Ash and Martock Nature - Phosphate Survey

Report 4

The impact of the drought on phosphate levels in the Parrett catchment

Andrew Clegg, August 2022

This is an extension of testing work done over the last year which has established a baseline against which the drought data can be compared.

A West Sedgemoor rhyne. To the right, azolla. In the foreground, thousands of water snails inverted, driven to the surface probably by the warm anoxic conditions

1 Main issues

- The river flow over this period was 30% of its normal summer flow.
- Almost the whole drought flow arose from the outflows of Sewage Treatment Works (STWs) with a small addition from springs–probably less than 5%.
- Phosphate dosing of tap water by Wessex Water is probably a far more significant source of phosphate than is commonly suggested.
- Phosphate concentrations in the main river rose to unprecedented levels, up to 500x normal
- Flow through the Somerset Moors, and even in the main rivers, became very slow and all watercourses became clogged with nutrient-resistant plants, particularly Azolla (duckweed)

2 River Flow

Mid August 2022 was very dry. The Parrett flow is continuously monitored by the Environment Agency at Chiselborough[1]. In August the data showed 0.14 m^3/s which is 'exceptionally low', about 30% of normal flow. When the drought broke it rose over two days to 0.39 m^3/s which is normal for this time of year. Normal winter flow is four times summer at around 1.5 m^3/s.

1 *https://eip.ceh.ac.uk/hydrology/water-resources/*

3 Parrett tributaries

What the drought has shown is that the Parrett is fed by tributaries that fall broadly into three categories,

1. Tributaries draining land areas via land drains and ditches,
2. Tributaries from springs – mainly from the limestone areas to the east.
3. Tributaries fed mainly by sewage treatment plants.

Category 1 had dried to occasional puddles; even the Parrett itself in South Perrott.

Category 2 streams are very small and remained at a constant but low level. They are largely pristine with a rich variety of riparian plants and very low values of dissolved phosphate.

Category 3 streams supplied almost all the water in the river, probably well over 90% in August. Over this time no storm water will have entered the sewage system so the outflow was almost entirely purified foul water–which will have the phosphate load of tap water. Phosphate levels downstream of these were extremely high, typically over 100x what is desirable and in some places, over 500x.

In summary, it seems that almost all the Parrett flow this summer was generated by purified foul water sewage outflows; in a normal summer this sewage outflow typically accounts for around 30% of the water and in a normal winter, less than 10% (Chiselborough flow data, *vid. sup*.).

4 Where the phosphate comes from

Sewage treatment plants

The unusually dry conditions have shed a significant light on the main sources of phosphate in the Parrett which are overwhelmingly sewage treatment plants. The outflow of phosphate from these will have remained constant at a time when the river flow rates have dropped to well over half normal and in consequence we have seen a sudden doubling or trebling of the phosphate concentration to a level typical of tap water.

Not one of the many sewage treatment plants feeding the Parrett, including Langport, extracts phosphate.

Sources of phosphate

1 The outflow of Martock STW (August 4.5ppm) obscured by a rich growth of balsam, reed and duckweed

2 Witcombe Bottom Main Drain. 200+ heifers standing stationary in the heat in two tight groups on opposite banks their water supply. (May, 0.05, August, 2.50 ppm). See section 9 below.

Agriculture

If, what is commonly described as 'diffuse run-off' from agriculture was significant, we might expect a lowering of the amount of phosphate reaching the tributaries caused by the drying of the ditches. The opposite has been the case. In wetter times the outflow of several land drains in the area have been tested; all have been phosphate free. It would appear that any excess phosphate, applied to the land in a manner that allows it to percolate into the soil, is absorbed by the clay and does not affect the concentration in the rivers (see also section 5 below) .

We continue to see, however, very significant point discharges appearing to come from specific farms, all large dairies. Hot spots are Witcombe near Long Load and the west side of West Sedgemoor. We noted that one such discharge near Haselbury Plucknett had stopped by this round of data collection after being reported earlier.

