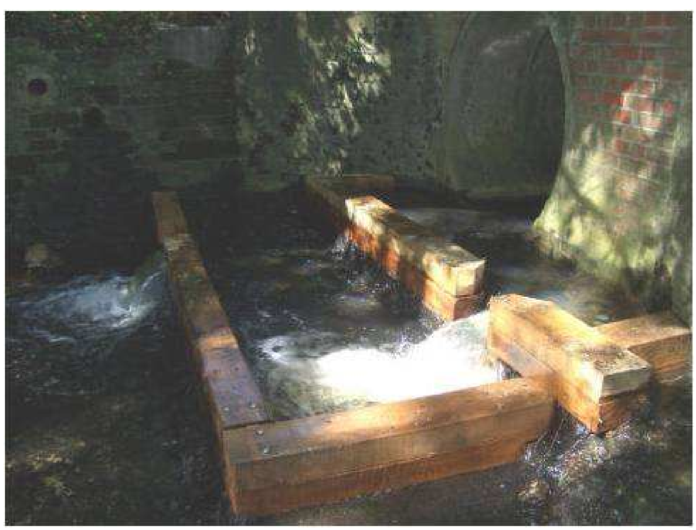

Figure 7: Simple "pre barrage" easement constructed by bolting wooden sleepers to the stream bed. For maximum efficacy - gently curved surfaces at the base of each slot are used to produce a solid "plume" of water for fish to swim up (cost £700).

Figure 8: Diagonal baulk fitted to a sloping-faced (crump) weir. Structure is pictured in the dry with flow passing down an existing bypass channel to the left of frame. Could also be constructed using bolted wooden sleepers (cost - cement and metal pins)

For overwide, straightened sections it would be ideal to use a combination of suitable imported stone and re-distributed stream bed material to produce a staggered series of alternating side-berms. In this way a meandering planform of the river flow could be created within the river channel. It is important to make the bank-side edges of such berms the highest point – with the lowest points occurring in the river channel. If this guideline is not observed, the water tends to cut behind such installed berms during spate flows and erode the banks. The berms should also be planted up with suitable wetland plant species seed (consider also installing mature sedge grasses grown for at least 6-months to 1 year in flat coir pallets - not rolls; see Appendix 1 for selecting appropriate materials). An example of berm creation within an engineered/straightened channel is given over (Fig. 9). Note the size of stone selected and also the gentle, vertically sloping nature of the berms towards the centre of the channel. It may also be possible and desirable to introduce spawning substrate (gravels in the 20 – 40-mm diameter size range). The existing presence of large boulders, as well as the introduced berm features would be valuable in grading and retaining such spawning gravels during the natural processes of remobilisation and deposition during spate flows.

Figure 9: Meandering planform, aquatic plant establishment and introduced gravels/cobble substrate within retaining walls of an engineered channel.

For the section of the Porter Brook pictured in Fig.4, it would be very valuable to incorporate some securely anchored (using steel expansion bolts) brash bundle cover at the base of the concrete retaining wall on the

LHB. This should be installed approximately 25cm above the stream bed so as to provide a dense matrix refuge for small fish during spate flows – as well as providing overhead cover from predation during normal flow conditions for all age-classes of fish. Clearly, this should be only undertaken between berms – where the base of the retaining wall is exposed to the normally wetted portion of the channel (e.g. Fig. 10).

