THE STATUS OF SHERWOOD'S ANCIENT OAKS

by

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INTRODUCTION

The Royal Hunting Forest of Sherwood covered over 50,000 hectares of Nottinghamshire at its inception in the 11th century. This 'heathland forest' was associated with the free-draining acid soils of the Sherwood Sandstone plateau and consisted of extensive areas of 'waste' (lowland heath and acid grassland), semi-enclosed arable land and well-established areas of old woodland, all of which were subject to grazing by a range of animals, both wild and domestic. The Forest included the woodlands of Birklands and Bilhaugh to the north of the village of Edwinstowe in Nottinghamshire. First referred to in 1251 (Boulton 1965), they now represent the finest remaining fragments of Sherwood's ancient woodland. These woods are particularly notable as they support a large population of ancient or 'veteran' oak trees, a sight now extremely rare in the UK and Europe and are now one of the most important localities for ancient trees in England. Birklands is home to one of the most famous and most visited veteran trees in the country, the Major Oak, which is estimated to be over 1000 years old. The area is also famously associated with the legendary exploits of Robin Hood and this cultural heritage enjoys international recognition.

Following a gap of over 200 years, information was gathered during the period 1996-99 to assess the size, distribution and condition of the ancient oak population of Birklands and Bilhaugh. The study area of almost 800 hectares is defined by the woodland boundary as mapped during the 1730s and includes Birklands and Bilhaugh Site of Special Scientific Interest (SSSI), an internationally significant site for wildlife. This work was undertaken in the spirit of the historic surveys of the Sherwood oaks and sought to provide a further baseline for future study and management of the site.

THE IMPORTANCE OF ANCIENT TREES

Trees that are of interest biologically, culturally or aesthetically because of their size, age or condition are loosely termed ancient or veteran trees (Read 2000). They are a significant yet often overlooked part of our historic, cultural and ecological heritage. In the past these trees had considerable social and economic value as part of working landscapes. Later they became important elements of 18th and 19th century landscapes. More recently there is now a much greater understanding of their great ecological importance and Britain, largely due to historic reasons, is thought to support large numbers of old broadleaved trees of European importance. Some of the most notable sites in England for old trees, the New Forest, Windsor Great Park, Epping Forest and Sherwood Forest, are considered to be internationally important for nature conservation.

In Britain, concentrations of old trees are most commonly associated with historic landscapes such as ancient woodland and old parkland. Woodland with significant numbers of very old trees is widely acknowledged to be of great significance in nature conservation and often takes the form of traditionally managed wood-pasture or open parkland systems of considerable antiquity (Kirby *et al.* 1995). The flora and fauna of these woods can often be exceptionally rich and highly specialized in their habitat requirements. In particular, communities of saproxylic invertebrates - those animals dependent upon habitats with an abundance of decaying wood and mature timber - are closely associated with old woodland and ancient trees and are often characterized by an abundance of rare and endangered species (Kirby and Drake 1993; Alexander 1999). These communities are amongst the most threatened faunas in Britain, being restricted to a limited number of sites across the UK (Harding & Rose 1986).

THE IMPORTANCE OF BIRKLANDS AND BILHAUGH FOR NATURE CONSERVATION

Much of the impetus for recent tree survey work within the site has arisen as a result of the outstanding ecological significance of the site. English Nature, the statutory nature conservation agency in England, notified part of both Birklands and Bilhaugh as a single Site of Special Scientific Interest (SSSI) in 1954 and again in 1983, in recognition of their outstanding wildlife interest. Parts of the SSSI have recently been selected as a candidate Special Area of Conservation (cSAC) by the UK Government, as required by the European Habitats Directive, as the most northerly UK example of old oak woodland on sandy plains, with a notable assemblage of ancient trees and a rich associated invertebrate fauna.

The finest remnants of ancient semi-natural woodland within the study area form the core of the SSSI. This woodland is dominated by pedunculate oak *Quercus robur*, sessile oak *Quercus petraea* and birch *Betula pendula* which form typically species-poor woodland stands characteristic of the Sherwood Sandstone (Plate 1). The site contains significant populations of old or veteran oak trees, characterized by their large girth and a noticeable loss of crown that produces a 'stag-headed' appearance. Tree-ring counts from fallen oaks suggest the majority of these trees are likely to be between 400-600 years in age. The woodland stands are now best described as relict or derelict pasture-woodland. Although now largely closed canopy woodland, the form of many of the large veteran oaks that remain suggest they developed in open forest conditions, their growth shaped by historic management practices of timber harvesting and grazing. The wood was historically grazed by a variety of herbivores, originally deer and later domestic stock such as pigs and sheep (Watkins 1998) but such practice is thought to have largely ceased by the early 1900s.

