

Ancient
and other
veteran
trees:
further guidance
on management

Editor **David Lonsdale**

ANCIENT AND OTHER
VETERAN TREES:

FURTHER GUIDANCE ON MANAGEMENT

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FOREWORD



Ted Green MBE,
founder President of the Ancient Tree Forum

In the 1940s as a small boy, at a time of great insecurity in my life, I wandered among the “gentle giants” in Windsor Great Park. Although I didn’t really realise it at the time, the trees gave me a life-enhancing sense of peace and security because of their great age and size. These Windsor wonders of nature set me on a path of lifelong learning about the natural world and an appreciation of the unique qualities and values of ancient trees.

Looking back over nearly eight decades, I see now that talking to others about the value of old trees has introduced me to many friends from the world of arboriculture and forestry who share my passion. Both trees and friends have fundamentally changed my life. This manual should simply be dedicated to them and I could end this foreword here. The manual should inspire us to share knowledge and understanding among all those who care about and for old trees. Most of all, I hope it will show tree owners the depth of thought that has gone into ways to conserve these wonders of nature. We must not overlook the many thousands of people, including landowners, our aristocracy, managers and tree workers and all who have done their bit to preserve and perpetuate our heritage and unique British treescape. All those who planted and cared for trees in the knowledge that future generations would appreciate them are our inspiration.

In 2000, English Nature, through its Veteran Trees Initiative (VTI), a conservation partnership, published the handbook *Veteran Trees: A guide to good management*. It was inspired by the collective wisdom and hard work of the Ancient Tree Forum (ATF), a new kid on the block that had begun to wake up the world to an appreciation of the ancient tree. The ATF as individuals and as a group were open-hearted, knowledgeable, dedicated enthusiasts, who for good reason were concerned about our ancient trees today and the risk of losing them in future.

Having embarked on an adventure of ancient tree discovery, I am confident the Forum will continue the debate it started, exploring everything that concerns our old trees. This interest has initiated what might be a *new science, knowledge and appreciation of ancient trees* whose exponential growth makes this manual fundamental to making the information accessible to all.

Man’s passion for ancient trees is boundless, touching all walks of life, professions and classes in society and is a continuous thread throughout history. Simon Schama wrote recently in the *Tree that shaped Britain*: “Romantic histories told their readers that liberty had been born, not with the Magna Carta, but in the ancient oaks where the druids had convened their sacred rites.” Since then the list of enthusiasts has become vast, from Elizabeth I, Charles II, John Evelyn, Admirals Nelson and Collingwood, Francis Rose, to our present day specialists such as Oliver Rackham. Equally, it includes all, like that small boy, who love and care for old trees.

Today we should recognise that the UK’s single greatest obligation to the conservation of European biodiversity, heritage and culture rests in this awareness and the care of our ancient and veteran trees. I dedicate this book to all who, like me, have loved trees and tried to share their passion with others.

Let our adventure continue and remember that a friendship made under a tree lasts a lifetime.

ENDORSEMENT

Dr. Helen Read,
author of *Veteran Trees: A guide to good management*

Our knowledge of how to manage ancient and veteran trees has moved on substantially from the situation in 2000 when the book familiarly known as “The Handbook” – *Veteran Trees: A guide to good management* – was published. At that time we had a lot of enthusiasm but, in reality, not really a great deal of experience of the long-term impacts of looking after our ancient trees. We had realised that they were very special and often needed different treatment to younger trees but, as Ted Green would say, we were very early on in our journey.

The handbook, however, was written in an innovative way; the early drafts were circulated widely and a range of experts approached and their brains picked. As a result of this collaborative approach, the content of the handbook has remained relevant for many years and, indeed, much is still relevant and accurate. The content was novel but also applicable to those in other countries and, as a result, the book is currently being translated into several other European languages.

However, as time proceeds and our experience of working on ancient trees grows, the handbook has needed updating and expanding. David Lonsdale has taken on a considerable challenge in order to do this and the result has taken several years to achieve. The approach aims to be more targeted towards arborists than the 2000 guide but still remains an important reference for those from other disciplines. David has taken up the baton and the result is this new addition to our growing resources, aiding people with the responsibility of managing our heritage of ancient trees. I am sure that this book will become the next “must read” for tree owners, managers and advisers.

PREFACE

David Lonsdale, January 2013

In the mid-1970s, a colleague and I watched some “hazardous” branches being removed from a group of veteran oak trees. He felt strongly that a much better and cost-effective option would have been to fell the trees (which he called geriatric) and to plant some new ones. I scarcely attempted to disagree, sensing that I would have been branded as sentimental and perhaps even as unprofessional. I knew that wood decay is one of the world’s key ecological processes but I also sensed that most people in the “tree world” regarded it mainly as a cause of economic loss, much as the decay of potato tubers represents a loss for a farmer.

Thanks to the efforts of many dedicated enthusiasts, especially Ted Green, awareness of the immense and multifarious value of old trees has grown so much that their protection is now part of mainstream conservation in the UK and elsewhere; not just a Cinderella subject for a few eccentrics. A milestone was reached in 2000, with the publication by English Nature of Helen Read’s book *Veteran Trees: A guide to good management*. This was the culmination of the Veteran Tree Initiative, an educational project that had, in turn, drawn upon ideas and information published in the proceedings of a series of meetings hosted by the Corporation of London in the early 1990s.

Thirteen years on, *Veteran Trees: A guide to good management* remains an indispensable source of guidance but there has been a need to develop the guidance in the light of recent experience and ideas: hence the inclusion of “further guidance” in the title of this new book. Since, however, any book is proverbially out of date before it is published, readers are advised to make use also of other recent and forthcoming publications, including the series of Ancient Tree Guides, published by the Ancient Tree Forum (ATF) and the Woodland Trust.

In order to provide “further guidance”, there has regrettably been a need to include some general information about factors that are becoming an increasing threat to trees. Climate change and the spread of alien invasive pests and pathogens (mainly through international trade) are of particular concern in this context.

There is one other reason why I was asked to compile this book. At the start of the millennium, veteran trees were still scarcely mentioned in conventional guidance for the management of trees and woodlands. Inspired in particular by Neville Fay, the ATF therefore set out to publish some guidance in a form that could be quoted as an operational standard for tree work, alongside other guidance issued by authorities such as the British Standards Institution and the Forestry Commission and by professional bodies such as the Arboricultural Association. Meanwhile, also with much help from the ATF, such “other guidance” has been considerably improved and augmented with regard to ancient and other veteran trees and their associated habitats. It is, therefore, with hope for the future care of this great heritage that I approach the end of my work on this book.

ACKNOWLEDGEMENTS

The Ancient Tree Forum gratefully acknowledges the assistance of the following organisations, whose financial contributions made the publication of this book possible:



The Board members also gratefully acknowledge the following organisations, who have endorsed and provided additional support for this publication:



As indicated in the title, this book presents further guidance, which supplements the ground-breaking work represented by *Veteran Trees: A guide to good management*, published by English Nature in 2000. There is, therefore, a remaining debt of gratitude to the author, Helen Read, and to all those who provided material and advice in its compilation.

The contributions of several authors are gratefully acknowledged. Owing to the need to adopt a certain “house style” and to divide text between various chapters, their work has been re-worked to the extent that any resulting errors, omissions or bias must be attributed to the editor and the other members of the Editorial Board. The contributing authors should, however, take the credit for the expertise that they have contributed and without which this book could not have been compiled. Thanks are also due to Prof. Julian Evans, who gave advice on the shade tolerance of tree species. The principal contributions, other than those of the editor, are as follows:

Keith Alexander	Most of Chapter 5 (habitat management) and habitat sections of Chapter 7
Vikki Bengtsson	Most of Chapter 3, up to Section 3.5.2, and estimation of tree mortality rates (Chapter 2 and Appendix B)
Jill Butler	Most of Chapter 6 (landscape) and contributions to Chapter 1 and 2 (especially 1.3.2 to 1.3.2.4) and selections of maps used in various images
Alan Cathersides	Management of avenues in Chapter 6
Neville Fay	Provision of source material for tree work, Individual Tree Management Plans (mainly in Chapter 7) and much else throughout the book
Reg Harris	Section 7.3.6.2 and Appendix D
Ben Rose	Information on tree population dynamics in Chapters 2 and 7, including Fig. 7.1
John White	Method for estimating age of trees by girth, with accompanying data, in Chapter 2.

Owing to the multidisciplinary content of the book, the work of expert reviewers was no less essential than that of the authors. Thanks are therefore accorded to all the reviewers, especially to the first six in the following list, who commented on many sections of the draft in detail: Dr. Keith Alexander, Luke Barley, Vikki Bengtsson, Alan Cathersides, Jack Kenyon, Dr. Helen Read, Mick Boddy, Reg Harris, Peter Herring, Paul Melerange, Suzanne Perry, John Smith, Luke Steer and Jenifer White.

The Editorial Board of this landmark publication comprises:

Jill Butler
Caroline Davis
Neville Fay
David Lonsdale (Ed.)

The editor gratefully acknowledges the essential contributions of the other members of the Editorial Board, who conceived the entire project as an aspiration of the Ancient Tree Forum and pursued it with commitment to its conclusion. They not only reviewed many successive drafts of the book but also helped to shape it through their expertise and their understanding of the needs of the intended readership.

In turn, all the Editorial Board members greatly appreciate the care and professionalism of Pages Creative, who helped us produce a document of which we are proud. We are also grateful to The Tree Council for facilitating the publication of this document.

Last, but by no means least, the generosity of many individuals and organisations who provided artwork, diagrams or photographs, whether included in this book or not, is gratefully acknowledged. For images used in this book, copyright remains with the individual contributors, whose names are shown here, with the relevant figure numbers.

Diagrams or artwork

Jill Butler	1.3, 1.6, 7.3
Neville Fay	4.23, 5.2, 7.2
David Lonsdale	1.12, 1.15*, 4.15, 4.18
Pierre Raimbault	4.12
Ben Rose	7.1
John White	2.6, 2.8
Woodland Trust	2.3, 2.4, 6.5, 6.7

Photographs

Keith Alexander	5.11
Mick Boddy	2.9 (left)
Jill Butler	1.4, 1.7, 1.10, 2.7, 2.10, 3.6, 3.8, 3.12, 4.7, 4.21, P112, 6.6, 6.9
Vikki Bengtsson	3.2, 3.3, 3.4, 3.13, 3.14, 5.6, 6.10
Antony Croft	P158
Neville Fay	2.2, 3.16, 4.3, 4.13, 4.17, 4.19, 5.3, 5.5, 5.14, 6.1, 6.2, 6.4, 6.8, 6.11
Roy Finch	P73, 4.1
John Fuller	4.29**
Ted Green	3.5, 4.24, 4.25, 5.8, 5.13
David Humphries	P174
Roger Key	5.1, 5.7, 5.9
David Lonsdale	1.8, 1.9, 1.11, 2.1, 2.9 (right), P44, 3.1, 3.7, 3.10, 3.15, 4.2, 4.4, 4.5, 4.6, 4.8, 4.9, 4.10, 4.11, 4.14, 4.16, 4.20, 4.22, 4.26, 4.27, 4.28, P138, 5.4, 5.10, 5.12
Rob McBride	1.13, 1.14, P24
James Smith-Wright	Px, P72
Philip Stewart	2.5***
Jon Stokes	1.1, 1.2****
Frans Vera	3.11
Pete Wells	1.5, 3.9, 6.3

* From an original idea by Jill Butler and including artwork by Neville Fay.

** Procured by Brian Muelaner.

*** Parts obtained from several sources as follows: 1910 – Henry Taunt, with acknowledgement to Oxford City Library; 1920s – *Country Life*; 1950s – anonymous; 1981 – Paul Lack; 2009 – Philip Stewart.

**** From an historic postcard.



CHAPTER 1

Introduction: concepts and principles

1.1 THE PURPOSE, SCOPE AND LAYOUT OF THIS BOOK

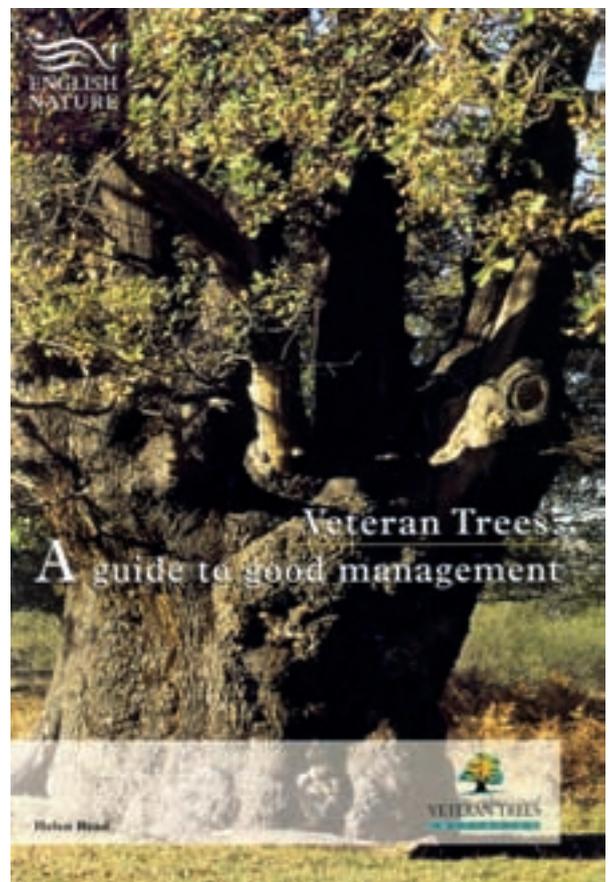
1.1.1 Purpose and scope, in relation to other sources of information

This book is about managing ancient and other veteran* trees to help prolong their lives and to ensure the continuity of habitat required by many of their associated species. It describes relevant aspects of tree work and of land management in outline but it does not go into practical details of work practices, except where appropriate guidance is not readily available elsewhere. There is therefore a need for users of this book to be acquainted with the available guidance on the care and management of trees in general. The relevant sources include textbooks, training courses and (where appropriate) operating standards. In certain instances, especially with regard to the statutory protection of trees and their associated species, there is also a need to be conversant with current law.

With specific regard to veteran trees, other sources of guidance include the following:

- Read, H. (2000). *Veteran Trees: A guide to good management*. English Nature, Peterborough.
- Davis, C., Fay, N. & Mynors, C. (2000). *Veteran Trees: A guide to risk and responsibility*. English Nature, Peterborough, 17 pp.
- Woodland Trust/Ancient Tree Forum *Ancient Tree Guides*.
- Fay, N. & de Berker, N. (1997). *Veteran Trees Initiative Specialist Survey Method*. Veteran Trees Initiative, English Nature, Peterborough, UK.

Although the present book is not intended to be a “bible”, every reasonable attempt has been made to take account of all the relevant information (as available on 31 August 2012) and thus to provide updated guidance on various aspects of management that are covered by Read (2000), which was the first comprehensive guide on the subject, at least in the English-speaking world. This book is, however, not intended to reproduce all the detailed guidance that Read (*op. cit.*) has provided. Although, at the time of writing, her book is out of print, each of its chapters can be downloaded from the Natural England website.



* See 1.2 for definitions of “veteran” and “ancient”.

The second of the above-listed publications is a companion to Read's (*op. cit.*) book. It sets out general principles whereby site owners and managers can fulfil their legal responsibilities with regard to risks that might be posed by veteran trees. Guidance on risk assessment is provided in various other publications, some of which are cited in Chapter 4 of the present book.

The present book should be used in conjunction not only with Read (*op. cit.*), but also with the above-listed series of guides that continue to be published by the Ancient Tree Forum. Each guide provides information on a specific aspect of the protection and management of ancient trees or their associated habitats. This book brings these aspects together under a single cover, while also providing additional information on some of the underlying principles. There are, however, certain aspects of detail that are provided only in the individual guides. Also, future guides are likely to provide new information not included in the present book.

Chapter 2 of this book refers to the above-listed Specialist Survey Method (SSM), which was developed under the Veteran Tree Initiative, a project run by English Nature (later part of Natural England) in order to provide a standardised framework for recording veteran trees. It provides a basis for surveys of individual trees and populations and can be used for monitoring the condition of trees. Where trees are being managed in order to protect them and to enhance their longevity, sequential use of the SSM enables comparative studies to be conducted, with a view to gaining further knowledge of the efficacy of different techniques.

With regard to operating standards in Britain, particular attention is drawn to the following:

- BSI (2010). *Tree work – Recommendations*, BS 3998:2010. British Standards Institution, London, 68 pp. (This is mainly relevant to Chapter 4 of the present book.)
- BSI (2012). *Trees in relation to design, demolition and construction – Recommendations*, BS 5837:2012 British Standards Institution, London, 42 pp. (This is relevant to Chapters 2 and 3 of the present book, mainly in relation to tree evaluation and tree root protection.)
- Hazell *et al.*, (2008). *Standard conditions of contract and specifications for tree works*. Arboricultural Association, 40 pp. (This is relevant mainly to Chapters 4 and 7 of this book.)



Fig. 1.1: Ancient hornbeam pollards, showing growth that has developed after cutting in recent decades



Fig. 1.2: The Major Oak: a famous named tree, shown here on a postcard from the turn of the last century

1.1.2 Layout of this book

- **Chapter 1** provides a general introduction to the management of veteran trees and the sites where they occur, outlining the various forms of management and explaining the circumstances under which they might be appropriate.
- **Chapter 2** mainly concerns the principles of, and procedures for, surveying and evaluating the trees and the related assets that might require management. It also outlines the principles of formulating a flexible long-term management plan for a particular site.
- The three middle chapters are concerned with specific management practices, as follows:
 - **Chapter 3** concerns tree protection (including management of soil and vegetation)
 - **Chapter 4** describes tree work (to help prevent catastrophic tree failure)
 - **Chapter 5** recommends habitat management (to help ensure habitat continuity)
- **Chapter 6** explains the origins and current status of veteran trees in the British landscape. It includes guidance on the implementation of provisions for protective designation and management.
- **Chapter 7** is concerned with the planning of management and the specification of particular items of work, with emphasis on certain types of specification that are especially relevant to the protection and management of veteran trees.

In Chapters 3, 4 and 5, which deal mainly with practical aspects of management, the main text consists principally of guidance. In the other chapters, the main text includes both guidance and items of information that underpin the guidance.

In each of the chapters, other kinds of information are shown in shaded text boxes as follows:

- background information
- statements that identify a continuing need for research
- comparisons of guidance in this book and in other sources.

1.1.3 Use of words in relation to guidance in this book

- “Should” denotes guidance that is recommended in the circumstances described.
- “May” denotes guidance that is optional, taking account of choice or of differing circumstances.
- “Can” is not used to denote guidance. It is used to refer to an action, an event or a situation that is unconditionally possible.
- “Might” and “could” are the past tenses of “may” and “can” respectively. As in everyday speech, they are also used to denote conditionality; i.e. where a possible action or event depends on circumstances. They do not refer to guidance.

1.2 DEFINITION OF ANCIENT AND VETERAN TREES*

Ancient Tree Guide No. 4 (ATF, 2008) defines an ancient tree as one “that has passed beyond maturity and is old, or aged, in comparison with other trees of the same species”. Similarly, according to current guidance for use in the Ancient Tree Hunt (Owen & Alderman, 2008), an ancient tree is one that has all or most of the following characteristics:

- a) biological, aesthetic or cultural interest, because of its great age**
- b) a growth stage that is described as ancient or post-mature
- c) a chronological age that is old relative to others of the same species

Earlier definitions pre-date the distinction that is currently made between “ancient” and “veteran”. For example, the above characteristics were listed by Read (2000) as defining a veteran (rather than an ancient) tree. Shortly afterwards, the Woodland Trust adopted a partly age-related definition of veteran in its Position Statement on Ancient Trees (Woodland Trust, 2001).

According to the current distinction, a tree can be a veteran without necessarily being very old. Thus, if a tree has the physical characteristics of an ancient tree but is not ancient in years, compared with others of the same species, it is classed as veteran but not ancient. In the present book, the term veteran is used throughout to describe all trees that have markedly ancient characteristics, irrespective of chronological age. The term ancient is applied specifically to trees that are ancient in years.

More precise and universally accepted definitions of ancient and veteran are probably unachievable, since these terms are to some extent subjective. It is, however, possible to state the general principles by which the above list of characteristics has been derived.

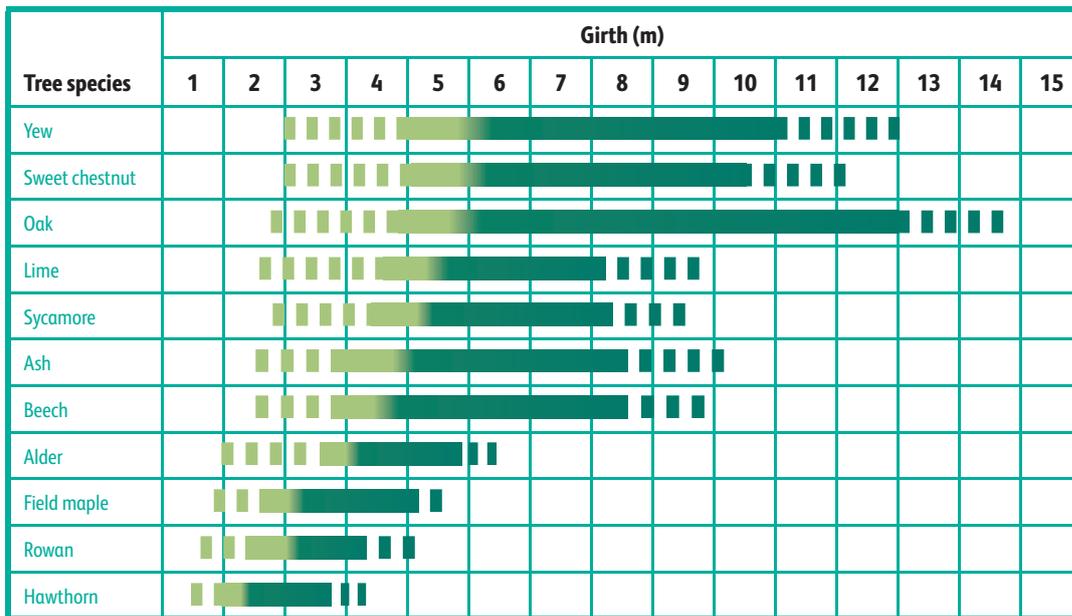
Characteristics (a) and (b) are mainly based on developmental and morphological criteria: i.e. the stage of growth, decline and decay of the tree concerned.

