Between dry rocks and a hard place: detecting ecological responses to human impacts in stream communities altered by natural drying

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We report a recently published study in which we disentangled macroinvertebrate community responses to natural river drying and to human impacts, to inform better biomonitoring of ecological health in temporary rivers (Stubbington et al. 2022). Richard Chadd, along with coauthors Alex and Emma, contributed to the study, with Richard's expertise ensuring the real-world relevance of the paper's core messages.

Temporary rivers are those in which water sometimes stops flowing, and many dry out. Dominant in drylands, natural temporary rivers are also widespread in cool, wet countries such as the UK—not least in regions with chalk and karst limestone bedrock, as occurs across Richard's patch in the wilds and Wolds of Lincolnshire. Temporary rivers are becoming more common, in part due to climate change. As such, we need to develop methods to effectively assess their ecological health, but doing so is tricky, because their biological communities respond concurrently to human impacts and river drying.

We collated a European dataset comprising studies reporting invertebrate communities identified to family level, flow permanence regimes and human impact levels. We sourced data from 406 rivers in eight countries. Most data were from the Mediterranean Basin, but we also got three UK datasets: two provided by the Environment Agency, including one from near London (Fig. 1) and one from Lincolnshire (Fig. 2); and one from Wessex Water representing streams on the southern chalk (Fig. 3).

We ran analyses at the European scale and also for individual regions, including the UK. Our analyses sought to determine whether metrics summarising invertebrate communities—including family-level taxa richness, and the WHPT index of environmental degradation (Paisley et al. 2014) and its ASPT (average score per taxon)—responded to drying, human impacts or both, and whether these responses were interactive or independent. Only metrics with independent responses can be adapted for use in ecological health assessments (Soria et al. 2020).

In the European-scale analysis, all community metrics declined independently with both drying and impacts. In contrast, in the UK, few metrics responded to impacts, possibly because impact levels were quite similar at all sites. Metrics that did respond to

Figure 1. The Misbourne, a chalk stream impacted by a range of human activities. © Environment Agency.

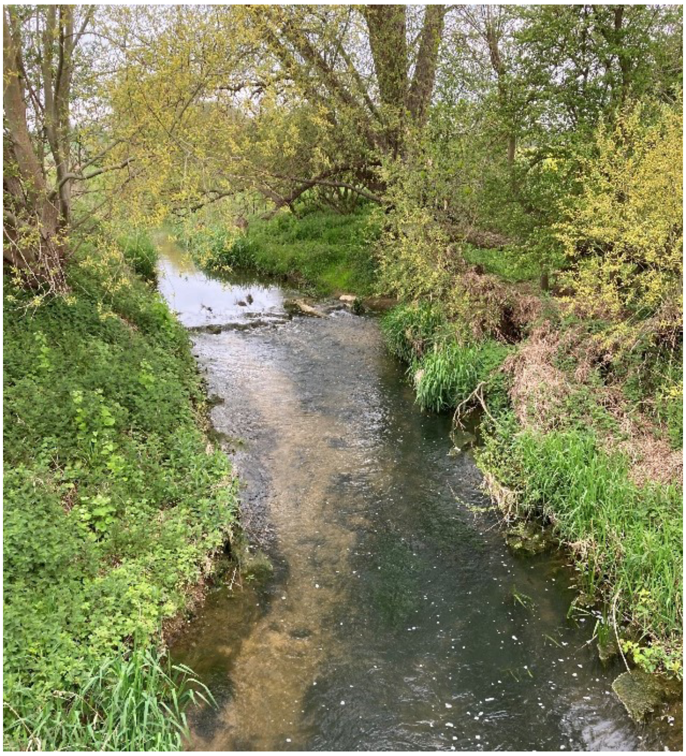

Figure 2. A temporary reach of the River West Glen, in Richard's neck of the woods. © Environment Agency

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Figure 3. The River Till, a chalk winterbourne in the Hampshire Avon catchment. © Trish Steel CC BY-SA 2.0.

Figure 4. The scarce purple dun, Paraleptophlebia werneri, is a temporary stream specialist. © Adrian Chalkley

impacts comprised taxa richness and the WHPT total (Paisley et al. 2014), which is influenced by richness. Their responses were 'antagonistic' declines (sensu Côté et al. 2016), meaning that their combined response to impacts and drying was less than the sum of their independent responses, likely because drying eliminates impact-sensitive taxa. Metrics with such interactive responses are very hard to adapt for use in biomonitoring (Soria et al. 2020).

In contrast, the WHPT ASPT did not significantly decline in response to impacts. As per Wildling et al.'s (2018) findings in winterbourne streams, we suggest that the ASPT has high potential for use in temporary river biomonitoring. An ASPT metric would also align with current practice in regulatory biomonitoring. To ensure accurate estimation of ecological health, this ASPT should be considered alongside a metric of taxa richness—but first, both metrics need adaptation to reflect the communities in temporary rivers.

To develop an ASPT and taxa richness metric for use in temporary river biomonitoring, we should base our expectations of their values on the invertebrate assemblages that occur in these streams. These assemblages can comprise fewer taxa than those in perennial streams, so—to make them responsive to human impacts—we need to better represent:

1. temporary river specialists. For example, *Paraleptophlebia werneri* (Fig. 4) should be distinguished from other leptophlebiids.
2. taxa that are resistant or resilient to drying, for example beetles. Again, this will require genus or species-level identification.
3. the taxa present in all temporary stream habitats, including the semi-aquatic taxa in marginal habitats (England et al. 2019).

Research following these recommendations is then needed to characterise the assemblages present within specific temporary river types (such as winterbourne chalk streams) exposed to different types and levels of human impact.

Finally, as highlighted in the press and on social media, we recognize the severe impacts of over-abstraction on both perennial and temporary UK rivers. The challenge of distinguishing between biotic responses to natural and artificial drying was beyond the scope of our study, but is a high priority for future research.

Acknowledgement

Funded by COST Action CA15113 (European Cooperation in Science and Technology).

Source

Stubbington, R. et al. 2022. Disentangling responses to natural stressor and human impact gradients in river ecosystems across Europe. *Journal of Applied Ecology* **59**: 537-548 https://doi.org/10.1111/1365-2664.14072

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