These woods are host to an exceptionally rich invertebrate fauna, particularly the assemblage of saproxylic invertebrates. The study area has long been known by naturalists as an outstanding site for

PLATE 1: A general view of semi-natural woodland in Sherwood Forest Country park with ancient standing oaks, scattered birch and fallen decaying wood in the foreground (English Nature)

Coleoptera (beetles) and Arachnida (spiders) associated with the decaying wood and mature timber of native oaks and birch. In terms of Coleoptera alone, 37 nationally rare species have been recorded at Birklands and Bilhaugh, along with a further 109 species which are considered to be nationally scarce. Over 50 of these recorded species are indicative of a long continuity of semi-natural woodland habitat and the site is amongst the finest for rich saproxylic beetle faunas in Britain (Harding and Alexander 1994). The site continues to support this exceptional diversity of invertebrates associated with decaying wood. The decaying wood resource is locally abundant in the form of fallen dead wood, rot-holes, trunk cavities and broken limbs. Recent studies commissioned by English Nature and Forest Enterprise have also confirmed that the remnant ancient oaks found within the most modified woodland compartments, conifer-dominated plantations, continue to support a high quality decaying-wood beetle fauna (*e.g.* Lott 1999). The value of the standing oaks, both alive and dead, for wildlife is clear and these surveys suggest that the rich invertebrate fauna of Sherwood is almost certainly dependent on the existence of large numbers of old trees across a large area.

METHODS

The study area of Birklands and Bilhaugh covers 797 hectares (ha); it is illustrated on Figure 1 and the compartment details are given on Table 1. The area embodies the larger woodland complex as indicated by some of the earliest detailed maps of the site dating back to 1735 (Thoresby Estate archives). However, it is known that these woods were distinguishable on some of the earliest maps of Sherwood Forest dating to the 14th and 17th centuries (Mastoris and Groves 1997; Mastoris 1998). The study area also includes 326 ha of Birklands and Bilhaugh Site of Special Scientific Interest (SSSI).

This paper draws together the results of a series of ancient tree surveys within the study area. Surveys commissioned by English Nature and Forest Enterprise in 1996 produced detailed information on the veteran tree population within various parts of the SSSI, including Sherwood Forest Country Park and Bilhaugh Buckgates (Watkins and Lavers 1998). These surveys sought to establish an inventory of trees for particular compartments within Birklands and Bilhaugh SSSI and land managed by Forest Enterprise. The adopted methodology involved the marking of individual ancient trees using aluminium tags, the mapping of individual trees using aerial photographs, recording of tree condition and the detailed measurement of a wide variety of variables for each oak encountered. Each recorded ancient oak was then classified into one of the following condition categories;

1. Standing live tree
2. Standing dead tree >1 metre high
3. Fallen tree or trunk
4. Stump or standing dead < 1 metre high

The 1996 surveys were supplemented by tree surveys of the wider area carried out by English Nature in order to fill important gaps in our knowledge of the ancient oak population (Clifton 2000). The 1999 survey was less detailed and focused on those areas where no previous tree recording had been undertaken. Individual blocks of woodland within the study area were identified and compartmentalised to allow more detailed analysis if required. Stands were searched during early May and late September (to avoid peak growth of the woodland ground layer) using public rights of way and forestry rides and tracks to ensure complete visual coverage of each compartment. The location of veteran trees was recorded onto Ordnance Survey or more detailed estate maps where available, although individual trees were not tagged during this survey. Oak condition was classified using the four categories used during the 1996 tree surveys.

The survey methods were effective, but rather labour-intensive. Tree detection rates were considered to be high during both surveys. The woodland ground layer did not generally preclude visibility across the woodland under-storey or the detection of standing trees through plantation areas. Large standing trees with their typically low crown were generally conspicuous amongst blocks of tall conifer woodland, but less so within more diverse broadleaved woodland stands. This may well have led to some under-recording of low, hidden stumps and/or fallen trees, despite more intensive searching. It is equally possible that a small proportion of standing trees

