

A health check for European streams

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In a unique field experiment, ten research groups from nine different countries have studied the ecological status of 100 streams across Europe. This was the first study to make extensive use of leaf-litter breakdown as an assessment method. The findings of the study - in which Eawag played a key role - are reported in the latest issue of Science.

To assess the condition of rivers and streams, environmental scientists generally measure variables such as temperature, acidity and nutrient concentrations. They also determine the composition of the benthic macroinvertebrate community – insect larvae and other small streambed organisms. This method was originally developed to assess water pollution caused by wastewater. But today, surface waters are exposed to a more complex range of stressors: freshwater ecosystems may be severely impaired by bank reinforcement, weirs and altered flow regimes as well as by cocktails of chemical pollutants, invasive species and the effects of climate change.

According to biologist Professor Mark Gessner, this means that the existing measures are no longer adequate for assessing an ecosystem as a whole: "Just as a patient can be ill without having a temperature, rivers and streams with clean water can still have a lot of other problems as ecosystems." Also crucial to ecosystem health, he points out, is the functioning of processes which are characteristic of natural systems – an aspect which has been neglected to date in the assessment of surface waters.

Gessner and his colleagues therefore tested a new method based on one such process – the breakdown of leaf litter. "Litter input is the main source for stream food webs and is of major importance for whole-system metabolism," says Gessner, who carried out the investigations with the research group he formerly led at Eawag (he now works at the Leibniz Institute of Freshwater Ecology and Inland Fisheries and at the TU Berlin). Leaf litter is broken down largely by microscopic fungi – some of which are noted for their bizarrely shaped spores – and by benthic macroinvertebrates.

The researchers deployed mesh bags filled with oak and alder leaves in 100 streams in France, the UK, Ireland, Poland, Portugal, Romania, Spain, Sweden and Switzerland. They then determined how long it took for half of the leaf litter to be broken down – a measure analogous to the half-life of radioactive elements. In some of the streams, they also determined the number and diversity of benthic macroinvertebrate species, as well as concentrations of phosphate and inorganic nitrogen compounds.

It was found that low-nutrient waters contain few organisms which can make efficient use of litter resources. Conditions in heavily enriched waters are likewise unfavourable for organisms of this kind. Breakdown rates were thus low in both cases. With intermediate nutrient concentrations, however, no correlation was observed between concentrations, benthic macroinvertebrates and breakdown rates. Accelerated litter breakdown may thus indicate impairments caused by nutrients in cases where conventional methods would suggest good water quality – i.e. where nutrient concentrations are relatively low.

Gessner believes that this method has significant potential: "Just 'taking the patient's temperature' is certainly no longer a reliable way of checking the health of streams and rivers in Europe. Modern assessment of freshwater ecosystems calls for the kind of differential diagnosis which we take for granted in medicine – identifying the underlying causes of symptoms on the basis of additional criteria. Here, processes such as litter breakdown can make an important contribution."

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