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Eutrophication led to fish extinctions in Alps

Nutrient pollution and resulting eutrophication has caused a rapid loss of whitefish species from lakes in the European Alps, according to a new genetic and ecological study that sheds light on how these fish became extinct in Swiss lakes. The researchers suggest that diversity loss among whitefish during the last century was related to environmental changes induced by eutrophication such as changes in oxygen levels and food composition in lakes.

Eutrophication is characterised by low levels of oxygen in fresh or seawater, caused by a build up of nutrients that leads to rapid growth of algae and microbial decomposition over and above a level that the ecosystem can support. The main pollutants involved are nitrogen and phosphorus, which come from agriculture, household waste and industry. In the EU, eutrophication is controlled under the Nitrates[1] and Urban Wastewater Treatment[2] Directives.

In the mid to late twentieth century, eutrophication was widespread in Swiss lakes. Low levels of oxygen at the bottom of eutrophicated lakes reduced the number of whitefish eggs surviving to hatching. Diversity among whitefish species has decreased substantially during that same time, with the number of different species present declining by more than a third on average across 17 Swiss lakes. The researchers wanted to find out whether this loss of diversity was associated with eutrophication.

Their results suggest that eutrophication was to blame for losses in whitefish diversity to a very large extent. Based on analyses of whitefish DNA and morphological characters from samples before, during, and after the eutrophication peak – centred around the 1970s – they show that eutrophication has altered the habitats of whitefish and driven extinctions through a process known as 'speciation reversal'. Speciation reversal occurs when species that were previously distinct breed together, thus mixing their genes and losing the genetic and phenotypic differences that once made them unique.

According to the researchers, speciation reversal can be rapid, resulting in extinction of species over just a few generations. It may also be difficult to detect because historical DNA samples are rarely available, or may be of poor quality. The species reversal that occurred in Swiss lakes was probably related to eutrophication reducing oxygen levels at the bottom of lakes. This caused a loss of the spawning habitats of deep-spawning whitefish species. At the same time, eutrophication also caused changes in the plankton communities preyed on by whitefish. Together these changes relaxed the mechanisms that maintained differentiation between the species and some whitefish species were lost as a result of breeding with other species.

In the lakes of the Alpine foothills, whitefish are keystone species, meaning that other species in the same ecosystem likely depend on their continuing survival and diversity. The researchers therefore suggest that their loss has had wider impacts on the ecosystems in the lakes that they inhabit. The same may be true of many other species in areas affected by eutrophication. Awareness of these more complex effects of eutrophication may help to inform monitoring programmes and attempts to reduce the impact of nutrient pollution on aquatic ecosystems.

1. See: http://ec.europa.eu/environment/water/water-nitrates/index_en.html
2. See: http://ec.europa.eu/environment/water/water-urbanwaste/index_en.html

Source: Vonlanthen, P., Bittner, D., Hudson A.G., *et al*. (2012). Eutrophication causes speciation reversal in whitefish adaptive radiations. *Nature*. 482, 337-362. DOI: 10.1038/nature0824.
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