



Changes in hedgerow floral diversity over 70 years in an English rural landscape, and the impacts of management



Joanna T. Staley^a, James M. Bullock^a, Katherine C.R. Baldock^b, John W. Redhead^a, Danny A.P. Hooftman^a, Nick Button^{c,1}, Richard F. Pywell^{a,*}

^a NERC Centre for Ecology & Hydrology, Maclean Building, Wallingford, Oxfordshire OX10 8BB, UK

^b School of Biological Sciences, University of Bristol, Woodland Road, Bristol BS8 1UG, UK

^c Dorset Environmental Records Centre, Library Headquarters, Colliton Park, Dorchester, Dorset DT1 1XJ, UK

ARTICLE INFO

Article history:

Received 5 February 2013

Received in revised form 17 July 2013

Accepted 25 July 2013

Keywords:

Diversity

Species richness

Regional species pool

Plant traits

Management

Taxonomic homogenisation

Eutrophication

Land use change

ABSTRACT

Hedgerows provide key habitat and refuges for wildlife in otherwise intensively-managed landscapes, and may play a role in connecting increasingly fragmented habitats. However, the processes governing changes to the floral biodiversity of hedges are poorly understood. We analysed a unique, long-term data set of plant species richness over a 70 year period at 357 hedgerow sites in southern England to quantify changes in α , β and γ diversity, and identify the role of hedge management and other possible drivers of change. Alpha diversity increased in hedgerows, while a reduction in β diversity was indicated by taxonomic homogenisation, whereby previously distinct communities of species become more similar to one another over time. Changes in the regional species pool (γ diversity) differed with plant life-history; it increased for woody species but decreased among herbaceous hedge species. Hedgerow communities shifted towards species associated with higher soil fertility, a more competitive ecological strategy and, in unmanaged hedgerows, greater shade tolerance. Probable drivers for these changes include the move from traditional forms of management such as coppicing and hedge-laying towards either no management or frequent cutting with a mechanical flail, and eutrophication. The extent of changes in plant diversity over time was determined by both historical and recent hedgerow management, but these management effects varied with plant life-history attributes. However, changes in hedge quality and floral diversity were not linked directly to a 60% increase in the proportion of land use categories classified as 'intensive' adjacent to the sites over the 70 years. Recommendations are made for future hedgerow management based on conservation objectives for specific groups of hedge plant species.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

Hedges are a key habitat in many areas of the world including Europe, North America, Africa and China, and have been a large component of managed landscapes for over 2000 years (Deckers et al., 2004; Hannon and Sisk, 2009; Yu et al., 1999). Hedges have the potential to play a significant role in habitat conservation, as they are a widespread habitat for wildlife (Baudry et al., 2000; Gelling et al., 2007; Hannon and Sisk, 2009), and may provide important refuges for a variety of plants, invertebrates, birds and mammals within otherwise intensively managed landscapes (French and Cummins, 2001; Merckx and Berwaerts, 2010; Wehling and Diekmann, 2009). Hedgerow networks, and associated lin-

ear habitats, could also play a key future role in adaptation to climate change by connecting habitat fragments and facilitating the movement of species through the wider countryside (Davies and Pullin, 2007; Lawton et al., 2010).

Changes in land use and management, climate and an increase in invasive species can lead to a loss of biodiversity (Hooper et al., 2012). Declines may be manifest as losses in α (declines in local species richness), β (e.g. biotic homogenisation) and γ (species declines over a whole landscape) biodiversity (Ernault and Alard, 2011; Keith et al., 2009; Lambdon et al., 2008; Olden and Rooney, 2006). Hedge floristic diversity is very variable, and has been related to hedge age (Roy and de Blois, 2008); a long history of human intervention in terms of planting (Boutin et al., 2002) and management (Deckers et al., 2004); adjacent land use (Ernault and Alard, 2011); and numerous landscape parameters including connectedness of the hedge network (Davies and Pullin, 2007). These previous studies have addressed current hedge floral diversity rather than changes in diversity over time. Changes to biodiversity, and analyses of their drivers, are best examined using

* Corresponding author. Tel.: +44 (0)1491 838800; fax: +44 (0)1491 692424.

E-mail address: rpf@ceh.ac.uk (R.F. Pywell).

¹ Present address: Worcestershire Wildlife Consultancy, Lower Smite Farm, Smite Hill, Hindlip, Worcester WR3 8SZ, UK.

long-term data on community change at multiple sites in a landscape. However, datasets amenable to this type of analysis are rare.

To investigate floral biodiversity changes in hedgerows, we used a unique botanical data set for 357 hedge sites across a study area of 2600 km² (in Dorset, a southern English county), collected in the 1930s and again in 2001. This dataset allows quantification of changes in α , β and γ diversity, and investigation of drivers of these changes. Changes in the Dorset flora over a similar time scale have been examined previously for woodland (Keith et al., 2009) and grassland (Newton et al., 2012) sites. While γ diversity decreased, there was no change in α diversity over time for woodland sites, but taxonomic homogenisation had occurred (Keith et al., 2009). Taxonomic homogenisation is one component of biotic homogenisation, a loss of β diversity, which leads to spatially distinct communities becoming more similar to each other over time (Olden and Rooney, 2006). Among the grassland sites α and γ diversity had increased over time, with no evidence of taxonomic homogenisation. For both habitats, analysis of plant species changes suggested eutrophication due to atmospheric deposition of nitrogen and agricultural fertilisers was the major driver of change (Keith et al., 2009; Newton et al., 2012). Species changes in the woodlands suggested reduced management and the resulting increased shading was an additional driver of biodiversity loss (Keith et al., 2009). However, neither study directly tested for the effects of management or agricultural intensification on changes to plant communities.

