Survey Methods & Development of Innovative Arboricultural Techniques
Key UK Veteran Tree Sites

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Summary

The quality and condition of Britain's old tree heritage is reflected in the great number of ancient tree sites found in the British Isles, reputed to be among the finest in Northern Europe. Environmental arboriculture and veteran tree conservation methods have been influenced by a multidisciplinary approach that considers the tree in co-evolutionary terms, inherently linked to its ecological context. This approach considers the importance of the ageing process and the use of terminology relating to the developmental stages a tree passes through. The interactions between trees, fungi and other dependent organisms are considered, particularly in the light of the need for arboriculture to take account of how tree management can work to maintain or re-establish conditions suitable for a functioning tree-ecosystem. Understanding the rates of decline in old tree populations has been improved considerably in the UK since the development and use of the Specialist Survey Method. Studies of important veteran tree sites indicate that the rate of tree loss may be unsustainable. This in turn threatens the continuity of dependent saproxylic communities. Innovation in arboricultural management techniques has been influenced by observations of natural processes. The recent emergence of environmental arboriculture provides a framework for considering such issues and for developing appropriate practices to manage trees to enhance longevity and biodiversity. Principal among these is the development of Individual Tree Management Plans for veteran trees, which set planned treatments programmes for 30 to 100 years. Environmental arboriculture, while responding to all current conventional arboricultural considerations and practices (including tree hazard management and amenity tree care), offers scope for an interdisciplinary synthesis of perspectives between all those involved in the appreciation of veteran and ancient trees.

Keywords: environmental arboriculture*ageing process*ancient*veteran*tree-fungi-system* functioning ecology*retrenchment pruning*natural fracture technique

Terminology: Veteran & Ancient

In the UK the term 'veteran' is used to describe both the age and condition of a tree. A 'veteran tree' has the anthropomorphic, cultural connotations of a battle-scarred survivor: a valued, old comrade that has been through the tribulations of life. 'Veteran' has come to describe the quality of dead wood habitat in trees. The term is widely used, being both accessible to the specialist and to the public imagination. In recent years an increasing appreciation that decay in trees is important for wildlife. As a result, arboricultural techniques have evolved that inflict deliberate damage or wounding on trees to induce conditions suitable for the progression of rot or other niche habitats. This has caused the need to invent and convey unusual concepts, such as 'to veteranise' and 'veteranisation'. These express effects or actions (deliberate or inadvertent) that impact upon trees, causing the development of dead wood habitat features.

The terms 'veteran', 'old' and 'ancient' are all used to describe trees that are 'of interest, biologically, aesthetically or culturally' (Sissitka 1996) as a product of 'age or condition' (Read 2000). Moreover, 'veteran' is used to describe an 'old' and valued specimen, which may have survived beyond the typical age range for the species' (Lonsdale 1999). These terms are often used interchangeably. This paper will explore the conceptual difference between the factors of age and condition and why it is important to clarify these concepts for the purposes of developing appropriate criteria for recording the

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biodiversity value of such trees and for the formulation of appropriate methods for their conservation. In broad terms, 'old' and 'ancient' refer to age class, while 'veteran' refers to habitat condition (Fay 2002).

The term 'ancient tree' may be understood as an age classification to describe the stage when, after the loss of apical dominance a tree passes beyond full maturity and the crown begins to shed redundant parts and accumulate dead wood. The crown begins to reduce in size (crown retrenchment) and the annual increment (CAI) eventually reduces, compared to earlier developmental stages in the trees growth (White 1998). This is the final stage in the life of the tree (Read 2000) and, where conditions are favourable, can be the longest.

While all ancient trees will have habitat features sufficient to qualify them as 'veteran trees', all veteran trees will not necessarily have entered into the 'ancient' age-class. Mature trees that show a moderate to high level of veteran features are now termed 'early veterans'. Until recently, the terms veteran and ancient had been used interchangeably, however it is useful to clarify this distinction. For survey purposes, when required to quantify veteran trees to assess the quality of tree habitat, all ancient and early veteran trees will typically be included. When surveying to evaluate the age structure of the tree population, the inventory of the ancient age class will include only those trees past full maturity. Therefore, as there is scope for misinterpretation, it is important that, when using the terms 'ancient' and 'veteran', the above contextual distinctions are understood and explicit.

