



Advisory Visit

Sandybeck

(Tributary of the River Cocker, Cumbria)

26/07/2016



Key Findings

- Sandybeck is an incredibly artificial watercourse, having been relocated from the natural valley bottom, up the slope, to an elevated position on the valley side, and a significantly straightened course.
- The present position of the beck is also almost certainly counterproductive for land drainage in the adjacent field, with seepage downhill from the channel maintaining the field in a damper state than it would naturally be without the channel relocation.
- The morphology and habitat of beck is now naturally recovering from the straightening, with notable improvements achieved through lateral erosion and the scouring of new pools, but it remains well below optimal habitat quality for a beck of this type.
- If the channel continues to migrate laterally there is a significant risk that the entire beck will be lost out of its current channel and across the fields to the valley bottom, where there is no defined channel. Although allowing natural channel recovery is usually an option this would mean that the beck then bypasses the road bridge downstream (likely also flooding the nearby road), so is not a realistic option. There would also be a notable short-term impact of lost habitat until a new channel developed.
- A major river restoration scheme to reinstate a natural channel at the low point of the valley and natural watercourse location would solve all of the land management and habitat issues. Significantly improving the situation from all aspects.

1.0 Introduction

This report is the output of a site visit to the Sandybeck at the request of Mike Farrell (Environment Agency Fisheries Officer). The purpose of the visit was to assess issues being experienced with bank erosion and whether the site would be suitable for a green bank protection workshop.

Normal convention is applied with respect to bank identification, i.e. the banks are designated left bank (LB) or right bank (RB) whilst looking downstream. Upstream and downstream references are often abbreviated to u/s and d/s, respectively, for convenience.

2.0 Background

Healthy watercourses naturally migrate over time with the rate at which they do so affected by a range of factors, all of which must be considered when assessing areas of erosion (e.g. is the rate of erosion natural or is it being exacerbated by other impacts). The current state of the channel, how natural the gradient and planform are and the land use (both adjacent and within the wider catchment) can greatly affect runoff and bank stability and the erosion rates and the speed at which a watercourse will migrate within its floodplain.

Sandybeck has been subjected to significant modification in the past (likely pre-1860s, as the current course shows on the 1864 map - www.old-maps.co.uk/#/Map/312890/526681/12/100106) having been completely relocated from the low point of the valley up to a higher elevation on the valley side (Map 1), where it is retained with raised banks. The course is also significantly straightened, something that rivers always fight against as the natural diversity of flow and bed and bank resilience in different areas create variable erosion rates. Growth of bankside vegetation and trees strengthen areas of the banks but can sometimes also weaken them, in the case of species like Himalayan balsam, and inputs of other materials to the channel (both natural and manmade) also diversify flows contributing to variable erosion. All of these factors lead to straightened channels naturally reinstating a more sinuous course over time which, in most cases, is very favourable and part of natural river recovery.

3.0 Site assessment

The site was assessed working in an upstream direction from Sandybeck Bridge, u/s for approximately 0.7km, and the findings will be reported in the order they were observed.

3.1 Upstream of Sandybeck Bridge

Immediately u/s of Sandybeck Bridge, issues associated with relocating a watercourse to higher ground are apparent. The fields to the RB (downhill) side of Sandybeck, between the current elevated course and the valley bottom remain wet and are dominated by rushes (Fig. 1). This is almost certainly exacerbated by water seeping downhill through the bed and RB bank from the current, perched watercourse towards the much lower land at the natural valley bottom. This is one of many reasons that relocating a watercourse from its natural channel not only negatively impacts on the function and health of the watercourse but also creates issues for land management and / or drainage.



Figure 1. Looking d/s at the natural slope (left to right) between the now perched, current Sandybeck Channel (just out of sight to the left of shot) and the low point of the valley (right of shot). The land on the slope in-between will receive sub-surface seepage from the current watercourse and so remains wet and dominated by rushes (centre of shot).

