Background to aquatic macroinvertebrates sampling and index calculation

1 Purpose and Scope

This document and its companion document *Aquatic macroinvertebrate sampling, processing and index calculation* outline the methods used to derive the indices on which the aquatic macroinvertebrates water quality objectives (WQOs)(*Environmental Protection (Water) Policy 2009*) are based.[1] . When assessing whether a site meets the aquatic macroinvertebrate water quality objectives (WQOs) currently prescribed under the Environmental Protection (Water) Policy (2009), the live picking method must be followed, as this method was used derived the published WQOs. Local WQOs may be derived using the laboratory picked method, provided adequate reference site data are available (in terms of number of sites and over time) (see EHP 2009 for guidance). The method used to define any WQOs should be clearly stated, and then consistently used for any comparisons.

2 Associated documents

Biological assessment: Aquatic macroinvertebrate sampling, processing and index calculation

3 Introduction

The structure of plant and animal communities of rivers can provide valuable information on the condition or health of waterways (in addition to water quality parameters). Aquatic macroinvertebrates are the most widely used biological indicators globally, because they are abundant and diverse, and can be sensitive to changes in water quality, flow regime and habitat conditions. Aquatic macroinvertebrates are animals without backbones and are large enough to be seen with the naked eye (e.g. prawns, shrimps, crayfish, snails, mussels and insects such as dragonflies, damselflies and mayflies).

Nationally, two methods are commonly used for collecting organisms: sampling a defined length of habitat using a dip net and either field picking or laboratory picking the sample. For Queensland, the field picking option has been used to derive aquatic macroinvertebrate WQOs that are defined for a number of river basins under the Environmental Protection (Water) Policy (2009). Locally relevant WQOs can be derived for either method, providing data are collected from enough reference sites over enough time (see EHP 2009 for guidance).

Macroinvertebrate indices, including those used to derive WQOs, can be insensitive to environmental change (including impacts from point source pollution). Therefore, it is recommended specialist advice be obtained when a study is being undertaken for any purpose other than comparison to WQOs. The study should be designed to fully address the complexity of the environmental problem being assessed. For example, the use of replicated quantitative macroinvertebrate sampling may be appropriate for assessing point source pollution (e.g. SSD 2013). Any environmental data (including macroinvertebrate data) used to assess environmental harm should be used as part of a multiple lines of evidence approach—a sole indicator of aquatic ecosystem impacts should not be used.

[1] Further information can be found at http://www.des.qld.gov.au/water/policy/

4 Aquatic habitats

A reach of a stream may have several habitats, each of which may have a different taxonomic composition. Bed samples can consist of riffles, pools, runs and macrophyte habitat. Riffles have a rocky bed (Figure 1), whereas runs (Figure 2) and pools (Figure 3) can consist of either rocky or sandy beds. Composite samples are a combination of all bed habitats present at a site.

The habitats most likely to be encountered in Queensland are summarised below. The definitions of pool, riffle and run can be confirmed by measuring and calculating the ratio of velocity (V) to depth (D). The definitions are based on the following ratios: V:D >0.032 = riffle; V:D <0.0124 = pool; V:D 0.0124-0.032 = run.

A riffle (Figure 1) is a reach of relatively steep, shallow (generally <0.3m), fast flowing (≥0.2m/s) and broken water over stony beds. A run (Figure 2) is a reach of flowing, unbroken water over a sandy, stony or rocky bed. Pool habitats (Figure 3) are relatively deep, stationary or very slow flowing water over silty, sandy, stony or rocky beds in the main channel. Edges (banks and under bank areas) (Figure 4) are habitats along the bank with little or no current. There may be some terrestrial vegetation (e.g. paragrass and sedges), tree roots or the area might be bare. A backwater is a zone where the bank indents and a pool of water forms away from the main channel (e.g. ox-bow, off-cut channel). It might have a circular or back flow, and a silty bed with accumulated plant litter. Macrophyte habitats (Figure 5) are areas where emergent, submergent and floating aquatic plants are present and can occur in still to fast flowing waters.

