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Long-term changes in the tree and shrub layers of a British nature reserve and their relevance for woodland conservation management

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A B S T R A C T

Changes in the woodland extent over the last 200 years were assessed from old maps for a 100 ha woodland nature reserve in southern Britain. More detailed changes in the composition and structure of the tree and shrub layers were measured using data from 95 permanent vegetation plots (10 × 10 m) distributed across the reserve at the intersections of a 100 m grid. These were recorded in 1973, 1992 and 2009. The woodland area has more than doubled since the 18th century, but whereas the pre-1800 woodland was mainly *Fagus sylvatica* the more recent woodland was initially predominantly conifer plantation. These plantations have since developed into mainly broadleaved high forest of *Fraxinus excelsior* and *Acer pseudoplatanus*. Changes on the site are the combination of active interventions through management and natural processes (differential species growth, death from disease, windthrow, herbivore damage). Further changes are likely in future in particular from ash dieback (*Hymenoscyphus fraxineus*) and climate change impacts. Many of the changes seen on this reserve are mirrored in woods elsewhere in Britain and Europe. Over periods of a few decades and at the whole-reserve scale the woods can be considered to be relatively stable; at the plot level, or over time-scales of centuries they are very dynamic. Whether woods are judged to be resilient must include definition of the temporal and spatial scales.

1. Introduction

In Britain, as in much of Europe and eastern north America, woodland exists as part of cultural landscapes with a long history of human intervention (Rackham 1986, 2003; Foster et al., 1998; Kirby & Watkins, 2015). The structure and composition of woods, stands and even the shapes of individual trees reflect the legacies of past land-use change, woodland management or neglect. These in turn reflect the objectives of the owners and users of the woods (e.g. Von Oheimb & Brunet, 2007; Lindbladh & Foster, 2010; Kirby et al., 2014; Rochel, 2015). Overlain on these deterministic forces are the effects of natural processes such as tree growth, storms, droughts, pests and diseases, herbivore damage, fire etc. (Koop & Hilgen, 1987; Kirby & Buckley, 1994; Peterken & Mountford, 1996, 1998; Pontailler, Faille, & Lemée, 1997; Mountford, 1997, 2006; Mountford, Peterken, & Burton, 1998; Mountford & Peterken, 1998, 2003; Emborg & Heilmann-Clausen, 2007; Brunet, Bukina, Hedwall, Holmström, & Von Oheimb, 2014; Latałowa, Zimmy, Jedrejewska, & Samojlik, 2015; Müllerová, Hédl, & Szabó, 2015).

Permanent plot studies can be invaluable in allowing direct observation of long-term changes, their causes and consequences e.g. Bakker, Olff, Willems, and Zobel (1996); Peterken and Jones (1987, 1989), Barker-Plotkin & Foster (2006); Perrin, Kelly, and Mitchell (2006). However, researchers generally only stay with a site for a few decades, because of changes to their jobs, or their interests, and ultimately their lifespans. Coupling analysis of historical maps and accounts with long-term monitoring data can help to identify and interpret older events that have legacies in today's woods; comparison with nearby sites or national data may allow the separation of site-specific from more general patterns (Magnuson, 1990).

We illustrate this approach through a study of the changes in the tree and shrub layer of a woodland nature reserve in southern Britain. Our data come from permanent vegetation plots established in 1973 by Dawkins and Field, (1978), with subsequent recordings in 1992 and 2008–10, together with insights from maps dating back to the middle of the 18th century.

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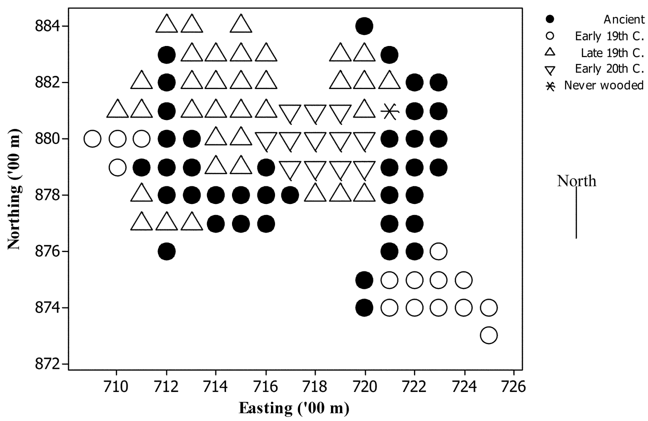

Fig. 1. Distribution of plots at the Warburg Reserve by woodland origin. The axes are UK National Grid values, each unit being 100 m.

