RIVER NAR restoration project

By Charles Rangeley-Wilson

We started working on a catchment restoration of the River Nar in about 2011. It came together serendipitously: I'd been thinking for years about starting a Norfolk Rivers Trust, but when a routine "maintenance" operation on the river went disastrously wrong and an over-zealous drainage ops team removed most of the habitat and then a touch more for good measure, I was spurred into getting a move on.

The Rivers Trust and Defra helped us get started. The drainage board made an about turn and have been brilliant ever since. And then World Wildlife Fund (WWF) came on board and sponsored the production of a catchment restoration strategy which has proved its worth ten times over as we have used it again and again over the years to unlock funding, first from the Catchment Restoration Fund (CRF), then Flood Defence Grant in Aid (FDGIA) and more recently from the Water Environment Grant (WEG).

In the strategy, which built on previous work by Natural England, we divided the river into reaches classified by levels of naturalness and habitat quality. There were a few reaches that were just fine as they were, with good gradient, an intact river bed, natural meander patterns and plenty of habitat heterogeneity. These I coloured blue on the map and set them up as reference reaches: the goal being to make the whole river as good as these bits in due course.

Below this category were the green-plus reaches: reaches which were nearly good and which could be made good with a modest amount of investment. The key here is gradient and the integrity of the river bed. If you have those two things, then excess width and even to a degree a lack of meander (which might have been caused by overgrazing, for example, or afforestation, or channel diversion, or all three) can be fixed quite easily for a modest outlay with a chainsaw and a good supply of split chestnut posts. We tackled about 7km of river like this, felling trees into and across the channel and pinning them in place. If we learned anything it was that less is more. The more we did, the less we did. At first we cut up the trees and shaped the bank edges and used far too many posts. Eventually we learnt to cut the tree down and walked away like they do from explosions in the movies. It's way, way, way better to imitate nature than to try and better it. We almost exclusively used selected alders from multi-stemmed clumps and so the exercise also let light in here and there to create a more mottled pattern of light and shade.

Then, after a few years we moved on to the green-minus reaches: these were technically more challenging and typically were places where the river had been "managed" for drainage in the past (aka dredged) or reaches that were impounded or diverted. It can take a little practice to read a chalk stream for these things, and trying to communicate their significance has been ►

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Pre works: Using a digger to re-create the natural channel

one of the most challenging aspects of the whole project.

Most, if not all, chalk streams have been very extensively modified over the years. They have been diverted and impounded for all sorts of reasons: to ease river navigation, to drive mills and to create water-meadows. Most recently they were dredged in the post war land-drainage era, a dark-age for our chalk streams and one which has only just ended (and which threatens to come back every time a flood prompts a politician to reach for the wrong medicine).

The impoundments and diversions compromise the gradient of a river-type that is generally of a low gradient anyway. To drive a mill, or flood a water-meadow, you have to divert the river (or a channel off the river) from the centre line of the flood-plain towards a contour line on the edge, then run it along that contour line at a much shallower gradient than the natural river course, all in order to build up a head of water to drive the mill or work the water-meadow. For both mills and water meadows, the natural river channel was retained, either as a by-pass channel or as the 'catch' channel. But in the hundred years or so that have passed since both milling and water-meadow farming fell into obsolescence, the natural channels have tended to vanish beneath the plough, or just through lack of flow.

The majority of our natural chalk streams are effectively lost, or so changed as to be lost, and what we have retained are diverted channels: after all, these have formed the primary water pathways for over a thousand years. Most chalk stream mills pre-date the Domesday book. These diverted channels, that have become over time the primary, mapped channels, are generally of a much lower gradient than the natural gradient line of the valley: 1 in 1200 or 1800 compared to 1 in 600. The altitude gained by running the river along the edge of the floodplain tends now to be lost in a series of steps: when once our chalk streams flowed down a slope, they now flow down a staircase.

The flattening of the gradient brings with it quite a number of problems, not least a tendency for the impounded or flattened channel to silt up that has in many instances driven the dredging that then made a bad situation far, far worse. Dredge a diverted mill-leat or higher-level carrier and pile the spoil along the bank and you have basically created a morphological straight-jacket from which a chalk stream will never escape this side of the next Ice Age. No amount of revetting, or woody material, or willow spilling, or dig-and-dump, or even ingots of gravel will really amount to much of an improvement in these reaches.

It is at this point that morphological condition overlaps with water quality. Of course we need to address the sources of pollution, whether from a pipe or the wider landscape. But the condition of the river makes a vast difference to the impact of diffuse pollution, especially. Great lengths of the River Nar are diverted, gently impounded and dredged in exactly the way I have described. Surrounding the Nar we have pig fields and beet fields that supply vast amounts of sediment run-off every winter via a network of rural roads and grips helpfully cut by the Highways Agency. This stuff gets into the river and drifts along in great dunes: in many places the river bed looks like the beach after the tide has just gone out.

On the whole the river bed has been dredged by about 50cm, but not along the entire course. Beyond the mill impoundments there are numerous other interruptions made by the places where the dredger did not bother, by bridges, under power lines, where big trees prevented access. The river bed is thus a series of sumps and in these sumps lies half-a-meter of sediment run-off, that is stirred along each winter: tons and tons and tons of the stuff that never gets out of the channel, which feeds benthic algae and eel grass and burr reed.

Post-works: The natural channel reinstated.

In one of these reaches a dig-and-dump project proved utterly worthless: it worsened the impounding effect and the accretion of sediment. In another a Large Woody Material project proved almost as worthless: it narrowed the channel and scoured out the bed, but the bed was still too deep and the channel was now too narrow. And still it was impounded.

