Appendix F

SNEP IBI Metric Response Mechanisms

Metrics in the SNEP low gradient IBI were selected for inclusion in the index based on performance statistics (DE and Z-score), response mechanisms, and metric diversity (metrics representative of many metric categories). The recommended IBI consists of metrics representative of relative taxonomic richness, community composition, pollution tolerance, functional feeding groups, and voltinism. The IBI input metrics (Table F1) have comprehensible mechanisms of response to increasing environmental stress, as described below. Interpretable metrics provide easier interpretation of assemblage structure in relation to index scores. Taxa attributes related to the metrics are in Attachment B.

Table F1. Metrics included in the low gradient IBI.

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| Metric (abbrev) |
| % Plecoptera, Odonata, Ephemeroptera, and Trichoptera (POET) taxa (pt\_POET) |
| % Predator taxa (pt\_ffg\_pred) |
| % Non-insect taxa (pt\_NonIns) |
| % Odonata, Ephemeroptera, and Trichoptera (OET) individuals (pi\_OET) |
| % Tolerant taxa (pt\_tv\_toler) |
| % Semivoltine taxa (pt\_volt\_semi) |

**% Non-insect taxa (pt\_nonIns)**

*Description:* Of all taxa, the percentage of taxa that are non-insects

Taxa richness generally decreases with increasing stress, as the sensitive and specialist taxa emigrate or perish when exposed to intolerable conditions such as pollution, greater sedimentation, or reduced food quality. Non-insects (primarily gastropods, bivalves, crustaceans, and worms) can be tolerant or take advantage of stresses, and therefore, an increase in relative richness indicates the presence of disturbance. Relative richness of non-insects can increase either when non-insect taxa increase or when insect taxa decrease.

*Metric Category:* Relative Richness

*Trend:* Expected to increase with stress and increases in the SNEP dataset.

*References:* Barbour et al. 1999; Yuan and Norton 2003

**% POET taxa (Plecoptera, Odonata, Ephemeroptera, and Trichoptera) (pt\_POET)**

*Description:* Of all taxa, the percentage of taxa that are in the insect orders Plecoptera (stoneflies), Odonata (dragonflies and damselflies), Ephemeroptera (mayflies), and Trichoptera (caddisflies)

In riffle dominated streams, EPT taxa are generally sensitive to environmental degradation such as reduced dissolved oxygen, unstable substrates, reduced food quality, and contamination due to heavy metals and other pollutants. EPT are also sensitive in low gradient streams and Odonata (dragonflies) can be a fourth sensitive insect order. As environmental conditions become worse, the sensitive and specialist taxa of these insect orders will emigrate or perish.

*Metric Category:* Relative Richness

*Trend:* Expected to decrease with stress and decreases in the SNEP dataset.

*References:* Angradi 1999; Barbour et al. 1999; Yuan and Norton 2003; Hutchens et al. 2009; Steele 2013; Onana et al. 2019; Gomez-Tolosa et al. 2020

**% OET individuals (Percent of Odonata, Ephemeroptera, and Trichoptera individuals) (pi\_OET)**

*Description:* Of all individuals, the percentage of individuals that are in the insect orders Odonata (dragonflies and damselflies), Ephemeroptera (mayflies), and Trichoptera (caddisflies)

The stressor mechanisms described for % POET taxa also affect the relative abundance of sensitive insect individuals in a stream. Plecoptera (stoneflies) are more meaningful as a presence/absence signal than they are as a relative abundance signal because they are usually not abundant in low gradient streams. Therefore, this metric does not include stoneflies. The sensitive and specialist individualsof the dragonfly, mayfly, and caddisfly insect orders emigrate or perish with increasing stress.

*Metric Category:* Composition

*Trend:* Expected to decrease with stress and decreases in the Michigan dataset.

*References:* Angradi 1999; Barbour et al. 1999; Yuan and Norton 2003; Hutchens et al. 2009; Steele 2013; Onana et al. 2019; Gomez-Tolosa et al. 2020

**% Predator taxa (Percent taxa of the predator (PR) Functional Feeding Group) (pt\_ffg\_pred)**

*Description:* Of all taxa, the percentage of taxa that consume other organisms using different strategies to capture them

Predators employ a diversity of strategies for capturing prey, including modified mouth parts and behavior. Some species of invertebrates are predators in both the larval and adult stages of their life.

*Metric Category:* Functional Feeding Groups

*Trend:* Expected to decrease with stress and decreases in the SNEP dataset.

*References:* Kerans and Karr 1994; Merritt et al. 2008; Hutchens et al. 2009; Xu et al. 2014; Lan Fu et al. 2016;

**% Tolerant taxa (Percent tolerant taxa with tolerance value ≥ 7) (pt\_tv\_toler)**

*Description:* Of all taxa, the percentage of taxa that are relatively tolerant to stressors

Taxa respond differently to environmental stressors, therefore, can be arranged on a continuum from intolerant to tolerant. Intolerant taxa will emigrate or perish as environmental conditions worsen. Conversely, tolerant taxa may not respond negatively to environmental conditions and may actually increase as niches open from extirpated intolerant taxa.

*Metric Category:* Tolerance

*Trend:* Expected to increase with stress and increases in the SNEP dataset.

*References:* Hilsenhoff 1987; Yuan 2006; Megan et al. 2007; USGS 2013

**% Semivoltine taxa (Percent Semivoltine taxa) (pt\_volt\_semi)**

*Description:* Of all taxa, the percentage of taxa that require more than one year in a reproduction cycle

Taxa respond differently to environmental stressors, therefore, can be arranged on a continuum from intolerant to tolerant. Intolerant taxa will emigrate or perish as environmental conditions worsen. Conversely, tolerant taxa may not respond negatively to environmental conditions and may actually increase as niches open from extirpated intolerant taxa.

*Metric Category:* Voltinism

*Trend:* Expected to increase with stress and increases in the SNEP dataset.

*References:* Barbour et al. 1994; Dole´dec et al. 2006; Statzner and Beˆche 2010

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