BENTHIC MACROINVERTEBRATE METRIC REFERENCE GUIDE

	Metric	Calculation & Description	Response to Disturbance
Richness metric	**Total Richness**  Microscopic view of a variety of taxa, Photo ECCC CABIN	Total number of unique taxa identified at the selected taxonomic level (i.e. order, family, genus, species). Richness of a stream can decline as flow regimes are altered, habitat is lost, chemicals are introduced, energy cycles are disrupted, and alien taxa invade.	There is usually a decrease of intolerant taxa and increase of tolerant taxa. 
Richness metric	**Ephemeroptera taxa**  Heptageniidae mayfly, Photo credit: Society for Freshwater Science image library leclair001 Licensed under CC BY-NC-SA 2.0	Ephemeroptera is an order of insects commonly known as mayflies. Richness is calculated by counting the number of unique Ephemeroptera taxa in this order at the selected taxonomic level (family, genus or species) Large numbers of these short-lived adult insects tend to appear in late spring/early summer, hence the common name mayflies. The aquatic stages feed on organic matter such as algae and leaf litter, and are an important food source, along with adults, for fish and other aquatic predators. Their larval stages are pollution-sensitive.	The richness of Ephemeroptera taxa is expected to decrease in response to disturbance. 
Richness metric	**Plecoptera taxa**  Perlodidae, *Baumanella sp.*, Photo credit: Society for Freshwater Science image library buchwalter001 Licensed under CC BY-NC-SA 2.0	Plecoptera is an order of insects commonly known as Stoneflies. The richness of Plecoptera is calculated by counting the number of unique taxa in this order at the selected taxonomic level (family, genus or species). The nymphs, which are found in cooler, unpolluted streams and rivers, both prey on other aquatic invertebrates and consume plant matter.	The richness of Plecoptera taxa is expected to decrease in response to disturbance. 

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Richness metric	**Trichoptera taxa**  Hydroptilidae, Photo by ECCC CABIN	Trichoptera is an order of insects commonly known as caddisflies. The richness of Trichoptera is calculated by counting the number of unique taxa in this Order at the selected taxonomic level (family, genus or species). The pollution-sensitive aquatic larvae use silk to make protective cases reinforced with items such as sand, gravel, and plant material. Feeding strategies vary between species.	The richness of Trichoptera taxa is expected to decrease in response to disturbance. ⇩
Richness metric	**Diptera taxa**  Diptera, *Tipula abdominalis,* Photo credit: Andrew Hoffman licensed under CC BY-NC-ND 2.0.	Diptera is an order of insects commonly known as flies. The richness of Diptera is calculated by counting the number of unique taxa in this order at the selected taxonomic level (family, genus or species). Flies are a large and diverse group of insects and tend to be more pollution tolerant; high Diptera richness may indicate a water quality issue.	The richness of Diptera taxa is expected to increase with disturbance. ⇧
Richness metric	**Odonata taxa**  Odonata, *Ophiogomphus sp.,* Photo by ECCC CABIN	Odonata is an order of insects comprised of damselflies and dragonflies. The richness of Odonata is calculated by counting the number of unique taxa in this order at the selected taxonomic level (family, genus or species). Odonata are commonly found in standing waters or slow-moving streams. They are predators and may range in pollution sensitivity depending on the families present.	The richness of Odonata taxa is expected to generally decrease in response to disturbance. ⇩

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Richness metric	**Coleoptera taxa**  Coleoptera, *Oreodytes scitulus* adult, Photo by ECCC CABIN	Coleoptera are an order of insects commonly known as beetles, many of which are aquatic or semi-aquatic. The richness of Coleoptera is calculated by counting the number of unique taxa in this order at the selected taxonomic level (family, genus or species). Beetles are highly mobile and common in all freshwater environments. They are generally considered pollution sensitive.	The richness of Coleoptera taxa is expected to decrease with disturbance. 
Richness metric	**Chironomidae taxa (genus level only)**  *Chironomus sp.* (Chironomidae), Photo Credit: B. Schoenmakers at waarneming.nl, a source of nature observations in the Netherlands. licensed under CC BY 3.0	Chironomidae is a family within the Diptera order commonly known as midges. The richness of Chironomidae is calculated by counting the number of unique taxa in this family at the genus level only. Chironomidae are often the most abundant family in any freshwater environment. They are generally pollution tolerant, although some species are more or less sensitive.	The richness of Chironomidae taxa may increase or decrease in response to disturbance. 