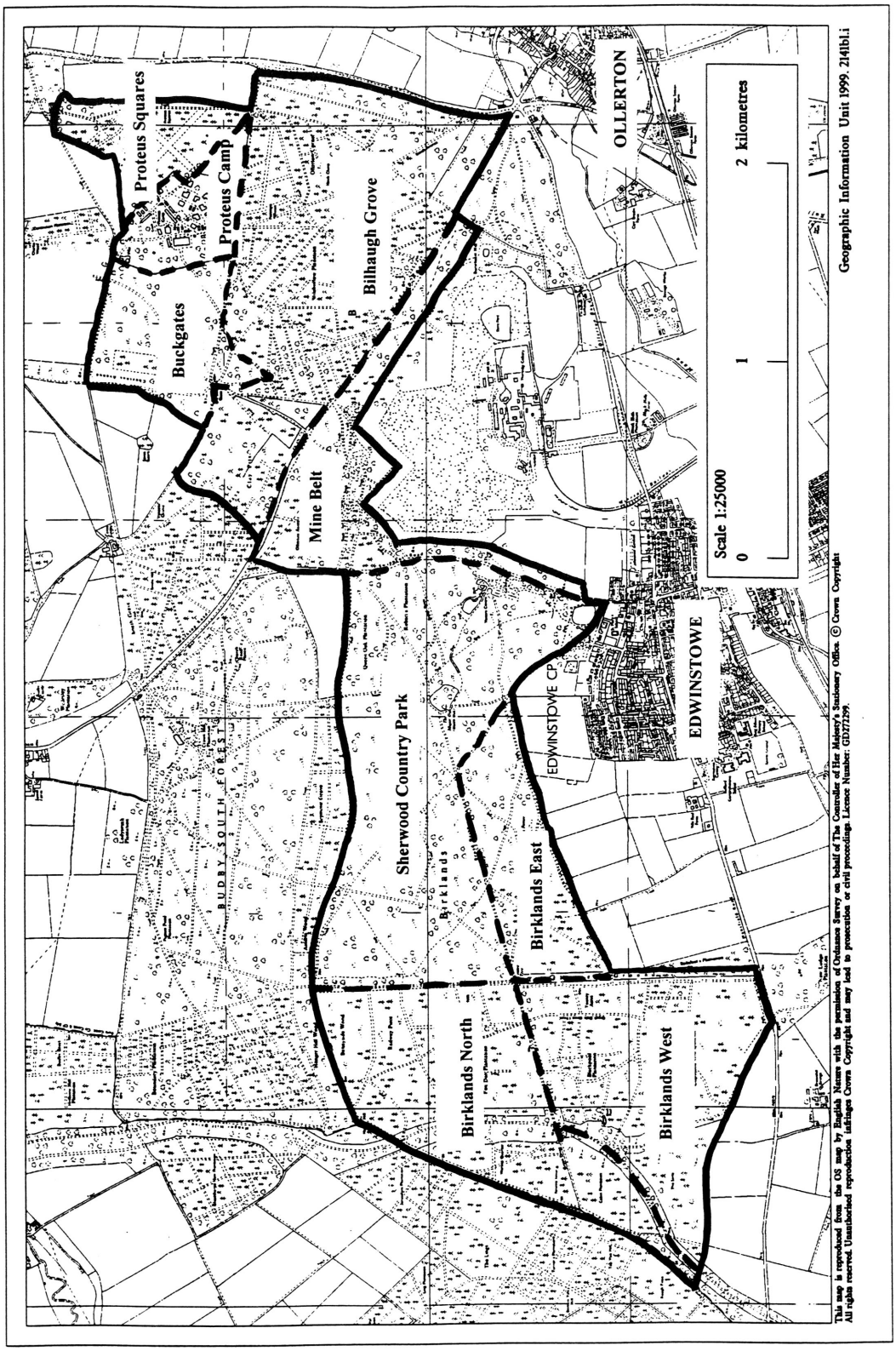

FIGURE 1: The study area of Birklands and Bilhaugh, Nottinghamshire

Table 1
The study area - compartment details

Site	Compartment (non-SSSI area in *italics)*	Survey date	Woodland type	Area (ha)
Birklands	Sherwood Country Park	1996	Broadleaved semi-natural woodland	177.1
	Birklands East	1996	Plantation woodland	51.1
	Birklands West	1996	Plantation woodland	108.7
	Birklands North	1999	Plantation woodland	113.3
Bilhaugh	Buckgates	1996	Broadleaved semi-natural woodland	47.8
	Proteus Squares	1999	Plantation woodland	30.7
	Proteus Camp	1999	Broadleaved woodland (open)	27.2
	Mine belt	1999	Broadleaved semi-natural /plantation woodland	62.5
	Bilhaugh Grove	1999	Plantation woodland	178.6
				797.0 ha

were not identified or recorded during the surveys, as a result of the nature of this methodology. This would lead to an under-estimate in the numbers of these trees also, although it is suggested that this is likely to be limited to a very small number. More detailed repeat surveys, perhaps utilising Global Positioning Systems (GPS), will hopefully eliminate these inaccuracies and reduce the effort required to re-survey and monitor the old oaks in future years.

