Gloucestershire headwater streams – site visits, May 2015

Strawberry Banks

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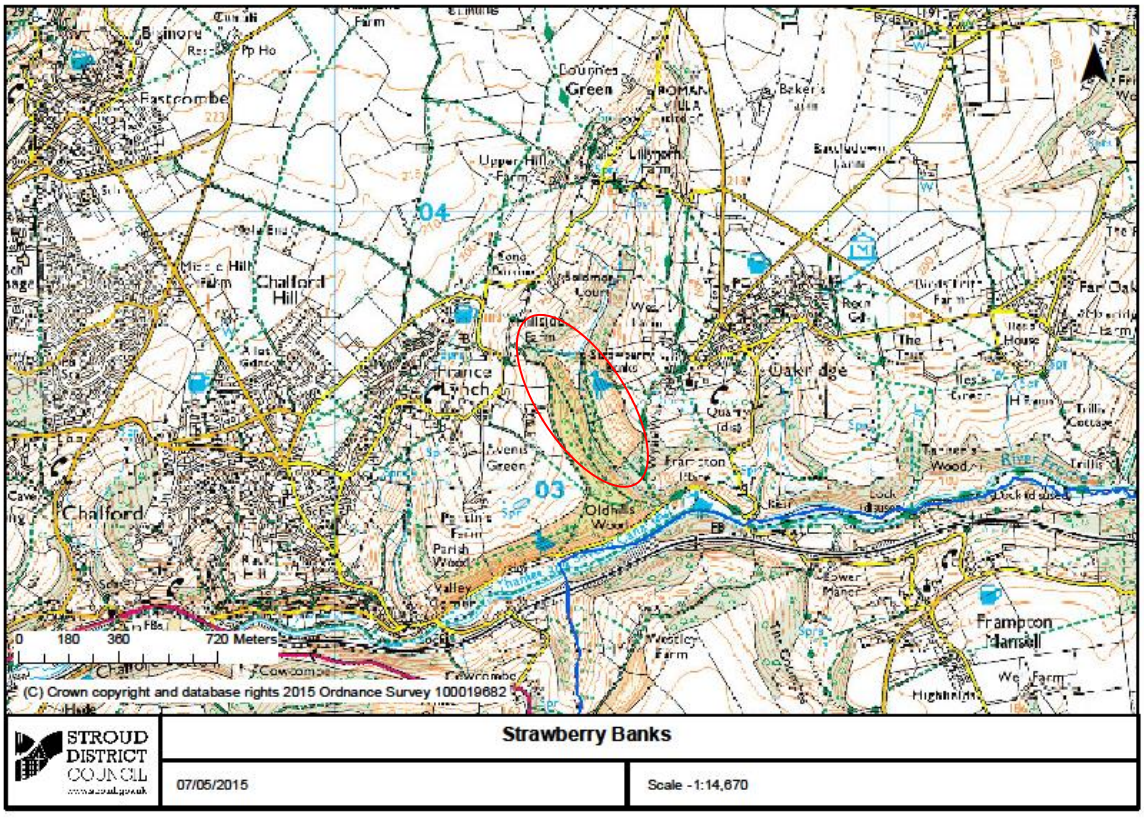
April 2017

In attendance: Chris Mainstone (Natural England), Chris Uttley (Stroud District Council), Ann Skinner (Environment Agency), Iain Diack (Natural England), Richard Spyvee and Pete Bradshaw (both of the Gloucestershire Wildlife Trust).

The stream runs between Strawberry Banks NNR on the east bank and a broadleaved woodland owned by the Woodland Trust on the west bank. We walked up the stream from NGR SO 912 029 to the tufa chute at the upstream end of Strawberry Banks reserve, then turned up the small side stream entering the main stream at NGR SO 908 035.



Map indicating stream length visited (circled in red).

The stream is extremely strongly tufa-forming, set in a v-shaped valley cloaked in broad-leaved woodland with an understorey dominated by wild garlic (Figure 1). The stream is completely unmanaged, with an abundance of woody material in the channel. This material has a strong influence on stream morphology and hence habitat provision.

Figure 1. Tufa deposition and woody material in the channel (channel looking suspiciously straight at this point).