On the other hand, the third characteristic (c) is based on demographic criteria: i.e. the age of the tree, with respect to the age distribution of trees of the same species in a population that is not subject to felling or other sudden lethal events. On this basis, the number of years required to attain ancient status could vary according to climate and other factors that influence the growth rate and longevity of trees.

* **Note:** Other terms, such as “aged”, are sometimes used as synonyms for “ancient”.

** **Note:** The biological interest is largely derived from the development of a diverse range of habitats associated with dead and decaying wood. This is a largely age-dependent process: see the further definitions in Section 1.2.1.

Crown retrenchment is believed to result from a combination of physiological and biomechanical changes associated with growth and aging (Lonsdale, 2004). The biomechanical changes include an increase in leverage as branches lengthen, together with the effects of an increasing incidence of wood decay. Among the physiological changes, the increase in distance between absorptive roots and shoot tips might be especially important. Also, in broadleaved species, the progressive reduction in the length of annual shoot increments in the crown periphery is thought to lead to an increase in hydraulic resistance because of an associated increase in the number of vessel endings per unit length of branchwood (Rust & Roloff, 2002). A further increase in resistance could occur when sapwood increments become increasingly narrow as a result of being spread around a very large stem girth.



KEY: ■ Locally notable ■ Veteran/notable ■ Ancient ■ Late ancient

Fig 1.3: Chart of girth in relation to age and developmental classification of trees*

The following text in this chapter explains the principles that underlie the definition of both categories of veteran tree. Guidance on the practical application of the criteria is provided in Chapter 2.

1.2.1 Ancientness in relation to development and form**

The developmental characteristics that tend to develop with increasing age in trees [represented by the second characteristic (b) listed in 1.2 above] include the following:

- a large girth (for the species), owing to the long-continued accumulation of annual increments
- the progressive narrowing of successive annual increments in the stem, associated with sustained diminution of crown volume
- the aging and associated decay (leading to hollowing) of the central wood
- changes in crown architecture (Raimbault, 2006)
- a progressive or episodic reduction in post-mature crown size, often known as retrenchment (Lonsdale, 2004; Rust & Roloff, 2002).

* See 1.2 for definitions of “veteran” and “ancient”.

** **Note:** Many trees have a form that originates partly from a history of cutting (e.g. as pollards or coppice). Options for managing veteran pollards and coppice are provided in Chapter 4 of this guide. For definitions of terms such as pollard, coppice and coppard, see: Fay & de Berker (1997).



Fig. 1.4: Ancient hawthorn. Hawthorn can be considered ancient where its girth exceeds about 2.5 metres, as shown on the girth age chart on page 5. Girth at this stage can vary considerably between upland and lowland situations

1.2.2 Ancientness defined by chronological age within a tree population

In principle, ancient trees represent a small percentage of a population, in the upper part of the age-range. In practice, however, there is rarely enough demographic information to make a reliable age comparison between a particular tree and the rest of the population of the same species. Also, as a result of felling for many purposes, reference populations are often deficient in trees that have been allowed to age naturally. This makes it difficult to calculate average lifespan and life expectancy in the way that is done with human populations. We can nevertheless often recognise trees that have clearly survived longer than most other individuals of the species concerned.

1.2.3 Available categories, in addition to ancient, for classing a tree: veteran, notable, champion and/or heritage

- **Veteran:** this term describes a tree that has survived various rigours of life and thereby shows signs of ancientness, irrespective of its age. In order to qualify as a veteran, the tree should show crown retrenchment and signs of decay in the trunk, branches or roots, such as exposed dead wood or fungal fruit bodies.
- **Notable:** trees qualifying for this category are usually very large (also see champion on page 8), but might not qualify as ancient or veteran. Notable trees have been defined as mature and often magnificent, standing out locally because they are larger than other trees around them (ATF, 2008).

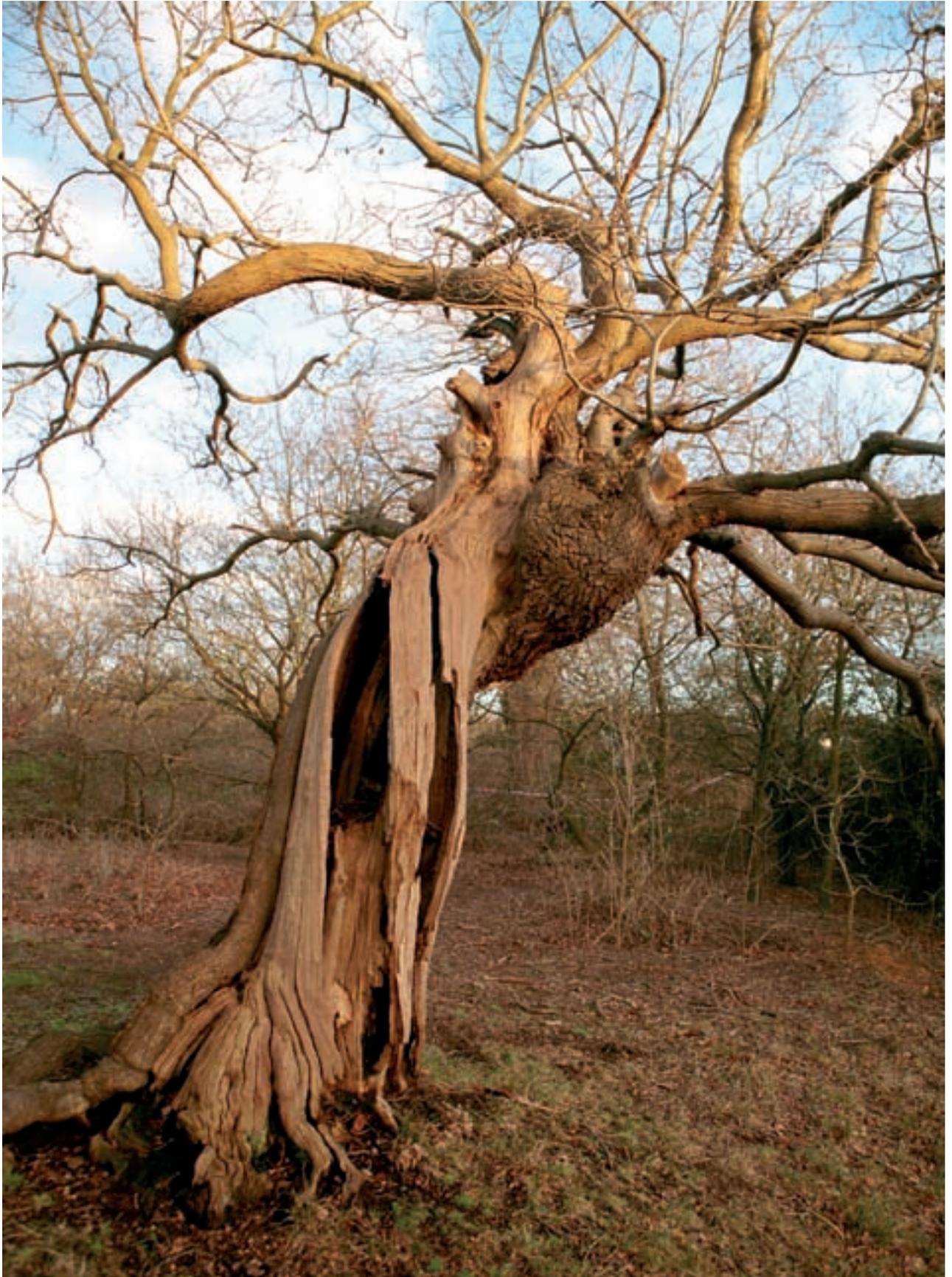


Fig. 1.5: A small oak tree with veteran characteristics, including a healthy crown and a hollow stem

- **Champion:** this term is reserved for a tree that is the tallest or has the largest trunk girth of its kind in the UK (or a given region).
- **Heritage:** trees answering any of the above descriptions could qualify for this category, together with others of special cultural or historical interest.

Surveyors should record trees for possible inclusion in the notable, champion or heritage categories, even if they lack ancient or veteran characteristics.

Certain trees have certain veteran characteristics (e.g. extensive hollowing of the stem), but are relatively small in girth (Fig. 1.5). Such trees should be included in the management plan for the site concerned (see Chapter 2), even if they do not formally qualify as veterans. They can play an important role where nearby ancient trees have no immediate successors and where habitats in smaller hollow trees could therefore help to fill a gap in continuity. Such trees are, however, unlikely to contribute as much to biodiversity in situations such as urban streets, where habitats associated with ancient trees cannot readily develop.

The size criteria shown in Fig. 1.3 should be applied, for example, when trees are being evaluated according to BS 5837: 2012, Table 1 (BSI, 2012).

Certain individual trees have special significance because of associations with culture, heritage, history and landscape, as outlined in Section 1.3.2.2. A heritage tree has been defined as one that has contributed to or is connected to human history and culture. Most trees that are valued for cultural or historical reasons are veteran, if not also ancient, but there are a few, such as the Arbor Tree in Shropshire or the Boscobel Oak in Staffordshire, which are substitutes for older trees that have died.

Since the above categories of tree overlap to some extent (see Fig. 1.6), there are certain trees that could be classed in two or more of those categories.

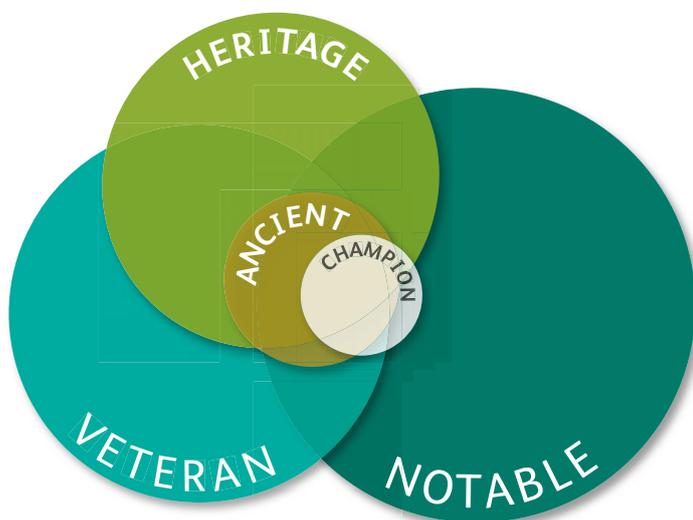


Fig. 1.6: Potential overlap of classification for an individual tree

1.2.4 Exceptions related to growing conditions and life history*

Although mis-recording can often be avoided by applying all relevant criteria, there can still be cause for uncertainty. The following are examples of trees that might be hard to classify.

- A relatively young tree that has been affected by adverse factors could show crown retrenchment, hollowing or other characteristics more typical of an ancient tree. Such a tree might simply be in a state of terminal decline, unworthy of recording as a veteran unless it has evidently recovered from adversity and can thereby be regarded as a veteran by virtue of being a survivor.
- A very slow-growing ancient tree could be much smaller in girth than might usually be expected for the species concerned (e.g. in very poor growing conditions or where kept small by pollarding).
- If an ancient tree consists of one or more small-diameter relict portions of the original stem, these could be mistaken for two or more small individual trees.

* See also Section 1.2.1



Fig. 1.7: Dead ancient tree retained as a feature in the entrance of a university campus. In the first four years of the Ancient Tree Hunt, 2,905 dead trees of a total of approximately 80,000 ancient and other veteran trees were recorded. Of these, 271 have been verified as ancient

- An unusually fast-growing tree could, relatively early in life, attain a girth typical of an ancient tree, even allowing for good site conditions. The same is true for a “tree” that is really two or more trees that have become established in the same spot (e.g. by bundle planting), but these are said to be identifiable by having an oval cross-section at the base.
- Owing to deviations from a predicted rate of girth expansion over decades or centuries, trees of a similar girth can be very different in age, even next to each other on the same site. Yew trees (*Taxus baccata*) often show this phenomenon.
- A tree could be both large in girth and ancient in years, but without showing significant signs of crown retrenchment. According to developmental criteria, such a tree could be regarded

Most tree species have an indefinite (indeterminate) growth pattern, producing new shoots, roots and radial increments of wood and bark throughout their lives (Lonsdale, 2004). If branches die or break, new ones can replace them by re-iterative growth (Raimbault, 2006) (Fig. 4.12). Since there is generally no theoretical limit to a tree’s capacity to produce new tissues, there is no intrinsic limit to its lifespan*, even though parts of it can die. An accumulation of disadvantageous mutations might limit longevity but advantageous mutations could have the reverse effect. The growth of trees is therefore fundamentally different to that of most animals, including man, despite misconceptions that tree species in general have a fixed lifespan.

Even though trees of most species do not have a fixed lifespan, they eventually die owing to a variety of changes and factors that tend to accumulate with age. These include the progressive attenuation of new increments of growth around an increasingly large dead, central core.

* The main exceptions are species that do not produce radial increments (e.g. palm trees) or that tend to do so only for a limited number of years (mostly small, shrubby species).

as post-mature, rather than ancient, and yet would clearly merit recording and protection (see Chapter 2, regarding notable and champion trees).

- As a result of recent vigorous growth in response to cutting, the crown of an ancient tree could have a form that is more typical of a young or mature tree.

The above possibilities should be taken into account in surveys, especially when tree age is estimated (see Chapter 2).

1.2.5 Dead or alive?

Veteran trees should be recorded and valued as such after death, even though dead trees are sometimes paradoxically deemed not to be trees, according to certain aspects of planning and other procedures. Dead veteran trees provide many aspects of the value of living ones and should be retained and conserved in the same way.

1.3 WHY SHOULD WE VALUE ANCIENT AND OTHER VETERAN TREES?*

1.3.1 Qualities of veteran trees in their own right

Ancient and other veteran trees often have superb visual qualities, which can include sheer size, a gnarled appearance and bizarre patterns of growth. These qualities, together with a sense of connection with something that is older than many human generations – and yet still alive – inspire feelings of awe, reverence and fascination in many people.

1.3.1.1 Rarity and accumulation of value through time

Ancient trees are uncommon because, by definition, they form only a small percentage of a tree population. Throughout the world, people recognise the value of rarity in its own right. For this reason alone, owners and managers, as current guardians, have a duty to protect ancient trees for future generations. This duty is especially important in the UK, which is home to a high proportion of the ancient trees of Europe, north of the Alps and the Carpathians.

Ancient trees can be regarded as an important regional and local genetic resource, since their longevity has probably depended partly on genes that confer tolerance of adverse circumstances or events and that could be passed on to a new generation. In the USA, where ancient trees occur in relicts of the wildwood, an organisation (Archangel Ancient Tree Archive**) has been set up to propagate them clonally in order to perpetuate their genetic resource. In the UK, the origins of ancient trees are complicated by a long history of felling and planting. There are, however, certain

ancient trees that pre-date the planting schemes of the last few centuries (see Chapter 6) and that are therefore relatively likely to be of local provenance and that thus might be the descendants of wildwood (old growth) trees.

Apart from their sheer rarity, ancient trees provide unique kinds of value (see above), which have developed over a very long time; often several centuries. If an ancient tree is destroyed or allowed to die for want of suitable care and protection, the planting of new trees cannot replace all the aspects of its value that have thereby been lost; at least not within the timescale of any realistic management plan.

Wildwood is often synonymised with primary woodland, which is not found in Britain. Old growth is understood to include both wildwood and secondary forests (including wood pastures and parkland) that have developed the structures and species normally associated with early undisturbed (post-glacial), grazed, wooded landscapes [see Alexander *et al.*, (2004)]. For definitions in the north-eastern United States, see Kershner (2004).

* Section 2.4 indicates how various aspects of the value of trees should be assessed and recorded for surveys.

** <http://www.ancienttreearchive.org/#/en/>

These aspects of value can, however, be perpetuated within the local landscape if they are still being provided by other ancient trees and if there is an adequate succession of younger trees. The need to ensure continuity is therefore of key importance in the formulation of a management plan.

1.3.2 Qualities of veteran trees in relation to landscape, people and biodiversity

1.3.2.1 Landscape*, aesthetics and amenity

Most parts of Europe arguably lack relics of the wildwood that, in prehistoric times, probably consisted of a mixture of relatively open savannah-like areas and of high forest (Vera, 2000; 2002). The clumps and individual trees (ancient and otherwise) of wood pastures and parklands are, however, perhaps a surviving counterpart of the prehistoric landscape.

Across the British Isles, the diverse distribution of ancient and other veteran trees contributes towards local distinctiveness. Their distribution is partly economic in origin, as for example in the pattern of farmland, hedgerows, wood pasture and woodlands. In many farmland areas, the veteran trees originated as hedgerow trees and have often survived even when the rest of the field boundary has been removed. They therefore have great importance as visible relics of former field and land-use patterns. Veteran trees also play an essential visual role in many designed



Fig. 1.8: Hollow pollards of ash are a feature of the landscape in the Cotswolds. Such trees sometimes shed major branches but they can survive by producing new branches and by maintaining good physiological function in the residual outer shell of sapwood

* See Chapter 6 for further information on veteran trees in relation to landscape.



Fig. 1.9: The remains of a dead named tree, retained as a feature of an historic landscape in a Royal park, while continuing to provide habitat

landscapes, including medieval deer parks and the ornamental parks of more recent centuries (see Chapter 6). In many instances, towns and cities have absorbed such areas or, in some cases, include similar areas that have their origins in the design of urban green space over the last few centuries.

Modern landscape management has increasingly recognised the importance of retaining and enhancing the distinctiveness of local landscapes in Britain. Thus, there are various initiatives – often supported by government and by communities – to maintain and enhance tree populations that are a key feature of landscapes; for example, the pollarded ash trees of the Lake District, pollarded oaks in the Weald of south-east England, pollarded willows in fenlands and the trees within the clusters of great parklands around cities such as Bath, Bristol and London.

Veteran trees are of course important for their individual aesthetic qualities, as well as in relation to landscape. Some of them have become so familiar to certain communities that they have become like well-loved friends. Thus, many of them provide immense visual enjoyment and amenity value (see Section 2.4).

1.3.2.2 Heritage, culture and history

Ancient trees link us culturally and historically to past generations of people who lived among them and who worked the land around them, shaping both the trees and landscapes such as wood pastures and coppices. Certain individual trees have significance in relation to specific events or historical and fictional characters. Some, like the Major Oak in Sherwood Forest, Nottinghamshire, and the Darley Oak in Cornwall have the distinction of being named. Thus, ancient trees are a heritage of past centuries, for which reason alone they deserve protection and conservation as much as any other form of heritage.

1.3.2.3 Insights into aging processes in trees and other organisms

Ancient trees are some of the largest and oldest living organisms on Earth. They are valued for this reason alone but they also give us scientific and philosophical insights into the physiological processes of aging in different kinds of organisms (see text box on page 9). We understand some of the reasons why, in practice, all trees eventually die, but there is still much to learn from studying them.

1.3.2.4 Relationships between trees and other organisms (biodiversity)

Complex interrelationships have developed between trees and other plants, fungi and animals, both above and below ground. Owing to their size and structural complexity, trees also influence micro-climate and provide many kinds of habitat for other species.

Fungi have a special set of relationships with trees. In particular, those that cause wood decay are instrumental in the development of some of the key characteristics of veteran trees, in association with bacteria and other micro-organisms. The decay process recycles mineral nutrients and provides a wide range of habitats for many invertebrates and other animals, many of which are rare. Some of these animals appear to be uniquely associated with ancient trees and the same is true of certain fungi, including some mycorrhizal species as well as decay fungi.

As trees age, there is generally an increase in the diversity of the wildlife habitats that they provide, as explained in Chapter 5. Ancient trees are especially important with regard to habitats that exist in decaying wood and cavities. Although some of these habitats can develop in younger trees, there are many rare and endangered invertebrates that occur only on sites where ancient trees have provided a unique continuity of habitat over many centuries. Also, the bark of ancient trees can be a vitally important habitat for certain rare lichens.

1.4 PRINCIPLES FOR PROTECTION AND MANAGEMENT OF TREES

The present book is based on the aim* that there should be no further avoidable loss of ancient trees, and to maintain a tree population in which the values associated with ancientness are sustained.

1.4.1 Why protect veteran trees from harm?

In a landscape managed by people, trees are often removed for a variety of reasons long before they can become veteran or ancient. In many parts of the world, ancient trees have thus become very rare or non-existent. Where such trees still exist, as in parts of the UK, their survival is often threatened in many ways, especially where there are changes in the type or intensity of land use. Protection from such threats is therefore essential in order to avoid accelerating the losses that would occur anyway due to natural causes.

1.4.2 Protection through site management and tree work

Avoidance of further losses requires protection of trees from harmful activities. In the present book, the term “protection” refers mainly to the prevention of direct injury to trees and the management of their surroundings so as to promote, maintain or enhance favourable conditions for their survival. This includes a positive approach to natural processes that enable trees to survive or resist collapse; e.g. layering, phoenix regeneration or internal support from aerial roots. In some cases, protection can also refer to statutory provisions, such as Tree Preservation Orders, under which certain activities are deemed unlawful.

* This is a stated aim of the Ancient Tree Forum.

Protection of trees through sympathetic site management is covered in Chapter 3 of this book. Also, as explained in Chapter 4, tree work can be protective, by preventing catastrophic mechanical failure and thus helping to prolong the lives of trees. A related but different purpose of tree work is to reduce a risk of harm to people or property where necessary.

