**Supplementary Materials 1-2**

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**- Article**

**biomonitoR: an R package for managing ecological data and calculating biomonitoring indices**

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 **SM1 – Reference datasets in biomonitoR**

The reference taxonomic dataset is fundamental to get the most from biomonitoR. It allows to i) calculate most indices at different taxonomic level effortless and ii) to check for misspelled taxa names and to suggest correct names. biomonitoR comes with three ways to construct a reference dataset.

**Built-in taxonomic datasets**

Four datasets for diatoms, macrophytes, macroinvertebrates and fish are currently available.

* **Diatoms:** Diat.barcode-release-version 10.1.xlsx (2021-06-25) (Rimet et al., 2019).
* **Macrophytes:** taxonomic information was retrieved from freshwaterecology.info version 7.0 and modified to fit with the biomonitoR format. Species aggregation, undescribed species, lineages were removed to better fit with biomonitoR. Synonyms were replaced with accepted names.
* **Macroinvertebrates:** taxonomic information was retrieved from freshwaterecology.info version 7.0 and modified to fit with the biomonitoR format. Species aggregation, undescribed species, lineages were removed to better fit with biomonitoR.
* **Fish:** Fishbase version 18.07 with additional checks using the Eschmeyer dataset (https://www.calacademy.org/scientists/projects/catalog-of-fishes).

**Functions to retrieve taxonomic information from online resources**

There are currently four functions to retrieve taxonomic information from online resources for any biotic group. New functions will be added in the future targeting online resources different from those already implemented.

* get\_gbif\_taxa\_tree: it relies on the Global Biodiversity Information Facility (GBIF, <https://www.gbif.org/>). This function automatically replaces synonyms with accepted names.
* get\_iucn\_taxa\_tree: it relies on the International Union for Conservation of Nature (IUCN) red list of threatened species (https://www.iucnredlist.org/). Its usage is recommended for taxa included in the Red Lists. This function necessitates of token to work properly.
* get\_nbn\_taxa\_tree: it relies on the National Biodiversity Network of UK (NBN, <https://nbnatlas.org/>).
* get\_worms\_taxa\_tree: it relies on the World Register of Marine Species (WoRMS, <https://www.marinespecies.org>).

**Users’ datasets**

**Taxonomic reference dataset**

Users can build their own reference dataset in the biomonitoR format using a standard taxonomic tree and the function ref\_from\_tree. See supplementary material 3 and the function documentation for a usage example.

**Functional information dataset**

See Supplementary Material 3 (R File) for usage examples from Poff et al. 2006 (trait information from North American insects) and Sarremejane et al. 2020 (European aquatic macroinvertebrates).

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**Table SM2.** List of the main metrics available in biomonitoR. Target group, aims, methodologic refences and examples of applications are also provided. SEA= Supporting Ecological Assessment; BD=Biodiversity assessment; SP=Single Pressure: MI= Macroinvertebrates; MP= Macrophytes.

Metric glossary: BMWP=Biological Monitoring Working Party; ASPT=Average Score Per Taxon; IBMWP=Iberian Biological Monitoring Working Party; IASPT= Iberian Average Score Per Taxon; EPT=Ephemeroptera, Plecoptera, Trichoptera; Log10(SEL\_EPTD+1) = Logarithm of the selected families of Ephemeroptera, Plecoptera, Trichoptera and Diptera plus 1; 1-GOLD= 1 minus the relative abundance of Gastropoda, Oligochaeta and Diptera; WHPT= Walley, Hawkes, Paisley and Trigg; IBMR= Macrophyte Biological Index for Rivers; LIFE= Lotic-invertebrate Index for Flow Evaluation; PSI= Proportion of Sediment-sensitive Invertebrates; EPSI= Empirically-weighted PSI; ACI= Abundance Contamination Index; RCI= Richness Contamination Index; SBCI= Site-specific Biocontamination Index.