RESULTS

Number and condition of the oaks

Table 2 demonstrates that a minimum of 2386 ancient oaks of all categories was recorded within the survey area, 1643 or 69% of which were standing trees. Of these standing trees, 991 were considered to be living, representing 42% of all veteran trees recorded. A further 27% were recorded as standing dead trees and 23% fallen trees or trunks. Only 8% of the total number of records were classified as stumps. Only ancient oaks *Quercus robur, Q. petraea* and perhaps hybrids were encountered, although no attempt was made to record each individual tree or gather species data. If undetected trees in whatever form were included in these overall figures, it is likely that the total number would exceed 2400.

Sherwood Forest Country Park supports 41.3% of all veteran trees recorded across the study area, followed by Bilhaugh (Buckgates) at 17%. The greatest numbers of oaks were found in Sherwood Forest Country Park with 985 trees, 439 (45%) of which were standing live trees. 47% of all standing veterans, both alive and dead, are found within the park. Almost 80% of these trees were standing, the remaining fifth consisting of fallen trees or trunks and stumps. Woodland managed by Forest Enterprise contained 30% of the veteran tree population in Birklands and Bilhaugh, with the largest collection in Birklands West, an area currently out with the SSSI. Proteus Squares holds the least number of veterans, totaling just 1.8% of the total population.

The surviving living oaks (Plate 2) are concentrated in three compartments; Sherwood Forest Country Park (44.3% of all live trees), Buckgates (25.4%) and Birklands West (12%). The populations of living oaks within all compartments were highly

variable, ranging from 12 -62%, but was not consistently high. Bilhaugh (Buckgates) has the highest individual proportion of live trees across all compartments within the study area with 62%, with just less than half of trees in Sherwood Forest Country Park living. Certainly the greatest concentration of living trees outside of the SSSI occurs within Bilhaugh Proteus Squares, an area with the lowest total of records but with a high proportion of standing live trees within its local veteran tree population. Part of the Forest Enterprise landholding at Birklands supports the lowest grouping of live trees (Birklands North) but the highest group of standing dead trees (85%) across the study area, with few fallen trees and stumps recorded. Over half of the veterans recorded in an adjacent area of timber crop in Birklands West, which supports the greatest collection of veteran trees outside of the SSSI (15% of total), were fallen trees or trunks.

There is generally a low stump occurrence across Birklands but a noticeably higher proportion in Bilhaugh. Accordingly, there is a much smaller population of standing trees in Bilhaugh (Table 3), an area that accounts for just over one quarter of all trees in this category. The proportions of fallen trees and stumps were higher in coniferous blocks such as Bilhaugh Grove (50% of veterans), Birklands West (55%) and Bilhaugh Mine Belt (77%) and in compartments subject to other forms of intensive land use, such as Bilhaugh Proteus Camp where 82% of veterans are fallen trees or cut stumps.

Table 4 illustrates that the greatest overall population of standing (both live and dead) veterans, as a proportion of each compartment, was found in Birklands North, where 97% of trees were standing. These were mostly dead and constitute less than 7% of the total number of standing trees (see Plate 3). This compartment was closely followed by Buckgates (83%), Sherwood Forest Country Park (80%) and, interestingly, Bilhaugh Proteus Squares (77%), an area which only represents 1.8% of the total population. The lowest proportions of standing veterans

Table 2
Number of ancient oaks recorded (all categories) number (%)

Compartment (non-SSSI areas in *italics*)	**Standing live**	**Standing dead**	**Fallen tree/ trunk**	**Stump**	**TOTAL**
Birklands					
Sherwood Country Park	439 (45)	344 (35)	149 (15)	53 (5)	985
Birklands East	98 (36)	73 (27)	93 (34)	7 (3)	271
Birklands West	119 (35)	33 (10)	179 (53)	9 (2)	340
Birklands North	14 (12)	95 (85)	2 (2)	1 (1)	112
Bilhaugh					
Buckgates	252 (62)	85 (21)	59 (15)	11 (3)	407
Proteus Squares	24 (55)	10 (22)	3 (7)	7 (16)	44
Proteus camp	20 (17)	1 (1)	29 (25)	68 (57)	118
Mine belt	10 (22)	0	16 (34)	20 (43)	46
Bilhaugh Grove	15 (24)	11 (16)	15 (24)	22 (36)	63
TOTALS	**991 (42)**	**652 (27)**	**545 (23)**	**198 (8)**	
	1643 (68.9)		**743 (31.1)**		**2386 (100)**