1.4.3 Tree work: a rationale for veteran trees



Fig. 1.10: Major branch failure, several years previously, which has possibly led to an increased rate of decay of an already hollow tree. Previously, the acute angle of branching might have been the only external sign that such failure was likely

In a primeval landscape, such as the mixture of savannah-like areas and more densely wooded areas envisaged by Vera (2000; 2009), a proportion of trees in any population would always be ancient or veteran. This proportion would probably vary according to local conditions, such as the depth of soil, which influence vitality and biomechanical stability. Although ancient individuals would eventually die, younger ones would succeed them, so as to provide a continuity of habitat for their dependent species of fungi, animals and plants.

In most areas that are intensively used by people, ancient trees and their potential successors are so uncommon that intervention to help prolong their lives is often essential in order to retain continuity of their value. Apart from the need to protect trees from harmful activities (see 1.4.1), there is sometimes a case for intervening so as to help prevent individual trees from undergoing life-shortening mechanical failure. Chapter 4 gives guidance on deciding where such measures are appropriate. The principles that underlie that guidance are based on our current understanding of the aging process.

As the stem, branches and roots of an ancient tree increase in diameter, its living bark and sapwood occupy an increasingly

BACKGROUND

The physiologically functional outer envelope of tissues, described as the **dynamic mass of the tree (Shigo, 1991)** consists both of dead, hollow cells (e.g. vessels, tracheids and various types of fibre), and cells with living contents. The living contents, which form a three-dimensional network via connections between the cells, are collectively called the **symplast**. The space through which water can pass is known as the **apoplast**. This includes the hollow interiors (lumina) of cells such as vessels, together with intercellular spaces and the inter-fibrillar spaces in cell walls.

The dead core of heartwood or ripewood, described as **static mass (Shigo, 1991)**, plays little or no part in physiological functions but it contributes mechanical support. Decay does not significantly impair this support, provided that the tree retains an adequate “residual wall” of sound wood and that the decay does not extend into areas of locally high mechanical stress (see Chapter 4 for guidance on the use of criteria for assessing the strength of partially decayed parts of a tree).

thin outer envelope, surrounding a physiologically dysfunctional core, which eventually decays after becoming exposed to the atmosphere by injury or by natural processes of root or branch dieback (Fig. 4.12). Such dieback can extend far into parts of the outer envelope, but the tree as a whole survives unless there is a total break in the conductive pathways between roots and shoots. Furthermore, the root system gains access to mineral nutrients, which the decay process releases from a previously locked-up state in the wood. Decaying wood is also vital for a wide range of organisms and their predators (see Chapter 5).

As branches grow longer and heavier, they can become increasingly liable to fail at points where growth patterns or decay have caused local weakness. If, as a result of such failure, a large proportion of a tree's woody cross-section is exposed to the atmosphere, the resulting decay can sometimes become extensive enough to shorten the life of the tree by leading to eventual failure of the main stem. Some trees tend to produce relatively small branches that can be shed without serious long-term consequences. Branch shedding is a dynamic aspect of healthy growth, which also plays a role in the maturation of the crown of a younger tree.

After maturity, growth and shedding both continue, but the overall effect is often the gradual diminution of crown size that is widely known as retrenchment. During this process, many trees also produce numerous epicormic growths, which are capable of developing into new branches when older ones are shed. Retrenchment of the crown, together with an increasing trunk girth, has enabled many trees to remain biomechanically stable. In this way, and also by reducing the water demand on the roots and conductive system, retrenchment has enabled many trees to survive to a great age without human intervention. In other cases, the traditional practice of pollarding has similarly contributed to longevity.

Trees that tend to produce very large, failure-prone branches are relatively unlikely to have a prolonged ancient phase of life. Intervention in the form of tree work can sometimes extend the lives of such trees. Such intervention is arguably a form of interference, since it favours trees that are perhaps not genetically disposed to survive to a very great age. In reality, however, ancient trees and their immediate successors are generally too uncommon to be allowed to fail where this can reasonably be prevented.

1.5 CONCEPTS OF DECAY AND DISEASE IN RELATION TO LONGEVITY

Attainment of great age depends on a balance between (a) the tree's ability to maintain itself physiologically and biomechanically (see 1.4.3 above, in relation to intervention) and (b) its interactions with organisms that utilise its living and dead tissues.

1.5.1 Interactions between trees and fungi

Organisms that utilise the tree's living tissues are often referred to as pests and pathogens, but many of them have co-evolved with the host species so as to cause so little, if any, damage that they do not shorten the host's life and hence their own. Moreover, they include beneficial symbionts such as mycorrhizal fungi, which provide essential mineral nutrients to the tree. At the other end of the spectrum, others are inherently more aggressive but cause serious harm only to genetically susceptible individuals, which tend to die before they can become ancient. Many more trees can, however, be harmed if exposed in later life to an exotic pest or pathogen, or to a new one which has arisen through mutation or genetic recombination.

Of the organisms that utilise the tree's non-living tissues, the most dominant are decay fungi. Many of these are confined to dead wood and are in no sense pathogens. The decay process can, however, weaken parts of the tree enough to contribute to mechanical failure. If this involves the main stem or the rootplate, the tree is unlikely to survive, since catastrophic loss of roots or conductive pathways tends to cause physiological failure. In contrast, decay-related failure that



Fig. 1.11: *Ganoderma resinaceum*. The native oak trees of the UK seem to co-exist with this decay fungus. It can cause more rapid decay, together with a decline in health, in non-native oaks such as the North American Red oak and Turkey oak

affects only relatively small branches can contribute to the process of crown retrenchment, which generally helps to prolong the life of the tree, as explained in Section 1.4.3.

Both the properties of the woody tissues and the decay capacity of the decay fungus influence the extent of decay and hence its mechanical effects, if any. The probability of consequent tree failure depends partly on environmental factors, as in the case of the depth and texture of the soil, which influence root anchorage.

The properties of the woody tissues depend largely on the species of tree concerned. In this context, the following information should be taken into account when a prognostic assessment of the biomechanical integrity of a tree is attempted.

- **Durable heartwood.** The heartwood of some species (e.g. the native oaks of the UK) contains protective substances (extractives), which slow down the decay process and sometimes make the wood available only to specialised heart-rot fungi (e.g. Chicken of the Woods *Laetiporus sulphureus* in the heartwood of oak). In many cases, the continuing growth of sapwood, which eventually becomes new heartwood, seems to keep pace with the spread of decay for centuries.
- **Ripewood and heartwood of low durability.** Other tree species (e.g. beech) have a less durable heartwood, or contain ripewood (sapwood which has gradually died over many years), rather than a distinct heartwood. Such species tend to decay more rapidly after their

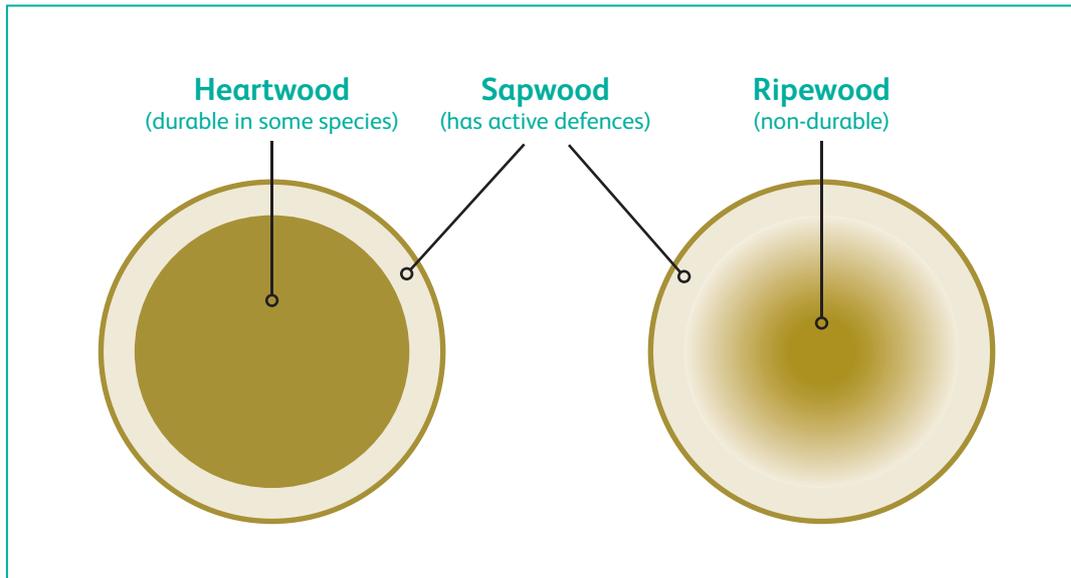


Fig. 1.12: Comparison between tree species with true heartwood (left) and with a ripewood core (right). High moisture content acts as a passive defence, whether the wood is living, non-living, durable or non-durable. Wounding usually causes moisture loss and so impairs this defence

central wood has become significantly aerated via the openings created by dead or broken branches and roots. For this reason, such species tend to have a shorter typical lifespan, but individuals with a short stature and a complex anatomical structure (especially pollards) can live much longer. In any case, durability of the heartwood is by no means the only factor that influences the longevity of trees. In ash, *Fraxinus excelsior*, for example, relatively rapid decay of the heartwood sometimes leaves little more than a thin outer shell of sapwood, but the sapwood often retains good physiological function (Fig. 1.8).

- **Sapwood** is a living tissue with high moisture content, by which it is passively defended against loss of function and the ingress and activity of decay fungi (Boddy & Rayner, 1983). Also, if injured, it forms an active defence in the form of coloured reaction zones, in which physical and chemical blockages develop in the spaces through which fungi might grow. Furthermore, new wood formed after injury is strongly defended against fungal ingress from the injured zone, since it is to some extent disconnected from the pre-existing wood, partly because of the anatomical characteristics of the first-formed layer of cells in the new wood. This layer can form a recognisable barrier zone (Pearce, 1996). Reaction zones are weaker than barrier zones and can be breached by certain decay fungi, which have the ability to degrade defensive substances or to bypass the blockages by tunnelling inside cell walls.

In theory, unbroken annual rings of sapwood are produced around the entire circumference of the main stem of a tree until the ratio between crown size and stem girth becomes so small that the foliage can no longer provide the required amount of sugars via translocation through the phloem. In a ring-porous species, this stage might theoretically be reached when the sapwood increments become too narrow to accommodate more than a single row of springwood vessels. It has been stated that most species can barely survive when their annual increments are less than 0.5 mm wide (White, 1998). In reality, the thinning of successive increments is rarely uniform around the stem circumference. Instead, sapwood tends to form more thickly within discrete axial strips of the stem that connect the most vigorous branches with the most functional parts of the root system. Eventually, sapwood formation becomes confined to such strips, which thus

BACKGROUND

Trees and decay fungi have generally co-evolved in ways that reduce the probability of catastrophic failure, which would shorten the life both of trees and of fungal individuals within them. There are, however, some important differences between fungi regarding both their capacity, if any, to colonise functional sapwood, and their effects on the strength of wood.

BACKGROUND

Endophytic or latent decay fungi can remain quiescent in wood until they are perhaps eventually triggered into activity by physical or chemical alterations within discrete columns within in the wood (e.g. following aeration due to injury). Such fungi can then actively decompose wood within the altered columns, but not usually beyond those columns. Some of these species are strongly antagonistic to other fungi, and are thus able to defend their occupancy of their columns of wood. This antagonistic activity is thought also to help defend their hosts against harmful organisms in certain instances (Carroll, 1988).

alternate with strips of dead sapwood. The dead strips, which are either exposed at the surface or covered by dead bark, become colonised by decay fungi, either by outward progression of heart-rot or by fresh colonisation from the outside.

When deciding whether tree work is appropriate, account should if possible be taken of the particular decay fungus, or fungi, that are present in the tree concerned.

With regard to the ability of different fungi to colonise functional sapwood, the following information should be taken into account when tree work is being considered.

BACKGROUND

As far as wood strength is concerned, the main contrast is between brown-rot fungi (e.g. *Laetiporus sulphureus*, which make wood brittle by breaking down the cellulose content, and selective white-rot fungi (e.g. *Pholiota squarrosa* and various *Ganoderma spp.*), which reduce the stiffness of wood in the early stages of decay, by preferentially breaking down the lignin content. A stem in which stiffness has been reduced tends to sway more in the wind, often with the result that adaptive growth is stimulated (Fig. 1.13). This helps to provide mechanical integrity even when the decay becomes more advanced.

- Decay fungi that can colonise living sapwood (e.g. *Ustulina* [=Kretzschmaria] *deusta*) could be regarded as parasitic. In many cases, however, there is little or no discernible effect on the vitality of the tree as a whole and so these fungi cannot generally be regarded as pathogens; i.e. the decay that they cause is not necessarily a form of disease. They can, however, kill individual roots when developing below ground level, with the result that parts of the crown die back. It could be argued that, at this stage, decay has progressed to a state of disease.
- Although it is questionable whether sapwood-colonising decay fungi can be said to cause disease, their ability to colonise sapwood helps them to extend from the central wood towards the bark, thus making failure more likely than it would otherwise be.

- At the far end of the spectrum, certain decay fungi can kill so much sapwood as to be undoubtedly pathogenic (e.g. the silver leaf fungus, *Chondrostereum purpureum*). Such fungi are not responsible for the age-related decay which is typical of veteran trees, but they can cause the dieback of sapwood which has been exposed at breakages and pruning wounds.
- Certain decay fungi are present in a latent state in living sapwood. If a traumatic event triggers such a fungus into activity, the outcome will depend partly on the species of fungus concerned. The various species cover a wide spectrum with regard to their effects on the host tree (Hendry *et al.*, 1998). Some can induce long decay columns in wood that has become non-conductive but still contains living cells; for example, above and below a severe injury such as a flush pruning cut that has been inflicted during drought stress. The decay of a strip of sapwood is followed by the death of the overlying bark, so that an elongated canker (a strip canker) forms. Other fungi, such as *Hypoxylon fragiforme* in beech, seem to become active only in sapwood that has died completely owing to other causes. Yet others develop mainly in small branches that are dying back because of shading or an inadequate water



Fig. 1.13: Beech tree showing adaptive growth, which is enhancing stability by broadening the spread of the buttress zone, previously decayed by a fungus (suspected to be Giant polypore *Meripilus giganteus* and apparently no longer active). The growth consists of stilt-like roots surrounding this zone and of new roots that have grown into the cavity

supply. These latter sometimes have a beneficial role in decaying the branch at its base, so that it falls and leaves a scar that can readily become occluded* by new tissues.

- Environmental factors and the general health of the tree can shift the balance between the rate of pre-existing decay and the formation of new wood. For example, deterioration in growing conditions or the onset of disease could lead to a weakening of defensive boundaries (reaction zones) within the sapwood, thus allowing the rate of decay to increase. An accompanying reduction in the rate of wood formation could also reduce the capacity of the tree to keep pace with the development of the decay.
- In species such as beech, the passive resistance of ripewood, which depends on high moisture content – and hence low aeration – is impaired when wounding exposes the ripewood to hot, dry conditions. Containment (compartmentalisation) of the zone of increased aeration will depend partly on the size of the wound(s) relative to the girth of the affected stem or branch. It will depend also on the capacity of the tree to maintain the flow of moisture in the surrounding sapwood, and hence on the overall health of the tree and on the growing conditions (see Chapter 3 for information on protection from adverse conditions).

* New wood and bark develop around the edge of the wound and, given enough time, can eventually cover the wound completely (i.e. occlude it). Total occlusion prevents aeration of the wound and thus helps to slow down decay that might be developing behind the wound surface.

1.6 HABITATS ASSOCIATED WITH VETERAN TREES

There are many kinds of habitat associated with veteran trees, as explained in Chapter 5. Some of these are associated mainly with foliage and the younger branches or roots and are provided by young as well as old trees. The special value of veteran trees is due mainly to the multiplicity of habitats that are associated with decaying wood (saproxylic habitats) or the bark surface. Veterans that are ancient in years are potentially the most valuable, since they are likely to have been providing continuity of habitat over several or many centuries.

Continuity is essential for many dependent species that have very limited capacity for dispersal and that are therefore unable to move across areas devoid of veteran trees. Before the days of intensive land use by humans, such species could have thrived widely, owing to an abundance of suitable trees. Now that these species are confined to few sites, their survival depends critically on maintaining continuity in our remaining populations of veteran trees (see Chapters 5 and 6).

Decay is caused mainly by a wide range of fungi, each of which has a range of strategies for the colonisation of wood of a particular type or condition, as explained in Section 1.5. These fungi collectively represent a key component of biodiversity as well as being vitally important for the many other organisms that are associated with decaying wood. They include rare or endangered species, some of which could become nationally or globally extinct in the absence of a sustainable population of ancient or veteran trees. Like other decay fungi, these species have airborne spores and might therefore be expected to be widespread, but they are largely confined to sites where ancient trees occur.

Certain species of lichen also have a special relationship with ancient trees, being found only on very old bark, which provides suitable niches for them and has persisted long enough to enable their extremely slow development to take place. Although, like fungi, they can spread via the wind, some species such as the rare lungwort *Lobaria pulmonaria* appear to have limited capacity to form new colonies, perhaps because of unsuitable conditions in the tree population (Werth, 2005).

Invertebrates comprise many of the species that require saproxylic habitats. Some of these are rare and endangered, especially a range of species which – in the UK – are associated mainly with veteran trees in wood pasture and other open areas. Many of these seem not to occur anywhere else in these islands. It is believed that a high proportion of these rare species have very limited mobility, so that they will die out from an area if it does not contain suitable habitat very close to a micro-location where the habitat has been lost.

Veteran trees provide important nesting or roosting habitats for various vertebrates, including many birds and bats. Some of these species depend on a diet that consists partly of saproxylic invertebrates.

1.7 MANAGEMENT OF INDIVIDUAL TREES, POPULATIONS AND HABITATS: PRINCIPLES AND OBJECTIVES

1.7.1 Maximising the longevity of individuals within a tree population

The following principles and objectives apply if the underlying aim is to maximise the longevity of all the veteran and ancient trees within a particular area. There might, however, be a need to give preference to certain trees over others, which are likely to respond well to management. There might also be a need to apportion resources where they are most beneficial, especially where there are many trees. Management issues of this sort are outlined in Chapter 7.

- On the basis of a survey (see Chapter 2), any individual trees that are assessed as being vulnerable either to damaging activities or to catastrophic failure should if possible be covered by individual tree management plans (ITMP) (Fay, 2008b), as explained in Chapter 7.



Fig. 1.14: Veteran tree on a canal bank. The nearer stem shows a major tear-out wound and some of the branches previously overhanging the canal have been shortened. This tree work has probably reduced the probability of further failure

In any event, every individual which urgently warrants management in the form of tree work or protection from harmful factors should be identified. The following steps should be followed where appropriate:

- assess any factors which are likely to shorten the life of the tree if unchecked
- intervene (i.e. undertake tree work) to avoid catastrophic break-up of the tree if its mechanical integrity is significantly compromised, doing so in a way that allows for the ability of the tree to grow and survive under the altered conditions of light and shade that will result from the intervention*
- protect the area around the tree, especially within its rooting area (see Chapter 3).

1.7.2 Ensuring the continuity of ancient tree populations and associated habitats

Although continuity can to some extent be achieved by managing individual trees, a more wide-ranging plan (see Chapter 7) is often necessary in order to identify and overcome current and potential generation gaps. Such a plan will usually include the encouragement of natural regeneration or (trans)planting, to avoid a decline in the number of veterans to the extent that the habitat quality of the site would be placed at risk (see Chapter 5). At the very least, every reasonable effort should be made to avoid a complete gap in habitat continuity, as could occur where there are currently few ancient trees. Any gap in the continuity of saproxylic habitat will lead to the local extinction of the less mobile dependent invertebrates and perhaps of certain fungi. Habitat creation, as outlined in Chapter 5, may be undertaken if such gaps (or periods of scarcity) seem likely to occur before a future generation of trees can become veterans.

1.7.3 Safety of people and property

An owner's responsibility towards veteran trees and their dependent organisms is accompanied by a duty of care towards people and property. The need to balance the two is outlined in Chapter 4. By way of introduction, a distinction needs to be made between (a) remedial action for the benefit of trees and habitats and (b) action to protect people and property.

Remedial tree work, as outlined in Chapter 4, can often help to prevent the catastrophic break-up of veteran trees. The same work can thereby protect people and property within the potential zone of failure, but the objectives can be very different. In particular, veteran trees tend to shed relatively small branches without significant threat to their own survival, but with potential harm to people or property. Such trees do not generally require remedial action for their own protection and so the question is whether they pose sufficient risk to people or property to justify action for the distinctly different purpose of reducing that risk. Even if remedial work is required for this purpose, it should preferably consist of "moving the target", rather than resorting to work that would harm veteran trees and their associated habitats. Also, conflicting objectives can often be reconciled by compromise. A range of possible solutions is shown in Chapter 4.

1.7.4 Management of veteran trees within the wider landscape

From the management perspective, veteran trees should never be seen in isolation. They should be managed as part of the ecological, visual and historical landscape (see Chapter 6) and as members of a tree population, which can extend far beyond the area of ownership. In particular, proper account should be taken of the spatial connectivity and the temporal continuity of the wildlife habitats which they support and which exist around them (i.e. including pollen and nectar sources for saproxylic invertebrates; see Chapter 5). The following strategies and actions are of particular importance.

* See Chapter 4, regarding canopy structure and the shade tolerance of different species.

- Co-operate with organisations and with managers of other sites, so as to plan for development and continuity of the population of veteran trees within the wider landscape.
- Maximise as far as possible (with grant aid where available) the area of sympathetic land management around veteran trees. Thus, in addition to local protection (e.g. by excluding some forms of land use such as car parking entirely from beneath the canopy areas of the trees), a low intensity of land use should if possible be maintained within areas of land which link groups of veteran trees.