As the ageing process progresses, dead and dysfunctional woody tissue is colonised by fungi, which change the nature and condition of wood material. Natural damage and shedding of tree parts can lead to trunk hollowing, branch cavities, live stubs, shattered branch ends, loose bark, sap runs and a range of rot types. The organs of the saproxylic fungi (fruiting body, mycelia etc) may in turn be colonised, for example, by specialised invertebrates. This complex saproxylic substrate, held within a living sapwood envelope of the tree, provides specialised niches for different organisms with diverse 'life-styles'. A recognised exemplary system, developed in the UK, provides an index of conservation value for woody habitats. This is known as the Saproxylic Quality Index, which compares the site-specific species richness of saproxylic Coleoptera (dead wood beetles) against a standard list, for which rarity scores have been assigned (Fowles, Alexander & Key 1999). Colonising saproxylic invertebrates may have very limited powers of dispersal and certain species may only colonise rot sites once circumstances are favourable. The greater the length of time a group of trees exists on a site, the greater the possibility for particular specialised and rare species to colonise dead wood habitat. Alexander notes that six percent of British invertebrate fauna depend on other species that, in turn, depend upon decaying wood. He estimates that as many as 1,700 invertebrate species are dependent on ancient trees (Butler, Alexander & Green 2002). Continuity is therefore a major factor in biodiversity associated with old trees (Alexander 1996 & 1999).

UK Context
History of Tree Cover: wood-pasture and parkland

In the UK, wood-pastures are the natural inheritance of medieval hunting forests, historic parks and wooded commons. Records indicate that there has been continuous grazing in wooded landscapes throughout lowland Britain, dating from the Norman Conquest. These show that large areas of wood-pasture existed both in private ownership and on common land in the eleventh century (Rackham 1993). Recently, the significance of grazing animals in the development of wooded landscapes has been examined with the conclusion that grazers are effectively a natural agent of landscape management. Taking the oak as a focus of study, Vera examines the natural processes involved in wood-pasture mosaic habitats, and concludes that the relationship between herbivores and trees is co-evolutionary (Vera 2000).

Grazing history has been a major factor in the formation of the British landscape. Britain has a history of emparkment dating from medieval times. Our ancestors used wooden staves, hedging and walling to enclose deer, and the relics of these boundary features can still be found in many parks. After the Norman Conquest, fallow deer (*Dama dama*) were introduced and the practice of establishing new parks spread. By the fourteenth century, it is claimed that 3,200 parks were recorded in England, estimated to cover 2% of the country (Rackham 1980).

While many original parklands still exist, the Romantic Movement that flourished in the seventeenth and eighteenth century inspired the construction of naturalistic, designed landscapes with formal gardens and features. These parks were associated with the conscious planting of trees of great character, often intended to provide pleasure gardens and framed views. Tree plantings were often superimposed on an existing matrix of old trees (Fay 2001). Parklands today typically contain examples of tree populations dating from the earliest period of recorded emparkment to modern times, including a great number of pollard trees, cut to prevent deer from browsing regrowth.

Pollards were cut and managed as 'working trees' (Green 1996) for a wide range of produce. The size and frequency of cutting depended on local and regional economic requirements (Read 2000). Principal traditional pollard species include oak (*Quercus robur* and *Q. petraea*), hornbeam (*Carpinus betulus*), beech (*Fagus sylvaticus*), common lime (*Tilia cordata*), willow (*Salix fragilis* et al), ash (*Fraxinus excelsior,* holly (*Ilex aquifolium*) and sweet chestnut (*Castanea sativa*).

In the UK, old trees are abundantly found in old growth woods, parklands and wood-pastures, and to a lesser extent in hedgerows, river and boundary banks, commons and churchyards, (Read 2000). In woodlands, their long-term presence is often the result of coppice history, where it was periodically necessary to manage and restrict grazing animals to prevent browsing of new growth.

The cultural tradition of pollarding exists throughout the European wooded landscape. Old pollards may be seen from the wooded meadows and pastures of Sweden and Finland (Hæggström 1998; Ranius 2000; Slotte 2000) to the silvopastoral 'La Dehesa' systems of southern Spain (Montero, San Miguel & Canellas, 1998). They are found in wood-pastures in upland Scotland (Quelch 2000) and in the grazed olive groves of Crete (Rackham & Moody 1996). Their continued presence today owes much to methods of husbandry. The practice of cutting tree crowns above grazing level for produce, while varied by region, culture and species, has ensured the endurance of pollards in the landscape as open grown trees (Green 1996).

Pollard wood-use included fodder, firewood and charcoal, fencing, furniture, tannin, wicker-work, and house and boat building, and it is interesting that a very large population of old pollards still exists within a twenty-mile radius of the London conurbation. An example is Epping Forest, with an estimated population of 50,000 veteran trees over 400 years in age, the majority of which are pollards. This forest, like many wood-pasture sites, is characterised by areas of open space, roads, housing and extensive areas of pollards set in grassland and shrub. It historically formed part of the medieval Royal Forest of Waltham, subject to Forest law according to which commoners enjoyed rights of pasture and woodcutting. Many wood-pasture sites passed through different ownerships while retaining their open wooded character, despite periodic attempts to enclose portions and suppress commoners' rights of use. Since the late eighteenth century, throughout most of Britain, pollard management practices have progressively fallen into disuse. At Royal hunting forests such as Epping Forest, dwindling deer populations coincided with declining Crown interest, illicit enclosure and urban exploitation.

