Factsheet: Benthic Macroinvertebrates and Indices

SUBMITTED BY LAWA **AUTHOR** LAWA **PUBLISHED DATE** 21 SEP 2018

What are benthic macroinvertebrates?

Benthic macroinvertebrates are small animals without backbones that live on or just below the stream-bed.

In most streams, the majority of benthic invertebrates are macroinvertebrates, which means they can be seen with the naked eye and range in length from 0.25 mm to 15 cm in the case of a fully grown freshwater crayfish – kōura. Most are the larvae of insects but other groups such as snails, worms and crustaceans are also common.

Benthic macroinvertebrates are sampled for assessing stream health as they play a central role in stream ecosystems by feeding on periphyton (algae), macrophytes, dead leaves and wood, or on each other. Benthic macroinvertebrates are extremely important for processing terrestrial and aquatic organic matter. In turn, they are an important food source for animals further up the food chain, such as wading birds and fish. When the insects become adults they leave the water and become food for animals such as birds, bats, spiders, etc.

How to measure river or stream health using invertebrates

Benthic invertebrate communities are widely used as indicators of stream ecosystem health because they include a wide range of species, each with relatively well-known sensitivity or tolerance to stream conditions. The most common stream health indices are taxa richness, percentage of EPT taxa and the macroinvertebrate community index (MCI).

Macroinvertebrates

Small animal that has no backbone or internal skeleton large enough to be visible to the naked eye (>500µm), such as insects, freshwater crayfish, worms, and snails.
Macroinvertebrates are sampled to provide an indication of stream water quality. Generally, the greater the diversity, the better the water quality in the stream.

Taxa richness

Taxa richness is considered a very coarse indicator of stream health, which is measured by counting the number of different species of invertebrates present in a sample. The benthic invertebrate community typical of pristine conditions has a high variety of species or “taxa”. In general, high taxa richness is considered good, although mildly impacted (nutrient-enriched) rivers can have higher taxa richness than pristine streams and rivers.

EPT

EPT stands for Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) which are macroinvertebrates that are sensitive to water pollution. Because these species are generally found in streams with good water quality, their abundance can give us an idea about how healthy a stream is.
The percentage of EPT-taxa (or %EPT) is most commonly calculated by counting the total number of mayfly, stonefly and caddis fly taxa in a sample, then dividing that number by the taxa richness and multiplying by 100. A high percentage of EPT taxa indicates good stream health. However, in some New Zealand streams there are naturally few mayflies, stoneflies, or caddis flies present.

Macroinvertebrate Community Index (MCI)

MCI stands for Macroinvertebrate Community Index which is an indicator of general river health: excellent >119; good 100-119; fair 80-99; poor <80.
It is a qualitative sampling method, which means it will tell you which species are present or absent in your sample. If you want to know the abundance (i.e., how many) of a certain species are in your sample, you will need to use the Quantitative MCI (QMCI) sampling methodology.

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Percentage of EPT taxa

The invertebrate community is usually dominated by three orders of insects: the mayflies, stoneflies, and caddis flies. Together, these insects are known as EPT, referring to their scientific names Ephemeroptera, Plecoptera and Trichoptera, respectively. These freshwater insects are generally intolerant of pollution, so the fewer found in a sample, the poorer the stream health.

The percentage of EPT-taxa (or %EPT) is most commonly calculated by counting the total number of mayfly, stonefly and caddis fly taxa in a sample, then dividing that number by the taxa richness and multiplying by 100. This is known as the %EPT by taxa.

A high percentage of EPT taxa indicates good stream health. However, in some New Zealand streams there are naturally few mayflies, stoneflies, or caddis flies present. Ecologists need to be aware of these factors when using the %EPT to assess the ecological health of a river or stream.

EPT Index

Some macroinvertebrate orders, such as Diptera (true flies), are generally tolerant to higher levels of pollutants in streams. Other orders, such as Ephemeroptera (mayflies), Plecoptera (stoneflies), and Tricoptera (caddisflies), are very sensitive to many pollutants in the stream environment.

The EPT Richness Index estimates water quality by the relative abundance of three major orders of stream insects that have low tolerance to water pollution.

EPT can be expressed as a percentage of the sensitive orders (E= Ephemeroptera, P= Plecoptera, T= Tricoptera) to the total taxa found.

$$\frac{\text{Total EPT Taxa}}{\text{Total Taxa Found}} \times 100\% =$$

A large percentage of EPT taxa indicates high water quality.

