Infaunal Quality Index: WFD classification scheme for marine benthic invertebrates

Project summary SC080016

The Water Framework Directive (WFD) requires the ecology of River Basin Catchments to be assessed to determine where action is needed to improve the water environment. Benthic invertebrates are one of five biological quality elements to be assessed under the WFD. They are an important component of marine ecological systems and are effective indicators of certain types of disturbance or 'pressure'. They complement the other WFD biological quality elements for transitional and coastal surface waters; angiosperms (flowering plants), fish, macroalgae and phytoplankton. This report describes the development of the method for assessing the ecological status of the macrobenthic invertebrates of sediment habitats in coastal and transitional (estuarine) water bodies for the first River Basin Management Plans (RBMPs) under the WFD for the United Kingdom (UK) and the Republic of Ireland (ROI). The method is named the Infaunal Quality Index (IQI).

The development of the IQI depends on the quality and range of data available. While data quality is upheld through national Analytical Quality Control (AQC) programmes, the development of further data treatment protocols was necessary as the IQI will rely on data from many sources. This ensures that the benthic invertebrate fauna data used for assessment are comparable to those upon which the index is based.

The approach to developing the IQI used existing studies of how invertebrate communities change over environmental pressure gradients related to anthropogenic disturbance.

Multivariate statistical analysis (Principle Component Analysis) was used to select a sub-set of metrics that in combination encompassed the majority of the variability in invertebrate communities shown through the UK Clean Seas Environment Monitoring Programme. The metrics selected were: number of taxa; a measure of taxa sensitivity to disturbance (the AZTI Marine Biotic Index (AMBI)); and a measure of the distribution of individuals among the different taxa (Simpsons evenness).

Contaminant data from two pressure gradient data sets (sewage sludge disposal and mine waste) were used to derive the IQI using regression analysis. The index was normalised to operate over an Ecological Quality Ratio (EQR) scale of zero to one.

Reference conditions provide the benchmark against which the ecological health of the invertebrate assemblages is assessed under the WFD. The IQI incorporates each metric as a proportion of its expected value under reference conditions so that the EQR provides a measure of the extent to which the ecological health falls below non-impacted conditions. Reference condition values were initially set by representatives of the UK and ROI WFD monitoring authorities using data from sites considered to be exposed to low levels of anthropogenic pressure. To enable the IQI to be applied to a range of habitats common to UK and ROI coastal and transitional waters, the reference condition values were adapted according to natural factors (sediment and salinity) and sampling methodology. Relationships between the IQI metrics and salinity and sediment particle size were used to estimate reference condition values for taxa number, AMBI and Simpson's evenness in different habitats. Due to differences in sample collection methods and the influence of exposure to air on shoreline benthic communities, reference condition models were derived separately for intertidal and subtidal habitats.

The WFD requires the ecological health of the biological quality elements to be categorised as ecological status classes, defined by the extent to which the biological community deviates from reference conditions. Class status boundaries were developed by first examining how proportions of AMBI ecological sensitivity groups changed over an organic enrichment gradient. These boundaries were then calibrated with other member states of the North East Atlantic Geographical Intercalibration and modified to ensure comparable results.

Water body assessments using the IQI are based on the average EQR. The average EQR is prone to variability (spatial, temporal and random sampling and measurement error), which needs to be defined in order to: i) establish the statistical confidence of a water body assessment and the confidence of classification (CofC) or the risk of misclassification (RoM); ii) establish sampling effort needed for monitoring programmes. The project report describes how methods for these calculations were derived by the Water Research Centre (WRc) and applied in the context of the IQI.

Finally, the report makes recommendations to improve the approaches developed by the project.