Wood-pasture systems are richly present in the UK and widely distributed. Many contain a significant population of pollard trees with a mosaic of habitats, showing continuity and structure remaining unchanged for many centuries. Hatfield Forest is one such example that has been extensively documented. Recorded originally in the Doomsday Book in 1086, it has remained virtually unaltered for over one thousand years, still containing 'all the elements of a medieval forest' (Rackham 1998).

The ancient trees at this site have been surveyed and monitored, the results of which have been used to inform management prescriptions for environmental arboriculture restoration treatment (Fay & Fay 2000), as will be discussed later in this paper.

Initiatives to Record & Conserve Veteran Trees: Habitat Action Plans

The UK Biodiversity Group (1998) refers to lowland wood-pastures and parkland as 'the product of historic land management systems and represent a vegetation structure rather than being a particular plant community. Typically, this structure consists of large open-grown or high forest trees (often pollards) at various densities, in a matrix of grazed grassland, heathland and/or woodland floras'. Much of the nature conservation effort in Britain is currently directed through Habitat Action Plans (HAPs). One of these is the Lowland Parkland and Wood-Pasture HAP. It recognises that various factors are necessary for the biodiversity of old tree habitat, and in particular, that the high levels of light and warmth afforded by open-grown trees favour special colonising communities.

The loss of old trees is identified as a major cause of the decline and poor condition of dead wood habitat and dependent communities. The Common Agricultural Policy (CAP) has caused considerable harm to veteran trees in arable and pasture land. Deep ploughing, the use of herbicides, inorganic fertilisers, wormicides and other veterinary pharmaceutical products, have damaged soil structure, mycorrhizae and other parts of the root ecosystems. In the UK veteran tree populations have suffered from the effects of poor tree and land management. Isolation and fragmentation of wood-pasture habitats are a threat to dependant communities. Where there are large populations of veteran trees with officially recognised nature conservation value, such sites usually have a survey history. However, survey methods are typically inconsistent with respect to veteran tree data collection. While the value of many UK veteran tree sites is acknowledged, the habitat quality and tree condition is poorly documented and understood. This situation is slowly changing. One of the factors influencing the momentum for improvement has been the involvement of arboriculturists with conservationists.

During the early 1990s, there was a growing interest in the necessity to compare information gathered about veteran trees. Until that time, no standardised system had been developed. English Nature (UK government agency for implementing nature conservation policy) identified a broad strategy for improving survey data quality and methodology. The Ancient Tree Forum (ATF) is the lead UK NGO for the conservation of ancient trees and their habitat. It is a collaborative group of conservation professionals, specialists and managers. The ATF identified the need for a standardised recording system to collect tree habitat information. This was considered essential to the understanding of the national status of veteran trees through recording and monitoring key factors influencing population dynamics. (Fay & de Berker 2003).

A multidisciplinary approach, led by arboriculturists, resulted in the publication of the Specialist Survey Method (SSM). This is the current national standard for veteran tree surveying. It operates on three levels. *Level 1* is the introductory standard for non-specialists; *Level 2* is the first level technical standard (typically for arborists, foresters, etc.); *Level 3* is used by conservation specialists. The SSM records basic tree data (position, species, form, dimensions), dead wood habitat (tears, scars, stubs, hollowing, rot, dead wood), tree associates (flora and fauna) and growing context (damage, shade, management) (Fay & de Berker 1997).

Conservation experts claim that Britain contains the greatest number and the best concentrations of old trees in Europe (Alexander, Green & Key 1996). This claim has both raised awareness and stimulated study in attempts to quantify the population. Recent research has shown that surveys using the SSM have recorded over 45,000 veteran trees at key UK sites (Fay & de Berker 2003). Assuming that 1 in 200 trees have been recorded, as a conservative estimate, this would indicate that there are more than 9 million veteran trees in the UK. To date, the traceable investment in nature conservation surveying of old tree habitat using the SSM is an estimated £291,000.

While veteran trees may be present in great numbers in the UK, there are disturbing trends. Studies show that many veteran trees are under threat and there is evidence that the future of veteran trees at these UK sites is not promising. Data collected from a number of populations indicates that, even at protected sites, and those that are considered to be in the best condition (Cox & Sanderson 2001), populations are susceptible to unsustainable rates of tree loss, posing a direct threat to the dead wood (saproxylic) communities.

