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Greenhouse Gas Emissions From a Danish Riparian Wetland Before and after Restoration

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ABSTRACT

Restoration of riparian wetlands often aims at increasing the removal of nitrogen and phosphorus by re-establishing the hydrological connectivity between the stream and the surrounding floodplain. However, the geochemically reduced soil conditions in the newly restored area may favor the emission of greenhouse gases (GHG) such as nitrous oxide (N2O) and methane (CH4). To evaluate this risk the fluxes of N2O, CH4 and carbon dioxide from ecosystem respiration (Reco) were determined prior to and after restoration of a stream and its adjacent riparian areas. The data collected during the first year after restoration revealed spatially and seasonally variable N2O emissions ranging from 0.1 to 3.1 g N m−2 y−1, but no statistically significant effect of the restoration on N2O emission was observed as tested for comparable 8-month periods before and after restoration. The re-establishment of a high groundwater level (GWL) induced a significant increase in CH4 emissions ($p < 0.001$), from -0.04 to 31.7 g C m−2 at a permanently flooded, restored area during comparable 8-month periods before and after restoration. Ecosystem respiration at the restored sites decreased or remained stable after the restoration, but a decrease in Reco was also observed at a control site. According to mixed model statistical analyses both the soil temperature at 10 cm depth (T(−10 cm)) and GWL were apparent controllers of CH4 and Reco. Nitrous oxide emissions were related to N content in the top soil. Annual CH4 emissions the first year after restoration were comparable to those of natural riparian wetland sites and the increased CH4 emission appeared to be compensated for by a decrease in Reco, while the effect of the restoration on N2O was more uncertain–not least because of large spatial variation.