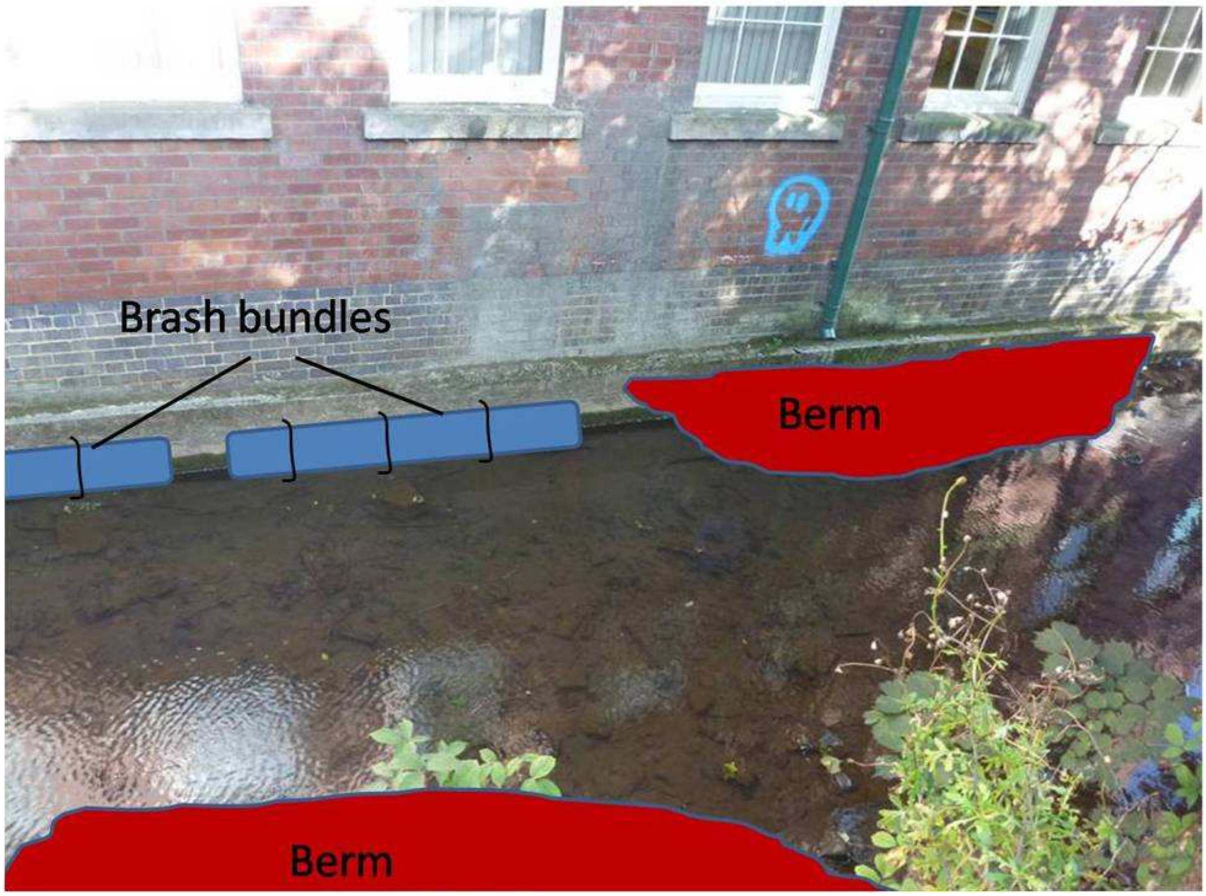

Figure 10: Example of locating "overhead" brash bundle cover. Bundles to be secured using wire to steel expansion bolts drilled into concrete wall. Berms to be constructed using a mixture of imported stone and redistributed stream bed material. Planting or seeding with appropriate native species should also be incorporated within the berms

Finally, in combination with pursuing suitable fish passage easement measures, the habitat upstream of the larger weir pictured in figure 5 could be improved by:

- Notching the weir (subject to suitable permissions from the structure owner and also subject to E.A. approval and lack of risk to underground services such as sewers, gas mains, electricity cables etc.)

- Side casting the stream bed material to produce a deeper slot towards the RHB and a shallower sloping berm at the LHB