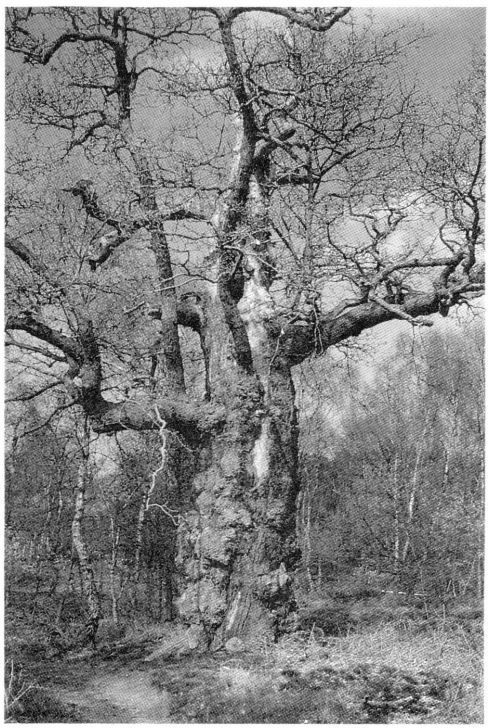

PLATE 2: A large living standing oak in Bilhaugh Buckgates (Steve Clifton/English Nature).

were within Bilhaugh, along the Mine Belt, Proteus Camp and Bilhaugh Grove where the highest number of fallen trees and stumps occur.

Density of ancient oaks

The number of old oaks per unit area is an important attribute of a site rich in old trees and supporting a specialized invertebrate fauna with limited powers of dispersal. The whole study area covered 797 hectares and supported an average density of just under 3 veteran oaks per hectare (ha). However, the density of ancient oaks varied enormously between compartments. Buckgates supported the highest density of trees at 8.5/ha, followed by other SSSI and cSAC compartments of Sherwood Forest Country Park (5.6/ha) and Birklands East (5.3/ha). Bilhaugh Proteus Camp also had a comparatively dense population at 4.3/ha but a low grouping of standing trees at only 0.8/ha.

In terms of standing oaks, Buckgates again clearly contained the greatest density of trees, averaging 7.1 trees per ha, followed by Sherwood Forest Country Park (4.4/ha) and Birklands East (3.3/ha). The tree density amongst other compartments was generally low and differed little, ranging from 0.2 to 1.4 trees/ha. The average density of standing veterans across the study area as a whole is relatively low at 2 per ha, outlining the relative importance of compartments such as Buckgates, Sherwood Forest Country Park and Birklands East.

Distribution of ancient oaks

The survey confirmed that veteran oaks continue to be widely scattered across the whole study area, reflecting the ancient woodland boundary of Birklands and Bilhaugh indicated in maps of the 18th century. A 1735 map of Thoresby Park by Reynolds held by the Thoresby Estate shows the medieval extent of

Table 3
Total standing ancient oaks by site

Compartment	**Total veterans**	**Number of standing oaks (live and dead) and % of site total**	**Number of fallen trees & stumps and % of site total**
Birklands	1708	1215 (71%)	493 (29%)
Bilhaugh	678	428 (63%)	250 (37%)
TOTAL	**2386**	**1643**	**743**

Birklands and Bilhaugh, extending the boundary of the site beyond that illustrated by Rooke in 1799 (reproduced in Watkins 1998). Over two-thirds of all standing veterans are located in Birklands and some compartments such as Bilhaugh Grove and Bilhaugh Mine Belt contained only a very low concentration of trees, suggesting both extensive clearance of trees and a historically scattered distribution of trees as indicated by old site maps. The greatest densities of trees occurred in just three key compartments (Bilhaugh Buckgates, Sherwood Forest Country Park and Birklands East). Of all of the standing veterans across the study area, 68% were restricted to just two compartments, Sherwood Forest Country Park and Buckgates, with a further 10.4% within Birklands East.

Ancient oak characteristics

Ancient trees in Sherwood are generally native oaks, either sessile oak *Quercus petraea*, pedunculate oak *Q. robur* or hybrids of the two, and these trees form an important component of semi-natural woodland cover within the study site and the wider Sherwood area. In work commissioned by English Nature and Forest Enterprise, Watkins and Lavers (1998) studied in detail a range of physical attributes associated with the ancient oaks. These veteran oaks were found to be typically large in girth with a mean diameter at breast height ranging from 118-148 cms. Well over half of all trees within SSSI compartments are affected by heart-rot. For example, up to 73% of veterans in Sherwood Forest Country Park are known to be hollow. Bark loss on veterans is generally high; trees within replanted coniferous forest typically showed higher mean bark loss per tree (79%) with lower values (50-59%) in deciduous woodland compartments.