Fig 1
The Bowthorpe wood-pasture oak: Britain's largest *Quercus robur*, (Girth at 1.5m height is 12.79m) Shed a major part of pollard crown in 2003.
This tree is said to be over 1000years old

Fig 2:
Ancient tree wood-pasture at Brockworth, Gloucestershire. The fate of many veteran trees in the UK. Lapsed pollards with crown limbs prone to mechanical failure. Often crown limb loss threatens the viability of the entire tree.

Population Dynamics

One of the major ancient tree sites in the UK is Burnham Beeches, occupying 220 hectares of wooded common. In the seventeenth century, there were 3,000 pollard trees. By 1957, this number was reduced to approximately 1,300. In 1990, when survey methods became more detailed, the population numbered 555. By the year 2000, the total had fallen to 463. The rate of population decline in recent decades is typical for many ancient tree sites. At Burnham Beeches, the rate of loss represents 16.6%, which is an average of 1.6 trees per annum (Read 2000). Attrition rates of between 0.9% and 1.8% are common. The main cause is loss from collapse from mechanical failure (as a result of the cessation of pollard practice) (see Fig 1) and rapid decline from environmental impacts (Fay & Rose 2003).

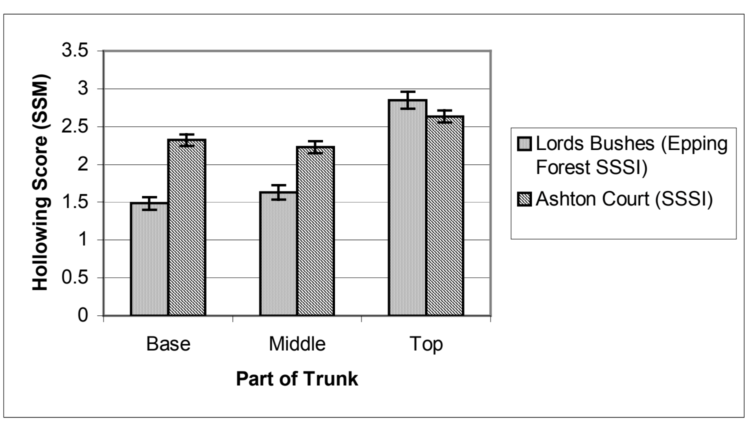

Fig 3.
Survey of ancient pollards at Ashton Court, Bristol and Lords Bushes, Epping Forest.
Data derived from surveys at two key sites of 444 trees and 155 trees respectively, with neglected, lapsed pollards, shows trunk hollowing to be significantly higher at the top of the bole, whereas hollowing is common at the base of maiden veteran trees. Failure trends are the result of heavy pollard branches breaking at mechanically weakened pollard points or tipping the entire tree due to excessive end loading (error bars ± one standard error). (Fay & Rose 2003).

Recognition of current rates of loss in old tree populations has resulted arboricultural intervention to mitigate the risks posed to trees.

Modelling a Sustainable Population

The key to a sustainable population capable of supporting a functioning ecosystem requires that first an existing ancient tree population is consolidated. Secondly sufficient numbers of trees must remain in the vicinity of the current population to be capable of becoming veteran and then reaching the ancient stage. This may require the recruitment of non-veteran mature trees and veteranising these (to 'prematurely' create bridge saproxylic habitats). This treatment involves implementing techniques that mimic natural damage.

Tree population dynamics have conventionally been used to model populations based on utility. In this context, full maturity is regarded to be the optimum target age class. Utility considerations of trees places value on the sound wood condition of the main trunk prior to the development of decay. Techniques of tree population management have yet to be developed that favour post-mature age classes. Such an approach requires the assessment of numbers and mortality rates in each age class. It is then necessary to ascertain whether sufficient numbers are present to ensure successors for older age classes to produce a sustainable population structure. Typically this involves considering arboricultural intervention to reduce mortality rates in the older pre-ancient generations. Site management techniques also need to be targeted to enhance tree longevity for all age classes.

Management for a sustainable tree population, targeted to maintaining functioning tree ecosystems, must be based on knowledge of tree mortality. This needs to take account of loss in each age class within the overall population. By responding to these factors, the required rate of recruitment into the veteran population can be estimated. This form of modelling can identify expected change in the veteran population over time and is vital to understanding the actual vulnerability of the ecosystem at a particular locality. This method has been applied to a number of sites to identify the safeguard-requirement of younger age-class trees. The need for tree planting is widely recognised. However, the reasons for conserving mature and fully-mature age classes are now better understood.

Tree life expectancy in the UK may be progressively being eroded due to human influences on the environment. If the future ancient tree populations are insufficient in size or integrity, local populations of dependant species may collapse. If this takes place then current investment in the conservation of wood-decay ecosystems will fail. It is therefore a priority that resources are targeted to evaluating ancient tree populations, requirements for succession and sustainable management.