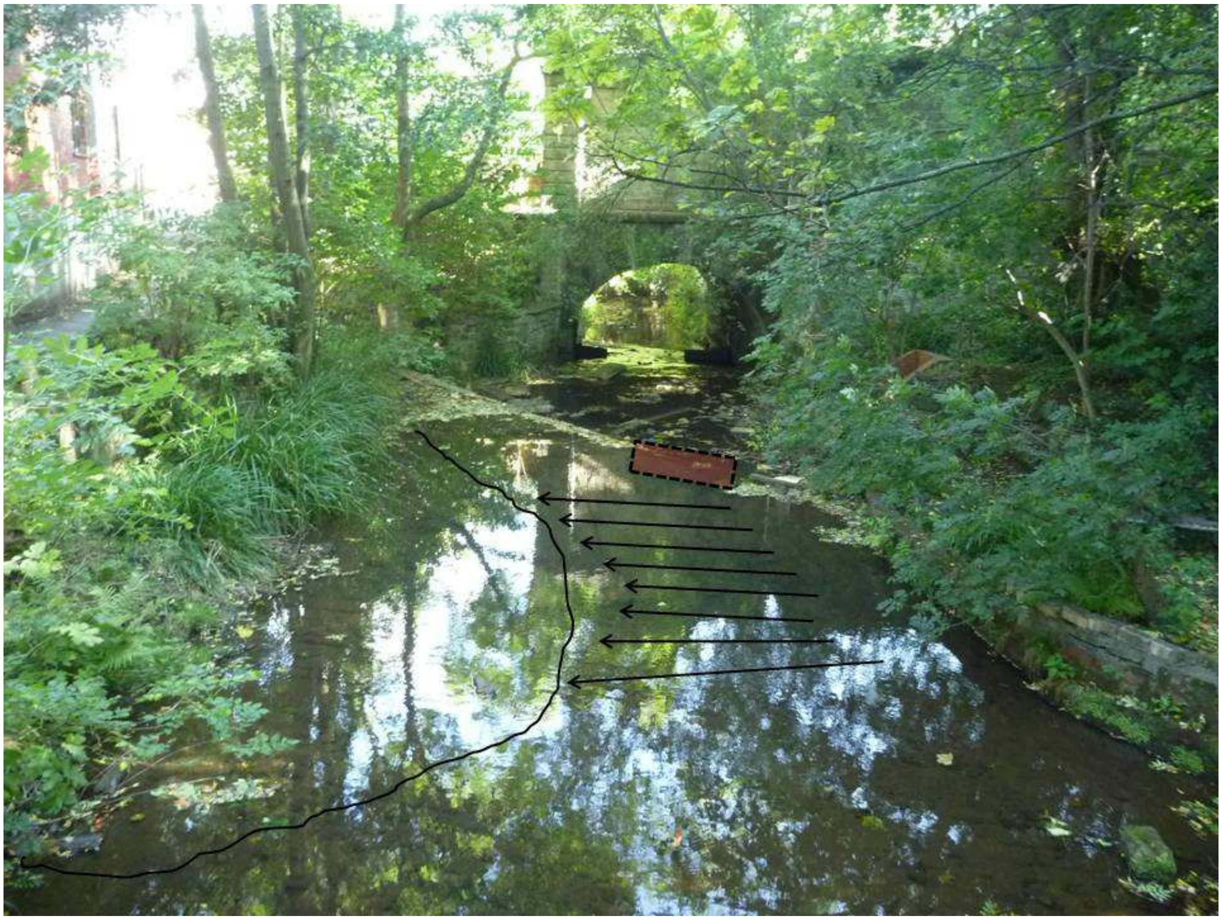

Figure 11: Cutting a small notch (red shaded box/dotted line) and redistributing the stream bed material according to the arrows would promote the existence of a deeper channel on the RHB and the formation of a shallow sloping berm on the LHB (outlined). The notch would aid fish passage measures below the weir as well as help to preserve the existence of cross-sectional depth variation created upstream of the weir

4.0 Making it Happen

Due to the extensive urban development surrounding the Porter Brook in the reaches considered in this report, there is a critical requirement to obtain all the required written permissions. The first requirement is a "Land Drainage Consent" approval – obtained by completing the standard application form available from local E.A. development control and flood risk management personnel.

Of equal importance will be the establishment of ownership (and subsequent obtaining of permissions) to make the required alterations to weirs to make them passable to fish. Suitable designs for such easements could be derived in partnership with WTT staff – as well as via consultation with local E.A. fisheries personnel. Similarly, all works that will require access to the river must be approved by the riparian landowners (both the works themselves and the attendant access requirements).

As a consequence of the involved nature of assessing flood risk implications of the recommended works, it will be necessary for the recipients of this report to provide a person or persons to drive forward the negotiations for permissions and identify all relevant stakeholders. The WTT can provide help and guidance in the completion of the required E.A. application paperwork. In addition WTT staff can also supply a more detailed proposal of each element of the recommended works (should this be required during the application process). Additionally, the WTT funding and communications officer (Denise Ashton; dashton@wildtrout.org) can offer assistance in strategies to raise any funds that may be required to undertake recommended works. It should be noted that, owing to the Porter Brook being accorded a "Good" rating under the Water Framework Directive classification, this will be accorded a low priority for funding from the E.A.

Depending upon availability, it may be possible to complete some of these works as part of a "Practical Visit" (PV) training event. Please bear in mind that demand for PVs is high and the availability of funding and staff will determine the WTT's capacity to run these events.