These actions can be achieved successfully only if there is good information about the veteran trees in the area concerned. Survey work (see Chapter 2) is important in this respect and is a means of enthusing people. It should be promoted by encouraging people to join the Ancient Tree Hunt (www.ancient-tree-hunt.org.uk) or a scheme under the aegis of a local organisation such as a wildlife trust

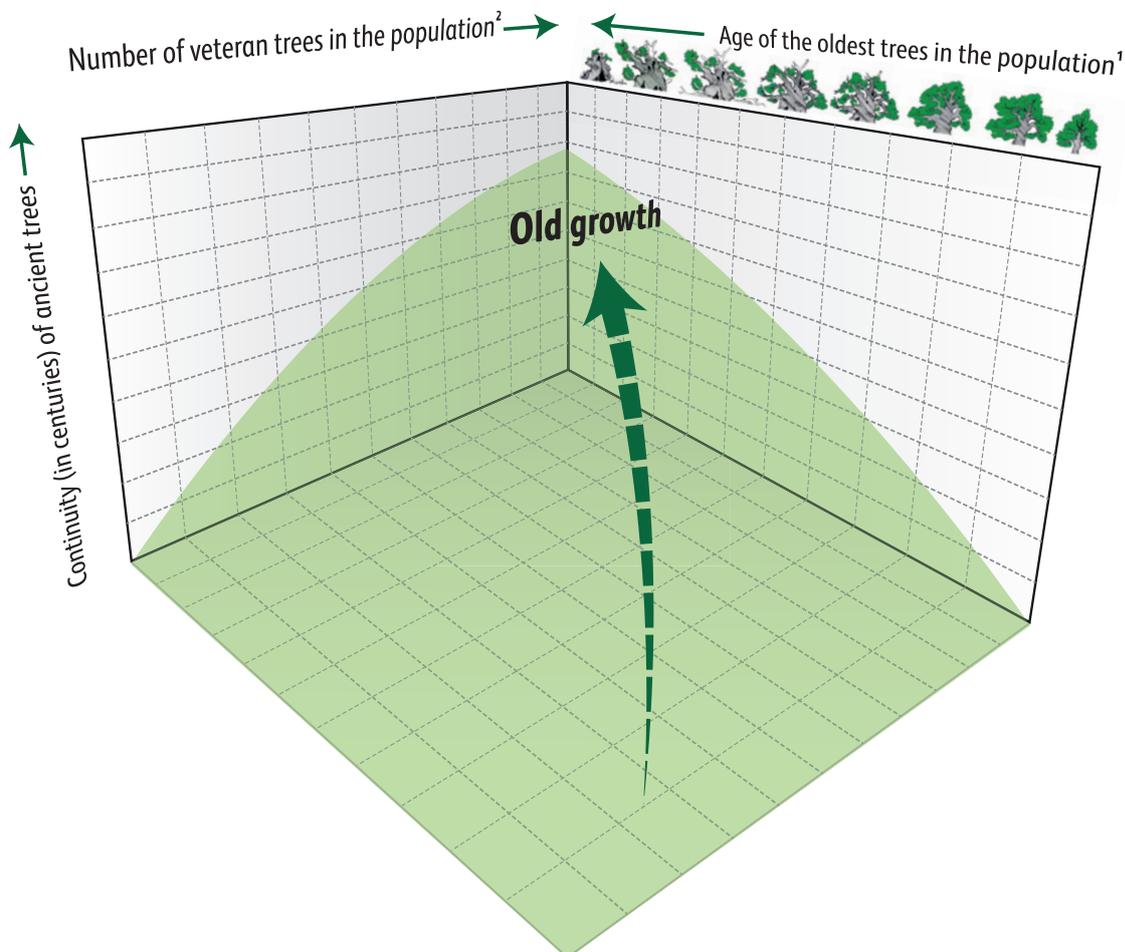


Fig. 1.15: A conceptual representation of current knowledge about habitat quality in relation to tree age and tree population size. The richest diversity, typical of “old growth”, occurs where ancient open-grown trees of successive generations have continuously formed part of a substantial tree population for many centuries. Since some of the species that depend on ancient trees have very limited powers of dispersal, many of these are now confined to a few sites where continuity of their habitats has not been broken

Note: The properties shown on the axes of this graph represent generalised concepts only, as indicated by the following key to the asterisks:

- ¹ The “age of the oldest trees” could be calculated in various ways; perhaps as the average age of the oldest five or 10 per cent of trees in the population. Such a calculation would, for example, help to avoid over-estimating the contribution of a single ancient tree in a population of much younger trees.
- ² The “number of veteran trees in the population” could, for example, be calculated as the number of verifiably identified open-grown veterans that each occurs within a given distance of one another. This distance could be decided in order to take account of the dispersal ranges of decay-dependent species of low mobility. The distance could be adjusted in order to help identify sites that merit designation for protection and for future enhancement.



CHAPTER 2

Veteran trees: survey and evaluation

2.1 BACKGROUND

2.1.1 Purposes of surveys and evaluation

Within a given area, information about veteran trees is needed in order to develop a favourable management regime. Information is needed also when evaluating the various requirements for action and when estimating costs, both of the regime as a whole and of particular items that need to be specified in applications for funding. Since considerable time and effort could be spent on gathering information, it is necessary to decide the scope and detail of the information required.

As a basic requirement for survey, the trees in the area concerned should be mapped if this has not recently been done. The map should preferably show each tree as a numbered individual. If, however, the currently available resources do not enable such detail to be recorded (e.g. in a large area with a very large tree population) a more generalised method of recording the distribution of trees, particularly veterans, would still be helpful.

2.1.2 Basic requirements for survey and evaluation

Before deciding what to record in the survey, the initial question should be as follows:

“What information already exists about the trees and the history of the site?”

For certain sites, existing information might provide a useful starting point; for example where trees are already mapped or where there are historical records of tree planting or of other changes in land use. In any case, the survey should be designed to enable the condition of trees to be determined and then monitored in order to decide how to manage them and the land around them. If the trees have not been individually mapped and numbered, a representative proportion of them should be individually assessed for their condition. The assessment should also value the trees according to the various contexts listed below in 2.4: e.g. intrinsic, aesthetic, cultural or ecological.

If there is little or no information about the veteran trees within the area concerned, the most basic aspect of the survey should be to map them according to species, at least in groups or in zones within the site if it is not feasible to map each tree in the first instance. The survey should also be devised in order to address the following questions, which are intended to provide information about the environment in which the trees are growing, together with the size and general condition of individual trees.

- How many ancient and other veteran trees are present in the defined area (at least approximately, if there are too many of them to record individually at present)?
- How many trees are there in each category of previous management (e.g. managed pollards, lapsed pollards, maiden trees)?
- How many trees are in different categories of vitality* (e.g. good, moderate, poor, dying, dead)?

* **Note:** Certain survey methods use the term vigour in the same way that vitality is used in this book. According to another definition that is often used in arboriculture, vigour is purely a genetically determined characteristic (Shigo, 1991).



Fig 2.1: This scene shows trees in various categories for recording, including a veteran Sweet chestnut pollard, an avenue of mostly veteran limes and a semi-mature birch

- Considering the above statistics and the population structure (see Chapter 7), how many trees could become future ancient trees, or at least veterans?
- In broad terms, how valuable are the trees on a local, regional, national or international basis (considering all the relevant contexts: see 2.4)?
- Are there any trees or groups of trees whose survival is threatened by unfavourable land use or other activities?
- What is the need, if any, for tree work in order to protect trees from major mechanical failure?
- Are any of the trees posing (or soon likely to pose) an unacceptable risk to people or property?

If individual trees are identified as requiring management (e.g. to help prevent serious structural failure or to mitigate risks to people or property), more detailed information about their condition is helpful. This may be used as the basis for developing individual tree management plans (see Chapter 7).

2.2 CRITERIA AND SCHEMES FOR RECORDING VETERAN TREES: BASIC TECHNIQUES

2.2.1 How to recognise ancient and veteran trees

According to guidance for use in the Ancient Tree Hunt (Owen & Alderman, 2008), an ancient tree is one that has all or most of the following characteristics:

- a) biological, aesthetic or cultural interest, because of its great age*
- b) a growth stage that is described as ancient or post-mature
- c) a chronological age that is old relative to others of the same species.

In order to recognise an ancient or other veteran tree in the field, surveyors should look for the following visual characteristics:

- a girth** that is very large for the species, allowing for the local growing conditions
- extensive decay or hollowing in exposed parts of the central wood
- a crown structure that, for the species concerned, is characteristic of the latter stages of life
- a crown that has undergone retrenchment, i.e. it has become smaller (owing to dieback and breakage) since maturity.

Also, with regard to item (c) above, surveyors should try to make use of available historical or other evidence as to whether the tree concerned is very old, relative to others of the same species. If the tree is not ancient in years but shows the above visual characteristics (see Chapter 1), it should still be recorded as a veteran.

On the basis of the above general criteria, it is unlikely that all the participants in a survey would, without prompting or instruction, fully agree which trees should qualify for inclusion. There is, however, more detailed, illustrated guidance, which can assist volunteers in the role of providing reasonably accurate regional and national records of veteran trees. By setting out a consistent set of terms and criteria, such guidance can also assist co-operation between the many other individuals and groups who work with trees, or who provide grants for their management. Principal sources of guidance on the recognition of ancient or other veteran trees are provided by Read (2000) and by Owen & Alderman (2008). Of the criteria that are listed for the classification of ancient and other veteran trees, the main ones are as follows:

Size-based attributes (these depend on the tree species concerned, together with soil and climate; the following criteria apply generally to oak – *Quercus robur* or *Q. petraea* in the UK)

- Trees with a diameter at breast height of more than 1.0 m (girth 3.2 m) are potentially interesting.
- Trees with a diameter of more than 1.5 m (girth 4.7 m) are especially valuable with respect to conservation.
- Trees with a diameter of more than 2.0 m (girth 6.25 m) are truly ancient.

Other key attributes (the more a tree has, the stronger the indication that it is a veteran)

- Girth large for the tree species concerned
- Major trunk cavities or progressive hollowing
- Naturally forming water pools
- Decay holes
- Physical damage to trunk
- Bark loss
- Large quantity of dead wood in the canopy
- Sap runs
- Crevices in the bark, under branches or on the rootplate sheltered from direct rainfall

* **Note:** The biological interest is largely derived from the development of a diverse range of habitats associated with dead and decaying wood. This is a largely age-dependent process: see the further definitions in Section 1.2.1.

** **Note:** Usually, the girth of the main stem is measured as described on page 34. The girth of a coppice stool may be used as an aid to estimating age if data for age-girth relationships are available for the species concerned.

- Fungal fruiting bodies (e.g. from heart-rotting species)
- High number of interdependent wildlife species
- Epiphytic plants (if these are abundant or include rare species)
- An old look
- High aesthetic interest.



Fig 2.2 This oak is probably too small in diameter to qualify as ancient unless it has grown very slowly. Nevertheless, it has veteran characteristics, mainly associated with a major branch failure that initiated heart-rot many years ago



Fig. 2.3: ATH system for online data entry

Attributes which can additionally apply

- A pollard form or other form indicating previous management
- Cultural/historic value
- A prominent position in the landscape.

2.2.2 Where to look for veteran trees

Ancient and other veteran trees, although only a very small proportion of the overall tree population, can be found almost anywhere in the UK. They have occasionally survived even within the suburbs of large towns and cities and, in very rare cases, within more heavily built-up areas. They are, however, mostly found in the relatively small proportion of the countryside that is not intensively managed, especially wood pasture, rural parkland and wooded commons. Smaller numbers are scattered throughout the wider countryside, including hedgerows and roadsides. Some occur also in areas of high forest, especially where they have originated in a more open situation but have become surrounded by younger self-sown or planted trees.

2.2.3 General information about survey forms and their purpose

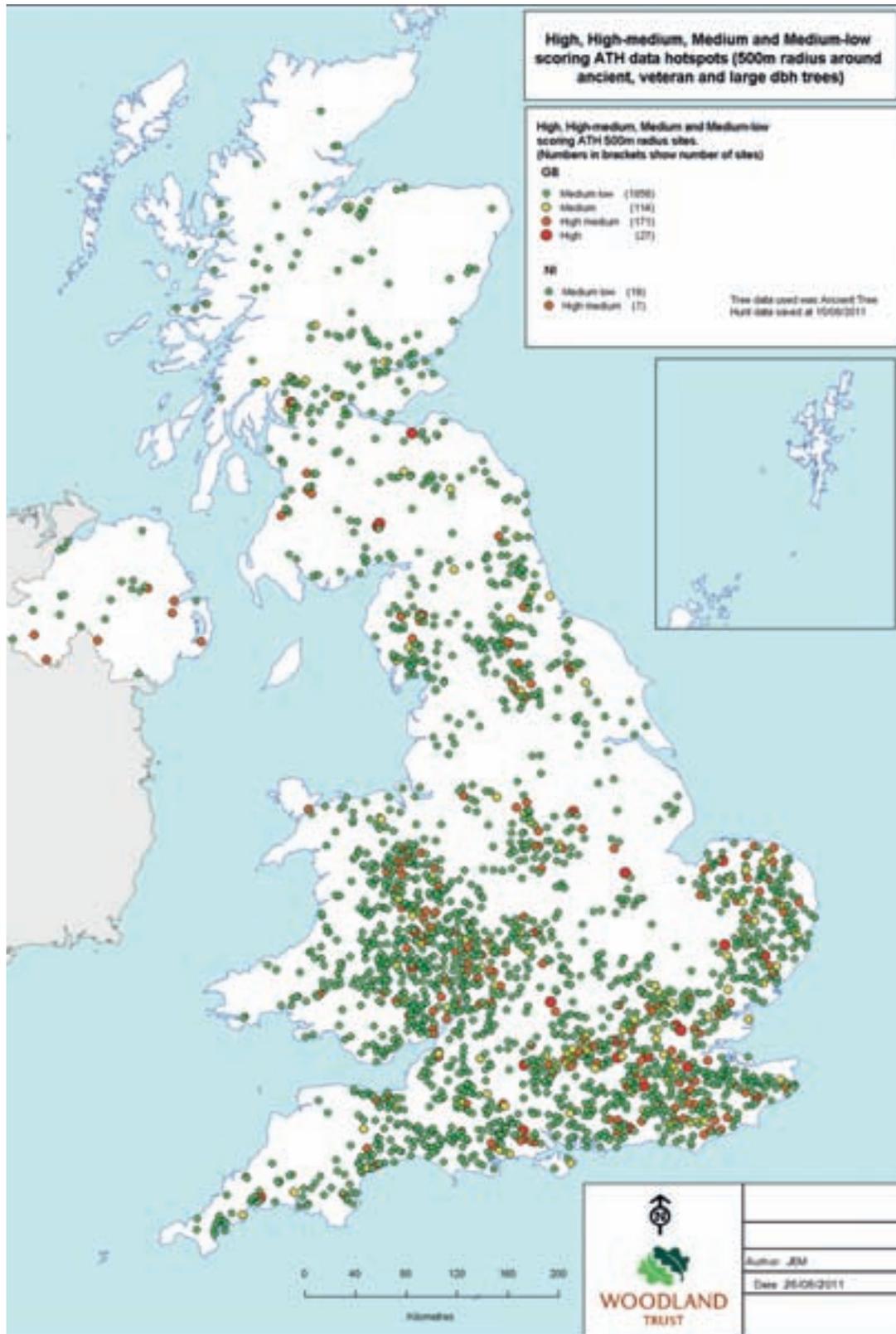
Simple recording forms for groups of veteran trees and for basic details of individual trees are available from various sources, especially the Ancient Tree Forum (ATF*). The Woodland Trust, which hosts the ATF, runs a scheme called the Ancient Tree Hunt, which is supported by local schemes run by various organisations, including local authorities and county wildlife trusts. The

Comparison with other guidance: recognition of veteran trees

Pryor et al., (2010) refer to Read's (2000) list of diagnostic attributes, together with guidance on stem diameter measurements. Their stated diameter values are, however, grouped for rather diverse species and there is a presumption (not made in the present book) that veteran trees are always relatively large in girth.

COMPARISON

* www.ancient-trees.org.uk



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Fig. 2.4: ATH data (Aug. 2011), showing concentrations of ancient and other veteran or large-diameter trees

Hunt enables volunteers, without formal training, to contribute information, which is valuable both for national statistics and for the management of regional and local tree populations. Details of the Hunt are available from the ATF website.

The Hunt gathers preliminary information about the presence of trees at a given location. After this information has been submitted, the status of the trees as ancient or veteran can be verified. More detailed information can be recorded using the Specialist Survey Method (SSM), which was developed by Fay & de Berker (1997) under the Veteran Tree Initiative, a project run by English Nature (later part of Natural England). The SSM comprises three levels of detail as follows:

- Level 1 is designed for schools and the non-specialist enthusiast, who can submit information on a recording card (one card per tree). This is the level at which the SSM has been used in the Ancient Tree Hunt.
- Level 2 is an intermediate generic survey, aided by a survey booklet (Fay & de Berker, 1997). Surveyors are asked to record essential data in selected sections of a specialist survey form, a copy of which is provided at the back of the booklet.
- Level 3 is a comprehensive specialist survey, conducted also with the aid of the booklet. Surveyors are asked to complete all the data sections of the specialist survey form. These are shown in Appendix A.

In order to use the SSM to the best effect, it is helpful to keep abreast of case studies and reviews of projects where it has been used. At the time of writing, there are reports of several case studies in the UK (e.g. Read *et al.*, 2007) and in Sweden (Forbes *et al.*, 2004; Fay & Forbes, 2006).

2.3 INDIVIDUAL TREE SURVEY AND EVALUATION

For a particular site and its trees, information about not only the tree population, but also the condition of individuals is needed in order to develop a management plan (see Chapter 7), with the aim of assuring a succession of future generations of ancient and other veteran trees. In order to assess the need (if any) for tree work (see Chapter 4) and for ensuring a succession of trees, it is helpful to gain some idea of the ages of the trees (see 2.3.1) but it is more important to record the condition of each tree.

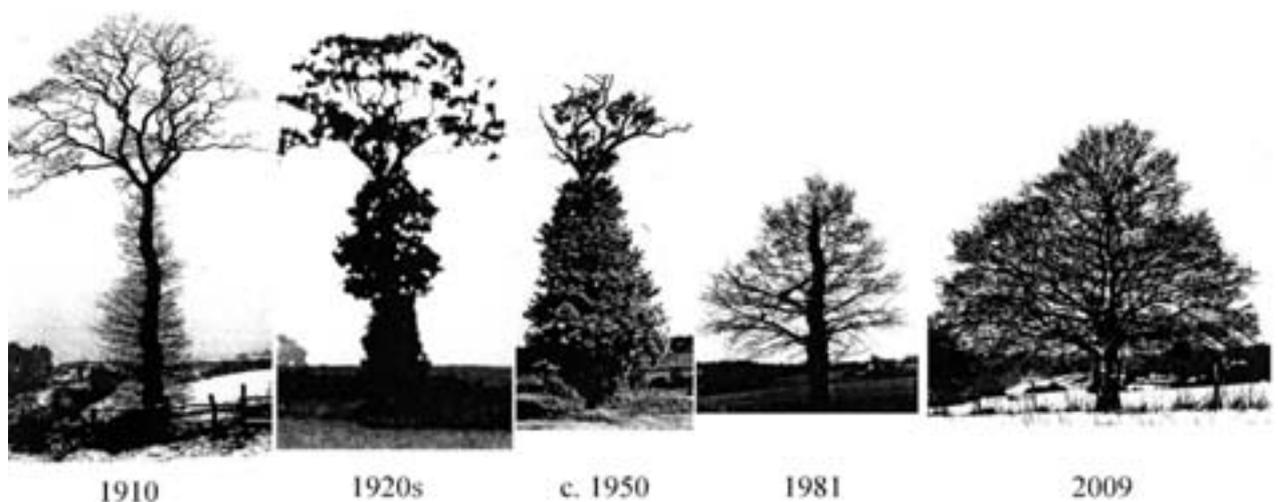


Fig 2.5: The “Arthur Clough Oak”, shown in a sequence of photographs over a century, demonstrates survival strategies and the potential for crown retrenchment. The first image shows growth of new lower branches after traditional management by shredding. Later, as the top of the crown died back, the lower branches formed a secondary lower crown

At Level 2, and more particularly at Level 3, the SSM can be used for storing and analysing information about the stock of veteran trees. It can also be used to record and monitor the condition of individual veteran trees. Such measures have been established at several sites, where internationally important populations of veteran trees are being managed. These include Hatfield Forest, Essex, Richmond Park, Greater London and Burnham Beeches, Buckinghamshire (Fay, Forbes & Rose, 2005; Read *et al.*, 2010).

For certain trees and for research projects, it might be necessary to record information in more detail than can be covered by SSM Level 3. In this way, for example, the frequency of formation of new shoots after the pruning of branches to stubs can be measured against variables such as stub length and diameter (Read *et al.*, 2010).

The survey should, in particular, provide information about the range and quality of habitats present in the area concerned. The survey should be devised with the particular aim of identifying any actions that might be needed to help ensure continuity of habitat for species that would probably lack the mobility to re-colonise the site following a temporary loss of habitat. A number of methods for recording categories or abundance of fallen timber (often called coarse woody debris, especially when lying in watercourses) have been described (e.g. Hubble & Hurst, 2008) and may be used if they are considered to provide enough details about the size and quality of the fallen items. There remains a need to devise a satisfactory method for surveying habitats in the heart-rot and cavities of standing trees, which include a very wide range of types and successional stages. A method of classifying hollow tree habitats has, however, been devised in Sweden by Liman *et al.* (2006). Also, a method for evaluating hollow trees for habitat has been devised in Tasmania (Koch, 2009).

For purposes of management, it is necessary to use a survey system with the capacity for recording changes in the condition of trees over time, together with details of any work that has been carried out (e.g. haloing or pruning). A number of such systems have been devised for use at particular properties but not yet for wider application.

The girth/age relationship holds good only while the stem remains within its optimum growth phase. During this phase, successive annual increments gradually decrease in average width because the same area of new wood is spread ever more thinly around an expanding girth. Relatively wide increments can continue to form in longitudinal strips of the trunk where there are well-developed conductive channels in line with particular branches or roots. Little growth occurs in the intervening strips, which sometimes eventually die. This pattern of growth can become especially pronounced in certain ring-porous trees, such as oak, ash and Sweet chestnut, in which annual rings less than 0.5 mm wide cannot accommodate a fully functional complement of vessels. Certain ancient yew trees have remained in good health during periods when their average annual increment was evidently less than 0.5 mm, perhaps because the conductive cells in their sapwood are tracheids, which are far narrower than the vessels of broadleaved species.