Tap water dosing

This round of observations all suggest that the phosphate added to our water supply by Wessex Water, to reduce the corrosion of its old cast iron pipes, is a far more significant source of phosphate in our rivers than is generally acknowledged. The data suggests that it indeed may be the most significant source. It is probably no coincidence that measurements taken a short distance downstream of Sewage Treatment Plants (STWs) like Crewkerne, South Petherton and Martock, all show concentrations around 3-4ppm, which is astonishingly high for rivers but which is suspiciously similar to the concentration in our tap water.

5 Where the phosphate goes to

A number of examples have been noted of a gradual decrease in phosphate along a watercourse after a sudden rise caused by a point discharge such as an STW. This is shown, particularly, in the Hills-to-Levels scheme near Martock where a series of retention ponds removes phosphate (unfortunately not much because most of the feeder spring-fed streams are fairly free of phosphate). It can also be seen along the Parrett between sewage outfalls where there is typically a sharp rise initially which then gradually tails off until the next outflow.

This gradual dissipation of soluble phosphate is shown most clearly in the Dorset Stour which rises (at the National Trust Stourhead garden) from groundwater springs that are contaminated with phosphate. This contamination has risen during the drought from 0.8ppm in normal times to around 1.0ppm. It is still, however, completely removed stepwise as it flows down through the seven artificial lakes at Stourhead.

6 Water-sediment phosphate balance

Phosphate is removed from watercourses by growing plants and also by sediment. The deep Somerset clay seems particularly effective in removing phosphate; clay soils are rich in aluminium and iron both of which form very insoluble phosphates. This suggests that the balance (equilibrium is the term chemists use) between the two continuous processes of phosphate moving from water to sediment and the reverse from sediment to water, may be a significant factor controlling overall levels in rivers flowing through clay soils. It is a two-way movement which serves to buffer the river concentration, removing it into the sediment in these drought periods when river concentrations are high and supplying it from the sediment when the river is in spate. We do not seem to see this kind of buffering to anything like the same extent in the smaller tributaries probably because these are not subject the sustained high phosphate levels characteristic of the main rivers.

There is much-debated evidence that the phosphate equilibrium may be influenced by the concentration in the water of dissolved oxygen. In deoxygenated water, more phosphate is released by iron particles in the sediment because they change their nature in deoxygenated water (technically they change oxidation state from 3 to 2 which causes some of the phosphate bound to them to be

released). This could be a contributory cause of some of the current very high phosphate levels recorded; we have noted a number of biological indicators of low oxygen levels in warm slow flowing watercourses.

7 Changes in watercourse ecology

The changes in species and in growth of watercourse plants is most striking. Nutrient tolerant plants such as reed mace, water lily, azolla, and himalayan balsam are common, often blocking even the main rivers. The difference between the variety and growth of main river plants and those along the spring-fed streams is very marked. This is a long-term trend often commented upon by seasoned observers of the Levels biodiversity who have also recorded steady decreases in invertebrates which directly depend on healthy plant growth.

Significant stretches of the Parrett above Gawbridge, where the flow is slow and naturally meandering, have become covered in a rime of what appears to be mainly blue-green algae.

We have seen evidence of unusual fish and snail behaviour suggesting poor oxygenation of the water of the lower Yeo and Parrett. Fishermen are reporting low catches in the Parrett.

Evidence of blue-green algae in the very slow flowing meandering Parrett just before it enters its artificially straightened channel to the sea.

8 Water movement within the Somerset Moors

We are looking at three Moors, Witcombe, Wetmoor and West Sedgemoor. In all cases the water is flowing out of the Moor through the pumps at a rate typically in excess of 10x below the usual summer rate (real-time pump activity is online). This has reduced and slowed water movement around the Moors resulting in a large increase is plant growth, most noticeably, reed mace and duckweed.

It is not easy to see common patterns across these complex systems but some are emerging:

- The main drains–that are at the end of the Moor flow and are pumped at the downstream end–tend to have particularly high levels of phosphate.
- Water from inlets from the Yeo or Parrett is high in phosphate but this tends to reduce gradually as it initially flows onto and through the Moors.
- In general, water in Moor rhyne systems tends to have lower phosphate concentrations than the Parrett, with the sometime exception of the Main Drain.
- A number of small streams feeding the Moors directly have been tested. Most of these have always been largely free of phosphate. Some of these, however, have been observed to show sudden and seasonal high phosphate levels; most of these are in the vicinity of large dairy

units and these phosphate levels often tend to peak at times when slurry is spread.

