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Biodiversity at the farm scale: A novel credit point system

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ABSTRACT

Farmland biodiversity has often been assessed, but seldom at the farm scale, although it is ultimately the farm level at which decisions are taken. Therefore, a credit point system (CPS) was developed based on 32 options known to enhance farmland biodiversity. It was verified whether the resulting CPS score and farm-scale biodiversity are correlated considering four indicator groups (plants, grasshoppers, butterflies and birds) on 133 farms in the Swiss lowland. We further compared the suitability of the CPS score in reflecting farm-scale biodiversity to three alternative habitat measures, i.e. the amount of ecological compensation areas (ECAs, i.e. agri-environment scheme options), ECAs with a high ecological quality and valuable semi-natural elements (SNEs).

Species richness and density of plants, grasshoppers, butterflies and birds were analysed, for 'all species', stenotopic farmland species and 'red-listed' species within each group, resulting in 19 biodiversity measures (dependent variables). Basic models were built, first without, then by including a range of environmental variables and compared to models expanded by the CPS score or one of the three habitat measures (ECAs, high-quality ECAs or SNEs). For each of the 19 biodiversity measures, the CPS score and the three habitat measures were ranked by how much their inclusion improved the basic model, to determine which measure best captured biodiversity at the farm scale.

We demonstrate that the CPS score reflects farm-scale biodiversity. For 13 out of 19 biodiversity measures, models including the CPS score performed better than those without. The CPS score was found to be the most suitable predictor for a fast and efficient assessment of farm-scale biodiversity, which makes it suitable for use in large scale agri-environment schemes.

1. Introduction

Farmland biodiversity has undergone strong declines over the past decades (Donald et al., 2002; EEA, 2013), a trend which has often been linked to agricultural intensification (Donald et al., 2002). To reverse this negative trend, agri-environment schemes (AES) have been set up in a number of EU countries and in Switzerland (Kleijn et al., 2004; Aviron et al., 2009). A decade of evaluation, however, showed that impacts of AES on biodiversity are mixed (Batáry et al., 2011), and no general increase in farmland biodiversity has been observed (EEA, 2006; Lachat et al., 2010).

Positive effects on biodiversity were mostly achieved in 'narrow-and-deep' schemes targeted at local scales or range-restricted populations (Perkins et al., 2011) rather than in 'broad-and-shallow' programmes (Baker et al., 2012). One reason for partial success at smaller scales (plots, farms) but failures at regional or national levels might lie in the fact that, despite participating in AESs, farmers might base their management decisions on farming optimisation processes, economic aspects or subsidy payments rather than on what is most effective for biodiversity (Jahrl et al., 2012). This has led to poor ecological quality of many implemented conservation options (Jeanneret et al., 2010) or to conservation areas being insufficient in size and connectivity (Aviron et al., 2011; Rösch et al., 2013).

The principle unit of decision making is the farm (Dallimer et al., 2009; Schneider et al., 2014), and decisions about participating in AES schemes are also taken at that level. On-farm experience shows that many farmers are in fact interested in biodiversity, but a general lack of information about ecology,

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biodiversity and agri-environmental issues (Jahrl et al., 2012) seems to hinder them from managing their land in a more sustainable and wildlife-friendly manner (Home et al., 2014). Even farmers who are attentive to biodiversity matters are usually uncertain about the contribution they (could) make to enhancing biodiversity on their own farms.

To fill this gap, a tool was designed to help farmers with the assessment of biodiversity-favouring measures on their land, the Credit Point System (CPS; Jenny et al., 2009). The CPS combines quantity as well as ecological quality and connectivity (spatial distribution) of 32 options known to enhance farmland biodiversity (Table 1). The CPS yields a total score for each farm. In contrast to simple proportions of ECAs per farm, the CPS weights the measures according to their presumed or measured impact on biodiversity and also includes additional biodiversity-favouring measures, such as in-field grassland and in-field arable options.

The aim of this study is to investigate whether the farm-based CPS score is indeed correlated with various measures of biodiversity (derived from plants, grasshoppers, butterflies and birds), i.e. whether a farm with a higher CPS score harbours a higher biodiversity than a farm with a lower CPS score. To our knowledge, this is one of very view studies where several biodiversity indicators are assessed and where this occurs on the entire farm area (but see Schneider et al., 2014). We compared whether models including CPS score fitted the data better than models with the mere quantity of ECAs or valuable semi-natural elements (SNEs; Graf et al., 2011). ECAs would be even simpler to record for farmers while SNEs are usually used as a measure of habitat quality and diversity by ecologists. They comprise all natural elements on a farm, also those which are not/cannot be managed by the farmer. We also tested whether models including the CPS score were still valid when various environmental variables likely to affect biodiversity were added to the models and whether these models fitted the data better than models containing proportions of ECAs or SNEs.

