

Development of guideline sediment targets to support management of sediment inputs into aquatic systems

The effects of anthropogenically enhanced loads of fine sediment on aquatic wildlife are a major environmental concern. In addition to well-documented effects of siltation on the early life stages of salmon and trout, excessive fine sediment loads also create unfavourable conditions for many other fish, invertebrate and plant species, in terms of enhanced water turbidity, excessive sedimentation rates, and the clogging up of interstitial habitat in coarse substrates.

Natural England is responsible for defining conservation objectives for sites designated for wildlife. This involves the specification of "favourable condition", in which targets are defined for a range of biological and environmental attributes in different habitat types, including rivers, lakes, ditch systems and coastal waters. Suspended solids and siltation levels are explicitly included in the list of attributes for rivers, and also need to be managed to secure favourable condition in other habitat types.

In a parallel but related process, the Environment Agency is involved in the specification of Good Ecological Status (GES) under the Water Framework Directive. This similarly involves the definition of critical values of biological and environmental attributes consistent with GES. "Suspended material" is listed as one of the "main pollutants" in Annex VIII of the Directive, for which critical values may need to be set.

To date, work to define critical thresholds in relation to sediment input has focused on trying to specify the most ecologically relevant end-points, such as the level of fine sediment in salmonid spawning gravels, or suspended solids

levels. Whilst thresholds of this type are vital, they are notoriously difficult to define against a background of high natural spatial and temporal variability, and the exact specification of relevant end-point varies from species to species and habitat to habitat.

Ecological requirements relating to fine sediment load need to be defined using a common denominator that has practical relevance to catchment management. Catchment sediment yield, and related parameters characterising fine sediment delivery, seem to have the potential to fulfil this role, linking into catchment management models such as PSYCHIC that can help provide the basis for determining appropriate management action.

Initial investigations into the potential role of catchment sediment yields and sediment rating curves in target-setting have been reported in NERR007, summarised in RIN007. This subsequent work was commissioned to take forward a key recommendation of the initial investigations, i.e. that further analyses should be undertaken to develop generic guideline values for both sediment yield and rating curve for each UK catchment type, in order to help direct local action on

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controlling fine sediment delivery to aquatic ecosystems.

What was done

The research had the following objectives:

- To refine the catchment typology generated by the initial investigation.
- To analyse data on sediment yields and rating curves and identify best estimates of values consistent with near-pristine (reference conditions) with which to populate the refined typology.
- To consider ecological information being collated by parallel projects on the sensitivities of biota to enhanced siltation/sediment delivery, and identify (where possible) values of sediment yield and/or rating curves likely to protect against impacts, according to the refined catchment typology as mentioned above.
- To devise a statistical rationale and process for comparing observed values of sediment yield and shape/position of rating curve with reference/critical values.

The work was undertaken by literature review, consultation with key contacts, and the collation and analysis of existing data.

Results and conclusions

A refined catchment typology was generated based on an extended database of sediment yield data. Values of sediment delivery likely to be consistent with low anthropogenic impact within each catchment type were derived from lower percentiles of the frequency distribution of values within each type. These values were validated using available historic information derived mainly from sediment cores, generally supporting the use of the lower quartile value of frequency distributions as a guideline management target for protecting against enhanced sediment delivery. For some catchment types, however, available data suggested widespread elevation of fine sediment delivery at all sites in the database, making the use of quartile values unsafe.

Little information relating sediment delivery to ecological impacts was identified from on-going projects elsewhere. This meant that the definition of guideline generic targets had to rely solely on an understanding of anthropogenic elevation of fine sediment loads in each catchment type as determined by the spatial and temporal analyses of sediment yield data outlined above. Narratives on ecological risks from fine sediment delivery in different catchment types have been generated to ensure that all key mechanisms of impact are considered in the formulation of management strategies.

Investigations of suspended solids/river flow relationships demonstrated the usefulness of such data in interpreting catchment-specific sediment delivery regimes, targeting control action and potentially establishing site-specific targets. However, the very site-specific nature of the relationships observed suggested less potential for the development of generic guideline targets for different catchment types.

The report makes suggestions for how this work might be applied operationally to inform management decisions in the short-term. A catchment appraisal involving an analysis of sediment-related risks and impacts, and a local analysis of suspended sediment and flow data, is recommended to set context and ascertain the local relevance of the guideline targets suggested. This may result in modified targets being set, in addition to other targets relating to the suspended sediment concentration/flow relationship. Approaches to monitoring progress towards, and adherence to, sediment targets are outlined.

The researchers stress that the understanding of the quantitative link between sediment delivery (quantity and quality), sediment deposition and biological impacts remains poor, and should be the focus of strategic R&D to refine the framework for target-setting in the medium-term. Research recommendations largely relate to the need for fundamental, process-based science to fill this major gap.

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Natural England's viewpoint

This work has provided a basis for establishing quantitative targets for sediment delivery within conservation objectives for designated sites. An information note *Setting and applying sediment targets to protect designated wildlife sites* has been generated that provides guidance on how to establish fine sediment targets for a site within the context of a strategic management regime for fine sediment delivery. This Information Note is available from Chris Mainstone, Senior Freshwater Ecologist, Natural England.

Selected references

Natural England Research Report NERR007 *Investigations into the use of critical sediment yields for assessing and managing fine sediment inputs into freshwater ecosystems*.

Modelling sediment levels in salmonid spawning gravels using the SIDO-UK model - [URL://qg-svr7.geog.soton.ac.uk/staff/das/profile/Documents/DEFRA_Final.pdf](http://qg-svr7.geog.soton.ac.uk/staff/das/profile/Documents/DEFRA_Final.pdf).

Further information

For the full details of the research covered by this information note see Natural England Research Report NERR008 *Development of guideline sediment targets to support management of sediment inputs into aquatic systems*.

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Report authors

David Cooper, Pamela Naden, Gareth Old and Cédric Laizé, CEH Wallingford.