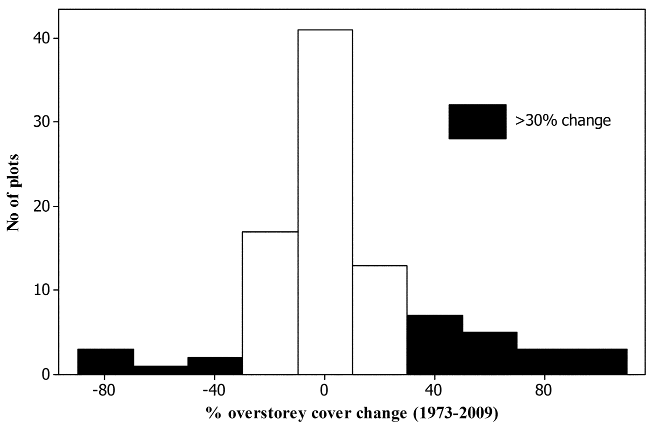

Fig. 2. Change in the overstorey percentage cover (1973–2009) of individual plots at the Warburg Reserve.

Studies of long-term woodland change in various protected sites in Britain have mainly been based on transects in ancient semi-natural stands under minimum intervention treatments (Peterken & Backmeroff, 1988). The systematic plot distribution set up by Dawkins and Field (1978) at the Warburg Reserve described here, and at Wytham Woods about thirty kilometres to the north-west (Kirby et al., 2014) also cover areas of recent plantations and actively managed stands. This allows for the description of influences on the composition and structure of woodland that may be more typical of the bulk of British broadleaved woodland. We show how the composition and structure of the reserve has changed over the last 200 years as a consequence, and discuss some implications for the future treatment of the reserve.

2. Site

The Warburg Reserve, c.100 ha, lies at 51°35′7″ north/0°58′3″ west, British national grid reference SU717879 (BBOWT, 2016). It is owned and managed by the Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust (Paul, 1985; Phillips, 1991) and forms part of a larger block of woodland in the Chiltern Hills of southern Britain (Tilney-Bassett, 1988; Natural England, 2013).

The reserve covers the sides of a dry valley (90–165 m above sea level) consisting of two north-south running sections connected by a middle east-west section. Mean temperature ranges from 2.7 °C in January to 15.8 °C in July, with an annual rainfall of 711 mm. Most of reserve lies on Cretaceous Upper Chalk, with just a narrow belt along the valley bottom on the Middle Chalk. Much of the chalk is covered by various superficial deposits, such that while many of the soils are calcareous, there are locally areas where the surface layers have been heavily leached.

2.1. Conservation significance

The reserve was acquired by the Wildlife Trust in 1967 when its value as a site for rare plants, particularly orchids, was being threatened by unsympathetic management for timber production (Paul, 1985). The reserve was designated as a Site of Special Scientific Interest (the statutory mechanism for protecting important nature conservation sites in Britain) in 1972 because of its complex mosaic of ancient beech and ash woodland, scrub and a small extent of species-rich chalk grassland. Over 500 species of vascular plants have been recorded from the reserve and it also hosts diverse invertebrate and fungal populations.

The woodland is a mixture of British National Vegetation Classification types W12 *Fagus sylvatica- Mercurialis perennis* woodland (mainly in the ancient woodland) and W8 *Fraxinus excelsior-Acer campestre-M. perennis* woodland (mainly in the stands of more recent origin) (Rodwell, 1991). The grassland areas are a mixture of *Festuca ovina-Avenula pratensis* CG2 and the *Avenula pubescens* CG6 communities (Rodwell, 1992). Both the beech woodland and the calcareous grassland types are priority habitats under the UK Biodiversity Action Plan (Anon, 1994) and are listed under Annex I of the European Habitats Directive (European Commission,1992).

2.2. Historical context

Britain's woodland cover had shrunk to about 5% by AD 1900, as a consequence of thousands of years of clearance, primarily to create farmland. Such woods as survived tended to relatively small and were managed intensively as part of the local rural economy (Rackham, 2003). Thus in the 18th and early 19th centuries the main markets for produce from woods such as that which would become Warburg Nature Reserve were for small roundwood produced by coppice or pollard systems (Edlin 1949; Rackham, 2003). This material would almost certainly have been used in the brickworks in the nearby village.

In the second half of the 19th century an agricultural recession in Britain, caused by factors such as increased imports of grain and meat, led to declines in the value of farmland. Where, as in this study area, the land was put into woodland, shifts in the timber market favoured the creation of productive plantations of introduced conifers (Aldhous, 1997). However the conifers were noted as growing badly almost from the start, probably due to lime chlorosis on these calcareous shallow soils (Tilney-Bassett, 1988) and broadleaves invaded many of the gaps that developed in the crops as trees died or following felling during the Second World War (1939–1945) (Phillips, 1991).

The objectives of management for the study site changed again in 1967 when the reserve was acquired by the Wildlife Trust (Paul, 1985). Priority was given to maintaining the ancient woodland and the range of other semi-natural woodland and grassland habitats present (Phillips, 1991), with some small areas managed as coppice or scrub. There is currently a presumption against any further tree planting.

3. Methods

3.1. Woodland origin

The origin of different parts of the woodland within the reserve was inferred from examination of the topographic maps (1:10560) produced at various dates through the 19th and 20th centuries by the UK Ordnance Survey (Old-maps.co.uk, 2016) supplemented