The intensity of tufa deposition is evident from the fallen tree in Figure 2, which has taken on the appearance of solid rock. The tufa has a heavy influence on bed substrates, which are concreted together to a large extent.

Figure 2. Tufa deposition on a fallen tree.

In addition to shaping habitat mosaics within the channel, woody debris dams are clearly important in maintaining and elevating stream bed levels (Figure 3). As dams

form, sediment from upstream infills behind and creates a step in bed levels. As this sediment is relatively coarse the elevated bed is typically firm and relatively well-aerated, and so suitable for a range of characteristic stream invertebrates. Below the dams, scour pools and associated downstream riffles are created, adding to habitat diversity.

Figure 3. The effect of a debris dam on stream morphology and hence habitat provision.

Figure 4. Further stepping in bed levels mediated by woody debris in the channel, with associated depth and hydraulic variation in habitat conditions.

The riparian flora is extensive, including herb paris (Figure 5). Within the stream there is no developed aquatic higher plant vegetation, which is typical of wooded headwater streams with high levels of shading. The strong tufa-formation also appears to limit

lower plant development within the channel, although small quantities of the Cratoneurion mosses *Cratoneuron filicinum* and *Palustriella commutata* (syn. *Cratoneuron commutatum*) were present in these lower stretches on fallen wood and tufa.

The main biological interest in the channel is invertebrates. A brief kick-sample was taken and revealed a fauna dominated by freshwater shrimps (*Gammarus sp.*), accompanied by a range of taxa including caddis-flies, stone-flies, mayflies, blackflies, tipulids and leeches. Three stonefly species were identified: the predatory *Isoperla grammatica* as well as *Leuctra nigra* and *Nemoura cambrica* which are shredders that thrive in streams with abundant leaf litter. L. nigra also exploits areas of siltier substrate where it sifts organic detritus (from leaf decomposition). The only caddis-fly species found were caseless species: the net-spinning *Plectrocnemia geniculata* and the free-living predator *Rhyacophila* sp.. Plectrocnemia species are headwater specialists, *P. geniculata* being more associated with calcareous waters than the more common *P. conspersa* (which dominates in acidic headwater streams). The abundant mayflies were all *Baetis* sp. – all nine species of this genus are grazers feeding on attached algae (periphyton).

Overall, invertebrate diversity seemed relatively low, although most individuals were not identified to species level and deeper examination of e.g. leeches and tipulids would have been revealing. This may be due to the brevity of the kick-sample, the time of year, or the physical effect of tufa formation on habitat availability. Concretion of bed sediments generally leads to fewer refugia, so strongly tufa-forming streams may be a challenging environment for many invertebrate species. There is no obvious reason to suspect that the fauna observed was not characteristic of the natural function of the stream, and the presence of a number of stonefly species suggested very good water quality.

Figure 5. Herb paris on the stream bank.

Figure 6 shows the effects of fallen wood on channel planform. This planform movement generates channel sinuosity that is critical to the full expression of stream habitat extent and characteristic habitat mosaics in headwater streams. The sinuosity creates variation in hydraulic energy across the channel, which creates differential hydraulic scour on the stream bed and banks, which in turn creates diversity in water depths, substrates and bank profiles. These processes provide the characteristic variety of habitat niches needed to support the full range of species characteristic of the stream.

The debris dams are important in catching leaf litter within the stream, which is the principal source of natural productivity in wooded headwater streams. The invertebrate fauna of such streams has a characteristically high abundance of ‘shredders’, which initiate the process of leaf litter decomposition and provide the platform for the rest of the stream’s food web. Freshwater shrimps are shredders, which explains their high abundance in this situation. Many stonefly species are also shredders, and some of these are highly dependent on natural headwater streams as a habitat.

Figure 6. Woody material initiating channel planform movement.

At the upstream end of the section we walked, stream gradient increases considerably and the channel forms into a tufa chute (Figure 7 and 8), which has no loose bed substrates but rather is composed of smooth tufa concretion. A remarkable natural geological and geomorphological feature, with an algal biofilm that creates interesting specialist habitat opportunities for invertebrates.