These are reaches that cannot be satisfactorily addressed with measures that do not tackle the fundamental problems of gradient and river bed.

So, in the green-minus reaches the cost of works goes up by a factor of three or four because instead of just felling and arranging (or not bothering to arrange, as the better option) trees, you have to either fill in the river bed with gravel, or cut a new channel down to the gravel that is still there to the side of the dredged and diverted channel, ideally in the centre line of the floodplain so that you can recover all the lost gradient and use it evenly along the new channel, riffle to riffle.

We have tried both, sometimes two different approaches, varying reach by reach on the same project, tackling small sections of a few hundred yards each time, growing in knowledge and confidence until in 2019 we began, after three or four years of planning, our most ambitious version of this type of work: excavating 2 km of new channel along the original course of the river, to one side and then the other of the diverted, higher-level channel.

One has to define the best pathway for the new channel, the best take-off point and the best return point. The depth of gravel under the floodplain is key. I used measurements from a number of reference sections in nearby natural reaches, as well as meander planform measurements from old maps to determine that the channel should be between 5 and 8 metres wide, ►

about 1 metre deep from surface of floodplain to bed of stream, with a single meander wavelength of 35 to 45 metres and a fall of about 5cm from riffle to riffle. Working down from the take off point, I could then plot the exact altitude I needed the river bed to be at each inflection point on the new river.

I then paced back and forth across the floodplain with a road-pin to probe for gravel depth and noted this against floodplain height to build up a contour map of both the floodplain surface and the gravel surface underneath. Using these data I drew a working corridor within which we would find gravel at the correct height: it was important that the gravel should be neither too high (because we'd have to excavate tons of it to get to the correct height) nor too deep (because our river bed would then be made of soil or clay).

Then, using the amazingly sophisticated technique of marking up a fly line with dots spaced at scaled intervals to mark the inflection points, I taped the fly line in a meandering formation to my map, set within the working corridor of correct gravel height, and moved it back and forth until I got to something I liked the look of. During this phase I spent an awful lot of time studying meander patterns on spring creeks in New Zealand and Patagonia, which was fun it itself. There are a few meanders marked on old maps of the Nar too. All this went into the meander computations, but no matter how hard you try, what you build with a digger will be ersatz and phoney until Nature comes along and rebuilds it as she prefers. So, I worked with this in mind always: that I wanted to construct something the river would then deconstruct.

I also wanted to add to the sum-total of habitat heterogeneity in the valley: to start with one impounded, uniform channel and end up with two or three channels of different types and with much wet ground around and between. A key stipulation of the Water Environment Grant was "hydrological connectivity" and that was, in essence, the whole point: to build a swift-flowing river that could escape its banks every winter, but also to include backwaters and pseudo-oxbows and in one section a "Stage Zero" diversion.

Stage Zero is a type of river restoration pioneered in Oregon, whereby the incised, modified river is simply filled in, and the floodplain is left to re-saturate and begin flowing, with the river now an anastomosed network of rills spilling over the ground. I have included one section like this, building on something the river was doing anyway through a gap in the old mill-leat; we have included an analogue beaver pond and flooded a feral wood. It's full of fish already, mostly bullheads but some fat trout too.

Of the 2000 meters of pre-existing, diverted channel, we filled in only 50 metres, at the very top, just to make sure the river's flow took the correct route. The other 1950 metres still hold water, most of it flowing: flood-plain seepage and springs gather pace along these old channels, which I have impounded with gravel bars and felled trees, to create spring-fed backwaters. Some very large trout have been seen in the one left behind by the first phase. Between these backwaters the new, swift flowing and meandering channel threads its way along the floor of the floodplain.

Phase 1 in 2019, 450 meters of new channel, took about six weeks and cost about £80K. We used one digger and one dumper, usually with three men on site including me, supervising. Phase 2 in 2020, 1200 metres of new channel, took about ten weeks and cost about £140K. We used two diggers and no dumpers (except for moving gravel around), usually with three men on site including me. The project thus far is well under budget and we are hoping to get permission to build in another phase and add another 400 metres.

A vital part of the work, once the digger has carved the main shape of the channel, is furnishing the bare river with woody material. So, just before the digger left after each phase, we used the machinery to distribute along the bank many large lumps of timber and a few hundred chestnut posts, which I then installed working with our faithful Norfolk A-Team of LWD, Richard and Pete of Acorn Tree Services. We got braver as we went, but never quite brave enough, I feel. I intend to go back in the spring and get more "confrontational" with the timber, using it to rough up the channel, and "blow a few holes here and there", now that we have returned to the river its gradient and gravel. It is amazing how energetic a chalk stream is when you give it back these things.

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I'm planning to arrange a tour of the site, when Covid restrictions abate, so if you'd like to join the day, then please drop me a line via the WTT.

I must give credit to the landowners (Holkham, West Acre and Narford) who have been far-sighted in letting such ambitious work take place on their estates, to the Norfolk Rivers Drainage Board for project-managing the work, to Natural England and Nik Bertholdt for tireless support, to Stu and the Five Rivers Team for their work on Phase One and to Gary and the WMA team for their work on Phase Two, to the Norfolk Rivers Trust who will be monitoring the ecological changes. And of course to Richard and Pete, mental beavers in human form. Thanks also to Peter Christensen and to Chris and Leo of Chalkstream Fly for help with filming and photographing. ❐

Charles Rangeley-Wilson is Vice President and one of the founders of the Wild Trout Trust.