Management: concepts of environmental arboricultural

Compared with the animal kingdom, ageing in trees is not necessarily unidirectional. Trees and fungi may both be described as indeterminate systems (Rayner 1993), equipped with the ability to alter developmental patterns in response to environmental stimuli. The meristematic (embryonic) system provides the tree with the potential for rejuvenation so that at any stage different parts of the tree may be in a different growth phases. Del Tredici refers to the various rejuvenation processes that occur in trees (ontogenetic, natural and physiological) reflecting the way the "ageing clock" is influenced by genetic or environmental factors (del Tredici 2000). Protracted serial rejuvenation in some species of tree is so effective that there is a tendency to near immortality (*Pinus longaeva*, *Tillia cordata*, *Taxus baccata*).

Fig 4
Phoenix *Crataegus monogyna* at Hatfield Forest, Essex

Natural vegetative regeneration in old trees may be considered as a survival strategy. When this occurrence is successful, the re-generated tree is termed a 'phoenix tree' (Fay & de Berker 1997). A number of phoenix strategies have been noted in UK fieldwork. Examples include cases where following tree collapse, the specimen layers, establishes roots and second-order laterals become first-order trunks of a successive generation. Similarly, when the adventitious roots become established within a hollow trunk, the roots may eventually change their mode and develop structural functions (and become independent). Hollow ancient trunks have been observed to rot ands break up to form two or more columns, each becoming independent and capable of breaking free from the original system. These processes are significant in the context of continuity of habitat, when considering that the woody substrate of the tree acts as a 'Noah's ark' for the dependent colonising fauna and flora. These observations are significant, as they have influenced arboricultural management practices intended to support strategies for tree longevity.

The convergence between arboriculture and other disciplines, particularly with ecology has led to a transformation in the understanding and appreciation of ancient trees, especially when considering the tree as a co-evolutionary partner that has developed in association with colonising species. Significantly, there has been a reconsideration of the interactions between fungi and tree. Much of the arboricultural terminology typically used to describe the presence of fungi in trees, presumes or implies a pathogenic relationship. Ingress is a basic presumption and the presence of fungi in or on trees is generally described in terms of 'invasion', with modes of 'attack' and degrees of 'aggression'; implying that the tree has evolved a primarily and comprehensively defensive relationship with respect to fungi.

During the 1990s, new insights were gained from investigations into the range of colonising strategies of different fungal species. Mycological research began to surface in the field of arboriculture, introducing notions of complexity not previously recognised. This described the presence of endophytic (dormant or latent) fungi that operate territorially and become visible after bark wounding and dysfunction have occurred. This complexity is evident where natural processes may be observed in sites such as old growth forests and low-intervention wood pasture. Arrays of different fungal modes operate including wood decomposition, recycling, nutrient foraging and pathogenic processes, all potentially organised through mycelial interconnection (Rayner 1993). The perception of the tree-fungi-system as complex, multifunctional and interactive is a vital concept in environmental arboriculture. It is fundamental to comprehending the co-evolution process as a factor of tree longevity and to informing tree health and pathology diagnosis.

New Arboricultural Techniques for Veteran Tree Management
In the eyes of environmental arborists, chainsaw cuts result in an unnatural flat plane-surface (i.e. such surfaces are literally not found in nature) and apart from the concern to replicate 'naturalness of form', there are further ecological considerations that have promoted work to develop natural fracture pruning methods. Branch breakage (from mechanical weakness and storm damage to trunk and limbs) results in a variety of effects on wood tissue at the point of breakage, leading to fibre separation (along the grain) and splintering in various planes (linear, radial and circumferential). This occurrence creates microhabitats that are colonised by microorganisms and succession species.