2. Methods

2.1. The credit point system

Since it is nearly impossible for farmers to quantify biodiversity on their farms we developed a tool allowing them to assess the measures they take to enhance biodiversity, the Credit Point System (Jenny et al., 2009). The CPS was designed to compose a wide range of options with which farmers can positively influence biodiversity on their farms. The CPS consists of a catalogue of 32 such options. Farmers can "score points" by applying these measures on their farms (Jenny et al., 2009). The majority of them are options from the Swiss agri-environment scheme, so called Ecological Compensation Areas (ECAs, i.e. extensively managed meadows, hedges, wildflower and rotational fallows etc.). Additionally, ecological quality and size of individual ECAs are also recorded, according to the 'quality' and 'connectivity scheme' (Ordinance for Ecological Quality (ÖQV); Schweizerischer Bundesrat, 2001). Further, application of arable and grassland options (e.g. no herbicide application, staggered mowing etc.) as well as for the conservation of genetic diversity (heritage breeds/heirloom crops) yield points. The point assignment accounts for farm size, i.e. points are assigned for the proportion of a given measure. An overview of the options in the CPS and their assignment to credit points is given in Table 1 (a demo version of the CPS can be filled in on http://www.ipsuisse.ch/secret/frmMain.aspx?SID=248).

The scores are weighted according to their known (expert-based) benefit for biodiversity, i.e. larger-sized meadows will yield more points than smaller ones and meadows with a high ecological quality (according to the 'quality scheme') more than those

Table 1
Contents and assignment of points in the credit point system (CPS).

	Assessed data/ options yielding credit points	Definition/content	Credit point assignment and range of scores
A	Average field/parcel size	A plot cultivated with one crop or grassland/pastures. Average parcel size = (UAA[a] − ECA[b])/number of fields.	1–3 points, with smaller parcels yielding more points (only inverse relationship between a measurement and credit point assignment)
	Number of land-use types	Arable crops, mown grass, pastures, litter meadows (similar to rush pastures, but cut rather than grazed and originally used as litter for cattle), horticultures, vineyards, vegetables, other special/permanent crops.	1–3 points
B	ECAs – registered	To receive any subsidy payments (direct payments), farmers must manage at least 7% of their UAA as ecological compensation areas (cross-compliance). There is a defined set of ECA types which can be registered and for which payments can be received.	ECAs are summed and calculated as percentage of UAA. 1 to 6 points if ECAs account for more than 7% of UAA.
	ECAs – high quality	Farmers can apply for extra payments for ECAs with a high ecological quality (monitored and verified periodically by experts).	A certain threshold of high-quality ECAs will yield 2 to 6 additional points.
	ECAs – structurally enriched	ECAs can be structurally enriched by stone walls, ponds and pools or by retaining at least 5% of rough grass.	2–6 points
	ECAs – size	High-quality ECAs larger than 0.25 ha. These ECAs are divided into 0.25-ha-units. An ECA of 1 ha thus equals four 0.25-ha-units.	All units are summed for the point score. 2 to 6 points
	ECA – spatial distribution	Number of ECA which are larger than 0.1 ha on arable and grassland, respectively. Several, homogenously distributed ECAs of a certain minimum size (0.1 ha) will improve connectivity of habitats on a farm.	Number of ECAs per 20 ha arable and grassland, respectively is calculated. 2 to 6 points
C	Arable options	Skylark plots (undrilled patches), wider sown rows, spring crops, catch crops, under-sown crops, wildflower area management, no pesticide, no growth regulators, no herbicides, no mechanical weeding after mid-April.	0.5–2 points per option based on the proportion of arable and grassland
	Grassland options	In extensively managed ECA grassland: use of bar mowers, staggered mowing, no-input meadows in fruit orchards, double fences. Intensively managed grassland: no silage, use of bar mowers.	0.5–2 points per option based on the proportion of arable and grassland
	Further options	Structured forest edges, genetic diversity: Heritage breeds/heirloom crops, specific measures for defined target species (monitored by experts).	0.5–2 points based on the proportion of arable and grassland

[a] UAA = utilised agricultural area.
[b] ECAs = Ecological Compensation Areas (options of the Swiss agri-environment scheme).