THE MACAULAY LAND USE RESEARCH INSTITUTE

BIODIVERSITY:CARBON TRADE-OFFS IN CROFTING SYSTEMS

Robin Pakeman and Jenni Stockan
The Macaulay Land Use Research Institute, Craigiebuckler, Aberdeen, AB15 8QH • r.pakeman@macaulay.ac.uk

THE ISSUE

Until recently, the impacts of agricultural change have been seen as a trade-off between productivity and biodiversity. Now there is growing recognition that agriculture and other land uses deliver a range of ecosystem goods and services. The provision of these services may or may not be optimised alongside biodiversity. A study of biodiversity and ecosystem function in a crofting landscape is used to illustrate the potential trade-offs between biodiversity and carbon sequestration.

TRADE-OFF SCENARIO

Traditional hay-cropping is now a restricted land use (Figure 1a). A range of land uses are possible when this practice is abandoned including; silage making (Figure 1b), conversion to pasture (c), abandonment (d) and winter grazing (e).

Figure 1

METHODS

Biodiversity assessments of ground beetles (Carabidae), bees and vascular plants were made on these land use types during the summer of 2007 on the National Trust for Scotland's Balmacara Estate using standard methods.

Three indicators of carbon dynamics were assessed; above-ground net primary production, litter decomposition rate (assessed as the rate of breakdown of standard litter) and litter quality (assessed as community-weighted leaf dry matter content, which is inversely related to litter turnover).

RESULTS

It is clear from Table 1 that almost all the potential transitions result in a drop in species richness.

Land Use (n)	Carabid species	Bee species	Vascular plant species
Hay meadow (4)	10.75^{b}	3.75^{a}	19.38^{a}
Abandoned (3)	9.00^{cd}	1.00^{c}	10.01^{c}
Pasture (2)	7.50^{d}	0.50^{c}	15.21^{b}
Silage (6)	12.67^{a}	2.33^{b}	14.62^{b}
Winter grazed (2)	9.50^{bc}	3.50^{a}	15.90^{b}
p	*0.035*	*0.047*	*0.028*

Table 1. Species richness of Carabids, bees and vascular plants on the five different crofting land uses. Different superscripts indicate significant differences between values from a one-way analysis of variance.

One land use type (silage) had a higher productivity than the meadows (Table 2). There were no differences in the decomposition rate between sites. Pasture and the abandoned sites had significantly poorer litter quality (higher LDMC) than the other land uses.

Land Use (n)	ANPP	% mass loss	LDMC
Hay meadow (4)	217.5^{bc}	0.58^{a}	239.7^{b}
Abandoned (3)	189.4^{c}	0.57^{a}	264.2^{a}
Pasture (2)	230.9^{bc}	0.56^{a}	259.6^{a}
Silage (6)	415.9^{a}	0.57^{a}	241.2^{b}
Winter grazed (2)	294.5^{b}	0.56^{a}	242.4^{b}
p	*0.029*	*0.657*	*0.013*

Table 2. Above-ground net primary productivity (ANPP, g m^{-2} yr^{-1}), percentage mass loss of standard litter (% mass loss) and community weighted mean leaf dry matter content (LDMC mg g^{-1}) on the five different crofting land uses. Different superscripts indicate significant differences between values from a one-way analysis of variance.

IMPLICATIONS FOR MANAGEMENT AND CONSERVATION POLICY

The impacts of the land use transitions on carbon and biodiversity are summarised in Figure 2.

There appears to be no win-win situation that maximises carbon and maximises biodiversity. All transitions result in a decrease in species richness in at least two of the groups, but the indicators of carbon dynamics suggest that three of the four transitions would be beneficial.

Developing land use management for the benefit of biodiversity may become more complicated if other ecosystem goods and services have to be taken into account and the resulting trade-offs identified and made.

Figure 2