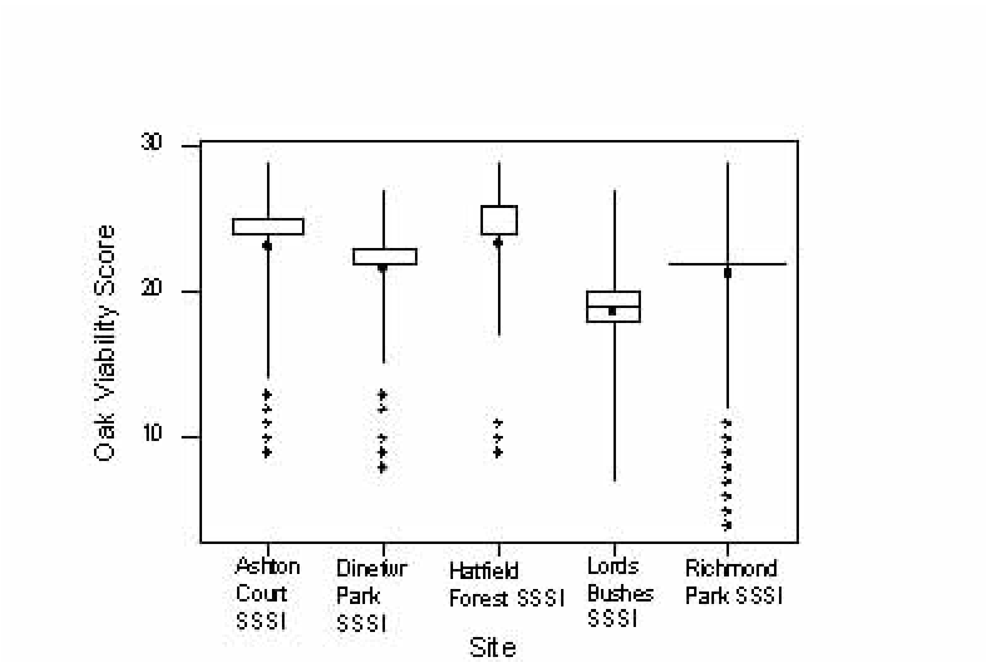

Fig 5:
Viability assessments of veteran oak populations at four key UK ancient tree sites.
The Specialist Survey Method has been further developed to enable an arboricultural assessment of tree stability and vitality to be carried out. This is used to inform an assessment of tree viability to allow comparisons between sites and inform 30-year individual tree management plans.

Interactions between trees and the species that live on them may have developed over exceptionally long periods of time, and as some trees may be several thousand years old, speculation therefore may extend to the relationships between tree longevity and the continuity of the organisms living on and inside the tree, and those living underground that are associated with the rhyzosphere. Over recent decades there has been a prejudice against dead wood in arboriculture, forestry and agriculture. This is now being redressed. There is an emerging trend to value biodiversity and to promote arboricultural practices for the benefit of wildlife, leading to the development of techniques designed to retain (and even create dead wood habitat) in crown management.

Fig 6:
Natural and artificial breakage in an oak tree: both show high levels of growth response at Melbury Park, Dorset

Natural Fracture:
Techniques that Mimic Natural Processes

Coronet cuts - Dead wood management

Natural fracture techniques involve pruning methods that are used to mimic the way that tears and fractured ends naturally occur on trunks and branches. A coronet cut is a type of natural fracture technique that is particularly intended to mimic jagged edges characteristically seen on broken branches following storm damage or static limb failure. It is carried out as a pruning treatment to a stub or reduced limb to mimic natural breakage. The form of the coronet cut is designed to shape the branch or trunk end-surface to resemble the fracture that might be imagined following a storm, (such as Beaufort storm force 9/10) and is cut to resemble a broken or shattered appearance.

Early experimental work exploring methods of cutting dead branches to mimic natural breakage was carried out at Ashtead Common National Nature Reserve, Surrey. This led to further developments and the current use of coronet cuts in both living and dead limbs. It was first trialed following a catastrophic fire, which seriously scorched, damaged or killed several hundred veteran trees on the Ashtead Common, affecting a significant proportion (10%) of the population of over 2000 veteran oaks at that site (Adam Curtis, James Green and Bob Warnock. 2000). The presence of so many dead trees in an area frequented by the public initially prompted a requirement to remove the trees for public safety. After consideration of the conservation values of the dead wood habitat, it was decided to retain as many standing dead trees as possible, while carrying out varying degrees of reduction to reduce risk of crown or trunk breakage to an acceptable level. Dead wood (over 150mm) was deemed potentially suitable for carrying out this exploratory coronet-cutting work.

Earlier attempts at replicating what was observed in nature had varying results. Trials at Stowe Park, Buckinghamshire, were carried out in the early nineties using explosives on dead trees to see what type of fragmented ends would result (Finch 1996). The use of explosives is *not* now advocated in the UK for both the obvious reason of safety and that outcomes are uncontrollable. The author witnessed similar attempts during a visit to Sweden in 1992, where the Swedish army had been recruited at a

nature reserve to use explosives on live trees attempting to recreate habitat-types suitable for rare invertebrates.
Other experiments carried out at Windsor Great Park, involved winching off partially cut branches to produce rip or tear-cuts on dead trees. This was in some measure successful, but it proved impossible to predict the appropriate winch-tension necessary to effect breakage. Many trees failed at their roots before the attached branch broke off. As a result such practice has for the most part been stopped as it is deemed to be harmful to the root system.

Where trees are scheduled for felling coronet cutting is typically carried out as an alternative in order that a part of the trunk may be safely retained, in reduced-scale as dead wood habitat, following the removal of the scaffold branches. It is also carried out following branch reduction – (usually of second or third-order limbs).