Veteran oaks typically possess quantities of related dead wood habitat, although this varies between compartments. A high mean number of fallen limbs per tree is matched by a high incidence of dead limbs attached to trees. In terms of living trees, generally high proportions also have dead limbs attached, over 50% of attached limbs per tree in some

Table 4
Distribution of standing ancient oaks by compartment

Compartments ranked according to % (non-SSSI areas in *italics*)	**Total number of standing (live and dead) oaks**	**% of veteran oak population within compartment standing (live and dead)**	**% of total standing oaks within study area**
Birklands North	109	97%	6.6
Bilhaugh (Buckgates)	337	83%	20.4
Birklands (Sherwood Country Park)	783	80%	47.6
Bilhaugh (Proteus Squares)	34	77%	2.1
Birklands East	171	63%	10.4
Birklands West	152	45%	9.2
Bilhaugh Grove	26	40%	1.8
Bilhaugh (Mine belt)	10	22%	0.6
Bilhaugh (Proteus camp)	21	18%	1.2
TOTALS	**1643**		**100**

cases. A key feature of the Sherwood veterans is a significant and noticeable loss in tree crown; a consistently high number of trees have lost their heads at some time, between 60-80% of all trees in each compartment, resulting in a 'stag-headed' appearance.

DISCUSSION

The oaks in their historic context

This paper contributes to a recent growth of studies into the historic ecology of this most significant area of Sherwood Forest. The influence of human activities on wildlife habitats has long been recognized but the importance of linking history and ecology to inform the conservation of important woodland sites has only recently come to the fore, as exemplified by a growing number of influential exponents, such as Rackham (1976 & 1980), Peterken (1981) and more recently Kirby and Watkins (1998). A number of studies based specifically in the east Midlands have also been undertaken, such as Squires and Jeeves (1994), which provide wildlife-rich ancient woods with a historic and cultural perspective. Such links have already been used to good effect in Sherwood. The work of Watkins (1998) at Birklands and Bilhaugh has ably demonstrated the value of combining ecological information on the oaks themselves with historic documentation and archive material. Such methods are likely to become increasingly important in piecing together the management history of the old oaks and planning their future survival in order to maintain the ecological, cultural and historic integrity of the Birklands and Bilhaugh area.

PLATE 3: A standing dead oak amongst coniferous woodland in Birklands West (Steve Clifton/English Nature)

It is clear that by 1609 a large proportion of the old forest of Sherwood was no longer under woodland cover. It is estimated that just 10% of the forest area at this time constituted woodland (Mastoris and Groves 1997). There is strong evidence provided by Domesday material that much of the original woodland cover of Sherwood had already been reduced to just one-third of its former size by 1086, 70 years prior to the requisitioning of the area by the King as a Royal Forest (Rackham 1986). A Royal Commission assessing the condition of Crown woods and forests, as part of an attempt to increase the revenue provided by royal estates, included a report on Birklands and Bilhaugh in 1793 (Grant 1991). This report noted that the trees of the wood were already of considerable age and stature showing noticeable signs of senescence. The Commissioners also noted the progressive decline in the extent of the tree population at the site as a result of the mis-management of the Royal Forest, which is now thought to date back as early as the 1300s (Laxton 1997). According to the report, the number of 'timber oaks' were substantially less than the 26,800 'oaks not timber' by 1608. Successive surveys in 1680 and 1788 indicate a large decline in the total number of trees and a high proportion of those remaining were hollow. The latter survey recorded 10,117 trees of which only 1368 were of use as timber by the navy. Many of these were noted as being of great size and in a general state of decay, with the youngest oaks considered to be at least 300 years old.

Numerous historians, reviewed by Hopkinson (1927), also noted the ancient condition of the oaks of Birklands and Bilhaugh. Camden in 1625 noted

that "the forest is sadly altered now only a few vestiges of its olden glories survive...at Bilhaugh, are oaks which cannot be less than six or seven centuries old", whilst Cox noted in 1680, "although there were many thousand standing trees, few there were but what were decaying". By 1794, Lowe noted the very open nature of the woodland and this is supported by the scattered representation of trees in parts of Birklands and Bilhaugh on the 1794 map of Sherwood by Chapman and subsequently by Sanderson in 1835 (Thoresby Estate archives). It is however very clear from this evidence, and the Royal Commission report, that the ancient oaks were likely to be remnants of a continously regenerating natural population which had been over-mature for several centuries.

Throughout the 18th century timber was progressively extracted from the woods, yet there is continued reference within the Royal Commission report to old and decaying trees and to the presence of grazing through the exercising of rights of pannage and pasturage by pigs and sheep during the 1700s. Regeneration of oak within the Forest had been historically intermittent since the 12th century, fluctuating with the type and effectiveness of management and the degree of control exercised by the Crown (Laxton 1997). Harvesting of timber coupled with grazing pressure would further restrict the natural recruitment of trees, adversely affecting the sustainability of the timber resource during periods where management of the woods was lacklustre and increasing the gap between the over-mature or ancient oaks and their younger generations. With increasingly poor timber quality, large-scale disafforestation of the woods at Birklands and Bilhaugh was only avoided by the aesthetic appreciation of the old oaks shown by the ducal landowners who followed (Watkins 1998).