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Richness metric	**Evenness**	Evenness is an index of the relative abundance of various taxa. **Simpson's Evenness** $E = \left(1 \Big/ \sum_{i=1}^{S} P_i^{2}\right) \Big/ S$ using $P_i = x_i \Big/ \sum_{i=1}^{S} x_i$ Where $P_i = x_i/\text{sum}(x_i)$ and x_i=abundance of species. **Pielou's Evenness** $j = \frac{H'}{LnS}$ Where: S=the total number of species, and LnS=natural logarithm of total taxa richness.	Even communities are an indicator of good water quality. Evenness is expected to decrease in response to disturbance. ⇩
Richness metric	**Diversity**	**Shannon-Weiner Diversity** $H = -\sum_{i=1}^{S} P_i LnP_i$ Where: S = the total number of species, and P_i = the proportion of S made up of the i_{th} species (i.e., n_i/N). Shannon-Weiner Diversity is an index that represents the proportion of different species in a population. Higher values indicate that individuals are occurring in similar numbers between species, while lower values indicate a less even distribution of individuals between species. **Simpson's Diversity** $D = 1 - \sum_{i=1}^{S} \left(n_i \big/ N\right)^2$ Where: S = the total number of taxa in the sample; n_i=count of the i_{th} taxa; N = count of all taxa. Simpson's Diversity is an index used to measure the number of taxa present as well as the relative abundance of individuals in each taxa. As taxa richness and diversity increases, so does Simpson's Diversity.	Diverse communities are an indicator of good water quality. Diversity indices are expected to decrease in response to disturbance. ⇩

	Metric	Calculation & Description	Response to Disturbance
No. Individuals	**Total Abundance**	Sum of all organisms present at the selected taxonomic level. Total abundance is estimated based on the extrapolated subsample count from a 3-minute kick net sample. It is standardized by sampling effort, not by area.	Abundance may increase or decrease in response to disturbance. ⇳
No. Individuals	**% EPT**	$\left(\frac{\sum EPT\ individuals}{\sum all\ individuals}\right) * 100$ These three orders have a low tolerance to water pollution; high numbers of EPT taxa generally indicate good water quality. The absence of any one of the three EPT groups at a site is significant, as they are typically the most sensitive to habitat disturbance.	The % EPT individuals is expected to decrease in response to disturbance. ⇩
No. Individuals	**% Ephemeroptera**	$\left(\frac{\sum Ephemeroptera\ individuals}{\sum all\ individuals}\right) * 100$ Ephemeroptera are an order of insects commonly known as mayflies, due to the large numbers of short-lived adults which appear in late spring/early summer. Nymphs feed on organic matter such as algae and are an important food source, along with adults, for fish and other aquatic predators. Their larval stages are pollution-sensitive.	% Ephemeroptera is expected to decrease in response to disturbance. ⇩
No. Individuals	**% Plecoptera**	$\left(\frac{\sum Plecoptera\ individuals}{\sum all\ individuals}\right) * 100$ Plecoptera are an order of insects commonly called stoneflies. The nymphs, which are found in cooler, unpolluted streams and rivers, prey on other aquatic invertebrates and consume plant matter.	% Plecoptera is expected to decrease in response to disturbance. ⇩