Hedges require management to prevent them encroaching on adjacent agricultural land, and developing into scrub or lines of trees (Barr et al., 2005; Baudry et al., 2000). Traditionally, this management would have included hedge-laying or coppicing, both of which are infrequent management techniques applied every 20–40 years, which rejuvenate hedges by encouraging them to produce new shoots from the base of woody species and maintains them as stock-proof barriers. Over 50% of the woody hedge biomass is removed during hedge-laying or coppicing, and between this infrequent rejuvenation management, hedges would have been trimmed every few years by hand to maintain their shape. Over the last 70 years frequent cutting with a mechanised flail has become the dominant form of management across Europe (Croxtan et al., 2004). While the removal of hedgerows is prohibited in many European countries (Baudry et al., 2000), the total length of hedgerows is still diminishing due to a lack of any management or over-intensive management (e.g. severe flailing every year) (Carey et al., 2008). The impact of management methods on hedgerow flora is little studied, especially in the context of ameliorating biodiversity loss.

In this study we build on previous analyses of long-term vegetation change in Dorset by testing the following hypotheses: (H1) community composition of hedges has shifted over time towards species associated with higher soil fertility and with more competitive life-history strategies in response to eutrophication; (H2) this shift in composition has led to taxonomic homogenisation (loss of β diversity) in hedges between the 1930s and 2001; (H3) hedges with evidence of historical rejuvenation management are more diverse and have undergone less taxonomic homogenisation than those with no sign of historical management; (H4) community composition of hedges with recent evidence of flailing has shifted away from species associated with shady conditions, and the species richness of published indicators of hedgerow quality has decreased, due to this management allowing more light into the hedge base; (H5) the extent of change of hedge floral communities correlates with the increase in the proportion of the adjacent land area under intensive use.

These hypotheses were tested separately on hedgerow woody species, which make up the majority of the physical structure of hedges, and herbaceous hedge species, a more diverse plant com-

munity found in the base of hedges. We predicted that these two groups of species would respond differently to changes in hedgerow management and surrounding land use, due to their differing life histories.

2. Methods

2.1. Vegetation surveys

2.1.1. 1930s Survey of hedgerow plants

Over 1000 hedgerow sites were surveyed by Professor Ronald Good in Dorset between 1931 and 1939, as part of a large-scale botanical survey covering a range of habitats (Good and Robinson, 1948). Good (1937) chose sites to represent specific habitat types, to be "...reasonably distinct topographical and ecological entities..." and to be "...as evenly scattered as possible" across Dorset. The hedgerow sites varied in length from 57 to 1040 m and were surveyed by recording all vascular plant species encountered over approximately 1 h. Each hedge was visited once, generating presence-absence data that are relatively robust to sampling error (Hirst and Jackson, 2007). Hedgerow site locations were recorded on a series of large scale (1:10,560; six inches to the mile) Ordnance Survey maps which are stored at Centre for Ecology and Hydrology, and were digitised by Dorset Environmental Records Centre in 1999 (<<http://www.derc.org.uk/projects/good.htm>>). Good's data have been used in other analyses of long-term vegetation change in woodland (Keith et al., 2009, 2011), grassland (Newton et al., 2012) and cliff-top sites (Wichmann et al., 2008).

2.1.2. Re-survey of hedgerow plants

During the spring and summer of 2001, a random sample of 357 hedgerow sites was chosen from the original dataset and resurveyed once. The size and shape of the original plots was re-located using the annotations on the large scale survey maps. The presence of all plant species within each site was recorded using the Good (1937) method. In addition, the management status of each hedgerow site was recorded, in terms of evidence of 'historic management' (categorised as either laid, coppiced or pollarded) and of 'recent management' within the preceding 2 years (categorised as flailed/trimmed, coppiced or laid). Coppicing can be detected in woody hedgerow species for decades after rejuvenation management, due to the characteristic growth of new shoots from a 'stool' (the main stem that is coppiced). Similarly, the presence of horizontal woody trunks is evidence of previous hedge-laying. The location of each hedgerow site was determined with a Geographical Positioning System, and a photograph taken of each site (Button, 2003).

2.2. Plant species classification and attributes

Hedgerows containing 'ancient woodland indicator species' are considered to have a high conservation value due to the implication that they were once part of ancient woodlands. In the UK, the 1997 Hedgerow Regulations includes a list of 57 indicator species (electronic supplementary material Appendix A; <http://www.legislation.gov.uk/ukxi/1997/1160/schedule/1/made>, last accessed 15 January 2013). Difference in the number of these indicator species at each hedge site between the 1930s and 2001 were analysed to measure change in habitat quality.

Plant species recorded in both surveys were classified according to the woodiness attribute in the PLANTATT data base (containing comprehensive information on status, size, life-history, geography and habitats for all British plant species; Hill et al., 2004): (i) woody and semi-woody (referred to below as 'woody' species) vs. (ii) herbaceous plant species. This allowed us to determine whether

Download English Version:

<https://daneshyari.com/en/article/6300593>

Download Persian Version:

<https://daneshyari.com/article/6300593>

[Daneshyari.com](https://daneshyari.com)