BACKGROUND

2.3.1 Estimating the age of a tree

The ages of individual trees at the site concerned should, as far as practicable, be estimated so as to show the number of ancient trees of each species and also the numbers of trees in a series of younger age groups.

2.3.1.1 Method for estimating age

In theory, the age of a tree could be accurately determined by counting the annual rings in the main stem, as viewed in a core extracted with an increment borer. This method is not, however, usually appropriate for potentially fragile old trees, since boring or drilling can have the undesirable effect of encouraging pre-existing decay columns to spread into previously sound wood. Also, the inner annual rings of veteran trees are in many cases missing because of decay and therefore cannot be counted. Any internal probing into a tree requires the agreement of the owner and, in the case of a tree covered by a Tree Preservation Order, of the local authority as well.

Although the counting or measurement of annual rings cannot generally be used for the accurate determination of age in veteran trees, it can be helpful in the following circumstances.

- Ring widths can be helpful when using trunk girth as a means of estimating age, which can be accomplished only if the growth rate is approximately known for the species and site concerned. This information is sometimes available from material such as nearby cut stumps, branch stubs or split stems. The more detective work of this type that can be done using such material in the field, the better*. This could include the use of historical or archaeological information of relevance to tree age.
- A complete ring count is often feasible in a branch that is being considered for shortening in the course of retrenchment pruning or other tree work (see Chapter 4). Measurement of the age of the branch at a given point along its length helps to predict the consequences of cutting it, with regard both to the potential growth of new shoots and the relative proportions of sapwood and older, physiologically dysfunctional wood.
- A ring count in a branch might help in the age measurement of the tree, but only if it is clear that the branch is one of the primary branches that formed before the tree reached maturity.

Since ring counts are not generally feasible or appropriate for living veteran trees, a method for age estimation in standing trees has been devised by White (1994; 1998). This is based on the species of the tree, its girth at breast height and the growing conditions (which affect the rate at which the girth increases).

The details underlying the estimation of a tree's age from its girth are set out by White (1998). The method is based on comparisons with trees of known planting date, together with detailed knowledge of how a tree grows and how to classify a site according to the growing conditions. The underlying principle is that a young tree gradually attains its maximum potential leaf area (e.g. at about 80 years in oak on a good site) and then lays down a more or less uniform cross-sectional area of new wood annually (subject to fluctuations caused by weather or defoliating caterpillars etc.) Meanwhile, there is relatively little increase in crown size, since shoot growth slows down and is partly counteracted by downward bending and localised dieback of twigs.

As mentioned in Chapter 1, caution is necessary in order to avoid overestimating the age of a tree whose girth measurement might be greater than would be expected from growth curves. Section 1.2.4 describes some of the reasons why this difficulty can arise. Equal caution is needed in order to avoid underestimating the age of a tree that has

Many trees appear to decline long before their girth becomes so great that the annual increments become unsustainably narrow. At an earlier stage of growth, they lose a large proportion of their crown volume by the death or shedding of branches. (Also, trees that have been managed as pollards for much of their lives tend to grow in girth rather slowly.) In principle, however, a modest loss of crown volume (as in retrenchment) need not necessarily cause a significant reduction in the increment in the cross-sectional area of the stem. There will be a reduction in the total production of wood volume, but this could be offset because less new wood is needed for branch growth.

Eventually, the conductive and energy-storing capacity of the increasingly narrow layer of sapwood becomes insufficient to sustain the full-sized crown that developed during the mature phase of the tree's life. A decline phase then ensues, when the increase in girth slows down markedly (Fig. 2.5) and the crown becomes smaller, as a result of the local dieback or shedding of branches (retrenchment: see Chapter 1). The longer that the tree has been in decline, the less accurate will be the use of girth measurements as a basis for estimating age. White (1998) states that, in most species, annual increments can be assumed to be in the region of 0.5 mm after crown decline. If representative increment cores were available, the onset of the decline period could be approximately dated, but in practice there is usually little that can be done to improve accuracy, other than perhaps to make use of comparative data from the stumps of nearby trees that have died.

* **Note:** It might be possible to measure the widths of some of the more recent annual rings of a standing veteran tree, but the growth around the circumference is likely to be so uneven that measurements at one or two compass points only are unlikely to represent the growth of the tree as a whole.

grown slowly in girth because its crown has, for many years, been smaller than expected for a mature tree growing at the site concerned. This difficulty occurs particularly with pollards.

Reference should be made to White (1998) in order to calculate an estimated age, based on the ring width pattern shown in Fig. 2.6. For this purpose, the only equipment required is a pocket calculator, a long enough tape measure, a notebook and possibly a camera.

Alternatively, age can simply be read from the girth age curves that are shown in Fig. 2.8 for several species. These have been provided by John White for the present publication and include new data. They can be used, subject to the following conditions:

- The girth of the tree can be measured with reasonable accuracy (this might, for example, not be possible if part of the main stem has torn away)
- The growing conditions are known, so that the appropriate curve (e.g. good site or woodland) can be selected
- The growth of the tree has not been in decline (e.g. owing to retrenchment or tree work); otherwise its age will be underestimated on the basis of girth alone: see above.

In any event, the following information should be recorded, in addition to the girth:

- the location (if possible, showing the National Grid reference)
- the date
- the species or species group of the tree
- the condition of the tree
- the relationship of the tree with any other trees and a detailed site description.

The girth should be measured with a long tape measure placed around the circumference at breast height (this is 1.5 m for the Ancient Tree Hunt) or the most regular girth point nearest to

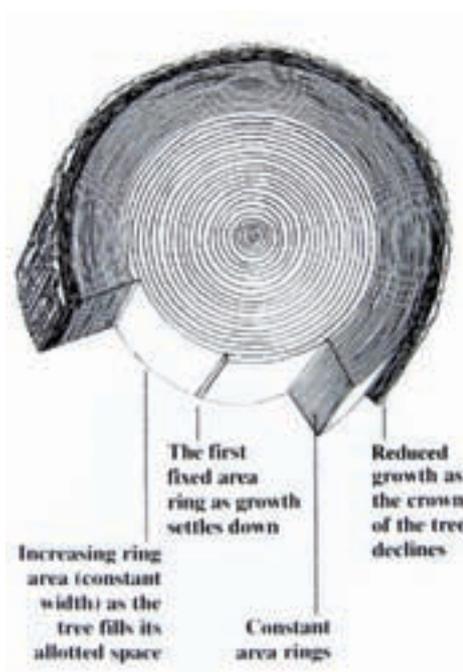


Fig. 2.6: Diagram showing the age-related phases of annual increment growth, which provide a basis for estimating a tree's age from its girth: adapted from White (1998)



Fig. 2.7: Girth measurement of an ancient pollard, showing placement of the tape at the "waist", in between the basal flare and the flare of the pollard branches

that level (Fig. 2.7). In order to estimate the age from this measurement, using the available datasets, it is necessary to place the tree or its growing conditions into one (or two) of the following six broad categories:

- Woodland
- Open grown pollard
- Good site
- Poor ground
- Average site
- Champion

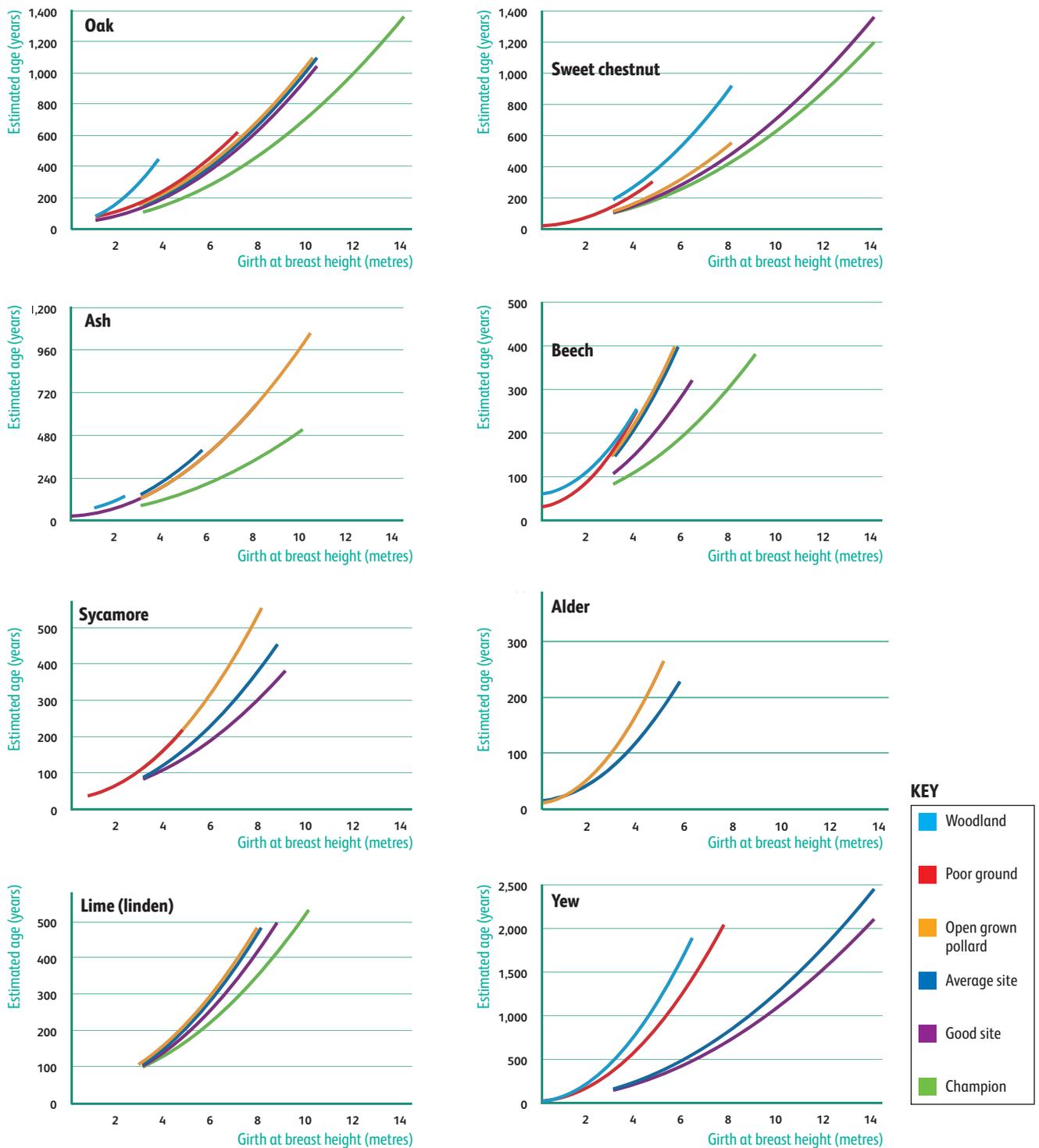


Fig. 2.8: Girth/age curves for several tree species that occur as veterans in the UK (including data obtained and processed for the Ancient Tree Hunt). Oak refers only to *Quercus robur* or *Q. petraea*

2.4 CLASSIFICATION OF TREES USING STANDARD EVALUATION METHODS

Standard evaluation methods (of which several are summarised below) are widely used in order to inform decisions about management or in statutory planning systems. Veteran trees should be evaluated only by methods that take adequate account of the main components of their value. The following list, which is not necessarily exhaustive, includes the components of value that have been widely attributed to veteran trees. Components of value that are based largely on long-term continuity are usually best represented by trees that are ancient in years, rather than by younger veterans.

- **Landscape:** this overlaps to some extent with other values, especially aesthetic, but it can to some extent be objectively assessed, in the light of expert knowledge.
- **Heritage:** this overlaps with cultural, but carries more of a sense of a connection with the past, whether this be a genetic or ecological link back to the wildwood or a link to our human predecessors who lived beside the same tree centuries ago. Generally, the older the tree and the more evidence of past human life which it portrays, the greater its heritage value.
- **Cultural:** this overlaps with most of the other kinds of value, but is more of a societal value than the values of amenity and aesthetic and has more present day connotations than the value of heritage. It can to some extent be measured according to any special significance that a tree might have for a local community.
- **Biodiversity:** this value exists beyond merely human values and is therefore of outstanding importance, as it embraces the intrinsic value of the myriad life forms that share the planet with us. It is, however, partly a human value because of our appreciation of the beauty and fascination of those life forms, not to mention their potential economic value in medicine and other forms of technology. This value is perhaps the most amenable to objective assessment, by applying criteria such as species richness or rarity.
- **Ecosystem services:** related to biodiversity, these are the innumerable ecological roles that different species perform in sustaining the ecosystem, including the pollination of plants and the cycling of elements like carbon and nitrogen. The description “services” helps to emphasise the dependence of human beings on the activities of a vast range of other species; not just the relative few that are directly exploited for food or other purposes.
- **Amenity:** this value overlaps with the aesthetic value, but extends more widely across the realm of human enjoyment and recreation within the treescape.
- **Aesthetic:** in the context of veteran trees, this value is primarily one of visual enjoyment and therefore exists to some extent in the eye of the beholder. The sheer size and the texture of many veteran trees is, however, widely admired and is becoming increasingly so. The aesthetic value also extends to enjoyment of the wildlife associated with veteran trees.

2.4.1 Sources of guidance on tree evaluation

The commentary in the above list of values provides some indication of the principles that can be applied, but it is clear that a large element of subjectivity exists. Further guidance should be sought from sources that represent the received wisdom of various professional or societal groupings. These include the following:

National Trust for England, Wales and Northern Ireland
National Trust for Scotland
Natural England
Scottish Natural Heritage
Natural Resources Wales
Forestry Commission

County and regional wildlife trusts
 Institute of Landscape Architects
 Tree Register of the British Isles
 Institute of Chartered Foresters
 Royal Institute of Chartered Surveyors
 Royal Forestry Society

2.4.2 Established methods for tree evaluation

A number of established methods can be used to evaluate individual trees for the various benefits that they provide. Some of these methods allow a pecuniary value to be estimated. Each method has its pros and cons, but they all have the advantage that they enable objectivity to be exercised within certain limits and therefore provide a basis for establishing priorities for management. Current methods that are used in the UK include the following:

- **The Helliwell method**

This is a well-established method, devised by Rodney Helliwell. It has recently been revised but it remains based only on the visual amenity value of trees and therefore explicitly excludes heritage and biodiversity values. An ancient tree with a small canopy will be calculated as having a lower value than a mature tree. Dead trees are also undervalued through this method.



Fig. 2.9: The ancient oak on the left has the potential to survive for many years, providing essential continuity of habitat. This tree might score poorly according to the Helliwell method, owing to the small size of its residual crown and its arguably poor form. It might, however, score quite well for its position in the rural landscape. The semi-mature sycamore on the right, with far less habitat value, would probably score more highly on account of its larger crown, a conceivably greater “life expectancy” and its position where its amenity value can be enjoyed by many

- **The FDB system**

This method, devised by de Berker & Fay (2004), is concerned specifically with calculating lost biodiversity value from environmental impacts upon ancient and veteran trees. It is based on the structure of the Helliwell method but it includes scores of biodiversity value in place of amenity-based scores.

- **Capital Asset Value for Amenity Trees (CAVAT)**

Under this method, devised by Neilan (2010), a pecuniary value is calculated either for individual trees or for a tree population, on a cost/benefit basis. The calculated value increases with the trunk diameter and also with the number of people who are likely to be able to benefit from the tree(s), as determined by the density of the local human population. The value of the tree(s) can be adjusted upwards or downwards, mainly according to functional value or functional status, which equates to a visual valuation according to arboricultural criteria. Additional factors may also be applied in order to modify the calculated value but only in special circumstances. They include appropriateness to the location, nature conservation (e.g. in relation to species listed under the UK Biodiversity Action Plan) and special cultural, commemorative or historical status. Importantly, a special weighting can be applied in respect of ancient or veteran status.

Under CAVAT, a veteran tree might be downgraded for arboricultural reasons if it had a small crown relative to its trunk diameter, but its rating could be enhanced by applying positive scores for its special kinds of value and for its veteran status.

CAVAT could also downgrade a veteran according to its estimated safe life expectancy. If this is less than 80 years (i.e. a notional human lifespan), the value of the tree is discounted according to a sliding scale. On this basis, a dead tree, or one that cannot be safely retained, is assigned a value of zero. A dead veteran with continuing value (e.g. for biodiversity) could thus be inappropriately rated. Otherwise, the CAVAT system is probably more suited for use with veteran trees than the other numerical methods currently in widespread use within the UK.

- **The Council of Tree and Landscape Appraisers (CTLA) method**

The CTLA method, widely used in the USA and sometimes in the UK, is similar to CAVAT in many respects but its main purpose is to provide a tree owner with an evaluation that can be used in relation to a property price or an insurance claim etc. It is similarly based on trunk diameter (in relation to the value of a newly-planted tree of the species concerned), together with the tree's visual value, local suitability and condition (including an estimation of life expectancy). The method does not, however, take account of the number of people who are likely to benefit from the presence of the tree. There is no provision for assigning value according to biodiversity, veteran status or for historical or cultural reasons etc.

Under the CTLA method, the formula for calculating tree value takes account of the cost of replacing a tree that has been, or might be, lost. It does not, however, take account of the time that would be taken to replace an ancient tree, which has acquired various types of value over a number of centuries. The following method has been designed to overcome this limitation.

- **British Standard BS 5837:2012**

(Trees in relation to design, demolition and construction – Recommendations)

BS 5837:2012 includes a relatively simple tree evaluation system, whereby each tree or group of trees is ranked according to four categories (A, B, C or U), where category U denotes

“unsuitable for retention” according to normal arboricultural criteria. There is, however, provision to upgrade Category U trees if they have identifiable value for conservation, heritage or landscape. This method is designed to be applied irrespective of any construction proposals that might already exist and it is sometimes used in the wider context of managing tree populations on sites not designated for potential construction.

Three groups of criteria are applied in assigning each tree (or group) to one of the categories A to C. These are as follows: (1) mainly arboricultural values, (2) mainly landscape values and (3) mainly cultural values, including conservation.

According to BS 5837 guidance, veteran trees or trees in wood pasture can be assigned to the A category (as A3) if they have significant value for conservation or for historical, commemorative or other reasons. They could also be assigned to the A category (as A2) for their landscape value. Thus, veteran trees can be highly rated even if they do not qualify for A category (A1) in respect of their arboricultural qualities. The A1, A2 and A3 categories are of equal status.

Unlike the methods mentioned above, the BS 5837 system does not enable assessors to assign numerical scores (as opposed to simple categories) to trees, but it specifically allows the inclusion of values associated with veteran trees. One major drawback, however, is that dead trees are assigned to Category U (unsuitable for retention), even though some aspects of their value can remain long after death.



Fig. 2.10: Veteran tree on a construction site. Judging by its former crown size (prior to the evident pruning), its root system extended well into areas that have been affected by soil trenching and compaction

- **The i-tree system**

This system was developed by the Forest Service of the United States Department of Agriculture (i-tree, 2011), especially with urban tree populations in mind but with a versatile range of criteria that can be adapted in order to evaluate most aspects of the value of trees, including individuals, in any situation. A particular component, known as i-tree Eco, which was primarily intended to assess the replacement value of trees and the benefits such as the moderation of climate and improvement of air quality, shows promise for the evaluation of veteran trees. At the time of writing there remains a need to configure and test the system in the UK for this purpose but it has been tested as a means of evaluating tree populations for their attributes such as structural value and carbon sequestration (Rogers *et al.*, 2011).

- **The TEMPO method**

This method, devised by Forbes-Laird (2009), is intended to assist the decision whether a tree has the necessary attributes to merit statutory protection by a Tree Preservation Order under UK law. It is based on an amenity assessment, which combines visual qualities with public visibility and an estimated retention span. It is therefore geared mainly to conventional arboricultural values but it includes provision to take account of other factors, including veteran values, provided that the tree(s) concerned have scored highly enough according to the main criteria.

2.5 ASSESSMENT OF POPULATION DYNAMICS

Survey data can be analysed as an aid to forecasting the future rate of attrition and recruitment of trees in different categories of age and condition at a given site. The use of this kind of information in developing a management plan is outlined in Chapter 7.

2.5.1 Principles of population dynamics

For practical purposes, the population can be regarded as comprising all the trees at the site. The biological concept of a population is, however, somewhat different, being a group of organisms (usually understood to be of the same species) occupying a particular space at a particular time. Such a population could, of course, extend beyond the boundaries of a site defined by human ownership or management.

The potential for survival of various categories of tree (cohorts) within the population can be illustrated by life tables. A life table summarises the fate of one cohort over time. To develop a life table, we need to know recruitment numbers (numbers of trees established from natural regeneration or planting) and mortality rates (number of trees that die or are removed). Trees that have died or that have been removed are, however, rarely recorded and often leave no trace of their existence, since their stumps eventually decay or are removed. There might therefore be little evidence available to enable life tables to be developed for a particular site. It might, however, still be possible to use available information about the age structure so as to help estimate the rates of recruitment and attrition and thus to identify the requirements for protecting trees and for establishing new ones in order to maintain the tree cover at a desired density on the site concerned and beyond.

2.5.2 Analysis of age structures

Age structures (or distributions) are the product of past recruitment and mortality and help to indicate future population trends (see Chapter 7). Since, however, they do not reveal information about trees that no longer exist, they cannot show whether the former tree cover was greater or less than at present.

The need for further knowledge or technical development

The general methods currently available for the survey of tree populations are probably sufficient in order to improve knowledge about the size and condition of the resource of veteran trees. The application of the Specialist Survey Method (SSM) has been reviewed (Fay & de Berker, 2003) but further field testing is needed in order to determine how well it is working in practice. Continued field testing could help to indicate whether resources would be best devoted to operating the SSM at Level 1, 2 and/or 3. There is also a need for further research in order to develop methods for evaluating data, as distinct from the gathering and recording of data, as in the SSM.

Despite the need for more empirical assessment of survival potential and of management techniques, there are other sources of information that have contributed to the guidance presented in this book. These include historical records of traditional practices, such as pollarding. Also, there is some understanding of the processes by which trees maintain a functional envelope of sapwood and bark. Such knowledge has been very useful but there is a need to develop it further through research.