	Metric	Calculation & Description	Response to Disturbance
No. Individuals	**% Trichoptera**	$$\left(\frac{\sum Trichoptera\ individuals}{\sum all\ individuals}\right) * 100$$ Trichoptera are an order of insects commonly known as caddisflies. The pollution-sensitive aquatic larvae use silk to make protective cases reinforced with items such as sand, gravel, and plant material. Feeding strategies vary between species.	% Trichoptera is expected to decrease in response to disturbance. ⇩
No. Individuals	**No. EPT individuals/Chironomids+EPT Individuals**	$$\left(\frac{\sum EPT\ individuals}{\sum Chironomidae\ individuals + \sum EPT\ individuals}\right) * 100$$ The ratio of the abundance of the sensitive EPT orders to the generally tolerant Chironomidae family is a measure of pollution tolerance. A low number close to 0 indicates poor water quality.	The ratio of EPT to Chironomidae taxa count is expected to decrease as disturbance increases. ⇩
No. Individuals	**% Trichoptera that are Hydropsychidae**	$$\left(\frac{\sum Hydropsychidae\ individuals}{\sum Trichoptera\ individuals}\right) * 100$$ Hydropsychidae are a family in the order Trichoptera that tend to be more tolerant than other families in the order. A high proportion of Hydropsychidae taxa may indicate poor water quality.	% Trichoptera that are Hydropsychidae is expected to increase in response to disturbance. ⇧
No. Individuals	**% Ephemeroptera that are Baetidae**	$$\left(\frac{\sum Baetidae\ individuals}{\sum Ephemeroptera\ individuals}\right) * 100$$ Baetidae are a family in the order Ephemeroptera that tend to be more tolerant than other families in the order. A high proportion of Baetidae may indicate poor water quality.	% Ephemeroptera that are Baetidae is expected to increase in response to disturbance. ⇧

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No. Individuals	**% Chironomidae**	$\left(\frac{\sum \textit{Chironomidae individuals}}{\sum \textit{all individuals}}\right) * 100$ Chironomidae are often the most abundant family in any freshwater environment. Pollution tolerance varies widely between species, though they are generally pollution tolerant.	% Chironomidae may increase or decrease in response to disturbance. ⇳
No. Individuals	**% Coleoptera**	$\left(\frac{\sum \textit{Coleoptera individuals}}{\sum \textit{all individuals}}\right) * 100$ Coleoptera are an order of insects commonly known as beetles, many of which are aquatic or semi-aquatic. Coleoptera are generally considered pollution sensitive.	% Coleoptera is expected to decrease with disturbance. ⇩
No. Individuals	**% Odonata**	$\left(\frac{\sum \textit{Odonata individuals}}{\sum \textit{all individuals}}\right) * 100$ Odonata are an order of insects comprised of damselflies and dragonflies. Nymphs live underwater and prey on other aquatic insects.	% Odonata taxa is expected to generally decrease in response to disturbance. ⇩
No. Individuals	**% Tribe Tanytarsini**  Tanytarsini, *Tanytarsus sp*. Photo by ECCC CABIN	$\left(\frac{\sum \textit{Tanytarsini individuals}}{\sum \textit{all individuals}}\right) * 100$ Tanytarsini are a tribe of midge larvae found in streams and rivers and are a well-represented group in freshwaters. High numbers of these short-lived taxa indicate intermittent flow pattern and/or sedimentation.	% Tanytarsini is expected to increase in response to disturbance. ⇧

	Metric	Calculation & Description	Response to Disturbance
No. Individuals	**% Diptera + Non-insects**	$\left(\frac{\sum Diptera\ individuals + \sum non\ insect\ individuals}{\sum all\ individuals}\right) * 100$ Dipterans and non-insect taxa represent many of the pollution tolerant taxa found in benthic communities. The metric is any individual in the Diptera order, plus any organism in any order not listed below: Collembola Ephemeroptera Odonata Plecoptera Heteroptera Megaloptera Neuroptera Trichoptera Lepidoptera Coleoptera	% Diptera + Non-insect individuals are expected to increase in response to disturbance. ⇧
No. Individuals	**% of dominant taxa** (% top 2 dominant taxa % top 5 dominant taxa)	$\left(\frac{\sum dominant\ taxa\ individuals}{\sum all\ individuals}\right) * 100$ Dominant taxa are those which have the largest number of individuals in a sample. There may be a water quality issue in a site when a large proportion of a sample is composed of a few taxa. Opportunistic taxa that can tolerate a wider range of habitat types may come to dominate the community, replacing other taxa with specific habitat or feeding needs.	The % of the five-, and two-, most dominant species in the community is expected to increase in response to disturbance. ⇧
Functional Measure	**% Gatherers**	$\left(\frac{\sum gatherer\ individuals}{\sum all\ individuals}\right) * 100$ Gatherers are organisms that feed primarily on fine organic matter deposited in the water.	The proportion of gatherers is expected to increase at a site in response to disturbance. ⇧

