

Abstract

Modelling of environmental flows of the Flint River in reaches with different degrees of hydromorphological degradation

In the framework of this work, environmental flow values (Q_{sr}) for macroinvertebrates were determined and analyzed. Additionally, several important issues related to the estimation of Q_{sr} and the weighted usable area of habitats for the examined group of organisms were studied. The analyses were carried out for two reaches of the Flint River with different degrees of degradation. The first one was of natural character, while the second one was characterized by a strong degree of transformation expressed by a clear hydromorphological degradation. The method of habitat suitability modelling (HSM) was used for the analyses and determination of environmental flows. Individual steps of HSM model development were performed using independent hydraulic models as well as statistical and GIS analyses. 2D hydraulic models were prepared in the HEC-RAS program, while the relationship between the distribution of organisms and water flow velocities, depths and bottom substrate was reflected by habitat suitability curves (HSC). In the last step of the development of HSM models, the ArcGIS program was used to prepare a tool for reclassification of hydraulic modelling results based on HSC curves.

The HSM models were used to perform analyses, which were divided into three parts. In the first one analyzed the differences in the values of environmental flows between the two research sections. In the second part the analysis of the possibility of transferring the habitat suitability criteria from the natural to the degraded section was performed. In both parts of the study was carried out for all the designated organisms as well as after taking into account additional functional feeding groups. In the last part of the study, a change in the weighted usable area of habitats over time was analyzed. In particular, the length of periods when the area was lower than the low average value over many years and limit values defining the range of environmental flows were taken into account.

The results obtained indicated that there are no significant differences in the species structure of macroinvertebrate communities between research reaches. However, the obtained mean values of Q_{sr} in section B were statistically significantly higher than those obtained for section A, and the main element influencing the differences were morphological conditions. Additionally, the obtained values of Q_{sr} were significantly higher than the inviolable flow determined by the Kostrzewa method, and the most demanding guild in terms of the environmental flow values were the filtrators. Analyses in the second part of the study showed that after taking into account the division of organisms into functional feeding groups, the transferability of habitat suitability criteria between sections is weak. This result was influenced by the difference in diversity and availability of useful habitats between the sections. Analyses of changes in the average value of WUA over time showed that the trend line over the 1951-2019 period showed no significant upward or downward trend. A similar result was obtained for the number of days when the WUA values for all macroinvertebrates were lower than the average low value from many years and Q_{sr} limits.

Key words: environmental flows, habitat suitability curves, macroinvertebrates, habitat suitability modeling, functional feeding groups.

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