5.0 Acknowledgement

The WTT gratefully acknowledges the funding support provided by the Environment Agency for the Advisory Visit programme.

6.0 Disclaimer

Appendix 1: Salix Bioengineering (http://salixrw.com/) advice on supportive planting

Ensuring Quality

Wetland plant establishment differs from terrestrial planting in one noticeable way.....Water!

Flowing and fluctuating water levels provide a stressful environment in which to establish plants and therefore plant stock needs to be of the highest quality. The presence of water also means that plants can spread rapidly over large areas. Therefore wetland plants should be free from invasive sub species which can colonise quickly and take over a water body. Additionally, wetland plants are often used in bioengineering applications in the form of pre established coir rolls and pallets which may be providing a genuine structural function in a civil engineering sense. Here, in particular, the quality of the living products needs to be of the highest standard. A pre-established coir roll should be of a suitable density of fibre fill and grown with suitable species for at least one year in order to be mature enough to be used as a bioengineering tool. Unfortunately, there are companies prepared to plant up a coir roll one day and deliver it the next day as "pre-planted". This will invariably fail and only serve to damage the reputation of bioengineering solutions. High quality plants should always be grown on outside and should never be delivered directly from a glasshouse into a dynamic water body. Roots should have developed through the coir to form a dense mat on the sides and bottom of a coir roll.

Nurseries

Unfortunately, nurseries growing native wetland plants and pre-established coir rolls/pallets have no specific industry regulation or standards. Therefore the emphasis must for now pass to the project team, designers and clients, with a suitably qualified ecologist or botanist on hand to inspect potential stock.

The spread of invasive water plants has been predominantly from plants bought for garden ponds from UK garden centres. Surprisingly, there are still UK nurseries growing both native and invasive species. Plants such as Parrots Feather (*Myriophyllum aquaticum*) and New Zealand Pigmyweed (*Crassula helmsii*) were,and in some case are still, being sold by UK growers to UK garden centres as pond plants. This is where the greatest risk of contamination to the native stock will occur. The only way to be satisfied that plants that are being procured for a project are free from invasive sub species is to visit the nursery and see for yourself. A professional and high quality nursery will welcome such visits. A few nurseries have signed up to Flora Locale's "Code of Practice for Collectors, Growers and Suppliers of Native Flora", which provides some reassurance on provenance but not necessarily quality (www.floralocale.org).

Specifications

Stock grown from local rather than UK provenance seed will need to be procured well in advance of the contract works commencing on the ground. Therefore an order needs to be in place at least one year in advance of the site works. This can cause budgetary issues with government agencies who can have issues procuring this far ahead. This can be overcome but needs advanced planning or a friendly nursery prepared to grow at risk.

There is still a knowledge gap amongst river professionals, including designers and clients, over what quality is required to provide the performance required for a specific project. This can be solved by either including a specialist bioengineer within the design team or by seeking out advice of a professional with extensive practical experience of bioengineering techniques. The species used should be carefully selected based on factors such as local applicability, water depth, flow characteristics, shading and known erosion control function.

Case Study

Following works within Worden Park to remove a culverted section of Cricket Field Brook that was the cause of flooding to neighbouring residential properties, a long term solution was required to re-landscape and stabilise the channel and establish new vegetation in the watercourse. The solution had to address rapid bank erosion as a result of a very high sand content of the subsoil. This was further compounded by very high flow rates following heavy rain events as a result of development within the watercourse's catchment area upstream. There was a desire to provide a watercourse that would positively contribute to the landscape of the park and also provide a range of wildlife habitats. The works to the watercourse were completed within two weeks of starting on site and, despite a number of prolonged heavy rain events both during and after the works, the mature pre-established coir rolls and pallets all began putting on new growth within a matter of days providing the watercourse with instant channel vegetation and protection to the toe of the banks. A coir blanket was installed to stabilise the banks has also prevented any erosion to the sandy soil beneath and has allowed the rapid establishment of grass which wouldn't have otherwise been possible.

Photo 1: Before - Eroded channel before

Photo 2: A mature pre-established coir roll ready to install

Photo 3: Installation - Mid July 2011

Photo 4: Post - The start of a flood event that eventually reached bankfull. Note the maturity of the vegetation installed just 6 weeks before. Immature coir rolls and pallets would have failed here.

Photo 5: Post - The channel immediately after the flood event after only 6 weeks after installation