Using science to create a better place

Uncertainty in WFD assessments for rivers based on macroinvertebrates and RIVPACS

Summary SC060044/SR4

Any two samples of macroinvertebrates taken on the same day from the same river site will naturally vary in their taxonomic composition and richness. According to UK research, this accounts for about one-third of the total variation in a UK river stretch over a typical three-year reporting period, the remainder being due to variability between sampling sites, dates and years. All these sources of sampling uncertainty influence the accuracy of assessments of the ecological quality of UK rivers, lakes and other water bodies

Under the EU Water Framework Directive (WFD), EU member states are required to assess, monitor and, where necessary, develop programmes to improve the ecological quality status of all water bodies. In the UK, this assessment for rivers is based primarily on the RIVPACS (River Invertebrate Prediction And Classification System) approach, which determines the quality of a river water body based on the population of macroinvertebrates that it supports.

This approach involves taking samples of macroinvertebrates from water bodies and then comparing the composition of these samples with the macroinvertebrate composition that would be expected from a similar water body in a high-quality state. To simplify this process, the macroinvertebrate composition tends to be represented as a few, easily comparable metrics, including the total number of different macroinvertebrate families and a score representing the average ability of the macroinvertebrates to tolerate pollution.

The expected values of these metrics are generated by a RIVPACS predictive statistical model that relates the macroinvertebrate composition of high quality water bodies to the environmental characteristics of those sites.

Dividing the observed value of the metrics for a site by the predicted values gives standardised observed/expected (O/E) scores, which can be used to classify the water body into one of five ecological status classes (high, good, moderate, poor and bad). O/E scores of one (or more) represent a high quality water body and very low or zero scores represent a bad quality water body. One of the intentions of the WFD is for the vast majority of water bodies to achieve a 'good' or better classification by 2015.

But an unavoidable limitation with RIVPACS is the uncertainty involved in calculating the O/E scores, which will affect the accuracy of any classification. Much of this uncertainty is a result of natural variations in the macroinvertebrate samples collected from a water body.

For a start, no two macroinvertebrate samples collected from a water body will be exactly the same, even if taken at the same site on the same day. But water bodies tend to be sampled at a number of different sites at various times, both in different seasons and years. This means that the difference in macroinvertebrate composition between different samples taken from a single water body can be quite large, producing a wide range of O/E scores.

Adding to the uncertainty will be any errors made in identifying the various macroinvertebrates in the samples and in determining the environmental characteristics of the water body, which are used to determine the expected values of the metrics.

Water bodies are usually classified based on average O/E scores for the various sampling sites within the water body. But if the variation between the samples collected at a site is fairly large and errors have been made in calculating the O/E scores, then these classifications could well turn out to be incorrect. This is especially likely if a site's average O/E score places it close to a boundary between two different classes.

So now Ralph Clarke from Bournemouth University, funded by the Environment Agency and SNIFFER, has set about trying to tease apart these different sources of variation and the contribution they make to the uncertainty inherent in classifying water bodies. To do this, he analysed various macroinvertebrate sampling datasets and studies provided by the three main UK government environment agencies: the Environment Agency, the Scottish Environment Protection Agency and the Northern Ireland Environment Agency.

This analysis yielded a whole host of findings, which are detailed in this report. These included that about one-third of the total variation between samples taken at different sites and times within a water body can be attributed to normal background variation between replicate samples taken on the same day at the same site. The levels of background variation in derived biological metrics was not influenced by the type or quality of a sampling site. Estimates for the likely impact of each source of uncertainty on the classification process were also assessed, thereby allowing this uncertainty to be taken into account when determining the quality status of a water body. It was highlighted that adding extra relatively imprecise metrics to multi-metric assessments can increase the likelihood that a water body is misclassified.

However, Professor Clarke argues that a much larger dataset is needed to obtain more accurate estimates of spatial uncertainty. He also makes a number of other recommendations, including calling for more detailed studies of sample processing error effects on new metrics and the development of a standardised macroinvertebrate sampling approach for assessing non-wadeable rivers.

This summary relates to information from Science Project SC060044, reported in detail in the following output(s):-

Science Report: SC060044/SR4
Title: Uncertainty in WFD assessments for rivers based on macroinvertebrates and RIVPACS
ISBN: 978-1-84911-038-9 **May 2009**

Internal Status: Released to all Regions
External Status: Publicly available

Project manager: Veronique Adriaenssens

Research Contractor:
Ralph Clarke, Centre for Ecology & Environmental Change (CCEEC), School of Conservation Sciences, Bournemouth University, Dorset House, Talbot Campus, Poole, Dorset, BH12 5BB

This report is the result of work jointly funded by the Environment Agency and the Scotland and Northern Ireland Forum for Environmental research (SNIFFER).

The Environment Agency's Science Department provides scientific knowledge, tools and techniques to enable us to protect and manage the environment as effectively as possible.

Further copies of this summary and related report(s) are available from our publications catalogue on or our National Customer Contact Centre T: 08708 506506 or E: enquiries@environment-agency.gov.uk.

SNIFFER
SCOTLAND & NORTHERN IRELAND FORUM FOR ENVIRONMENTAL RESEARCH