Figure 7. Tufa chute.

Figure 8. Top end of the tufa chute.

The side-stream runs through semi-natural grassland, with occasional riparian trees (Figure 9). The small channel is dominated by tufaceous deposits, associated with an abundance of the orangey green *Palustriella commutata* moss which is indicative of the

Habitats Directive Annex I habitat H7220 (petrifying springs with tufa formation)[1] and can be seen in Figure 9 on mounds at the edge of the channel.

Figure 9. The tufa-dominated side-stream.

Patches of base-rich fen vegetation occur around springs and areas of impeded drainage, with much *P. commutata* alongside meadowsweet, water mint, lesser water-parsnip, marsh marigold, and an abundance of marsh valerian. The vegetation is weedier than would be expected, possibly as a result of regular heavy poaching (see hoof prints in Figure 10).

[1] This habitat is identified at European level as a priority feature, i.e. a sub-set of the Annex I habitat types that are defined as being "priority" because they are considered to be particularly vulnerable and are mainly, or exclusively, found within the European Union (Article 1d). The importance of these priority habitat types is emphasised at several places in the Directive (Articles4 and 5 and Annex III), not only in terms of the selection of sites, but also in the measures required for site protection (Article 6) and surveillance (Article 11).

http://jncc.defra.gov.uk/ProtectedSites/SACselection/habitat.asp?FeatureIntCode=H7220

Figure 10. Base-rich fen on spring mound. Poaching evident with frequent willow-herb.

Figure 11. Some damage to tufa is also evident in the stream, again probably a result of stock trampling.

The stepped nature of the stream bed is again apparent (Figure 12), although the origin of this is not so evidently woody material on the stream bed (perhaps it has a bedrock origin here).

Figure 12. Streambed steps forming a cascade.

Walking back through Strawberry Banks NNR, we had a good perspective on the position of the stream between the flower-rich limestone grassland and the woodland trust reserve (Figure 13). The colony of marsh fritillaries were just emerging (Figure 14) – we saw around 40 on the wing.

Figure 13. The view of the stream valley from Strawberry Banks NNR, with the Woodland Trust reserve in the background.

Figure 14. Marsh fritillary on Strawberry Banks.

Key messages

Overall, this stream is an excellent example of a highly natural tufaceous stream, with good continuity with its springs and flushes.

1. Notification

The stream forms the boundary of two wildlife reserves but is not formally recognised by either as a feature of conservation value. The stream should be added to the list of notified features on Strawberry Banks, and consideration given to the location of the boundary so that the connected spring system can be given SSSI protection by recognising the stream habitat as a SSSI feature in its own right.

The site should also be included in an inventory of SAC habitat 7220 (petrifying springs with tufa formation (Cratoneurion).

2. Objectives

Natural ecosystem function is the over-arching objective for stream habitat, as outlined in the freshwater and wetland habitat narrative (Mainstone *et al.* 2016). This concept is embedded in UK Common Standards Guidance on SSSI river habitat.

3. Priority habitat mapping

This stream and its interconnected spring and flush habitat should be included in the priority river habitat map for England (Mainstone *et al.* 2014, 2015).

4. Management issues

Trees and woody debris - The importance of the interaction between standing and fallen wood and stream habitat is clear here as it is elsewhere in the headwater stream systems recently visited in Sussex and Kent. Fallen trees across mire and stream habitat should be left in place to generate characteristic habitat mosaics and provide dynamism in the stream/mire system. Debris dams should be allowed to develop and decay naturally.

Although running through woodland, bankside trees are relatively uncommon along this stream. This means that interaction with tree root systems is relatively infrequent. Bankside tree root systems are important contributors to the full expression of stream habitat mosaics, instigating plan form movement but preventing excessive channel destabilisation, and generating the bulk of woody debris in the stream. Selective planting of appropriate bankside trees at this site would be beneficial, as would the larger fallen wood that they will eventually generate.

Nutrient inputs - An increase in external nutrients, from domestic sources or agriculture for instance, destroys the characteristic trophic structure of headwater streams. Leaf litter decomposition becomes less important as easier sources of nutrients are exploited. The role of shredders declines and species may be lost, as species feeding on other nutrient sources (for instance, 'scrapers' feeding on algae) out-compete them. Artificial nutrient inputs should be avoided wherever possible.