Livestock grazing is denuding the banks of diverse vegetation and causing physical damage through poaching and this, along with the deterioration of the hard bank revetments allowing increased natural scour and deposition,

is leading to areas of the RB (downhill side) becoming eroded. The adjacent areas of the floodbank now also threatened. Figure 2 shows the first erosion area encountered, where the damage from livestock is clearly evident and introductions of stone along the RB are also altering flows and sediment transport, further contributing to the issue. Inspection of the area around the stone also revealed the remnants of old bank protection boards. These are facing diagonally d/s across what is now the current channel and acting as a flow deflector, turning flow towards the RB (Fig. 3).

In addition to the land management issues associated with the erosion it should also be considered that without this area and other areas of erosion and the associated pools resulting, the beck would be even straighter and more significantly lacking in depth variability, sinuosity and habitat diversity. This must be considered in any remedial action.

At the next erosion site u/s, the bank protection boards remain as a bank toe but the lack of trees and vegetation on the bankside and top leave it highly susceptible to erosion (Fig. 4). A similar situation is evident in figures 5 & 6 but there, the beck appears to have already completely outflanked the bank protection there and begun to undercut the bank.



Figure 2. Looking u/s at the first area of erosion inspected. Natural erosion (left of shot) threatens the RB and raised floodbank (note the ground sloping away to the left) which retains the watercourse in its perched location. Cattle poaching can be observed to the left of shot, further destabilising the bank and the lack of vegetation within the fence along the bankside show that the ground is still being grazed. Gravel deposition (right of shot) is now also occurring as a natural consequence of deposition the widened channel.



Figure 3. The remains of bank protection boards (red shaded block) acts as a sub-surface d/s flow deflector directing flow more acutely into the bank. This may be why the stone was introduced d/s (black circle). However, the stone increases turbulence and will add to the erosion issues at certain flows. The structure also diverts/interrupts the transport of substrate along RB line, potentially increasing erosion and undercutting d/s.



Figure 4. Looking d/s; a lack of vegetation on the bank leaving it susceptible to erosion. The remains of the bank protection boards are still evident but the fence has long since ceased to provide any protection. The valley slopes away to the right of shot. As with the other areas of lateral erosion, this is one of the few pools (deeper water) and better quality fish-holding and spawning habitat.



Figure 5. Looking d/s; minimal bankside vegetation and a lack of root matrices has allowed the RB to become undermined through lateral erosion. Note the slower, deeper water associated with the bend. The valley slopes away to the right of shot. The land to the left of shot is likely to have been created through deposition as the channel became over-wide by migrating through the RB (right of shot).



Figure 6. Looking d/s; this location is a similar situation to that shown in Figure 5, with the early signs of bank undercutting evident. The valley slopes away to the right of shot.

4.0 Discussion

The return to a more sinuous channel is simply a natural adjustment that inevitably occur on any straightened watercourse given time as the inappropriate, hard revetments required to hold it in place will always fail. From an ecological perspective, this is generally a very positive development, returning a watercourse towards a more natural, diverse state, reinstating beneficial flow diversity and higher quality habitat. A straightened, artificially steep watercourse will invariably have more uniform, higher flow velocities, with greater erosive forces acting upon the banks. The increased transport of sediment and reduced occurrence of discrete areas of erosion and deposition means that they lack the natural range of water depths and habitat types. This is a major consideration in assessing the issues and devising a solution as, ordinarily, the optimal outcome would be to facilitate the channel adjustment and natural recovery of the watercourse.

However, in this instance there is another important issue: if the beck is allowed to adjust much further laterally (as would usually be recommended) there is the risk of the watercourse being completely lost from its current channel, down the slope to the valley bottom. This would then bypass the only major road bridge (Sandybeck Bridge), which is located on the on the current perched channel course d/s. The absence of a defined channel at the valley bottom also limits the feasibility of a natural recovery option as the anticipated short-term impacts of fine sediment input and habitat loss may be unacceptable.

