

science summary



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Review of Lake Benthic Macro-invertebrate Sampling Methods and Strategy for the Water Framework Directive Summary SC030294/SS

These two Environment Agency reports, produced by the NERCs (Natural Environment Research Council) Centre for Ecology and Hydrology (CEH), present and evaluate a revised methodology for assessing the water quality of and classifying water bodies based on bioassessment methods. This assessment of the methodology is a response to the requirements of the European Commission's Water Framework Directive relating to water quality, and the overall intention is that the revised methodology will be cost-effective, in line both with the European Committee for Standardisation (CEN) and with current and future health and safety regulations, compatible with earlier sampling methods and suitable to use throughout the UK.

In the first report, *Improving methodology*, the existing Environment Agency and SEPA methods for collecting benthic (both littoral and profundal) invertebrates are reviewed, and their suitability to produce data which can be used to classify standing waters (particularly in relation to acidification and eutrophication) are assessed. An additional goal was to determine whether these data are robust enough for the development of diagnostic tools and predictive models.

The second report, *Quantifying variability*, uses data generated using the revised sampling method to assess the causes and levels of variability inherent within the new methodology.

While in essence, the existing methods were found to be suitable for generating the required data, a number of small revisions were recommended. Specifically, it was suggested that the meso-habitats sampled using the littoral method should be clearly defined and limited to two major types – hard substrate and vegetated areas dominated by submerged macrophytes. The objective of this modification was to reduce noise in the dataset and potentially improve model predictions.

Minor alterations were also made to the profundal method, and for both methods additional

recommendations relating to sample site parameters, levels of taxonomic identification and sample times were put forward.

The suggested list of site parameters to be recorded incorporates parameters required by the Water Framework Directive and includes both parameters which are not influenced by humans (for use in the classification of sites), and variables which are influenced by humans (for inclusion in predictive tools). In terms of taxonomic level, species-level identification has been proposed, in order to facilitate the production of the best possible tools. Finally, given the constraints on resources, a single sample per season per method has been advised.

The investigation into uncertainty specifically examined the level of variation between repeat samples, between operatives, within sites, within each lake, and between lakes suffering high or low impact of acidification. In addition, CEH audited data from species-level macroinvertebrate samples that had been processed by ECUS to assess the uncertainty associated with errors in sorting and identification.

This study demonstrated that community composition of stations within a lake were, on average, always more similar to other stations from the same lake, than to stations from a different lake. It also revealed significant differences in metric values between lakes **within** a given pressure (in this case due to acidification) class.

However, no consistent differences were found between lakes at high and low perceived risks of pressure from acidification. One reason for this could be that although considered to be highly susceptible to the effects of acidification, the lakes sampled may not have been affected at the time of sampling. Another possible explanation is that it may not have been possible to separate 'natural' acid lakes from those suffering from anthropogenic acidification.

Main conclusions and recommendations

- Reference macroinvertebrate communities in lakes need to be linked to specific, well defined, habitat types, ie the benthos of littoral stony/pebbly wave-washed shores should be separated from the benthos of vegetated/silty littoral habitats;
- It may be possible to adopt different strategies (in terms of taxonomic resolution) for littoral and profundal zones;
- In the profundal zone, because of limited diversity of benthic macroinvertebrate groups, identification should be to a high taxonomic resolution (species/genus-level) in order to differentiate between reference sites;
- In the littoral zone, because of much greater diversity of benthic macroinvertebrate groups, it may be possible to adopt lower taxonomic resolution (family-level) to differentiate between sites. However, any recommendation to use lower taxonomic resolution would need the support of robust analysis.
- As a precautionary principle the species-level is advocated for tool development, with the recommendation that lower resolution be considered in the future to reduce sorting time.
- A considerable proportion of the variation within a lake is at the small-spatial, within-station scale, and/or due to inter-operator effects. These differences are small compared to pure replicate sampling variability. Inter-operator differences have no apparent systematic effect on either ASPT or AWIC.
- Estimates of the biological status of a site generally become more precise the greater the sampling effort, while for a given number total number of samples, the variance of the mean is always minimised by taking one sample from each station.
- Sorting errors were responsible for 6-11% of the total variance, sample-processing errors causing an overall tendency to under-estimate the 'true' value for some metrics but not for others.
- The effects of variation due to field sampling, sorting and identification errors can be incorporated into estimates of the uncertainty in bioassessments using the software package STARBUGS (STAR Bioassessment Uncertainty Guidance Software).

This Summary relates to information from Science Project SC030294 reported in detail in the following outputs:-

Science Report SC030294/SR1

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