With regard to the trees that, by virtue of their girth, qualify as ancient and/or veteran, a simple age structure analysis might not, on its own, be of much use in identifying differences of survival potential. A more detailed analysis could, however, categorise the trees according to their condition, as well as their age or size. For example, by recording the incidence of branch failure in lapsed pollards over a number of years, a manager could become better able to predict the future rate of failure and to identify those trees most likely to require remedial management or replacement within a given number of years (see Chapter 7 for management options).

2.5.3 Assessment of age structure in relation to contributions made by trees

A simple evaluation of age structure is helpful when developing a strategy of ensuring continuity in the succession of ancient trees and in the various elements of the contribution that they make to habitat and landscape. Additionally, if possible, the trees should be assessed for their contribution towards specific elements of value, with a view to identifying any need to adopt a more detailed strategy to sustain these elements. For this purpose, it is necessary to identify particular trees or groups of trees that are principally contributing to each defined element. The effect of losing any of these individuals or groups should then be assessed, in the same way that is commonly done in a risk analysis for a project or an organisation; i.e. to identify and estimate risks and to identify and implement measures for risk mitigation.

Examples of elements that should, where appropriate, be thus defined and risk assessed include the following:

- **habitat** – the different components of habitat, as defined in Chapter 5, should be identified at the site concerned, in order to ascertain whether their continuity is dependent on a potentially unsustainable cohort of trees (or of stumps and fallen deadwood); if so, it might be worth carrying out veteranisation of other trees (see Chapter 4) in order to help ensure the continuity of saproxylic habitats.
- **landscape and other aspects of visual amenity** – as far as possible, allowing for subjectivity, the viability of particular trees or groups that are of particular importance for their visual effect (e.g. as part of a designed landscape – see Chapter 6) should be assessed.
- **historical or cultural associations of particular trees** – although such associations are partly lost with the death of trees, a strategy of risk analysis could help to perpetuate them in some respects; for example by laying down a plan to protect and retain a tree after death and by the taking of cuttings or seeds to be used later as a symbolic replacement.

In most instances, an analysis of the requirements for sustaining specific elements of value will reveal a need for long-term planning of management of sites and of individual trees (see Chapter 7, which provides guidance on the analysis of population structure as an aid to developing a management plan).

2.5.4 Estimation of mortality rate as an aid to assessment of management requirements

The rate of future mortality can be estimated from the actual mortality that has occurred over a given number of years and applying the following formula [V. Bengtsson, pers. comm.; see also Gibbons *et al.*, (2008)]:

$$x(t) = a \times b^{t/r}$$

where:

- a** = number of live trees at the starting point
- b** = mortality rate, which is the unknown*
- r** = the unit of time over which the mortality rate is to be estimated: usually, mortality is measured annually, so that r will be equal to 1*
- t** = number of units of time elapsed
- x(t)** = number of live trees present after the above number of time-units elapsed

A worked example, showing calculation of the mortality factor is included in Appendix B.

* The same basic formula is also used to estimate growth rate, which then takes the value "b". If so, "r" will be the unit of time over which the growth rate "b" is estimated.



CHAPTER 3

Protection of trees: sites and surroundings

The use of land where veteran trees occur is wide-ranging and is often based on management objectives that have little to do with the need to safeguard the trees and their younger successors. There is therefore often a need to modify conventional management and to promote appropriate awareness and knowledge among managers and site workers, including, for example, operators of agricultural and other machinery such as hedge-trimming equipment. Protection of trees from fire, intensive recreational use or other harmful activities is also advisable in certain situations.

The present chapter provides general guidance on the protection of veteran trees (and their potential successors) and of their growing conditions. It also provides specific guidance in relation to grazing land, arable land, woodland, construction sites and land used for recreation.

Prevention or alleviation of soil compaction (e.g. by machinery or livestock) is a key objective of these guidelines. Compaction can be extremely harmful to trees because it makes the soil too dense for healthy root growth and squeezes out the air spaces in the soil, thus depriving the existing roots of the gas exchange that they need in order to function and survive.

Compaction and trampling are also harmful to other vegetation, including the foodplants of some of the invertebrates that depend on veteran trees.

BACKGROUND

3.1 GENERAL GUIDANCE

Wherever veteran trees occur, the following guidance should be observed as far as possible.

- Ensure that all necessary consents are obtained for work to be carried out in any area that is designated for its nature conservation or archaeological interest (e.g. a Site of Special Scientific Interest or a Scheduled Monument).
- Avoid or mitigate any potentially adverse practices (e.g. involving soil compaction or chemical applications), at least within protective areas around individual trees or groups. The Root Protection Area (RPA) should ideally extend in all directions from the tree stem to a distance equal to 15 times its diameter, or five metres beyond the canopy, whichever is the greater (Read, 2000).
- For groups or rows of trees, e.g. in avenues or hedgerows (see 3.4.4), a collective RPA consisting of a buffer strip should, if feasible, be established. In a hedgerow, the aim should be to provide good soil conditions both for the older trees and their younger successors, while also perhaps enhancing habitats for wildlife, including birds, small mammals and invertebrates (RSPB, 2006).
- If a veteran tree is in good health and if the conditions do not appear to have changed significantly, leave well alone; i.e. keep to the existing management regime.
- If the soil conditions have significantly deteriorated, try to ameliorate them, whether or not the tree is in good health. Options may include mulching or aeration (see below for guidance on both these options).
- If the tree is in poor health, try to determine whether this can be attributed to adverse growing conditions. If so, assess whether it is feasible to ameliorate the conditions.

- Protect veteran trees from the effects of any intended change in agricultural, silvicultural or horticultural land use. For example, if grazing land is to be converted to arable use, a different set of guidelines for protecting trees should be followed (see Section 3.3). Be aware that veteran trees can be harmed even where the change of land use (e.g. from grazing to horticulture) involves disturbance that might not appear very radical at first sight.
- Do not, on any account, create any permanent vehicular access route, gateway, ditch or underground utility route within the RPA of a veteran tree. If an access route or gateway already lies within the RPA, it should, if feasible, be removed or re-designed, according to advice from a suitably qualified arboriculturist.
- Protect young and mature trees where they are the potential successors of the current generations of ancient and other veteran trees.
- Take advantage of available grant aid for tree protection, where compatible with management objectives. For farmland trees, some of the protective measures described in this chapter, such as the care and planting of trees or management of grazing, could qualify for grants under agri-environment schemes (e.g. Higher Level Stewardship in England). Information about such schemes is available from the relevant national agencies.

Root Protection Areas (RPAs) for veteran trees: comparison with other guidance

Guidance for establishing and enforcing RPAs for trees on construction sites, as opposed to agricultural land, is given in British Standard 5837:2012). This represents a compromise, as construction would generally not be practicable if the entire rooting area of every tree were to be protected. Some degree of compromise is often unavoidable also in areas where veteran trees co-exist with economic use of land, such as commercial farming. There is, however, often scope for providing a larger RPA than would normally be provided under BS 5837. A radius of 15 times the stem diameter at breast height, or five metres beyond the edge of the tree's canopy, whichever is the greater, is recommended in the present book (in relation to ploughing and grazing). On the other hand, it can sometimes be sufficient for the RPA to be a zone of very low-intensity use, rather than one of total exclusion of farming or other activities.



Fig. 3.1: The person on the far left (arrowed) is within the root spread (revealed by ploughing) of the oak on the right. For most open-grown trees, the canopy footprint (i.e. within the drip line) is a small proportion of the root area



Fig. 3.2: Longhorn cattle, in use for conservation grazing

3.2 MANAGEMENT OF GRAZING AND OF PASTURES AROUND VETERAN TREES

For the conservation management of wood pasture, grazing should, if possible, be used to maintain or restore the long-established conditions that have favoured the development of open-grown veteran trees in a matrix of flower-rich herbaceous and shrub vegetation. If, however, veteran trees must coexist with more intensive grazing, they should be given as much protection from its potentially adverse effects (see 3.1) as practicable.

3.2.1 Grazing in wood pasture

Grazing with suitable animals, at a suitable time of year and at suitable density, should be regarded as the ideal management for a wood pasture with veteran trees in the long term. It could, however, be difficult to establish a suitable grazing regime if one is not yet operating and so account should be taken of relevant considerations (as set out below) and to develop the regime according to the progress achieved and to changing conditions.

3.2.1.1 Choice of animal species and breeds

The choice of species and breed should be geared to the site, the land use, the soil and climate. The Grazing Animals Project has produced a guide to assist in the selection of breeds of livestock for the particular conditions concerned (GAP, 2001*). There is no single correct species or breed for a site, since breeds will perform differently under different husbandry conditions. Generally, local or traditional breeds are more

Traditional and locally adapted breeds of cattle generally thrive in unimproved grassland and are therefore not very inclined to congregate in choice localities. Being also relatively light in weight, they do not cause excessive compaction of the soil if deployed judiciously.

Sheep graze near ground level and thus tend to degrade the habitat value of the sward for invertebrates (including saproxylic species) that require a sward with a varied vertical structure and rich in sources of pollen and nectar. They also tend to scuff the bark or cause compaction and nutrient enrichment (from dung and urine) very close to the trees.

Horses, but usually not ponies, tend to leave certain plants such as thistles to multiply. Both often strip bark from unprotected trees, sometimes causing severe damage.

* See also the section on amenity sites, in relation to woodland recreational facilities.

suited to conservation grazing, since they are relatively small and can cope with poorer grazing conditions. In order to maintain diversity in the height of the sward – and hence of grassland habitats – cattle should be chosen in preference to sheep. The latter may, however, be chosen if the stocking density can be kept low enough to prevent the sward from becoming uniformly short.

3.2.1.2 Timing of grazing

Timing is important because grazing can lead to soil compaction in wet conditions or to gnawing of bark if palatable food is scarce. All-year-round grazing may be chosen as an option, depending on soil type, weather and a low stocking density. At many sites, however, livestock ought to be removed at certain times, especially in order to ensure the following requirements:

- **Avoid compaction**, which can occur when the soil is wet. The decision should take account of the soil type and the current ground conditions.
- **Prevent bark stripping**, which tends to happen when the current natural feeding capacity of the site is exceeded. (Also, see supplementary feeding in 3.2.4.)

3.2.2 Stocking density

Ideally, the grazing should be extensive; i.e. over large areas with relatively low stocking density. Aim to adopt a stocking rate that is commensurate with the productivity of the land. This will help to reduce compaction, nutrient enrichment and damage to individual trees, but bear in mind that a desirable reduction [e.g. to less than one cow per hectare (NT, 2004)] would almost certainly yield less income in comparison with intensive agriculture.

If the site is much undergrazed, the stocking density should be increased modestly on a trial basis. Such a situation can be recognised if the site is being heavily colonised by bracken (a fire risk for trees – see page 57), or excessively by scrub and saplings (a source of competition with veteran trees).

3.2.3 Physical protection of trees

If the stocking density cannot be reduced enough to eliminate the adverse influence of grazing on tree health, then prevent or deter the animals from congregating beneath the canopies of veteran trees, which they tend to do in rainy or hot, sunny weather. Choose options from the following, in order of preference:

- Exclude or discourage livestock by establishing RPAs, surrounded by physical barriers (see below for types of barrier) but ensure that alternative forms of shelter are provided in the interests of animal welfare and of reducing pressure on the trees as congregation points. Consider the following options, which could be used in various combinations according to priorities and resources:
 - **Fencing**: this is the most obvious choice but is costly, potentially intrusive and creates a need to manage the enclosed area in order to stop regenerating scrub from establishing and competing with the veteran tree(s).
 - **Heaped branches of thorny scrub**: branches of thorny scrub can be heaped to form a barrier at or beyond the edge of the RPA of a tree or group of trees. This has been effective on some sites, deterring access by the animals for a relatively short period; i.e. until the material breaks down. Meanwhile, the root systems might have a chance to recover, especially if some form of soil amelioration has been applied (e.g. see 3.7.1 Mulching). As the material breaks down, it acts as a soil conditioner, favouring the growth of roots and mycorrhizal fungi, which might have been lacking under adverse conditions
 - **Living thorny scrub**: planting a barrier of thorny bushes could provide a longer-term and



Fig. 3.3: Hawthorn branches heaped in rings to deter congregation of livestock near veteran oak trees (Hatfield Forest, Essex)

more natural deterrent than strewn branches. The bushes might, however, shelter saplings of trees, which could thereby become established too close to the veterans.

- **If it is not feasible** to put a barrier around the entire RPA of one or more trees, protect their bark from being stripped or gnawed by installing barriers around their bases. The design of the barriers and their distance from the bark should be suitable for the kind of animals concerned.

3.2.4 Feeding and watering of livestock in relation to tree protection

Wherever possible, trees should be protected from damage that can occur when grazing animals congregate in search of palatable food, water or salt. The following measures should be adopted.

- Preferably remove the animals from the site by the time that they would otherwise become short of food (but see on the next page, regarding drinking troughs and salt licks).
- If animals that require supplementary feeding cannot be removed, place the feeders well away from the RPAs of trees in order to avoid damage from soil compaction, which can occur when animals congregate around the feeders (Read, 2000; NT, 2004). Compaction from the movements of feed-delivery vehicles or of animals following “desire lines” should also be avoided in the RPAs.
- When pruning takes place, lay out the cut twigs and branches so that the animals can use the

foliage and bark as a supplementary feed. This should help to meet their requirements for palatability, fibre and minerals and thus reduce their tendency to gnaw the bark of stems. (Ash foliage is said to be particularly palatable to cattle.)

- Water troughs or salt licks should be sited well beyond the RPA of any veteran tree. Also, if water is to be piped underground, excavation for pipe laying should be kept outside the RPAs of all trees.
- When choosing commercial supplements or animal health products, try to ensure that they meet the requirements of organic certification, even if organic farming is not the aim. Such products are formulated in order to minimise their potential harm to the environment and to help provide a high standard of health and welfare for the livestock.



Fig. 3.4: Severe damage on oak, caused by livestock



Fig. 3.5: Oak, damaged by ploughing very close to the stem base and also by branch removal

3.2.5 Other aspects of grazing management in relation to tree protection

3.2.5.1 Worming drugs

Owing to the persistence and toxicity of this group of drugs to invertebrates and other organisms, they should not, as a general rule, be used on sites with high nature conservation interest. In an ideal situation, they should be used only when necessary; not routinely. If drugs are administered, the animals should ideally be removed from the site and kept away until all traces of the active ingredients can be expected to have disappeared, according to the specific information for the drug concerned (Strong, 1993; Cooke, 1997; Read, 2000). This period is likely to be prolonged if an avermectin is used. For less persistent drugs, the period of return could be relatively short but should never be less than 24 hours. Avoid using any wormer formulated as a slow-release bolus.

3.2.5.2 Fertiliser use

Inputs of fertiliser should be minimised, so as to mitigate adverse changes in soil structure and nutrient status. This should also help to maintain floristic diversity, which is important for some of the rare invertebrates associated with ancient trees (see Chapter 5). If inputs are reduced, traditional breeds should preferably be chosen, since they tend to fare better than modern breeds on unimproved grassland.

The need for further knowledge: soil micro-organisms

Pesticides and veterinary drugs are toxic to a range of micro-organisms, which in some cases include those that are important for the maintenance of good root function in trees (e.g. mycorrhizal fungi, which might be affected not only by fungicides but also by drugs that have activity against certain bacteria that are involved in the establishment of the mycorrhizal association). The extent to which such organisms are harmed in practice is uncertain, and so research is required. According to the precautionary principle, however, it is desirable to eliminate or at least reduce the use of these chemicals in the vicinity of veteran trees. Also, there is no doubt that certain drugs, especially the avermectins, are very toxic to dung-inhabiting invertebrates, some of which are endangered species (see Chapter 5).

3.3 ARABLE LAND

Ideally, arable farming should not be carried out near or around veteran trees. If there is a need to continue producing arable crops, the following general precautions should be observed:

- RPAs should be established around trees or groups of trees, according to the distances stated in Section 3.1.
- Avoid ploughing or other disturbance within rooting areas, at the very least within the RPA of the tree or trees concerned. (Generally, rooting areas extend much further than RPAs.)
- Preferably develop a low-input organic zone near any veteran trees (i.e. at the very least within their RPAs and preferably within a radius of at least 2.5 times the crown radius or 30 times the stem diameter, whichever is the greater). The exclusion of an intensive system, based on agrochemicals and artificial fertilisers, from the protected zone will help to avoid adverse effects on the trees and their associated organisms.
- Restore or maintain favourable soil conditions for the trees, with particular regard to compaction, disturbance and any excessive application of fertilisers, lime and manure.
- Irrespective of the size of a tree's RPA, never remove any of its branches in order to allow access by farm machinery; this can be a very damaging operation, which combines above-ground injury with below-ground injury in the form of soil compaction well within the rooting area.
- Avoid herbicide damage to trees, whether via the soil, spray drift or volatilisation of chemicals. In particular, avoid spraying in field margins where there are trees in hedgerows (but be aware that the roots of such trees can still be damaged by chemicals, since they extend well beyond the boundary of the hedgerow).
- If space is available, create a partial barrier against chemical sprays and other airborne pollutants by establishing a screening belt of trees, subject to the need to avoid shading the bark or foliage of the veteran trees.
- If the roots of veteran trees are being exposed to contaminated water run-off (for example from an agricultural field) barriers or drainage channels may, if appropriate, be used to intercept the flow. Any such earthworks should, however, be constructed so as to avoid damage to the roots of the veteran trees.

3.4 MANAGEMENT OF WOODLANDS AND OTHER VEGETATION AROUND VETERAN TREES*

The main potential adverse effects associated with surrounding vegetation (including trees) or its management are as follows:

- general shading from trees (especially where previously open-grown veterans have become surrounded by plantations or naturally regenerated woodland)

* See also the section on amenity sites, in relation to woodland recreational facilities.



Fig. 3.6: Root protection using a raised walkway, for very high-value trees in a frequently visited area

- bark shading from ivy (affecting the survival of epicormic shoots and of lichens and other epiphytes)
- sail effect and or weight of ivy (potentially increasing the likelihood of mechanical failure)
- fire risk from bracken (see page 57)
- damage from forestry activities (e.g. soil compaction or injury of trees by machinery)
- failure to protect or retain future generations of veteran trees (e.g. when trimming hedgerows).

3.4.1 Management of other trees near veterans

3.4.1.1 Shade from other trees

Shade from other trees that is jeopardising the survival of the veterans or of associated vulnerable species should, in most cases, be removed by clearing a circle or partial circle around each veteran (haloing) but this process should be gradual. If shade is removed too rapidly, veteran trees can be killed by the abruptly increased exposure to direct sunlight and to wind. This results in unaccustomed moisture loss by transpiration. Also, previously shaded areas of bark and underlying sapwood can become overheated and, perhaps, thereby killed.

In order to avoid abrupt and harmful change, shade should be progressively reduced over a number of years by the phased removal of the shade-casting trees or by reducing their height and/or spread or by ring-barking to kill them slowly. The timing should be subject to periodic assessment of the condition of the veteran trees, while taking account of the following factors:



Fig. 3.7: Veteran oak pollard dying because of shade from beech trees planted around it

- the density and seasonal duration of the shade (e.g. most evergreens cast a deep shade, all year round)
- the shade tolerance of the veteran tree species concerned (see Chapter 4)
- the age and condition of the trees concerned (if their crowns are already predominantly shaded, they are especially likely to be very sensitive to sudden change)
- slope and geographical latitude, which affect the annual pattern of shadow length
- soil type, climate and recent/current weather (a substantially increased exposure to sunlight during a drought or within the next year could cause serious physiological stress in a veteran tree).

The rate at which shade is reduced should, in part, be controlled by the order in which particular shade-casting trees or large shrubs (e.g. rhododendron) are removed or otherwise managed. Generally, the trees on the most sun-exposed side of the veteran(s) (i.e. often the south in a northern-temperate country like the UK) should be retained in the early stages. Also, only the furthest of the shade-casting trees should be removed at the first stage if the veteran tree concerned is assessed as being unlikely to tolerate a relatively abrupt reduction of shade. When deciding whether felling should begin on the “outside”, the density and seasonality of the shade cast by the tree species concerned (e.g. evergreen versus deciduous) should be taken into particular account.

The decision as to which of the shade-casting trees are to be felled or crown-reduced should take account of exposure not only to sunlight but also to the force of the wind and to the possible windborne influx of agrochemicals, other pollutants or salt spray. The potential habitat value of these trees after pollarding or crown reduction should also be a factor in the decision, especially where there is a need to fill a potential gap in the habitat succession.

If, according to the above considerations, there remains a choice as to which trees should be felled, those of higher value for timber may be selected in order to generate funds for conservation management. “Damaged” trees are more likely to provide habitats for wildlife if retained (Read, 2000).

Unless there is any evidence to the contrary, preference should be given to the choice of late autumn or winter for the felling or crown reduction of shade-casting trees. This avoids the sudden exposure of foliage that has developed in shade and that is therefore especially susceptible to sunscorch. Also, the bark of the veteran tree(s) might thereby have a somewhat longer period of initial adaptation before the onset of very strong sunshine in spring and summer.

3.4.1.2 Cutting and extraction of timber or other produce near veteran trees

In forestry operations or in the extraction of timber produced during haloing, the following precautions should be observed in order to protect veteran trees, including their roots.

- When thinning or harvesting a forest crop, any sudden exposure of veteran trees to sunlight and wind should be avoided (see haloing in the previous section).
- The branches of a veteran tree should not be pruned in order to improve access to a work area unless this is essential for the management of the tree concerned.
- If heavy branches have to be cut within the RPA of a veteran tree, they should either be lowered gently using a rigging system or dropped on to effective cushioning materials in order to protect the ground and underlying roots from impact.
- No bonfire should be lit in or near the RPA of any veteran tree (see 3.8.1 for guidance on the burning of arisings).

In most parts of the UK, ancient trees are relatively infrequent in woodland, occurring mainly in small numbers on historic boundaries. It is therefore unlikely to be onerous to establish RPAs around such trees during forestry operations. In the few UK woodlands where ancient trees are more numerous, they form exceptionally important populations, warranting maximum protection.