The optimal solution, from a land drainage, management and ecological perspective is a full river restoration scheme that would reinstate the beck's natural paleo-channel at the low point of the valley, thereby improving drainage and habitat quality. Many similar schemes have been undertaken and it is entirely feasible if the funding for the work can be gained. Similar schemes have been undertaken previously across Cumbria, joint-funded by the Environment Agency and Natural England and delivered by third sector organisations. Aside from the general cost of the earthworks, the requirement for landowner/tenant agreements, a new road bridge (and associated costs) and short-term road closures are likely to complicate the scheme, but that certainly should not preclude the feasibility of a scheme of such merit.

The alternative, make-do and short-term solution is that areas of erosion could be controlled with green bank protection, also requiring livestock exclusion to prevent trampling damage and allow revegetation to further stabilise the bank material. However, this work would be a poor second to fixing the issue with a proper river restoration and would have to be very

carefully initiated so as not to degrade the habitat of the beck by re-straightening its course and degrading the developing deeper-water pool habitat. Any form of maintaining the current channel would also completely fail to address the land drainage issues in the adjacent field. It is, however, possible that this option could be undertaken as an interim measure.

Ordinarily, soft bank protection techniques are employed in discrete areas where specific land or infrastructure must be protected but, in this instance, it would be applied to halt the natural improvements and recovery (increased sinuosity and pool creation) that are occurring following the realignment and straightening. Any such work would have to maintain the maximum channel sinuosity possible by limiting encroachment of the work into the channel (which would effectively straighten the bends) while also preventing the watercourse being lost laterally, away down the slope.

5.0 Recommendations

5.1 River restoration

There is no doubt that a full river restoration project is the ideal solution that would solve all of the problems at the site. It is strongly recommended that the possibility for full river restoration is explored with other potential partners such as the Environment Agency, Natural England, the County Council and Highways, the landowner and / or tenant.

5.2 Localised bank protection

In the short-term, localised bank protection could be employed to reduce the rates of bank erosion and prevent the watercourse being lost across the field until the feasibility of a restoration scheme can be ascertained. For best effect, this is likely to be in one of two forms:

5.2.1 Brash bank protection

Brash protection provides an effective energy-diffusing barrier that slows flow before it hits the bank. However the efficacy of this method results from actually altering the natural geomorphological processes around it, reducing the flow velocities and scour that ordinarily create lateral erosion and maintains deeper pool areas on the outside of a bend. Therefore, the more extensive and effective the brash is at dissipating flow and protecting the bank, the more potential there is for impacting upon the beneficial features by reducing pool depth and increasing sediment deposition (which should generally be avoided). The key here will be to undertake the minimum extent of work possible and preserve as much of the beneficial features as possible.

To install brash bank protection, posts are driven into the bank toe and top, ensuring to key into a stable area at either end (Fig. 7). Starting at the u/s

end, brash is densely packed between the post and the bank with the butt ends facing u/s and towards the bank (Fig. 8). The brash is then secured in place by either wiring directly over the top (Fig. 9) or by clamping the brash down beneath longer more substantial branches/batons (Fig. 10). The riverside edge should be left rough and untidy, with the tips of the branches trailing out into the channel to soften the edge and further dissipate flow energy. This also provides valuable fish and invertebrate habitat. Owing to the high energy of the Kirtle Burn, it will be important to ensure that any structure installed is sufficiently robust to withstand the flows and coarse sediment transport likely to be endured (Fig. 11). If installed correctly, the dissipation of flow energy created should actually encourage sediment suspended within the water column to be deposited along the bank.

Inhibiting geomorphological processes is not beneficial or recommended in a natural scenario but, where vital infrastructure (in this case the bank that prevents the watercourse being lost across the field) requires protection, the method can provide a nature-like solution and limit the detrimental impact upon a watercourse.



Figure 6. Note how the start of the bank protection should start tight up against the more stable bank area (in this case, the roots of a tree). Starting at the u/s end, the brash is tucked in amongst the tree roots to help anchor the whole structure. Bank protection needn't be tied into tree roots but should meet an area of stable ground at either end.



Figure 7. Subsequent brush then linked in to the adjacent brush upstream.