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| --- | --- | --- | --- | --- | --- |
| **Index/metric** | **Target group** | **Aims** | biomonitoR**function** | **Methodologic reference** | **Index application examples**  |
| TOTAL TAXA | All components | SEA /BD | richness, allrich | Buss et al. 2015 | Italy, Morocco, Spain: Gutiérrez-Cánovas et al. 2019  |
| BMWP  | MI | SEA | bmwp | Hawkes 1998 | UK: Clarke et al. 2002 |
| ASPT | MI | SEA | aspt | Hawkes 1998 | UK: Clarke et al. 2002 |
| IBMWP | MI | SEA | bmwp | Alba Tercedor et al. 2002 | Spain: Bruno et al. 2014 |
| IASPT | MI | SEA | aspt | Alba Tercedor et al. 2002 | Spain and Italy: Guareschi et al. 2017 |
| EPT | MI | SEA | ept, get\_taxa\_richness | Kitchin 2005 | Australia: Wright and Ryan, 2016 |
| Log10(SEL\_EPTD+1) | MI | SEA | eptd | Erba et al. 2006 | Spain: Munné and Prat, 2009Italy: Laini et al. 2018. |
| 1-GOLD | MI | SEA | igold | Pinto et al. 2004 | Italy: Laini et al. 2018. |
| WHPT | MI | SEA | whpt | Paisley et al. 2014 | UK: Guareschi et al. 2021a |
| WHPT-ASPT | MI | SEA | whpt | Paisley et al. 2014 | UK: Guareschi et al. 2021a |
| IBMR | MP | SEA | ibmr | Haury et al. 2006 | Cyprus, France, Greece, Italy, Portugal, Spain: Aguiar et al. 2014 |
| LIFE | MI | SP: flow variation | life | Extence et al. 1999 | UK: Monk et al. 2008 |
| Flow-T | MI | SP: flow variation | fuzzy\_trait\_ratio | Laini et al. 2022 | UK, Italy, Cyprus: Laini et al. 2022 |
| DEHLI | MI | SP: drought effects | dehli | Chadd et al. 2017 | UK: Chadd et al. 2017 |
| PSI | MI | SP: sedimentation | psi | Extence et al. 2013 | UK: Extence et al. 2017 |
| EPSI | MI | SP: sedimentation | epsi | Turley et al. 2016 | UK: Wilkes et al. 2017 |
| RCI | All components | SP: biocontamination | bioco | Arbačiauskas et al. 2008 | UK: Guareschi et al. 2021b |
| ACI | All components | SP: biocontamination | bioco, get\_taxa\_abundance | Arbačiauskas et al. 2008 | UK: Guareschi et al. 2021b |
| SBCI | All components | SP: biocontamination | bioco | Arbačiauskas et al. 2008 | Russia: Son et al. 2020 |
| Functional Richness | All components | BD: functional | f\_rich | Villeger et al. 2008 | Spain: Belmar et al. 2019 |
| Functional Redundancy | All components | BD: functional | f\_red | Pillar et al. 2013 | Spain: Bruno et al. 2016 |
| Functional Diversity | All components | BD: functional | f\_divs | Petchey and Gaston 2006 | UK: Mathers et al. 2020 |
| Functional Dispersion | All components | BD: functional | f\_disp | Villeger et al. 2008 | UK: Mathers et al. 2020 |
| Functional Evenness | All components | BD: functional | f\_eve | Villeger et al. 2008 | UK: Mathers et al. 2020 |
| Community trait specialization | All components | BD: functional | csi | Mondy and Usseglio-Polatera 2013 | France, Spain:Dolédec et al. 2017 |
| Shannon  | All components | BD: taxonomic | shannon, allindices | Shannon 1949 | Spain: Mellado et al. 2019 |
| Pielou index | All components | BD: taxonomic | pielou, allindices | Pielou 1966 | France: Biesel et al. 2003 Finland: Heino et al. 2007 |
| Margalef Diversity | All components | BD: taxonomic | margalef, allindices | Magurran and McGill 2010 | France:Thiebaut et al. 2006Ireland:Gray and Delaney 2008 |
| Menhinick Diversity | All components | BD: taxonomic | menhinick, allindices | Magurran and McGill 2010 | Ireland:Gray and Delaney 2008 |
| Brillouin index | All components | BD: taxonomic | brillouin, allindices | Magurran 2004 | Ireland:Gray and Delaney 2008 |
| Simpson index | All components | BD: taxonomic | simpson, invsimpson, allindices | Magurran 2004 | France:Thiebaut et al. 2006Ireland:Gray and Delaney 2008 |
| Simpson evenness | All components | BD: taxonomic | esimpson, allindices | Magurran 2004 | Netherlands: Verdonschot et al. 2012 |
| Berger-Parker index | All components | BD: taxonomic | berpar, invberpar, allindices | Magurran 2004 | UK: Wood et al. 2005 |
| McIntosh diversity | All components | BD: taxonomic | mcintosh, allindices | Magurran 2004 | France: Guerold 2000 |
| Fisher alpha | All components | BD: taxonomic | fisher, allindices | Magurran 2004 | Switzerland: Burdon et al., 2016 |
| Taxonomic diversity | All components | BD: taxonomic/phylogenetic | dness | Clarke and Warwick 1998 | Finland: Heino et al. 2007 |
| Taxonomic distinctness | All components | BD: taxonomic/phylogenetic | dness | Clarke and Warwick 1998 | Finland: Heino et al. 2005, Heino et al. 2007 |
| Variation of taxonomic distinctness | All components | BD: taxonomic/phylogenetic | dness | Clarke and Warwick 2001 | Ireland: Leira et al. 2009Finland: Heino et al. 2007 |

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