Macroinvertebrate Community Index (MCI)

The MCI is based on the tolerance or sensitivity of species (taxa) to organic pollution and nutrient enrichment. For example, mayflies, stoneflies and caddis flies are sensitive to pollution, and are only abundant in clean and healthy streams, whereas worms and snails are more tolerant and can be found in polluted streams. Most benthic invertebrate taxa were assigned a tolerance value ranging from 1 (very tolerant) to 10 (very sensitive).

An invertebrate sample is typically collected from within a small section of a stream (a reach). Higher MCI scores indicate better stream conditions at the sampled site. In theory MCI values can range between 0 and 200, but in practice it is rare to find MCI values greater than 150 and only extremely polluted or sandy/muddy sites score under 50.

The MCI for a stream site is based on the presence (or absence) of invertebrates. There are different sampling methods that can be used to sample for macroinvertebrates in streams, such as kick-netting of Surber sampling methods, depending on how much information is required.

Important to know

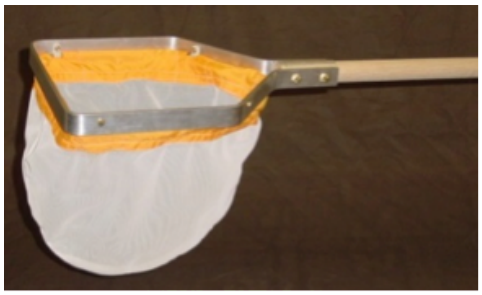
The MCI is designed specifically for stony riffle substrates in flowing water. This means that when interpreting scores some knowledge is needed of the types of instream habitat where the invertebrate samples were collected. For example, some streams in New Zealand naturally do not have high-scoring taxa such as mayflies, stoneflies or caddis flies, which may be due to the geology, climate, flow regime or a natural absence of riverbank vegetation. These streams may have a MCI score indicating "poor" quality (i.e. less than 80), but may not in fact be degraded. To help overcome this problem a set of different tolerance values have been developed to be used for sites with naturally silty, soft-bottom substrates. Ecologists need to be aware of these factors when using the MCI to assess the ecological health of a river or stream.

MCI grading guidelines

In the table below are the grading guidelines for MCI that are used to describe the health of a stream or river:

Quality class	Description	MCI score
	Stream in excellent ecological condition. Indicative of excellent water quality and/or habitat conditions.	>119
	Stream in good ecological condition. Indicative of good water quality and/or habitat conditions.	100 - 119
	Stream in fair ecological condition. Indicative of only fair water quality and/or habitat conditions.	80 - 99
	Stream in poor ecological condition. Indicative of poor water quality and/or poor habitat conditions.	<80

How do I sample benthic macroinvertebrates?



Two common methodologies for sampling macroinvertebrates are kick-netting (sometimes called hand-netting) and Surber sampling (see examples of sampling equipment for each of these techniques below). Which method to use depends on the reason for collecting the samples.

Example of a kick-net (left) and a Surber sampler (right).

Kick-nets are generally used when you want to know about the diversity of invertebrates or the general ecological health of a stream or river. Kick-netting is a semi-qualitative sampling technique, where the sample is not collected from a defined area of streambed.

A Surber sampler is used when you want to know the number of invertebrates in a defined area of streambed, for example per square metre. This is important if you want to understand how productive a stream or river is.

What else needs to be considered when sampling for benthic macroinvertebrates?

Timing

In New Zealand, the presence or absence or the amount of different invertebrate groups does not generally vary between seasons, so communities can be sampled at any time of the year for use of stream health indices such as EPT taxa richness and the MCI. However, to effectively compare sites and consider long-term trends, it is important to sample during the same season each year (typically summer) as other environmental influences on invertebrate communities can affect the presence and number of animals. For example, the amount of freshwater algae can affect the kind of aquatic invertebrates that make up a macroinvertebrate community and river flows such as floods can wash animals out, reducing the numbers found. Invertebrates are generally not sampled within 2 - 3 weeks following a large flood to allow the macroinvertebrate communities time to recover.

Habitat considerations

The diversity and density of invertebrates can vary a lot within a stream. For example, there will be a greater variety and number of invertebrates in shallow, swift riffles than in deep, slow-flowing pools; and invertebrates that inhabit the slower flowing margins of a steam may be different to those in swifter areas. It is therefore important to give thought to where in the stream invertebrates are being collected from.

Where do I find more information?

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https://www.lawa.org.nz/learn/factsheets/benthic-macroinvertebrates/