

## Publication

### Application of macroinvertebrate multimetrics as a measure of the impact of anthropogenic modification of spring habitats

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**Author(s)** Pešić, Vladimir; Dmitrović, Dejan; Savić, Ana; Milošević, Durad; Zawal, Andrzej; Vukašinović-Pešić, Vesna; Von Fumetti, Stefanie

**Author(s) at UniBasel** [von Fumetti, Stefanie](#) ;

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Springs are distinct freshwater habitats that are threatened globally by human impacts, but are not included in standard freshwater assessment tools. This study analysed how the standard macroinvertebrate metrics currently used in biomonitoring programmes for running waters perform in springs with similar ecological qualities but with a different degree of hydromorphological modification. Macroinvertebrate assemblages were analysed in 50 riparian springs along the Crvcka River in the Dinaric karst. Most metrics analysed (ASPT, EPTfam, PTHfam, BMWP, STAR\_ICMi, and Spring\_ICMi) showed significant differences between hydromorphologically modified and natural, i.e. unmodified, springs. A selforganizing map (SOM), an unsupervised artificial neural network, was used for patterning and visualizing 10 environmental parameters and the metrics analysed. Most macroinvertebrate metrics, besides IBE (which did not show any pattern) and PTHfam (which showed an opposite trend), had significantly lower values in the spring group with the highest electrical conductivity and the lowest discharge. The study showed that hydromorphological modification does not necessarily lead to a loss of crenobiontic species, provided that the discharge and substrate composition remain suitable. Future coordinated conservation strategies must take into account the fact that spring species assemblages are sensitive to habitat structure and organic pollution, as has been achieved in Europe for rivers assessed under the Water Framework Directive. Using multimetric indices, such as the new Spring\_ICMi, may help to provide a framework for assessing the response of macroinvertebrate assemblages to human impacts. They may also help in assessing the success of measures used for the conservation and restoration of these threatened but highly valuable habitats. Further investigations should verify the suitability of such metrics in assessing the deterioration of springs globally.

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