From the existing documentary evidence and field observations, there remains a question mark over the historic management of the old oaks themselves. Suprisingly, very few of the standing oaks show signs of pollarding (cutting of the tree well above the ground for timber produce) which was historically a common practice in the UK, despite the references to 'lopping' of oaks in historic documentation (Watkins 1998). It would appear that the history of Sherwood as a Royal hunting forest managed as pasture-woodland deterred such intensive management by local communities and the oaks as such were left unmanaged. This clouds any clear modern rationale to adopt with regard to perpetuating tree management to prolong their survival. To date the emphasis of management has been to allow the standing oaks to decline naturally, whilst restricting any negative impacts which may artificially accelerate the decaying process.

Changes in the numbers of ancient standing oaks

Despite timber harvesting, grazing under rights of common and oak depletion, the continued presence of large numbers of old trees within Birklands and Bilhaugh is consistently stated throughout local documentary evidence. However, from this it would be fair to assume a gradual decline in the number of old oaks and an increasing generation gap as grazing pressure regulated oak recruitment. It is of course very difficult to establish direct evidence for such a decline from the tree data of 1608, 1680, 1788 and 2000. The implication is that around 1700 there were almost 33,000 trees showing signs of over-maturity, falling to under 9000 by 1788. If the Royal Commission figures, in terms of trees unsuitable for timber, are taken as an accurate record of the number of ancient oaks within Birklands and Bilhaugh during the 1600s, it could be suggested from the results of this study that there has continued to be a progressive decline in the number of ancient standing trees within the area since 1800.

This loss of trees from Birklands and Bilhaugh appears to have continued as the remnant veteran tree population is now estimated to be now less than 2400 with only 1643 standing trees. In addition we have established that those stands of Birklands and Bilhaugh subject to less intensive management support high numbers of standing oaks at high densities. The disproportionately low densities of trees in afforested compartments do imply concentrated declines in the ancient oak population. Extrapolating the highest oak densities recorded in 2000 of 6.5 standing oaks/hectare across the study area, one could estimate over 5180 standing oaks prior to the onset of modern woodland management practices, suggesting a 46% reduction in the number of ancient standing oaks to almost half their number.

Actual documentary evidence for a continued decline in the veteran tree population during the last 200 years is however scarce, with very few modern accounts of management within the study area. From published material, it is known that the area was finally conveyed in 1827 from the Crown into the ownership of the Duke of Portland at Welbeck and later the Manvers family at Thoresby. Prior to this, the trees were retained by the Crown and although it was theoretically illegal to remove trees, this still took place (Rodgers 1908). In the hands of the Dukes, the woods of Birklands and Bilhaugh soon became areas for private recreation and hunting. Long, straight ridings, 20 to 30 metres wide providing a network of drives and avenues, became a feature of both woods. It is certainly possible that more veterans were lost during this period of the great Estates both as a source of timber to provide growing agricultural development of estate land and to make way for the great schemes of parkland landscaping.

Rodgers (1908) provides a rare reference to woodland management during the 1830s within the compartment of Birklands West (see Figure 1), which contained one of the many large and well-known veteran oaks, the Shambles Oak or Robin Hood's Larder. Visitors to the area recount in their letters "great quantities of picturesque old trees being cut down to make room for what was considered to be more profitable timber". This account corresponds with one of the few documented accounts of woodland management practices within the site at this time. The compartments of Birklands North and West were replanted with 'oaks and chestnuts' from 1821 - 1851 by the Duke of Portland of the Welbeck Estate, soon after Birklands and Bilhaugh was relinquished by the Crown. Old estate books dated 1852 (Welbeck Estate archives) record in detail the planting operations. Many woodland blocks were first 'cleared' (of what is not stated) and then sown with turnips and sheep grazed for a year or two prior to the planting of acorns and saplings in hand-dug trenches. The evidence presented by Rodgers perhaps suggests that clearance of veteran oaks did indeed take place as part of these operations. However, there is also clear reference within estate books to groups of 'old oaks' throughout this area, suggesting some veteran trees were deliberately retained during replanting operations. The distribution of these oaks on the 1852 maps corresponds well with the present day concentrations of veterans within the areas of Birklands North and West as recorded during the 1996 and 1999 tree surveys.