- The drought has led to some cases of extensive (and illegal) poaching by cattle in need of more water than usual; such places typically return high phosphate data.

9 Observations specific to particular moors

In West Sedgemoor, very little water is currently flowing out of the raised RSPB level. The phosphate concentration in the raised level has reduced and is now of the same order as in the lower level.

In West Sedgemoor almost the whole flow of the river feeding it from the south west was being diverted by a tilting weir onto the Moor. Consequently the river itself was low, almost stationary, and heavily overgrown. Water in this river brings high levels of phosphate from upstream–sources unknown–most of which usually flows directly through to the pumps but is now diverted almost entirely into the Moor system.

Witcombe Bottom Main Drain area was being used for summer grazing of about 250 heifers which had no other water source and extensive poaching was evident at the lower end of the Drain where the testing is usually done. This may be the main origin of the very high level of phosphate in this end of the drain which is in marked contrast to earlier (May) data which showed this Drain to be a significant remover of phosphate.

10 STW Storm overflows

Late on the16th August the drought broke and the Martock area had around 8mm of rain mainly in two showers. This was seemingly enough to trigger a storm overflow in Martock STW. (This happened 56 times in 2021). Unusually, the Martock storm overflow opens into a different watercourse from the main outlet (the small Hinton Meads Brook rather than the Parrett) This overflow resulted in an unusually high phosphate reading in the Brook for much of the following 48 hours. It also left the Brook littered with assorted detritus suspended from overhanging vegetation.

The whole Parrett catchment had similar rain on that day and it is not impossible that many more of the STWs also overflowed at the same time. Downstream in Langport on the morning of the 18th August a substantial group of young children were enjoying organised canoe and paddleboard lessons in the river.

11 Data examples

STW outflows into the Parrett during the drought

This table shows phosphate concentrations (in ppm) around STW outflows into the Parrett in the week beginning 8th August. Note that the ideal phosphate concentration is <0.04 ppm, the expected summer level in the Parrett is about 0.8 ppm and the highest recorded level in the past year before August has been around 2.2 ppm

STW	***Outflow***	***Watercourse above outflow***	***Watercourse below outflow***	***Comment***
South Perrott	*unknown*	*0.57*	*4.59*	*Upstream flow above limited to puddles*
Crewkerne	*4.80*	*2.40*	*4.00*	
Haselbury Plucknett	*unknown*	*0.20*	*4.28*	*Output into Small Brook, not Parrett*
Merriott (Goulds Brook)	*3.80*	*4.32*	*4.08*	*The high phosphate upstream was diluted by the Merriott STW outflow*
Martock	*unknown*	*2.54*	*5.48*	

West Sedgemoor phosphate changes from May to August 2022

This table summarises the changes in phosphate concentration (in ppm) at a number of points in West Sedgemoor consequent upon the drought. The main inlets are two from the Parrett and the inlet at Helland at the upstream end of the Moor. The outlet at the pump is very small in comparison suggesting a large loss by evaporation and a slow flow rate in all the rhynes.

Place	***Watercourse***	***Phosphate concentration, May 22***	***Phosphate concentration, Aug 22***	***Comment***
Helland Bridge	*Moor inlet*	*0.40*	*2.00*	*Tilting weir fully closed, almost all water diverted onto the Moor*
Hambridge Drove (RSPB)	*IDB rhynes*	*1.01*	*0.37*	
	RSPB rhynes	*0.68*	*0.39*	*No water flowing over weir into IDB rhynes*
	Small rhyne flowing directly from hillside	*0.16*	*0.06*	
Oath	*Moor inlet from Parrett*	*0.77*	*1.00*	*Point where the two upstream inlets from the Parrett join*
Stathe Pump	*Main Drain just below pump*	*0.69*	*2.82*	*Pump activity very low. 30-40 min once every 30 hours or so - equates to a mean of about 0.02m³/sec (20 l/sec)*

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