Combating eutrophication and biodiversity loss in Sweden: importance of constructed wetlands in the agricultural landscape

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Abstract: *The results of this evaluation show that constructed wetlands in the agricultural landscape are capable of a substantial reduction of the nutrient transport to downstream recipients, but only if properly located. These wetlands will also contribute to an increased biodiversity even if not planned primarily for this purpose. The use of wetlands for multiple functions needs to be developed to motivate large-scale wetland construction.*

Keywords: *constructed wetlands, eutrophication, biodiversity, nitrogen, phosphorus*

1. Introduction

Wetlands have been identified as cost effective nutrient traps in the agricultural landscape. The Swedish Board of Agriculture has decided that 12000 hectares (ha) of wetlands should be constructed until 2010 in Southern Sweden by means of various support systems to landowners. The purpose is that these wetlands should counteract eutrophication by removing nitrogen and phosphorus while simultaneously contributing to increased biodiversity in the landscape. We have evaluated the extent to which wetland construction in agricultural areas of Sweden have contributed to these goals (Svensson *et al*., 2004).

2. Methods

Basic data on 1182 wetlands constructed between 1996 and 2002, with a total area of 3300 ha, were compiled and registered. Field surveys and water sampling were conducted in more than 100 wetlands randomly selected from this register. Based on these empirical data and modelling, nutrient removal and decrease of nitrogen transport to coastal waters were estimated. The numbers of dragonfly species (Odonata larvae) in the individual wetlands were used as an indicator of the contribution of these wetlands to aquatic species diversity in agricultural landscapes. These data have later been supplemented with nutrient removal data obtained through flow-proportional water sampling in three wetlands and species diversity measurements in 36 wetlands.

3. Results and Discussion

The 3300 ha of wetlands constructed between 1996 and 2002 will remove approximately 300000 kg N per year. Nitrogen removal efficiency of individual wetlands varied between less than 10 to over 1000 kg N per ha and year. Decrease of N transport to coastal waters was estimated to between (depending on modelling approach) 100000 and 200000 kg N per year. Phosphorus removal in the 3300 ha of wetlands was estimated to between 1000 and 8000 kg P per year. Phosphorus removal efficiency of individual wetlands varied between 0 and 150 kg P per ha and year. In total, the effect of the wetlands on nutrient transport was relatively low. However, some individual wetlands were very efficient. These wetlands had 1) a high hydraulic load, 2) were placed in catchments with high nutrient concentrations in the water, and 3) were placed close to the coast. This suggests that a much higher effect on total nutrient transports could be achieved if constructed wetlands were placed to obtain such conditions.

The constructed wetlands clearly contribute to increased biodiversity in the agricultural landscape. When constructing wetlands in an agricultural landscape, the biodiversity of the area will almost automatically increase due to the introduction of a new habitat. The number of dragonfly species is highly correlated to overall biodiversity, but not, of course, to the biodiversity of every organism group. The total number of species of Odonata found in the wetlands in this study was relatively high, in fact the figures are comparable to those obtained during previous studies in more mature aquatic ecosystems (lakes) in forests, which indicates that constructed wetlands have a potential for high biodiversity. This is further supported by the occurrence of several particular species indicative of a high biodiversity, one of which is included on the EU habitat directive.

The average number of Odonata species in individual wetlands was however low. This means that the relatively high total number of species of Odonata found in the wetlands in this study was due to a high variation between wetlands. The study shows that several threatened species are able to colonise the wetlands, thereby increasing their populations. This might be the most important function of constructed wetlands for biodiversity. The large number of wetlands due to be constructed will certainly increase the possibilities of dispersal and survival for a large number of species.

4. Conclusions and perspectives for the future

The total wetland area constructed between 1996 and 2002 (3300 ha) exhibit an estimated nutrient retention of less than 100 kg N per ha and year, which is only 50% of the goal stated by the Swedish Board of Agriculture of 200 kg N per ha and year. However, this study also shows that constructed wetlands, in the right location, can reduce the transportation of nitrogen by up to 1000 kg per ha wetland area and year, exceeding the goal stated by the Swedish Board of Agriculture by 400%. Thus, future guidelines for wetland construction must strongly emphasize how placement and design should be planned to optimize nutrient retention. This has already been initiated by the Swedish Environmental Protection Agency based on this study. Biodiversity will benefit from these wetlands even if they are not primarily located and designed for that purpose.

Further, use of wetlands for multiple functions should be developed to motivate the large-scale wetland construction that is needed for substantially decreasing nutrient transports. The present study has focused on nutrient retention and biodiversity. Other functions are e.g. flood risk reduction, water storage for irrigation and production of bioenergy. Climate change has now emerged as the most urgent global environmental issue and therefore it is problematic that wetlands may contribute to production of climate gases. "Production wetlands", where the plant biomass is harvested and used for energy production, seems as a very interesting option in this perspective.

References

- Svensson J.M., Strand J., Sahlén G and Weisner S. (2004). *Rikare mångfald och mindre kväve - utvärdering av våtmarker skapade med stöd av lokala investeringsprogram och landsbygdsutvecklingsstöd.* Swedish Environmental Protection Agency Report 5362.