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Photosynthetic properties of boreal bog plant species and their contribution to ecosystem level carbon sink

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Boreal bogs have a low number of plant species, but a large diversity of growth forms. This heterogeneity might explain the seasonally less varying photosynthetic productivity of these ecosystems compared to peatlands with vegetation consisting of fewer growth forms. The differences in photosynthetic properties within bog species and phases of growing season has not been comprehensively studied. Also the role of different plant species for the ecosystem level carbon (C) sink function is insufficiently known.

We quantified the seasonal variation of photosynthetic properties in bog plant species and assessed how this variation accounts for the temporal variation in the ecosystem C sink. Photosynthetic light response of 11 vascular plant and 8 Sphagnum moss species was measured monthly over the growing season of 2013. Based on the species' light response parameters, leaf area development and areal coverage, we estimated the ecosystem level gross photosynthesis rate (PG) over the growing season. The level of upscaled PG was verified by comparing it to the ecosystem gross primary production (GPP) estimate calculated based on eddy covariance (EC) measurements.

Although photosynthetic parameters differed within plant species and months, these differences were of less importance than expected for the variation in ecosystem level C sink. The most productive plant species at the ecosystem scale were not those with the highest maximum potential photosynthesis per unit of leaf area (Pmax), but those having the largest areal coverage. Sphagnum mosses had 35% smaller Pmax than vascular plants, but had higher photosynthesis at the ecosystem scale throughout the growing season.

The contribution of the bog plant species to the ecosystem level PG differed over the growing season. The seasonal variation in ecosystem C sink was mainly controlled by phenology. Sedge PG had a sharp mid-summer peak, but the PG of evergreen shrubs and Sphagna remained rather stable over the growing season. This resulted in a much milder variation in the ecosystem scale PG than seen in sedges. The ecosystem level PG attained by upscaling the species level measurements tallied well with the GPP estimate. These results suggest that functional diversity in boreal bogs decreases the seasonal variation in ecosystem C sink.