



## **Effectiveness of birds, butterflies, dragonflies, damselflies and invertebrates as indicators of freshwater ecological integrity**

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Human activities such as mining and agriculture are among the major threats to biodiversity globally. Discharges from these activities have been shown to negatively affect ecological processes, leading to ecosystem degradation and species loss across biomes. Freshwater systems have been shown to be particularly vulnerable, as discharges tend to spread rapidly here than in other ecosystems. Hence, there is need to routinely monitor the quality of these systems if impacts of discharges from human activities are to be minimised. Besides the use of conventional laboratory techniques, several studies have recently shown that organisms such as birds, butterflies, dragonflies, damselflies and invertebrates are also good indicators of ecological integrity and should therefore be used as alternatives to monitoring the quality of various ecosystems. However, most of these studies have only studied one or two of these organisms against ecosystem health, and it remains unclear whether all of them respond similarly to changes in different drivers of environmental change. We investigated the response of the diversity of birds, butterflies, dragonflies, damselflies and invertebrates to changing water quality along the Kafue River in Zambia. Sampling was done at 13 different sampling points stretching over a distance of 60Km along the river. At each point, both the diversity of each organism and the water quality were assessed. Water quality was determined by testing its temperature, pH, redox, electrical conductivity, turbidity and copper parameters. We then tested how the diversity of each organism responded to changes in these water parameters. All water parameters varied significantly across sampling points. The diversity of birds and damselflies remained unaffected by any of the water parameters used. However, the diversity of butterflies reduced with increasing pH, turbidity and copper, albeit it remained unaffected by other water parameters. The diversity of dragonflies reduced with increasing redox, electrical conductivity and turbidity, but remained unaffected by other water parameters. The diversity of invertebrates reduced with increasing redox and copper, but remained unaffected by other water parameters. Generally, these results suggest that these organisms, especially butterflies, dragonflies and invertebrates can indeed be used as indicators of changing water quality and ecological integrity in particular. However, their use is limited to specific, rather than, all water parameters. Therefore, the decision as to which organisms to use should largely depend on which water quality parameters are to be tested.

Key words: temperature; pH; redox; electrical conductivity; turbidity; copper