	Metric	Calculation & Description	Response to Disturbance
Functional Measure	**% Predators**	$\left(\frac{\sum predator\ individuals}{\sum all\ individuals}\right) * 100$ Predators are organisms that feed primarily on other organisms found in their environment.	The proportion of predators is expected to decline at a site in response to disturbance. ⇩
Functional Measure	**% Filterers**	$\left(\frac{\sum filterer\ individuals}{\sum all\ individuals}\right) * 100$ Filterers are organisms that collect fine, floating organic material from the water column.	The proportion of filterers is expected to increase at a site in response to disturbance. ⇧
Functional Measure	**% Scrapers**	$\left(\frac{\sum scraper\ individuals}{\sum all\ individuals}\right) * 100$ Scrapers are grazing organisms that consume algae from material in the water.	The proportion of scrapers is expected to decrease at a site in response to disturbance. ⇩
Functional Measure	**% Shredders**	$\left(\frac{\sum shredder\ individuals}{\sum all\ individuals}\right) * 100$ Shredders are organisms that feed on leaf litter and coarse particulate organic matter.	The proportion of shredders is expected to decrease at a site in response to disturbance. ⇩

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Functional Measure	**Number of clingers**	Count of the number of unique taxa in the sample that cling to rock surfaces. These organisms are physically adapted to hold on to substrate in running water and typically live in the gaps between rocks and cobble on streambeds. When fine sediments fill these microhabitats, expect the number of clinger species to decrease. Common clingers include Simuliidae (blackflies), Ephemerellidae (mayflies), and Perlodidae (stoneflies).	The number of clinger taxa is expected to decrease in response to disturbance ⇩
Biotic Indicator	**Long-lived taxa**	Count of the number of unique taxa that need more than 1 year to complete their life cycle. These taxa, which include groups such as Perlidae (stoneflies) and Megaloptera, have been exposed to conditions in the water over a longer period and are helpful for providing information on historical and current water quality conditions.	The number of long-lived taxa is expected to decrease in response to disturbance. ⇩
Biotic Indicator	**Intolerant taxa**	Count of the number of unique taxa considered to be intolerant to pollution. These taxa are most sensitive to disturbance from organic pollution using Hilsenhoff Biotic Indices. Values are also specific to the geographic and regional area for which they are developed. Tolerance values can be determined at family or genus level.	Intolerant taxa count is expected to decrease as disturbance increases. ⇩
Biotic Indicator	**% Tolerant individuals**	Proportion of tolerant individuals in the sample. Tolerant taxa are better able to withstand poor water quality and disturbance from organic pollution using Hilsenhoff Biotic Indices. Values are also specific to the geographic and regional area for which they are developed. Tolerance values can be determined at family or genus level.	The % Tolerant individuals is expected to increase in response to disturbance. ⇧

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Biotic Indicator	**Hilsenhoff Biotic Index**	This index uses tolerance values for each taxa, and abundance of those taxa. $$HBI = \sum_{i=1}^{S} n_i \, {t_i}/{N}$$ Where: n=number of individuals of the i_{th} species, t=tolerance value of i_{th} species, and N=total number of individuals. Tolerance values are primarily based on responses to organic pollutants. Sensitive taxa receive low scores, and tolerant species receive high scores. This index will output a value between 0 and 10, where 0 indicates excellent water quality and 10 indicates very poor water quality.	The Hilsenhoff Index value is expected to increase in response to disturbance.