

Long-term experiences from the restoration of large and shallow Pyhäjärvi (SW Finland)

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Pyhäjärvi, located in the centre of an intensive agricultural area in southwest Finland, is an example of a large and shallow lake suffering from eutrophication. During the last 20 years the quality and general usability of water in Pyhäjärvi has varied: studies and frequent monitoring data show that it first deteriorated due to increased algal blooms, then showed some slight but evident signs of recovery in 2003-2007 and is now deteriorating again. These changes have been driven by both a variety of human activities and climate related factors such as exceptionally dry or wet periods.

Pyhäjärvi has been the target of an intensive restoration programme since 1995 when the Pyhäjärvi Protection Fund (PPF) was created by local municipalities, private industries and local associations to act in collaboration with regional environmental and agricultural authorities. Since 1995, all farmers in the catchment have committed to the European Union's (EU) agri-environmental programme to implement basic water protection measures. In addition, more intensive catchment management practices such as buffer zones, sedimentation ponds, and wetlands have been introduced. New innovative treatment methods such as filtering ditches and sand-filters were also constructed and tested for their ability to remove P from runoff waters. PPF also has been active in promoting waste water treatment in the rural catchment. However, all external load reduction measures in the catchment have been seriously challenged by the recent warm and wet winters with high external load.

Also, Pyhäjärvi has been the object of intensive biomanipulation for decades. It has been done by commercial fishermen, whose annual harvest rate approaches the total production of vendace (*Coregonus albula*), which is the main planktivore in Pyhäjärvi. The restoration project has also subsidized the harvest of commercially unwanted fish since 1995. In 2002-2006, the EU provided funds for this fishing, which was especially intensive in 2002-2004 and apparently resulted in water quality improvement. Lately, weak ice cover in exceptionally warm winters 2007 and 2008 prevented practically all seine fishing and left planktivorous fish stocks unusually strong in Pyhäjärvi, triggering new deterioration of water quality. Under the warming climate scenarios, there is an urgent need for the commercial fishermen to find new efficient fishing methods in order to be able to maintain food web structure favourable for water quality.