Fig. 3.8: Timber extraction route near a veteran tree without ground protection, causing root damage, soil compaction and waterlogging

- Protection of veteran trees from soil compaction and from above-ground injury should include the careful planning and deployment of routes for forwarders, skidders or harvesters. Such routes should, if possible, lie outside the RPAs (see 3.1) of all veteran trees on the site. If, however, this is impossible, ground protection (e.g. using brush mats) may be used (Murgatroyd & Saunders, 2005).
- If, for the above reason, ground protection is used, an appropriate system of timber extraction should be chosen in order to minimise compaction and rutting of the ground still further. If brush mats are laid down, forwarders would need to be used instead of skidders, since the latter would displace the mats. Horses or machinery with low-impact tyres may be used in order to reduce damage in the most sensitive areas.
- Extraction near veteran trees should, if possible, not be carried out when the ground is wet, especially on a clay soil, since this can greatly increase the potential for rutting and compaction. In areas where snow tends to lie for prolonged periods, extraction could be done at those times, thus reducing pressure on the soil surface.
- Machinery and skidder routes should be kept well away from the bases of veteran trees, even if the routes cannot be kept entirely outside their RPAs. As an additional precaution, in case of unauthorised incursion, protection for the bases of any tree(s) considered to be at risk should be installed, using suitable materials (e.g. straw bales or piles of tyres).

3.4.2 Management of ivy

Any decision to control ivy (*Hedera helix*) should be decided in the light of an assessment of its benefits for various forms of wildlife against its possible adverse effects; i.e. mechanical loading of weak branches etc. or the shading-out of rare epiphytes or of epicormic shoots that are potentially important in crown retrenchment. For the method of control, the guidance in Chapter 5 should be followed.

3.4.3 Control of bracken

In order to protect veteran trees from bracken fires, any bracken that is dominant or becoming so among the trees should preferably be controlled. Account should, however, be taken of the difficulty and cost and of the long-term commitment that would be required. There might, however, be a potential market (i.e. a means of offsetting part of the cost) for cut bracken, which was traditionally used for animal bedding and is still used for this purpose in some countries.

When planning a control programme, account should be taken of the importance of bracken for some forms of wildlife [e.g. see SNH, (2008)]. It is, however, often so abundant and resistant to control that there is usually not much need to balance the pros and cons of controlling it.

The expectation should be that any control programme would need to run for at least five

The most prevalent fire risk for veteran trees in the UK comes from bracken. If not managed, it shades the ground as much as dense woodland and thus excludes most other herbaceous plants. When its fronds die at the end of the summer, they build up into a deep litter layer or thatch which breaks down very slowly. This deep thatch can be a severe fire hazard, as fire can travel through it extremely quickly. If a hollow tree is reached by fire, it acts like a chimney and burns easily, as it contains a ready fuel supply in the form of dead wood. The effects can be catastrophic for a veteran tree population, as seen at Ashted Common in Surrey (see 3.8.2 for guidance on fire protection for individual hollow trees).

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Fig. 3.9: Veteran oak trees at risk from bracken fire

years, and that total eradication will probably never be achieved except where steps are taken to replace the bracken entirely with other vegetation (SEARS, 2008). The length of time taken depends mainly on the number and dormancy of the underground rhizome buds.

The control of bracken should be concentrated where it is most needed, in order to maximise the benefit to the tree. In particular, the leading edges of bracken stands should be targeted, with the aim of inhibiting colonisation into bracken-free areas. Also, fire breaks should, in the first instance, be created within the bracken; these are a key feature of management, as they help to isolate blocks of trees from one another as far as fire is concerned.

In other areas, control may be scheduled for a later date or avoided, according to the following guidelines.

- Maintain bracken-free areas around the bases of the veteran trees.
- Take account of the considerable importance of bracken as a habitat for certain species such as bluebells, fritillary butterflies and other invertebrates, and as cover for various vertebrates. Thus, total eradication should not be the aim. Also, undertake a survey in order to identify particular areas that need to be protected from disturbance; for example, where nesting birds and their unfledged young or deer fawns are present; often at the time of year when some forms of bracken control are most effective.
- Where appropriate, ensure that workers undertaking management are suitably protected against inhalation of bracken spores, which are carcinogenic. The spores are released in late summer and early autumn but densities in the UK have not been high, except in occasional years.
- Make an informed choice from among the following appropriate methods of bracken control, all of which need to be followed by some form of long-term management:
 - **Herbicides:** for chemical control of bracken, a relatively specific herbicide should be chosen in order to minimise harm to non-target plant species. Asulam (sold as Asulox), was the only herbicide suitable for this purpose and it could reduce bracken cover by as much as 98 per cent, with minimal impact on non-target plant species. However, owing to insufficiency of data for re-registration, it was banned in the European Union on 31 December 2011 for sale, transfer and promotion. The use of existing stocks was to be permitted until the end of 2012 and during a limited period each year thereafter, subject to authorisations for emergency use. If treatment of bracken with Asulam is permitted, it should take place in early summer, when the majority of the fronds are beginning to expand rapidly (i.e. when the lowest two pinnae of the frond are fully unfurled but not fully expanded). Longer-term control would require follow-up spot treatment (by mechanical means only, while unauthorised use of Asulam is banned) and by subsequent land management (e.g. grazing). Otherwise, the bracken will return after several years (Forbes & Warnock, 1996; Robinson, 2006). Asulam should be kept away from non-target species of fern.
 - **Cutting:** this is very labour intensive and requires dead wood to be piled out of the way beforehand if machines are to be used, but see below regarding swiping by hand. After the first cut, which encourages new growth, a chemical application could be used as a follow-up in order to increase the effectiveness of the treatment (Lewis & Shepherd, 1996) if legally permitted. In any case, cutting should be repeated at least twice a year for several years and it should be combined with some other long-term management such as grazing in order to help prevent rapid re-establishment after cutting ceases.
 - **Rolling or bracken breaking** employs a specially-designed machine, which damages the fronds and encourages the sap to bleed. Depending on soil conditions and weather (hot weather in July is optimal), rolling can reduce both the number and vigour of the stems by up to 50 per cent after one year. Like cutting, however, it requires dead wood to be moved

aside and it could also harm other plant species, invertebrates and reptiles. Ideally, it should be repeated for at least three years and, as with other methods, followed up by some form of long-term management.

- **Hand swiping**, using a hazel wand or similar implement, involves snapping the developing bracken fronds while they are brittle and sappy. It is therefore similar in principle to machine rolling, but is less easily done when the fronds have reached a large size. It has the advantage that expensive and polluting machinery is not required and that piles of cut woody material can be worked around, rather than moved beforehand.
- **Livestock**: pigs and wild boar dig for and eat bracken rhizomes in the autumn and can thus help to control the plant. Ideally, pigs should not be used as the sole method of management, as they can develop dietary deficiencies and also damage the ground very significantly if used intensively. Other livestock, such as ponies and cattle, can be helpful because they damage young fronds by trampling and thus maintain suppression of bracken at low levels, once it has been reduced by one of the above methods. Trampling helps also to increase the breakdown rate of the dense bracken litter. Correct stocking levels are critical to prevent bracken invasion. Cattle, horses or ponies may be used also to manage bracken by mob stocking in May and June so as to reduce bracken cover by crushing the emerging fronds, but this can damage other vegetation and tree roots.

Note: rolling has another advantage in that it contributes towards breaking down some of the thatch. If, however, a very thick thatch is to be removed, this will require additional work, which can result in tree root damage if done carelessly.

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3.4.4 Hedgerow management

In hedgerows, care should be taken to protect saplings as potential successor trees by following the Tree Council's Hedge Tree Campaign advice; in particular, to make them more obvious and thus avoid damage when cutting (NE, 2008e). When tagging stems for retention, any originating from damaged or deformed attachments within the hedge should generally be avoided, since they are likely to be too unstable to live long enough to become ancient (Hodge, 1990). Aim to trim hedgerows on a two to three year cycle rather than annually. This allows the saplings more time to get established, while making them more visible and thus more easily protected from the machinery. It additionally allows the shrubs to bear fruit (MacLean, 2000). Conversely, new trees should not be allowed to grow where they would eventually shade a veteran tree that is already in the hedgerow.

Comparison with other guidance: tree work in hedgerows

The guidance in Chapter 4 regarding work on veteran trees in general applies equally to veteran trees in hedgerows. Thus, pruning should generally be kept to the minimum required in order to help prevent severe mechanical failure. Also a veteran tree should not be cut specifically in order to help to stimulate new growth to fill a gap in a hedge. Other guidance might, however, apply if a veteran tree is growing on a hedge bank that is a Scheduled Monument under UK law. In such cases, the relevant statutory agency (i.e. English Heritage or its appropriate national counterpart) should be consulted if the tree is thought to be placing the bank at risk of damage in the event of uprooting.

The guidance in Chapter 4 applies equally to a coppiced or pollarded veteran tree in a hedgerow. After a long lapse in the cycle of cutting, some form of crown reduction would carry less risk of unintentionally killing the tree than if it were cut back to the original pollard or coppice points. Severe cutting can be tolerated by trees of certain species in favourable conditions, but probably not to the extent of justifying certain other guidance that coppicing can be undertaken on any size of stem or that pollarding is a means of reviving "sick" trees (Smith, 2002).

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Fig. 3.10: Moving the target: diversion of a footpath from old trees with a tendency to shed branches

3.5 RECREATIONAL SITES AND OTHER AREAS OF HIGH PUBLIC USE

Of the many kinds of site where trees and people are often in close juxtaposition, the main categories are recreational areas and public highways. Others include the grounds of various educational, medical and other establishments.

Where veteran trees co-exist with large numbers of people, protection should be provided not only for the trees, which could be affected by damaging activities, but also for people and property that could be harmed in the event of tree failure. Protection for the trees should be not only against unintentional impairment of their growing conditions, as in all areas, but also against activities such as vandalism, that are more prevalent in or near urban areas. Also, trees should be spared from work that is neither helpful for their survival nor necessary for public safety (see 3.5.1 and Chapter 4).

3.5.1 Risks to people and property: principles and objectives of management

In order to assess risk posed by trees, the site concerned should be broadly classified according to its frequency of occupation by people or high-value property. If sites within the estate or other landholding have different intensities of use, they may be assigned to a number of zones, each with an appropriate rigour and frequency of tree inspection and management (Lonsdale, 2000; FC, 2011). The risk should be assessed using an objective method that takes account of the components of risk; i.e. the probability of tree failure and the likely consequences of failure. These consequences depend in turn on the magnitude of the potential impact and the probability of a person or property (“target”) being present in the impact area (Ellison, 2005). The latter probability

might be higher or lower than the average for the entire inspection zone concerned, and so it needs to be separately estimated in the small proportion of instances where the risk from an individual tree needs to be assessed in detail.

The following information and guidance should be taken into account when assessing risk either on a broad basis for a site or in more detail for an individual tree.

- Apply different levels of risk acceptability as appropriate (HSE, 1989; FC, 2011). Acceptability differs according to the activities and objectives of those who are at risk. A member of the public going about everyday activities, such as using the roads, should not be exposed to a risk greater than 1 in 10,000 of a fatal accident in the course of a year (Ellison, 2005). Much greater risks are, however, accepted by those indulging in certain occupations or sports. The key factor is that they have exercised choice in the matter. The corollary is that a level of risk somewhat greater than 1 in 10,000 can be accepted by people who choose to be near trees which they know might be more than ordinarily hazardous.
- Warning signs can be of value (Davis *et al.*, 2000), subject to the following considerations:
 - Children and others who are unable to read or to heed warning signs cannot be regarded as making an informed choice. The probability of vulnerable persons being present without effective assistance or supervision should therefore be taken into account when the use of warning signs is considered.
 - A warning sign is appropriate only if there is a reasonable alternative to taking the risk (e.g. walking outside the “target area” of a tree); otherwise there is no reasonable exercise of choice.

The National Tree Safety Group (FC, 2011) has established a position, which is underpinned by a set of five key principles, as follows:

- trees provide a wide variety of benefits to society
- trees are living organisms that naturally lose branches or fall
- the overall risk to human safety is extremely low
- tree owners have a legal duty of care
- tree owners should take a balanced and proportionate approach to tree safety management.

3.5.2 Management of existing or developing risks

When managing risk, the target should be moved unless tree work is the best solution for the tree as well as for the target. For example, a footpath should be diverted or a car parking bay relocated in preference to carrying out potentially harmful tree work.

If tree work is really necessary, the least harmful form of work should be chosen: preferably this should be no more than would be beneficial for the tree by way of helping to prevent it from dying as a result of major mechanical failure (see Chapter 4). Owing to the special value of veteran trees, there should be a presumption never to subject them unnecessarily to any tree work (e.g. for cosmetic purposes) that is neither necessary for public safety nor specifically designed to aid the survival of the trees.

3.5.2.1 Avoidance of new, unnecessary risks

When managing sites for whatever reason, avoid creating new or increased targets; as happens for example following the construction of facilities (e.g. car parks or buildings) which will bring people or property into a high-risk zone. Not only does this create targets, it also harms trees and therefore makes them more hazardous. Specific guidelines include the following.

- Public facilities should, if possible, be located to avoid concentrating people or high value property where they could be harmed in the event of the failure of trees (veteran or otherwise). This option of “moving the target” should be preferred to tree work that might otherwise be required to mitigate the risk but would harm the trees. In particular:
 - long-term facilities such as play areas, permanent car parks, seats and paths that already

- exist near veteran trees should preferably be re-located
- short-term facilities (e.g. temporary car parks, marquees for outdoor concerts, or courses for occasional equestrian events) should be located according to the same principle.



Fig. 3.11: Root protection area: the area has been fenced around the footprint of the crown, but the latter has been reduced by branch removal. Also, the resulting wounds could lead to excessive decay. (Note the basal bark damage, which pre-dated the fencing.)

- For each tree, the risk that people might bring upon themselves by climbing on to (or by walking or running into) low branches should be balanced against the risk of inducing excessive decay by pre-emptive branch removal. If a low branch is considered liable to fail (especially if climbed upon), the option of securing it [for example by propping or soil-mounding (see BSI, 2010)] should be adopted where feasible.

3.5.3 Tree protection in recreational and other intensively used areas

3.5.3.1 Protection of rooting areas from compaction and other damage

An RPA (see Section 3.1) should be designated around each veteran tree or group of trees in a recreational area. The size of the RPA should be as described in relation to grazing. Given that a physical barrier (as on a construction site) is not appropriate in most recreational areas, the RPA should preferably be delineated from the surrounding land by regular mulching or by allowing the grass to grow longer and rougher than elsewhere on the site.

Depending on the use of the recreational area, the presence of rough grass within the RPA might be considered

sufficient to divert harmful activities elsewhere. Account should, however, be taken of the full range of activities in case any of them need to be actively restricted. Such activities could include the following:

- frequent and close mowing
- use of pesticides or fertilisers
- biking (mountain or motor)
- equestrian or other sports
- congregation at occasional events (pop concerts etc.)
- regular or frequent passage of traffic of any kind (even if only during temporary events), including pedestrians, horse riders, people engaging in sporting activities, and the movement or informal parking of vehicles (including those used by the media, caterers or set-up personnel during events)
- storage of machinery or materials
- construction of car parking facilities or any other installation of paving materials
- erection of any buildings or other structures, or siting of mobile facilities (including seats or picnic tables, which not only encourage damage to the tree, but also bring people within the target area of potential tree failure)
- underground cabling (causing potential root severance, rather than compaction)
- heaping of soil or other materials, often impeding gas exchange and causing dysfunction or death of tree roots (or killing roots directly if the material is toxic).

If relatively intense recreational use of the RPA of a veteran tree cannot be completely avoided, the ground should be protected (e.g. by the re-routing of an access route or by means of a load-spreading surface or a raised walkway or driveway).

If soil compaction is already a problem (owing either to long-term site use or to a particular event), it should be relieved, if feasible, using methods designed to avoid further harm to the tree(s) (see 3.7 and BS 3998: 2010). Mulching should be a preferred option where site use permits (i.e. perhaps not in localities where significant problems are likely to occur as a result of the mulch materials being kicked or blown around).

If an ancient or other veteran tree is currently affected by any harmful activities or if its RPA has been partly or completely covered with paving or tarmac, remedial action should be taken. If this would involve lifting any paving or tarmac, advice should be sought from an arboricultural consultant with specialist knowledge of veteran trees.

3.5.4 Protection of trees from vandalism

It is usually neither feasible nor desirable to install vandal-proof barriers around trees. Individual tree protection against arson (i.e. by lighting a fire in an open cavity) should, however, be installed if this is warranted by the value and the risk (see deterrence of arson in Section 3.8.2).

3.5.5 Veteran trees near overhead power lines

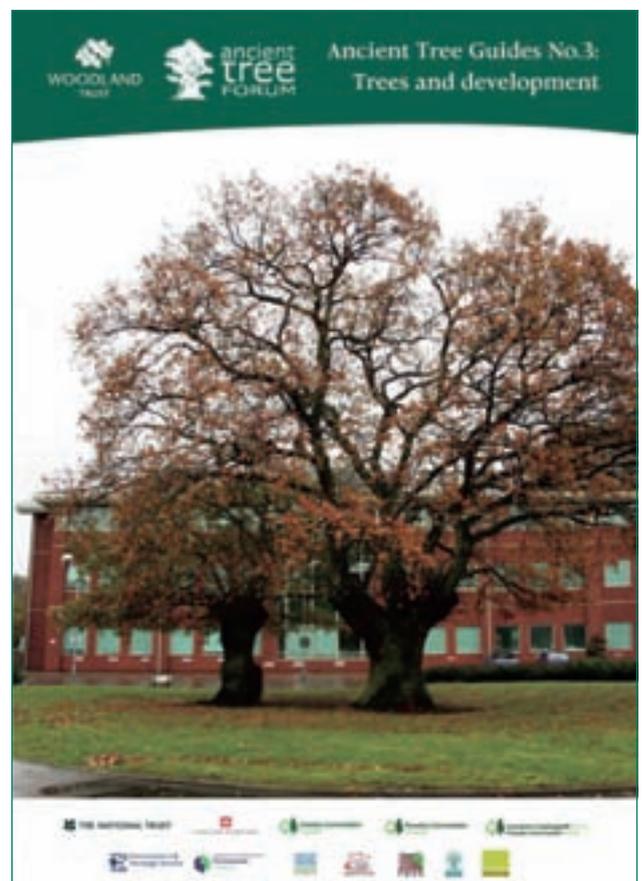
Within a specified distance of overhead power lines, utility companies or their agents may prune trees in order to safeguard the power supply. Where veteran or other highly valuable trees are involved, pruning should be kept to the minimum needed for this purpose. Tree owners should, as far as possible, liaise with the companies concerned in order to agree appropriate specifications for pruning.

3.6 CONSTRUCTION SITES

Every effort should be made (in the planning process) to avoid the situation described in 3.5.2.1 in relation to the risk that is created by bringing new buildings, and hence people, closer to veteran trees, since all the values associated with the trees can thus be compromised or lost entirely (ATF, 2007). Also, at every stage of the planning and construction process, full account should be taken of the full range of the potential effects of development on woodlands or wood pasture (Corney *et al.*, 2008).

The boundaries of an RPA for one or more veteran trees on a construction site should be decided according to the principle of erring on the side of caution. The rationale is that veteran trees have special value and are particularly vulnerable to the disturbance that inevitably results from a fundamental change of land use, such as construction.

Thus, the minimum extent of the RPA should be formulated as stated in Section 3.1, subject to modification, if appropriate, on the basis of a thorough and expert investigation of the extent of the root system and of the soil conditions (BSI, 2012).



The main potential impacts of construction on veteran trees can be summarised as follows:

- Root systems can be severely damaged by excavation and by compaction from the repeated passage of machinery. Compaction also damages the structure of the soil, reducing its suitability as a medium for root growth. Even if protective measures are in place, these are unlikely to include the entire rooting area.
- During construction, the above-ground parts of trees can be damaged as a result of permitted pruning or by activities that contravene planning consent by encroaching on a protected area.
- After construction, damaging activities (e.g. garden cultivation) often continue, owing to the change in land use.
- Also after construction, people and property will usually be closer to trees, thereby increasing the risk of harm to them. As a result, there is often pressure or even a requirement to remove trees or to carry out otherwise undesirable pruning.

3.7 AMELIORATION OF EXISTING COMPACTION AND OTHER SOIL DAMAGE

The first step should be to assess whether the soil conditions are likely to be conducive to healthy growth and function of the trees. In many cases, the condition of the soil will have deteriorated owing to factors that are readily apparent: e.g. increased animal stocking density. If appropriate, the objective should then be to try to return the soil to a state which is believed to have prevailed earlier in the life of the trees. The main aspects of adverse soil condition capable of amelioration include:

- soil compaction (including poor drainage and poor aeration)
- impoverishment or disturbance of soil microflora
- nutrient enrichment.

3.7.1 Mulching

Mulching involves covering the soil surface around the base of a tree. It improves growing conditions by suppressing the growth of surrounding vegetation that would otherwise probably compete with



Fig. 3.12: Group mulching of veteran Sweet chestnuts to ameliorate rooting conditions in an urban park

the tree for moisture. Moreover, if natural mulching materials such as wood chips are used, the resulting humus layer provides habitats for earthworms, which help to alleviate compaction. If, however, the bulk density of the soil exceeds 1.6 g cm^{-3} , compaction cannot rapidly be relieved except by mechanical means (see 3.7.2).