Grazing - While some grazing may be necessary to maintain open herbaceous fen, stock trampling can very quickly destroy small, bryophyte-dominated low-nutrient spring and seepage features. Even if not completely destroyed, poaching tends to allow weedy species into the vegetation which if nutrient levels allow can dominate. Stock numbers should be set at a level which avoids anything more than very minor trampling on these rare and easily damaged features.

Gloucestershire headwater streams as a network

The headwater streams of the south Cotswolds in Gloucestershire, including their associated spring and flush habitat, constitute a highly important habitat resource. There are many fine naturally functioning examples of stream habitat, most of which are still connected to intact flush and spring habitat. These streams have retained much of their natural function because of the steep topography of the area, which has resulted in the retention of semi-natural woodland and relatively unimproved grassland.

Their association with broadleaved woodland (some ancient), adds to the biodiversity importance of the landscape. Whilst these streams have high conservation value in their own right, they are also critical to the health of downstream river systems, and when functioning naturally they provide a range of ecosystem services that are too often taken for granted (Mainstone *et al.* 2016). These services include nutrient processing, water cooling (in association with woodland or riparian trees) and flow regulation, the latter in relation to moderating peak flows and supporting base flows in dry weather.

Damaged streams and stream sections can and should be restored to higher levels of natural habitat function, with all of the biodiversity and societal benefits that brings. Headwater streams are too easily forgotten by the decision-making processes that govern water management (including the Water Framework Directive) and so greater reliance needs to be placed on biodiversity drivers (protected sites and priority habitat) to make sure they receive the attention they deserve (Mainstone *et al.* 2014).

The Strawberry Bank stream/spring/flush system should be seen as part of a series of headwater systems of high conservation value running off the south Cotswolds that should be conserved in an integrated way based on naturally ecosystem functioning. Key messages to include:

- Maintain or restore continuity of natural water-related habitat from base-rich valley head fens, through springs to stream channels.
- Minimise physical interventions to the channel and its margins.
- Maintain tree cover (and increase to patchy cover where needed) and retain fallen trees and woody debris unless there is a significant safety risk – woody material is an essential element of natural stream/mire function.
- Be aware of water resource and water quality pressures in the catchment and raise awareness of the need to control these pressures to protect natural ecosystem function.

In addition, a local initiative to identify and map valley head fens, springs, flushes and naturally functioning streams, and to find or develop definitive names for all of the streams in the area, would be a positive step for headwater stream and spring fen conservation. The lack of names (or at least well-known names) seems symptomatic of a lack of societal value assigned to headwater streams. A naming initiative would help focus greater attention on them and their conservation importance, encourage greater care over activities affecting them, and foster public engagement.

Potential SSSI notifications for stream habitat in this area, including associated flushes and springs, should be considered within a wider perspective on SSSI notifications, which includes terrestrial habitats (particularly ancient broadleaved woodland) and rare species such as bryophytes. An integrated approach to notifications is necessary to

ensure that the links between these features, and the dependency of characteristic species on natural ecosystem function, is properly captured.

SSSI notification needs to be supported by appropriate use of priority habitat mapping, to ensure that valuable sites not selected for SSSI notification receive the recognition (and the drive for restoration where necessary) that they deserve. A new initiative is being set up to allow stakeholders to contribute to our collective knowledge of the naturalness of headwater streams and help refine the English priority river habitat map. A webpage and data portal is being developed by the Freshwater Biological Association which should be operational this summer.

References and further reading

Mainstone, C.P., Hall R., Diack, I. (2016) A narrative for conserving freshwater and wetland habitats in England. Natural England Research Reports, Number 064.

Mainstone, C.P., Skinner, A., Peters, S. and Rogers, M. (2015) Refining the priority river habitat map for England: a report on recent revisions and proposals for on-going refinement. Natural England joint publication JP012.

Mainstone, C.P., Laize, C., Webb, G. and Skinner, A. (2014) Priority river habitat in England – mapping and targeting measures. Natural England joint publication JP006.