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The multifunctional role of constructed urban wetlands in the Nummela Community, Finland (PO.62)

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INTRODUCTION
Urbanization and associated imperviousness changes water balance causing increased flooding and draught. Runoff washes pollutants from urban surfaces degrading water quality in receiving waters. Climate change is expected to increase rainfall intensities and duration, as well as intensify heat and drought periods in Southern Finland. Habitats become degraded and fragmented, and urban dwellers-distanced from local nature.

Urban wetlands are constructed primarily as mitigation tools to reduce changes in water balance and to improve water quality. The impact of wetlands on climate change is a balance composed by carbon (C) bound to fast growing and slowly decomposing vegetation, and the release of greenhouse gases (GHG) from microbial decomposition. In our ongoing studies we investigate the role of constructed urban wetlands and their design on water environment mitigation, GHG balance, vegetation establishment, and habitats.

METHODS
Our two study wetlands are located within an urbanized 350 hectare watershed, in the catchment of Lake Enajärvi in the Nummela Community, Municipality of Vii, Southern Finland. The Nummela "Gateway" and the Nummela "Nitty" wetlands are constructed as water environment mitigation landscapes and as urban parks. The two wetlands vary in design and have been monitored since establishment in 2010 and 2013 respectively. Holistic understanding of design and function relationships as well as public awareness rising are sought.

To measure water environment mitigation services by the wetlands, water quality is monitored both continuously and with grab sampling at the inflow and outflow of the wetlands. To elucidate the wetland C dynamics, CO2 and CH4 exchanges are measured year round with the micrometeorological eddy covariance (EC) technique, footprint area covering the constructed wetland, and biomas bound C (above and below ground) determined. The CO2 and CH4 gas concentrations are also monitored continuously in water at the inlet and outlet of the constructed wetland. Vegetation establishment is monitored at 0.5 m2 plots. Wildlife monitoring has included nesting avian pairs and amphibians.

RESULTS AND DISCUSSION
Vegetation self-establishment and wildlife. The wetlands were excavated on abandoned crop fields. Vegetation was allowed to self-establish. Annual monitoring for species and vegetation coverage in summers 2010, 2011 and 2012 at the Gateway wetland revealed that vegetation self-establishment was rapid, rich in taxa, and dominated by native wetland species. Only two alien plant species were identified: Elodea canadensis in deep water and Epilobium adenocarpum in dryer meadow areas. Amphibians (frogs and newts) and nesting waterfowl, wading birds, and small gulls found the wetlands already the first spring following winter time construction. The public found the constructed wetland parks very appealing due to the diversity of plants and animals seen, and because these native landscapes "changed every visit" providing "endless surprises" and "pride of own neighborhood." Water quality Nummela Gateway Wetland reduces the entrance of pollutants such as phosphorus rich clay particles into the Lake Enajärvi. Observed pollutant reductions vary and depend on season, inflow concentration, characteristics of the proceeding hydrological events (both recent and over the ongoing hydrological year) as well as design and maturity of the constructed wetland. The Gateway wetland water surface composes only 0.1% of its watershiled area. While event reductions have proven a strong positive impact on water quality, monitored two month snowmel period period averages are modest. Long term monitoring is underway to investigate how the densly vegetated yet modest in size wetland will perform in a full hydrological year scale. Design of the "Nitty" wetland includes repeated wetland sections intersecting flow, and a flood meadow area.

Greenhouse gases GHGs have been continuously monitored at the Gateway wetland by EC from air (measures fluxes) and directly from water (measures concentrations). Measurements of GHG concentration in water during winter, spring, and summer 2012-2013 indicate that the site has been a slight source of CO2 and CH4 into the atmosphere in winter. The beginning of growing season caused a strong peak in CH4 emissions, yet the fluxes soon leveled down closer to the winter time levels. The GHGs concentrations in the water have been sensitive to changes in flow rates. A mid-water snowmelt event caused strong CH4 peak. Polluted spills within the urbanized areas have impacted water quality as well as GHG levels in the water (Graph 1).
Graph 1. Turbidity reduction is demonstrated at the wetland with associated impact on water oxygen content. Right: The turbidity peak coinciding with CH4 concentration peak on 13 March 2013 is a result of an urban spill of unknown contamination. The CH4 flux measurement at the Freeze wetland show a slight steady source. Seaweed occurred later in April in 2013.

CONCLUSIONS
Monitoring of constructed wetlands for vegetation has shown rapid and rich self-establishment with native species. Birds, frogs and newts rapidly found the new habitats. The public recognized biodiversity as a source of local pride in the constructed wetland parks. Water quality is improved by the Nuuksio Gateway wetland at the event scale yet long-term benefit estimation requires full hydrological year monitoring, which is underway. GHGs presence in water is impacted by flows and urban spills. Sensors impact the observed fluxes. The established parks are cases of biodiversity within their urbanized watershed.

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REFERENCES