

Carbon sequestration by upland sheep grazing management

Stuart Smith^{*1,2,3}, Charlotte Vandenberghe⁴, René van der Wal², Sarah Woodin¹, David Johnson¹ and Robin Pakeman³ *Correspondence author: s.w.smith@abdn.ac.uk

¹IBES, University of Aberdeen, St Machar Drive, Aberdeen AB24 3UU, UK, ²ACES, University of Aberdeen, St Machar Drive, Aberdeen AB24 3UU, UK, ³James Hutton Institute, Craigiebuckler, Aberdeen AB15 8QH, UK, ⁴ÉPFL, Route Cantonale, 1015 Lausanne, Switzerland, CH-1015.

Background

The majority of European terrestrial carbon (C) is stored in upland soil. It is vital to manage upland ecosystems such that soil C loss is avoided. Livestock grazing dominates upland land use, but its impact on C sequestration is poorly understood. *Molinia caerulea* – Purple moor grass dominates 10 % of UK uplands, and it is likely to contribute substantially to soil C pools. It creates a sward of tussocks and inter-tussocks.

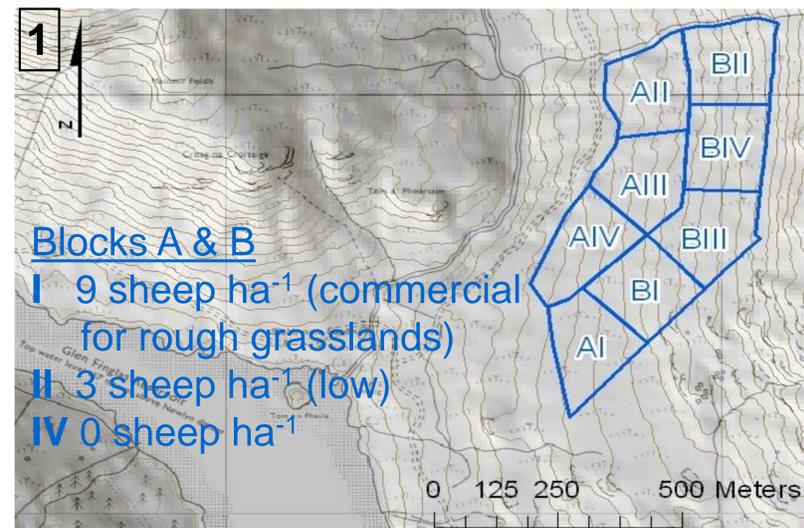
Aim: To quantify C stocks of *Molinia caerulea* swards under different sheep stocking densities.

Methods

C stocks were estimated for three sheep stocking densities, across a landscape-scale grazing experiment at the Glen Finglas estate, Scotland, established in 2002 (partly shown in Fig 1).

C was estimated at two spatial scales:

- (1) Tussock scale (20 cm x 20 cm): partitioning C into plant parts (shoots, shoot bases, shallow and deep roots) ($n = 4$).
- (2) Sward scale (2 m x 10 m): accounting for total area of tussock and inter-tussock using transect measurements ($n = 16$).



Results

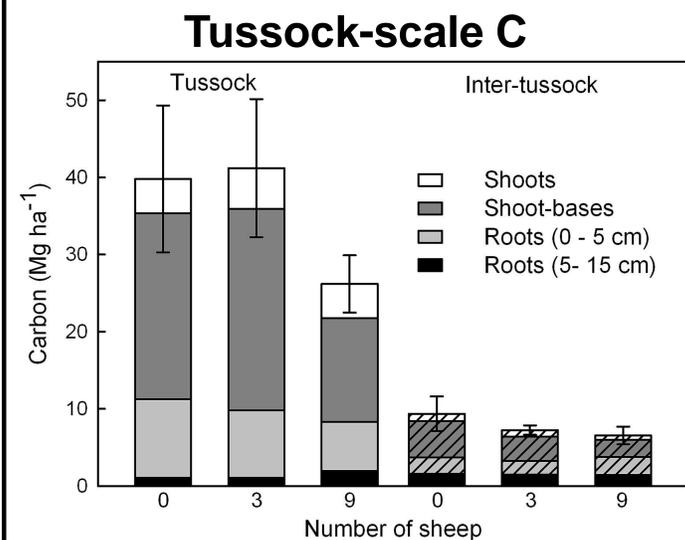


Fig 2: *M. caerulea* shoot bases were the largest plant C pool and most sensitive to sheep grazing pressure.

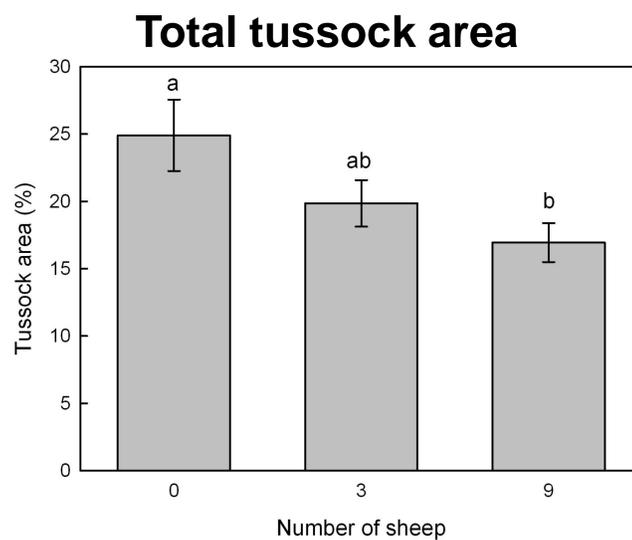


Fig 3: Removal of sheep caused an increase in tussock number and thereby tussock area.

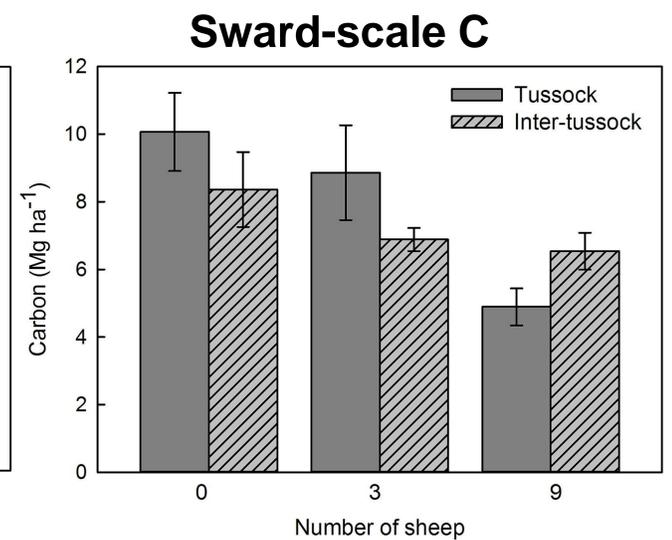


Fig 4: Across the sward, C stocks increased with decreased stocking density.

In comparison to commercial stocking density, removal of sheep resulted in an accumulation of ~ **3.50** (± 0.46) Mg C ha⁻¹ (Fig 4), whilst reduction to low stocking density accrued ~ **1.34** (± 1.01) Mg C ha⁻¹.

Conclusion

Removal of sheep from the uplands can increase plant C stocks, and potentially C inputs into the soil, over several years. However, the carbon benefit of low stocking density is smaller and more variable.