Figure 8. Bank protection secured in place by wiring over the top of the brush between posts. This photo was taken just before the posts were sawn off just above the brush height to reduce the potential for catching debris and being washed out.

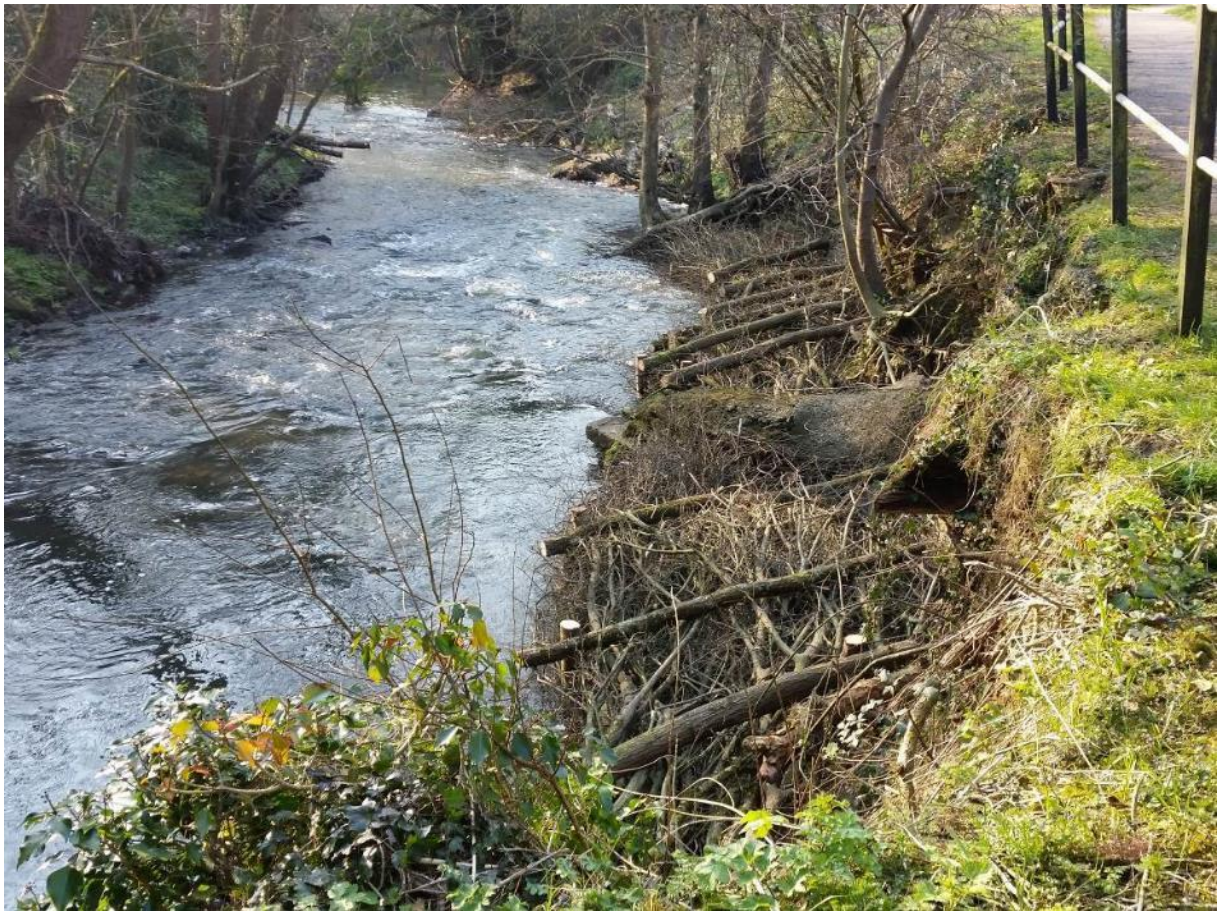


Figure 9. Brush bank protection secured with long branches/batons, rather than wire. The use of more natural materials is always preferable.