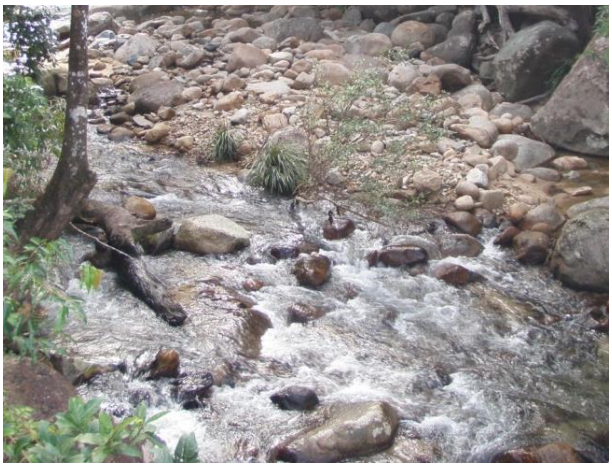

Figure 1: Riffle habitat

Figure 2: Example of run habitat


Figure 3: Pool habitats


Figure 4: Edge habitat

Figure 5: Macrophyte habitat

5 Macroinvertebrate indices

Macroinvertebrate indices are used as a measure of ecosystem health. Five macroinvertebrate indices have been used to derive macroinvertebrate water quality objectives (WQOs) in Queensland, and are described below. A change from a WQO can indicate an impact from changed environmental conditions. This change can include an increase or a decrease in the values of the expected WQO. For example, nutrient and flow increases can increase richness. Increased conductivity can decrease all indices.

5.1 Richness

Richness is a count of the number of different macroinvertebrate taxa present at a site. WQOs for richness are given either as a single number or a range. If the taxa richness falls between the provided reference range or is close to the reference WQO (in the case of a single value) then the waterway is considered to be more likely in a good condition.

5.2 SIGNAL Index

The SIGNAL Index (Stream Invertebrate Grade Number - Average Level) was developed for the bioassessment of water quality in Australia (see Chessman 1995; 2001; 2003). A sensitivity grade number is allocated to different macroinvertebrate taxon/taxa. These sensitivity grades are based on how sensitive each taxon is to various pollutants. Grade numbers are between 1 and 10 and are available for most macroinvertebrate orders/families encountered in Queensland streams. The higher the SIGNAL value, the better the condition of the water quality at a site. SIGNAL is calculated as the arithmetic mean of the grade of each taxon within a sample.

5.3 PET taxa richness

Macroinvertebrates belonging to the PET (EPT) orders - Plecoptera, Ephemeroptera, and Trichoptera are considered to be particularly sensitive to changes in their environment (Karr and Chu 1999). Therefore PET taxa richness can be used to assess degradation of habitat and water quality (Plafkin et al. 1989; Barbour et al. 1992). The PET index is not necessarily a useful indicator for many Queensland rivers and streams as: Plecopterans are usually rare in Queensland rivers; Trichopterans and Ephemeropterans in Queensland can be tolerant to a range of conditions and may not be sensitive to many impacts; and some areas naturally don't contain these taxa. PET is a count of PET taxa.

5.4 Per cent sensitive taxa index

The per cent sensitive taxa index was developed to overcome the dominance of tolerant taxa in the calculation of the SIGNAL Index (which results in low variability in SIGNAL Index scores between sites in Queensland). If a site is experiencing an impact, it is expected that there would be a change in the percentage of sensitive taxa collected. For this index, taxa with SIGNAL grade numbers of 8 or greater are designated as sensitive (Marshall et al. 2001), and the number of these sensitive taxa are compared to the overall taxa count and expressed as a percentage.

5.5 Per cent tolerant taxa index

If a site is experiencing an impact it is expected that there would be a change in the percentage of tolerant taxa collected. The per cent tolerant taxa index is calculated from SIGNAL grade numbers. Taxa with SIGNAL grade numbers of 3 or less are designated as tolerant (Marshall et al. 2001), and the number of these tolerant taxa are compared to the overall taxa count and expressed as a percentage.

6 References and additional reading

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