Trials took place between 1997 and 1999 to retain as much of dead oak as standing hulks with a reduced branch framework. Many of the truncated trees were experimented upon to promote a natural breakage effect through skilful chainsaw use. This resulted in the first studied attempts at coronet cutting (The practice was so called because of the crown-like appearance of the branch ends). It is noteworthy that this was well received by the public.

Retained standing trunks have been termed 'Monoliths' (Alexander, Green & Key 1993) and are defined as those trees where tree removal would normally be required but are retained as standing trunks in reduced and stabilised form (usually at some 4m to 6m height) as dead wood habitat. It is necessary to re-inspect monoliths to assess and address tree stability and the risks posed, as with any standing tree.

As aerial deadwood is valuable habitat, its removal is only specified where its presence about the tree is considered a threat to tree stability or public safety. In such cases, the removal of dead wood should apply only to the material that is considered unstable and prone to failure. Where dead wood removal is proposed it should be restricted to those aspects of the crown where dead wood failure may cause damage or harm. Elsewhere, dead wood may be retained and reduced in extent to stable proportions (Davis, Fay & Mynors 2000).

It is noted that with oak, hardened dead aerial branches can often be retained without undue risk, however where risks may be present from dead wood breakage, it is essential that this is assessed and managed as with any part of the tree. As a result of these developments in environmental arboriculture, current guidelines for risk management of aerial dead wood now frequently stipulates that aerial dead wood can be preserved, subject to an assessment of its condition so that it may be retained in stable form (with reduced lever arm and end-loading).

Coronet cuts-Live wood management
Currently the techniques involved in dead wood management are now also considered in the pruning of live amenity trees. Since the work at Ashtead, some pioneering work has been carried out by arboricultural practices in the UK. Treework Environmental Practice and others involved in environmental arboriculture have extended this form of dead wood management to the management of living trees to promote dead wood habitat (Fay 2002). This practice is termed 'veteranisation' (Cowan 2003).

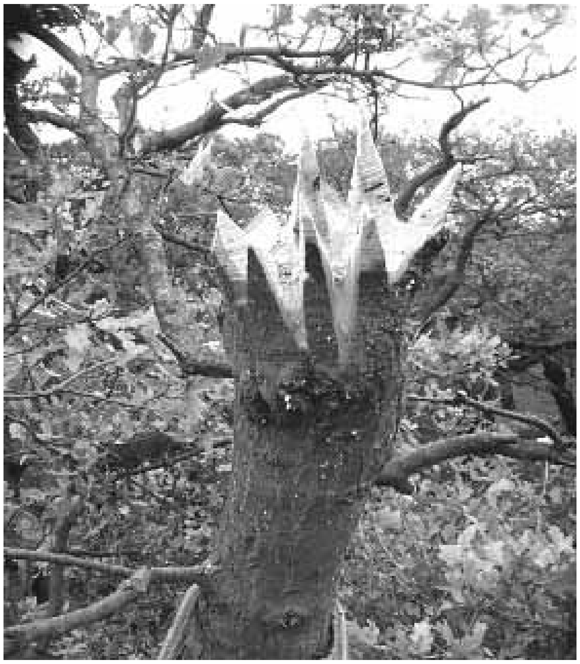

Fig 7:
Coronet cut on live *Quercus robur* stub at Richmond Park, Surrey

The general guideline for this technique requires the selection of potentially suitable stubs for retention. These are cut at a minimum distance that is approximately five times the diameter of the branch when measured at the point of attachment to the stem or higher order branch. Suitable branches will have a diameter greater than 150mm in diameter. The stub length is estimated from the point of attachment with the parent higher order member. Stubs are cut into a coronet appearance through skilful chainsaw use. Live branches may be selected for this treatment where crown reduction (see retrenchment pruning) is being carried out. A proportion of suitable live limbs (up to 15%) are typically selected for coronet cutting. This type of natural fracture pruning is applied to non-crucial structural members only. Cutting is carried out to give the appearance of deep uneven, shattered ends; optimally with an acute angle. Where occasional major stems require heavy reduction truncation, the final cuts are varied to promote a jagged finish.

Retrenchment pruning

Retrenchment pruning is a term coined by Paul Muir of Treework Environmental Practice to describe the technique. It is a refinement of the concept of restoration pruning referred to in the European Treeworker Handbook (EAC 2000) and has been developed to imitate the natural process of crown ageing, often referred to as the stage beyond full maturity when the tree 'grows downwards' (Green 1996). The term 'crown retrenchment' is used to describe the way in which peripheral dieback occurs as the tree redirects energy and growth to the formation of a consolidated lower region of the crown. Crown retrenchment pruning is used to extend tree viability, (both in relation to vitality and stability), whilst retaining habitat features associated with ageing.