Figure 10. A line of coarse brush bank protection, installed along an eroding bank line. This picture was taken before the posts were trimmed, which should be undertaken upon completion of the brush installation to prevent the posts from being ripped out by debris in high flows. Note how the meander and pool have been retained here to limit the potential impacts associated with inhibiting the natural erosion processes.

The brash technique usually employs at least a proportion of live willow material which should, ultimately take root and form a line of shrubs along the bank, providing further protection and habitat diversity. One consideration with this method is a possible requirement for future pruning/maintenance of the structure; however, it may never become an issue and simply require ongoing monitoring. If maintenance were required it should only consist of trimming the trees and laying some branches (as you would a hawthorn hedge) into the channel.

5.2.2 Willow spiling

Willow spiling could be used as an alternative to brash and although not generally favoured by the WTT on high energy rivers owing to the reduced flow diffusion it provides and lack of structure within the channel. The risk with spiling is that it does not reduce the erosive forces acting upon the bank as effectively and so stands more chance of being undercut or out-flanked by erosion. For the above reasons it may actually be nicely applicable to Sandybeck. However, it should be remembered that spiling is also more susceptible to mass failure than brash work if an area does become damaged, owing to the interlocking nature of the spiling structure.

Spiling is installed in a similar way to that of brash, however, the posts are generally more closely spaced in a more even line, with longer, thinner (less bushy) willow whips employed, to create a smoother, more solid willow hurdle.

5.3 Tree planting

In conjunction with any bank protection, excluding livestock and planting along and behind the eroding section of bank is vital. Providing the banks can be stabilised, the erosive forces of the beck will then be directed downwards into the bed, mobilising that material instead of the bank. Planting with a range of native, deciduous species would be beneficial, most of which can be bought as saplings and formally planted; however, live willow whips and even more substantial live willow posts could also be driven well into the ground to rapidly provide trees.

The quickest and easiest way of establishing willow trees is by driving short sections of freshly cut willow into the bank. This can be undertaken at any time of the year, but will have the greatest success during the dormant season, shortly before spring growth begins (ideally late Jan-March). Whips should ideally be planted into soft, wet ground so that there is a greater length within the ground than out of it, to minimise the distance that water has to be transported up the stem; 30-40cm of whip protruding from the ground is sufficient. Whips of 5mm-25mm diameter tend to take best, but even larger branches/stems can be used. Care should be taken not to leave

excessive amounts of foliage on the whips as these greatly increase the surface area of the plant and can lead to their dehydration.

The willow used in this instance should be the smaller shrub species, particularly grey willow or goat willow (*Salix cinerea* and *S. caprea*), which, being small, tend to create low, dense cover and better bank protection than the larger less-stable species. Material should be sourced locally in an attempt to utilise native trees and reduce the risk of disease and non-native species transport.

5.4 Buffer fencing

All options will require buffer fencing to exclude livestock from the banks to allow them to develop a natural diversity of vegetation and trees that will then naturally protect the banks from erosion. The exclusion of livestock will also prevent the trampling and poaching damage that is currently occurring along the banks. Bearing in mind the requirement for an adequate buffer of trees and vegetation to stabilise the banks, it is recommended that the fence is set at least 5 meters back from the watercourse. The increased roughness created by the trees and vegetation within the buffer strip will also help to slow the transition of high flows over the bank top. This will further dissipate the flow energy acting upon the bank and, potentially, even encourage fine sediment deposition on the bank top, so the greater the size of the buffer the better.

6.0 Further information

The WTT website library has a wide range of free materials in video and PDF format on habitat management and improvement, covering many of the techniques described in the advisory reports:

www.wildtrout.org/content/library

We have also produced a 70 minute DVD called 'Rivers: Working for Wild Trout' which graphically illustrates the challenges of managing river habitat for wild trout, with examples of good and poor habitat and practical demonstrations of habitat improvement. Additional sections of film cover key topics in greater depth, such as woody debris, enhancing fish stocks and managing invasive species.

The DVD is available to buy for £10.00 from our website shop www.wildtrout.org/product/rivers-working-wild-trout-dvd-0 or by calling the WTT office on 02392 570985.

7.0 Disclaimer

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