Modern management of the ancient oaks

Modern forestry practices are likely to have had the most significant modern impact on the oaks of Birklands and Bilhaugh, evident in those compartments much altered by afforestation such as Proteus Squares, Birklands North and Birklands West. Coniferous afforestation by both the landowning estates and the Forestry Commission began during the 1920s with activity peaking during the 1950s. This resulted in either the almost complete removal of oak generations to accommodate the commercial planting of non-native conifers and broadleaves or a resurgence of birch and oak regeneration within un-managed semi-natural woodland stands.

Although a significant proportion of trees still remain within afforested compartments, the vast majority of individual old oaks still present are largely restricted to plantation edges and rides. There is growing anecdotal evidence to support the notion that preparatory forestry operations, during the 1950s and 1960s in particular, involved the substantial removal of standing and fallen trees and the associated decaying wood resource. Dead wood was often seen as a threat to forest health, harbouring a wealth of destructive invertebrates. The burning of standing hulks, followed by the mechanical removal of the remaining woody debris, aimed to remove the risk of tree disease and maximize planting space in areas designed for re-stocking with commercial tree species. The practice of firing hollow standing trees may explain the high incidence of fire damage encountered on trees in certain compartments within the study area. The large proportions of stumps and fallen trees within compartments dominated by coniferous forest, up to 83% of recorded veterans in some cases, perhaps reveals the impact of these forestry operations on the ancient tree population as a whole. The large number of standing trees which are dead may be indicative of the heavy shading those that survived were then subject to following conifer canopy closure. The large-scale felling op-

erations taking place within the site at this time would also have resulted in changes to the microclimate within the forest, with sudden exposure to light and wind affecting the condition of the oaks and their dependent specialised invertebrate fauna.

A range of other factors may also be affecting the ancient oak population. The decay and death of a certain number of trees is likely to occur through natural disturbances such as storm damage. The premature dieback of semi-mature oaks is also a feature of a number of compartments and may well be linked to bouts of tree stress initiated by drought conditions, although this has yet to be fully explained (Gibbs and Greig 1997). It may be that the oaks of the Sherwood Sandstone have been particularly susceptible to intermittent episodes of such dieback for many centuries, triggering periods of stress, tree decline and the development of 'veteran' characteristics, followed by periods of recovery. This again requires further investigation.

The recreational and tourist potential of the area, capitalizing on the great cultural and historic significance of the old Forest, has led to much enjoyment of these eminent trees but placed additional pressures upon them. The development of facilities to accommodate thousands of visitors to Birklands has taken place within the most important compartment of the study area, concentrating large numbers of people and vehicles in specific areas. Further work quantifying these impacts would be valuable but the need for ensuring sustainable recreation and tourism within parts of the study area is clear.

CONCLUSIONS

It is clear that large, old oaks and large quantities of dead wood have long been a feature of Birklands and Bilhaugh, despite its increasingly intensive management since the 11th century. This survey confirms that Birklands and Bilhaugh continues to support one of the largest and most important concentrations of ancient trees in the UK. However, the last millennium has been a turbulent one for these woods and the wider Sherwood Forest. Harvesting and depletion of timber, illegal felling, unrestrained grazing, ornamental landscaping, coniferous and broadleaved afforestation, military training, mineral extraction and mass tourism, all in response to rapidly changing socio-economic and political climates, have influenced the size and condition of the ancient tree population. It is therefore likely there has been a steady decline in the number of ancient oaks during the last 200 years in particular. This survey has also confirmed that a high proportion of ancient oaks are now dead or decaying, with less than half of the oak population still alive.

In view of these findings, maintaining the integrity of the study area is now fundamental, particularly the semi-natural woodland stands that form a largely unmodified core central to the conservation of its natural and historic heritage. Of prime importance is the continued survival of all ancient standing oaks across the study area until new generations of oaks are approaching maturity and begin to display 'veteran' characteristics. In a number of areas, oak regeneration continues to be poor and the next immediate generation of old oaks, 150-200 years old, are largely absent. Conservation management is urgently required to reverse this situation. Measures to safeguard the oaks and their wildlife have already been put in place by Forest Enterprise (Barwick 1996) and the recent reintroduction of stock grazing to one important compartment seeks to restore the historic structure of pasture-woodland to benefit its special ecological interest.

Each year, a small but significant number of the standing oaks enter the next natural phase of tree decay and topple and slowly disintegrate, a reminder of the need to plan for the future of the forest. A woodland management strategy for the site, which aims to enhance the nature conservation value of the whole study area in partnership with landowners and managers, has been outlined recently (Clifton 2000). There is however more which must be learnt about the ancient oaks if considered and clear long-term management plans are to be produced. The traditional use of the oaks, their management and the historic factors affecting their condition are some of the key areas where future investigations would be valuable. A better understanding of these issues will enable us to ensure future generations of people and wildlife alike continue to treasure Sherwood's ancient oaks.

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