Retrenchment pruning is a technique that can be used to reduce the potential for a fully mature, late-mature or ancient tree to collapse or disintegrate under its own weight, as a result of excessive end-loading associated with long or weakly attached limbs. It is carried out according to a long term programme - typically termed 'Individual Tree Management Plan' (the ITMP). The ITMP may typically extend up to thirty years.

The technique is also used in trees where incipient decline appears to result from excessive transportation distances from the root system to the crown periphery. While this technique may have a general value, it is especially useful for managing lapsed old pollards and mature maiden trees that show signs of dieback, physiological stress or a tendency to long-term limb breakage (i.e., not where there is an urgent need to reduce crown limbs to avoid breakage).

The practice of retrenchment pruning follows a detailed inspection, which assesses the viability of the tree in terms of current vitality, the probability of tree loss as a result of expected decline in vitality or from structural collapse. This assessment informs decisions as to whether retrenchment pruning is appropriate. If the tree is an important specimen prone to imminent mechanical failure, threatening its viability, then gradual retrenchment treatment would not be appropriate. In such cases an alternative method is suggested involving significant reduction to selected failure-prone limbs (see Read 2000, pp 42-43).

If the tree shows a moderate level of vitality and mechanical stability appears vulnerable in the long term, while being sufficient to support a moderately reduced crown structure in the short term, then retrenchment pruning may be carried out to restructure the framework.

The Individual Tree Management Plan will follow from the assessment of tree viability, and will specify the first stage of treatment (possibly involving as little as 10% or less than a metre reduction). The Plan sets an ultimate height above the bolling or from ground level (Target Height) to which the crown will eventually be reduced at the time of Plan completion. In addition this will specify the return period (Retrenchment Cycle) for future retrenchment pruning visits, typically 3 to 5 years. Lastly the Plan Duration is set. This is overall duration for the programme of treatments up to completion (usually between 12 to 30 years, but sometimes up to 100 years).

Retrenchment pruning is carried out in stages and involves the reduction of the tree height and the extent of crown growth over a protracted period of time. It is carried out to 4th or 5th order branching, often within the constraints of using a turbo saw and secateurs, and usually involves at least three return treatments involving periodic monitoring and allowing re-growth to occur in the interim.

The process is intended to promote early crown stabilisation and reduce the risk of traumatic structural failure by reducing the lever arm, while at the same time increasing light penetration to inner aspects of the scaffold limbs. Epicormic growth arising from these lower and internal crown areas have the potential of becoming the scaffold limbs of a future reduced crown framework. The method is intended to stimulate internal and lower crown growth (rejuvenation) through reducing apical dominance to redirect hormonal growth regulation capable of re-iterative stimulation. Eventually retrenchment pruning will create a reduced crown framework over the Plan Duration.

For trees with moderate to high vitality, the first stage of retrenchment pruning should avoid overall reduction by more than 20%. For trees with low vitality the first stage of retrenchment pruning is typically less than 10%. Where tree stability is already heavily compromised reduction levels should be sufficient to reduce the lever arm to an acceptable level.

Conclusion

In the UK, governmental and non-governmental conservation agencies have recognised the value of old trees for wildlife. Through the work of a number of pioneering conservationists, drawn mainly from the ranks of the Ancient Tree Forum and the Woodland Trust (lead voluntary agencies with interest in old tree conservation), understanding of the biological and cultural values has been improved. A wide consultation between owners, managers, conservationists and professionals, involved in the study and care of old trees, has led to a number of publications to guide survey methodology and management. The publication of the Specialist Survey Method as the UK national standard for surveying veteran trees has provided the framework for consistent recording and data collection. While the British Isles is recognised to contain a very high proportion of Northern Europe's ancient trees, population studies at key UK wood-pasture sites have shown that there is an unacceptable rate of tree failure. This recognition and the convergence between arboriculture and ecology has resulted in an improved understanding of the ageing process in trees. Fungi are now understood to have a principally benign interactive relationship in the tree-fungi-system, creating conditions for colonisation by dependent species, many of which have poor powers of dispersal. The UK arboricultural profession is beginning to recognise that it is necessary to develop appropriate tree management techniques to foster optimum conditions suitable for the continuity and diversity of saproxylic species-rich communities. As the ancient tree is the 'ark' that carries these species through time, it is necessary that the features of value to dependent organisms are a focus for management practice. This approach has led to arboricultural innovations, such as the development of natural fracture techniques, coronet cutting and retrenchment pruning, and particularly the need to manage old trees in terms of appropriate space and time. When determining work programmes for old trees, management processes need to consider the whole environment of the tree's root-space and soil ecosystem. The conceptual framework for management prescriptions should consider the 'tree-time' (not human economic-time) necessary to implement a long-term Individual Tree Management Plan.

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The Ancient Tree Forum may be contacted on their website: www.woodland-trust.org.uk/ancient-tree-forum

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