European Commission

Science for Environment Policy

Multiple fish-based indicators successfully evaluate water quality in 8-year study

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Worldwide, programmes have been implemented to protect water quality from human pressures, often using ecological indicators as a method of evaluation. An eight-year study of a Portuguese estuary has found that indicators based on multiple measures of fish communities, such as the number and relative abundance of resident and migrant species, reflect human pressures on these transitional waters and could improve the implementation of water protection programmes.

To protect aquatic ecosystems, a range of policies have been developed for the sustainable use of water, such as the Water Framework Directive (WFD), which aims to protect groundwater, inland surface waters, transitional and coastal waters across the EU.

To measure the ecological status of water, indicators from aquatic communities have been used. In the EU, Member States have developed indicators based on multiple measures, such as community composition and function, called multi-metric tools. Fish are useful indicators as they are abundant in aquatic ecosystems, easy to collect and sensitive to stress. A fish community facing habitat loss, for example, will be characterised by a simpler structure, with less species diversity.

Although a number of studies have related changes in fish communities to water quality/ecological status, most have been over the short term. By contrast, this study was conducted over eight years, in the Mondego estuary on the west coast of Portugal. The researchers assessed changes in external (human) pressures over that time and changes in fish diversity, and established links between the two. They hypothesised that higher stress environments result in lower fish diversity and ecological quality.

Fish were collected from the estuary in spring every year between 2005 and 2012, following the recommendations for evaluating the ecological quality of Portuguese estuaries under the WFD. Human pressures were assessed based on several factors, including the number of industries in the watershed and the population density of surrounding areas, and via the anthropogenic pressure index (API, a summation of these indicators).

To assess changes in ecological quality, the researchers used several single metric indicators, including species number, diversity and evenness (how close in number each species is). They also used a multi-metric indicator called the Estuarine Fish Assessment Index (EFAI), which includes measures such as species richness, number of resident species and number of migrant species. The EFAI was used to develop a measure of total ecological quality.

Overall, 31 different fish species were found in the estuary which, according to the EFAI, maintained a 'good' ecological status across the period of the study. Anthropogenic pressures decreased towards the end of the study period, reflecting a drop in dredging activities, the number of ship berths, population density and agricultural and industrial activity.

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Source: Martinho, F., Nyitrai, D., Crespo, D. & Pardal, M. (2015). Efficacy of single and multi-metric fish-based indices in tracking anthropogenic pressures in estuaries: An 8-year case study. *Marine Pollution Bulletin*, 101(1): 153-162. DOI: 10.1016/j.marpolbul.2015.11.004.

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The single metric indicators were highly variable and not in agreement with ecological quality scores, leading the authors to suggest that multi-metric approaches perform better in ecological quality assessment. Furthermore, the multi-metric indicator was the only one that correlated with the API, confirming the hypothesis that lower anthropogenic pressure is associated with higher ecological quality.

These findings have relevance for water protection initiatives, such as the WFD. The study uses a large data set collected over a long time scale, showing that multi-metric indicators, such as the EFAI, can provide a measure of ecological quality and detect changes in fish communities specific to human pressures. The researchers conclude that extending existing long-term data sets and testing the method in other estuaries could improve the implementation of water-protection programmes worldwide.