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Biological recovery may lag behind chemical recovery in acidified Swedish lakes

Acidification of water bodies can have substantial impacts on aquatic wildlife, and even after chemical conditions improve, biological recovery may lag behind. A study of Swedish lakes shows that, although their chemical quality has improved as a result of international reductions of acidifying emissions, biological recovery has been much slower in some lakes.

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In Europe, the Water Framework Directive[1] aims to achieve 'good ecological status' in all water bodies, with the assessment of water quality typically based on disturbances from reference conditions. These are generally based on the pre-industrial era (before 1860).

In Sweden, the reference conditions regarding acidity are determined using a water chemistry model, MAGIC (Model of Acidification of Groundwater in Catchments), and ecological status can be 'good' only if acidity has changed by less than 0.4 pH units between 1860 and the present-day. However, this only accounts for a limited aspect of ecological status, which is a more general measure including biological elements in order to better reflect the condition of the ecosystem as a whole.

This study compared projections of the MAGIC model with data regarding the recovery of populations of roach (*Rutilus rutilus*). This species of fish is particularly sensitive to acidity and if the pH falls to 5.5, it can no longer reproduce and populations will die out. Researchers used historical records of the presence or absence of roach in 85 Swedish lakes and compared these to the years 1980 and 2010. 1980 represents a period of heavy acidification of lakes and 2010 represents the recovery period after international agreements, such as the Convention on Long-range Transboundary Air Pollution of 1979, were implemented to limit sulphur and nitrogen emissions.

Between 1860 and 1980, all lakes were affected by acid deposition, while between 1980 and 2010, MAGIC projections estimated that all lakes had achieved some degree of chemical recovery. Half of the highly impacted lakes had recovered by 2010. This highlights the success of efforts to curb sulphur and nitrogen emissions. MAGIC and roach assessments were consistent with each other for 78 of the 85 lakes included in the study. However, there were some discrepancies, for example, MAGIC did not predict acidification in four lakes, but roach were absent in them nonetheless.

Seven lakes still had acidic waters (below pH 5.5) after 1990, and only five of the 14 lakes from which roach had disappeared were able to support breeding populations once again. This suggests that the recovery of acid-sensitive roach is lagging behind the chemical recovery of the lake waters, say the researchers.

These results imply that biological assessment is a necessary addition to the chemical estimation approach to determining water quality. The researchers have also developed a new conceptual model based on this study that can be used to prioritise the management of the physical, chemical and ecological effects of human activities on water bodies.

Although the recovery of lake ecosystems may take some time, even when pressures have been reduced, the conceptual model may be useful to regulators when there is a limited budget. For example, remediation and restoration efforts can be targeted at lakes where there have been significant deviations from reference conditions, the researchers say.

1.See: http://ec.europa.eu/environment/water/water-framework/