The humus that forms from the breakdown of natural mulching materials provides a habitat for woodland fungi and other soil organisms. Some soil organisms slowly release minerals such as potassium and trace elements, while others form a beneficial mycorrhizal association with the tree roots. Also, there is evidence that an enhanced humus layer can indirectly improve the capacity of trees to allocate their resources towards defence against harmful organisms (Lugo-Perez & Lloyd, 2009). Mulching can therefore be beneficial in ways that are not achieved merely by discontinuing adverse practices from the vicinity of trees. There is, however, a need to avoid some potential disadvantages, as explained in the following guidance notes:

- **Do not apply mulches on waterlogged soils**, where they might impede desirable evaporation.
- **When mulching an area for the first time**, try to do so when the soil is reasonably moist. Mulch on dry soil could intercept moisture that would otherwise be available to roots, particularly when rainfall is light and of short duration.
- **Use natural materials for mulching veteran trees**, rather than artificial ones such as plastic sheeting, so as to provide conditions akin to those in a natural litter layer. The best choice is probably, but not necessarily, a local source of wood chips, derived from the same species of tree. Potentially toxic materials should not be used (see BS 3998: 2010).
- **Lay organic mulches to a depth of 50 to 100 mm**. They gradually contribute to the humus content of the soil and yet cause little depletion of nitrogen, unlike organic amendments (e.g. compost) that are mixed with the soil itself (Webber & Gee, 1994).
[Note: some degree of nitrogen depletion could be desirable in areas of intensive agriculture.]
- **Always keep mulching materials away from direct contact** with the bark of the stem or of exposed major roots; otherwise damp conditions conducive to the activity of pathogens such as *Phytophthora* spp. could result.
- **For veteran trees that have not previously been mulched**, it is wise to apply the rule of avoiding sudden and major environmental changes unless perhaps the existing conditions are so hostile that a rescue operation is needed. According to this principle, the mulch should at first be restricted to relatively small areas, perhaps distributed as a mosaic and covering a total area of soil equal to no more than about four times the cross-sectional area of the base of the tree. According to a yet more precautionary proposal, the mulch could be applied on one side of the tree only. A larger area could then be mulched if the tree's condition has improved or at least not deteriorated over the next, say, five years.
- **For young and early-mature trees**, which could become ancient trees in the future, there is no need to limit the area to be mulched. At least a square metre per tree should be mulched in order to provide some benefit.
- **For newly planted trees**, mulching is a very good aid to establishment (Davies, 1987), because it helps to control competing vegetation. The mulched area should extend to about three times the diameter of the root ball (Watson & Himelick, 1997). Artificial materials may be used if necessary for cost-effectiveness or in order to deter bark damage by rodents.

The need for further knowledge: mulching

The suggestion that mulching helps veteran trees is not currently based on experimental evidence specifically involving such trees. Research, or at least practical experience, is therefore needed, especially regarding the relative benefits of mosaic mulching and conventional mulching (see 3.7.1). Mulching is, however, good for trees in general and is, in principle, likely to provide better conditions than occur under grass.

3.7.2 Alleviation of compaction or waterlogging

In order to assess whether soil aeration is poor, owing to compaction and/or waterlogging, a rusting test using steel rods can be used as a measure of the rate of oxygen supply (Hodge, 1993a). This test was designed for urban sites, but the principles apply generally. If compaction is not very severe (i.e. the bulk density is below 1.6 g cm^{-3}) and if its causes are removed, it can be gradually ameliorated by natural processes such as earthworm activity. If the bulk density is higher, mechanical aeration could alleviate the problem but it involves methods that can damage fine roots. Considerable caution, taking the following information into account, should therefore be observed where veteran trees are concerned.

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Comparison with other guidance: soil amelioration

Relatively aggressive methods can be used for the relief of soil compaction and of poor drainage. These methods, for example soil ripping or subsoiling, are suitable beyond the rooting areas of trees and may also be practised with care within the outer rooting areas of young trees. In the present book, the recommendation not to use such methods in the rooting areas of veteran trees is based on the presumption that these trees generally have little ability to recover from disturbance.

- As root activity is usually greatest in the top 300 mm of the soil, hollow-tine aeration could be worthwhile as a relatively non-aggressive method on sites with surface compaction.
- Machines for injecting high-pressure air (e.g. the Terralift®) or nitrogen gas at depths of a metre or more are available, but it is not clear whether their effects are generally helpful (Hodge, 1993b). Alternatively, devices such as the AirSpade®, which delivers a high-pressure air jet, are available for breaking up and displacing soil to a depth of approx. 250 mm, so that it can be replaced in a loosened state, with the option of adding an

organic soil conditioner (Howe, 2008). If such a device is selected, the air compressor should be of a type that does not allow oil droplets to enter the air-feed and thus to contaminate the soil.

- As with mulching, any mechanical method of amelioration should not be used throughout the RPA of a veteran tree in the first year if there is any cause for concern that more extensive treatment might be harmful.
- More radical measures such as soil ripping and subsoiling are not usually appropriate where soil disturbance could harm existing trees.
- Alleviation of compaction helps to reduce waterlogging, where this is an associated problem. Amelioration of waterlogging is, however, generally not appropriate where it is a natural consequence of soil type and the drainage pattern. In such conditions, only tolerant species of tree (e.g. alder) are likely to be present. If, on the other hand, drainage has become impeded relatively recently, it should be restored if possible, provided that the resulting change in conditions would not be too abrupt.

3.7.3 Mycorrhizal supplementation to enhance root function

In the absence of contrary evidence, the considerations in the accompanying text box indicate that commercial mycorrhizal supplements should not be used on veteran trees. There is, however, no known cause for concern about the possible introduction of mycorrhizal fungi that might be naturally present in locally derived organic mulch materials.

3.8 PROTECTION OF TREES AGAINST FIRE OR LIGHTNING

In order to protect veteran trees against fire, the control of bracken (see 3.4.3) and adherence to precautions with bonfires are the main measures to be chosen. Special kinds of tree work may, however, be undertaken if a high risk of fire damage or of a lightning strike is considered to exist. (Tree work in general is covered in Chapter 4.)

Comparison with other guidance: mycorrhizal amendments

The addition of commercially available preparations of mycorrhizal fungi is controversial as far as established trees are concerned. These products can aid the establishment of new trees in “immature” soils, such as occur on reclaimed mineral workings but the situation is different for long-established trees, which generally have lifelong mycorrhizal associations. Those associations can, however, be inhibited by artificial fertilisers. Also, mycorrhizal fungi are thought sometimes to be unavailable to colonise new roots that grow following episodes of root killing by drought or waterlogging. On the other hand, if soil conditions are persistently unfavourable for mycorrhizal development, any justification for mycorrhizal supplementation would require a clearer rationale than has been proposed hitherto. Also, the commercially supplied mixtures of fungi include kinds that are not native to the area concerned and perhaps not the entire country.

COMPARISON

3.8.1 Avoidance of damage from bonfires

Burning may be used in order to deal with arisings consisting of small-diameter material if it is the only convenient and affordable means of doing so. All other options should, however, be taken into account, including the use of material that would otherwise be destroyed by burning on site. If burning on site has to be chosen, a burning trailer or similar ground protection (see 3.8.1.1) should preferably be used.

Fires should ideally not be lit anywhere near veteran trees for the disposal of cut woody material. It is better to allow the material to break down naturally, thereby providing habitats for wildlife and a source of humus and slow-release minerals for the soil. Some of it may be used to create temporary thorny barriers to protect trees from livestock (see Section 3.2.3). If operations such as scrub control yield more material than can be accommodated on site, some of it should preferably be converted to useful products, which could be sold to raise funds for site management.

If burning is the only reasonable means of disposing of a surplus of material that would otherwise hamper site use or management, the fire(s) should be sited well away from standing trees, veteran or otherwise. Careful siting of fires can avoid above-ground scorching of trees, but the distance should be sufficient also to avoid damage to tree roots and to soil structure. While there might be some debate over the degree of below-ground damage caused by burning, there is an advantage in adopting the precautionary principle when working around veteran trees.



Fig. 3.13: Bonfire patch at an environmentally sensitive site

Whilst burning might be convenient, it could cause damage not only to above-ground parts to nearby veteran trees but also to their root systems and the soil profile. This happens because of the high temperatures created when large quantities of woody material are burnt in a single location. In addition, it is common practice to create a number of fires in the same work site, owing to the inconvenience of moving or dragging the material to a single fire.

Another problem is that fires occasionally get out of control, perhaps harming veteran trees over a larger area. Certain species (including rare fungi and their associated invertebrates) are, however, dependent upon burnt habitats.

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3.8.1.1 Use of a burning trailer to avoid damage when burning woody material on site

If it is impracticable to site bonfires far enough from trees to avoid root damage completely, some form of physical separation between the fire and the ground (i.e. a platform) should preferably be used. Irrespective of the need to protect tree roots, this option avoids the creation of fire sites and thus ensures a quicker recovery of ground vegetation after the cutting of trees or scrub.

In order to avoid the need to build platforms at different work sites, a burning trailer may be used. This is a mobile metal platform that is designed both to be dismantled easily, or to be towed by an ATV quad bike while in use. The platform should be sufficiently high above ground to avoid scorch from heat radiating from its underside, but not so high as to endanger users. Although time is taken to assemble the trailer, this is offset because the trailer can be moved to exactly the most convenient location for working. For more detailed specifications and costings, see Forbes & Clarke (2003).

3.8.2 Protection of individual trees against wildfires, arson and lightning

For trees of very high value that are at high risk, individual protection can be considered as follows:

- To help prevent fire in high-value trees with open cavities, the opening(s) may be sealed. This may be done by filling the cavity with a non-toxic kind of concrete or other masonry, which is



Fig. 3.14: Lighting a fire on a burning trailer



Fig. 3.15: Tree cavity barrier in a high-usage area, made of logs wired together

effective against arson and also helps to prevent the chimney effect in case the base of the tree is engulfed in a vegetation fire.

- In order to help avoid reducing the habitat value of the cavity, stout sheets of steel mesh may be secured inside the cavity opening(s), using concealed bolts. Such mesh is a partial deterrent to arsonists but cannot prevent the entry of flames from vegetation fires.
- In order to provide a potentially more resilient barrier, a stack of logs may be wedged tightly inside the cavity and joined together using wire and nails (A.D. Clarke, unpublished; Fig. 3.15). The log method was devised mainly to prevent entry by small children who might become trapped in hollow trees, but can also deter arsonists.
- If a more natural-looking barrier is required, the method of Fay (2005) may be used. This involves sealing the opening(s) with tailor-made slabs of durable wood, such as oak heartwood. The slabs are secured by a system of cables and screw eyes inside the cavity and can be provided with small holes for access by bats and other wildlife.
- If a particularly valuable tree is considered to be at high risk of a lightning strike, a lightning conductor may be installed where feasible. Guidance on this is available (Rose, 1990). Height reduction may alternatively be chosen for the same purpose if it would be equally beneficial for mechanical reasons (see Chapter 4), or if a substantial proportion of the top of the tree is already dead.

In or near built-up areas, or in parklands open to the public, arson or fires started through thoughtlessness can damage trees, especially hollow ones, and can lead to their loss in severe cases. The same can happen when bonfires get out of control and spread to bracken or other vegetation around the trees (see 3.4.3).

Lightning occasionally causes serious damage to trees and can start fires. It is, however, not generally thought to be enough of a threat to the survival of veteran trees in Britain to justify protection of individual trees, except perhaps for those that have particularly high value and that, owing to their height or isolation, are quite likely to be struck. On the other hand, lightning damage could become more frequent owing to an increased incidence of extremes of weather, as predicted from models of climate change.



Fig. 3.16: Use of natural wood and bark slabs, secured with internal cabling in order to prevent fire in an ancient hollow oak (Fay, 2005)

3.9 MANAGEMENT OF PESTS AND PATHOGENS

In forestry and arboriculture, a pest or pathogen could be defined as any organism that affects the health, growth or appearance of a tree to the detriment of its economic or aesthetic value. In an ecological context, however, the terms “pest” or “pathogen” should arguably be reserved for organisms that tend to accelerate the decline and death of trees sufficiently to disrupt the age structure of the tree population and to have adverse effects on dependent organisms. Many such pests or pathogens are exotic in origin. Others are native but have the capacity to take advantage of physiological stress in trees, caused by events such as physical disturbance or extremes of weather. Maintenance of good health in the tree can make an important contribution towards control of stress-dependent pests or pathogens. This approach is, however, less likely to be of use against certain aggressive organisms.

In the management of veteran trees, potentially harmful organisms are of concern not only because they can shorten the lives of the trees, but also because decisions about the pruning of trees need to take account of the possibility that the trees’ response will be impaired as a result of damage caused by a pest or pathogen (see Chapter 4). For example, trees that are heavily affected by foliar diseases (e.g. rust, mildew or scab) or by defoliating caterpillars might lack the food reserves to produce healthy new growth after pruning.

If a veteran tree becomes affected by a notifiable pest or pathogen, the only available action (perhaps for legal reasons) might be to comply with guidance and instructions from the relevant authorities. If the spread of the organism cannot be contained on a regional or national scale,

voluntary preventive measures on a local scale might be futile. It could, however, be worthwhile to attempt to prevent the spread of certain pathogens, such as species of *Phytophthora*, into a sensitive area by disinfection of footwear or machinery brought on to the site concerned. Another possible option, where the pest or pathogen concerned has limited powers of dispersal, is to destroy susceptible plant species that could otherwise become a source of infestation for veteran trees in their vicinity. Guidance from the relevant authority should help to indicate whether preventive measures are worthwhile.

Since pests and pathogens are increasingly being introduced into the UK through international trade, as in other countries, it is necessary to consult the latest sources of information in order to keep abreast of methods for control, including legal restrictions on activities such as the transportation of plant material.





Failure of a named oak tree, the Mawley Oak, Worcestershire

CHAPTER 4

Tree work: assessment of requirements

4.1 PURPOSE AND SCOPE OF THIS CHAPTER

The guidance in this chapter concerns the assessment of individual trees to determine whether they are likely to benefit from particular kinds of tree work, taking into account their biomechanical integrity and their vitality. The principles of these kinds of work are described and reference is made to other publications, which provide technical details or guidance.

4.2 TREE WORK: GENERAL PRINCIPLES, TIMING AND THE LAW

Work on veteran trees should be done according to published standards and procedures for tree work (see BS 3998: 2010), except where indicated otherwise in this chapter (see text boxes for explanatory comparisons). The procedures include compliance with the law, which places certain restrictions on work involving protected trees (e.g. those covered by Tree Preservation Orders), or affecting protected species or Scheduled Monuments (see Appendix C). Additional care should be taken where work is planned and undertaken for veteran trees, since many of them are especially sensitive to the adverse effects of pruning and to changes in their growing conditions. Also, they might be supporting rare and vulnerable species, which have exacting habitat requirements.

4.2.1 Prevention of serious mechanical failure

Veteran trees sometimes shed relatively small branches in the process of natural retrenchment. In most situations, no action should be taken to prevent this relatively minor type of failure. When, in contrast, a veteran tree is seriously at risk of undergoing a life-shortening mechanical failure, it may be pruned or otherwise managed if such measures are assessed as being helpful. If, however, there is no reasonable prospect of enhancing the longevity of the tree, non-intervention might be the only practicable remaining option.

If a properly conducted risk assessment shows a need to protect people or property, and if other measures (e.g. “moving the target”) are not feasible, tree work should be carried out in order to mitigate the risk, even if this is not required for the sake of the tree alone.

4.2.2 Tree work for other reasons

Trees that form part of a designed landscape (see Chapter 6) are sometimes managed in order to maintain a particular shape or to keep the lower parts of their stems free from epicormic growth. If a tree is in generally good condition, such management may be continued without causing any serious physiological harm. If, on the other hand, a tree is in general decline, it should not be pruned any more than would be considered essential in order to help prevent biomechanical

failure. Otherwise, the removal of leaf-bearing twigs could cause the associated columns of sapwood to become dysfunctional, with potentially serious effects on the health of the tree as a whole. In particular, epicormic shoots should not be removed from such a tree, since they are likely to be functioning as the tree’s main “insurance policy” against the loss of function in the parts of the stem to which they are attached. If there is any concern about the ecological effects of discontinuing the routine removal of epicormic shoots (see the text box on epicormics), expert advice should be sought.

The removal or retention of epicormic shoots can have implications for dependent species (see Chapter 5). For example, if lichens or other epiphytes have previously received adequate sunlight by virtue of the removal of such shoots, they could become excessively shaded if the shoots are allowed to grow. On the other hand, the shoots will provide habitats for invertebrates that might not occur in the crown of the tree.

BACKGROUND

4.3 DECIDING WHETHER TREE WORK IS APPROPRIATE: FACTORS TO TAKE INTO ACCOUNT

4.3.1 The need for caution

Any form of work involving cutting is a form of damage, even though it might provide an overall benefit by helping to avert serious mechanical failure. It should therefore generally be kept to the minimum necessary for the purpose. Branches of a veteran tree, or of a neighbouring tree, should not be pruned with the intention of facilitating access to a site. New or improved access beneath the

canopy of a veteran tree should generally not be provided unless a ground protection system [see BS 5837 (BSI, 2012)], designed to prevent root damage, soil compaction or restriction of water availability, is first installed.

The management of trees should always be based on an understanding of their mechanisms for survival, which are often very effective. Thus, if a tree shows a good capacity to survive by natural retrenchment (see 4.4.4.1) or by other processes such as layering (see 4.5.3), it should be allowed to do so. This capacity should be assessed according to species, vitality, physical form and previous patterns of mechanical failure, if any (Fay & de Berker, 1997).

**Comparison with other guidance:
natural retrenchment**

In many urban and roadside situations, trees are often pruned or felled while too young to undergo natural retrenchment. Allowing this process to occur is, however, entirely consistent with good arboricultural practice, subject to appropriate risk assessments both for the survival of the tree concerned and for people and property. British Standard 3998:2010 includes provision for a decision-making process, whereby non-intervention is one of a range of possible options.

COMPARISON

4.3.2 Criteria for deciding whether tree work could be beneficial*

The main justification for work on a veteran tree arises if the tree is assessed as having a high probability of major failure; for example, because it is a lapsed pollard with heavy branches attached to a severely decayed bolling. In such a case, the option of some form of tree work (the minimum required, according to the criteria set out in 4.4) may be chosen if one or more of the following scenarios applies:

- Major mechanical failure would destroy much of the value of the tree, as assessed in relation to its status and relative importance (for all aspects of value, including biodiversity) within the area concerned.



Fig. 4.1: The location of seating and other features that might attract people should be decided or reviewed according to the need to manage risk from trees (i.e. move the target where appropriate)

* See Chapter 2 for general information about tree surveys.

INTRODUCTION

SURVEY/EVALUATION

PROTECTION

TREE WORK: ASSESSMENT

HABITAT

LANDSCAPE

PLANS & SPECIFICATIONS



Fig. 4.2: Catastrophic collapse of a lapsed hornbeam pollard, involving failure of all branches



Fig. 4.3: Warning signs can help to reduce risk, provided that visitors are deemed able and willing to heed them

- The tree is posing, or likely to pose, an unacceptable risk of harm to people, property or a structure of archaeological value, and tree work is the only reasonable solution. Depending on site usage, other options could include “moving the target” (Fig. 4.1) or restricting public access during or immediately after very severe weather. For further information on various options, see sources such as Lonsdale (1999), Davis *et al.* (2000) or FC (2011). The risk needs to be assessed, in order to help establish whether it is above a tolerable threshold, according to appropriate criteria (Ellison, 2005). Almost any tree could pose a risk to people or property, and so the question is whether the risk is great enough to justify some kind of action.
- Tree work has previously been done and there is a need for further management to maintain mechanical integrity following new growth.

If a tree meets the above criteria, pruning could be an option for preventing serious failure. There is, however, a need to assess not only the mechanical integrity of the tree but also its vitality and its potential for growth. In this context, three factors should be taken into account:

- **the form of the crown:** in particular, is there a framework of branches in the mid or lower crown that could form a residual crown of good density after height reduction?
- **the capacity for individual branches to survive after shortening**
- **the overall vitality of the tree, which will greatly influence its capacity to respond favourably to the work.**

4.3.2.1 Assessment of biomechanical integrity

In relatively simple cases, biomechanical integrity may be assessed by applying “engineering” criteria*, as for non-veteran trees, but the structural complexity of most veteran trees is likely to make the assessment highly subjective. Some of the changes could lead to an increase in brittleness. A range of different stresses, including torsional and shearing stresses, should be taken into account (Mattheck & Breloer, 1994; Mattheck, 2007), since there is no single rule of thumb for making such an assessment. There are, however, two general considerations – (1) whether a stem or branch with central hollowing or decay has a thick enough outer wall of wood to resist failure when its entire cross-section is subjected to bending stress and (2) whether there is enough sound wood to resist localised stresses, such as might cause a branch to tear out from its attachment. The latter consideration is especially important in lapsed pollards with long, heavy branches. Also, in cases where failure affects large-diameter hollow stems, it often involves the tearing-out of individual branches, rather than the shattering of the main stem caused by bending stress.

When assessing whether enough sound wood is present in a particular part of the tree, the factors listed below, most of which are unrelated to decay, should be taken into account.

- **Length and weight of branches:** these factors are important in assessing the potential for branch failure and should be taken into account, together with other aspects of body language, according to the principles of visual tree assessment (Mattheck & Breloer, 1994).
- **Size and residual strength of any dead branches:** dead branches can fail when they become brittle or decayed but their presence is usually of no concern in relation to the overall mechanical integrity of the tree. If, however, there is a risk of harm to people or property, the probability of failure and its possible consequences should be assessed. It is important to take account of climate and micro-climate with regard to the likely rate and pattern of decay (see text box on page 100).
- **Types of branch attachment:** these vary according to the following factors:
 - **branch angle:** in many cases, this widens with the increasing weight of the branch, so that downward bending stress increases
 - **the relative size of the branch and the parent branch or stem:** this gives some indication of whether the branch is co-dominant or sub-dominant – if it is co-dominant, the anatomical resistance of the union to splitting is likely to be relatively poor (Shigo, 1986)
 - **the presence of included bark (Fig. 4.4):** since a bark inclusion provides no strength in the branch attachment zone, an extensive inclusion can be a cause of weakness – for diagnosis of included bark unions, see Lonsdale (1999) and for their biomechanical assessment, see Mattheck (2007).
- **Decay near branch attachments:** this could be causing significant weakening if it has occurred in a critical area (e.g. in the part of the attachment which is under tension or close to a bark inclusion). In such an area, even a localised pocket of decay could add to the probability of failure. Nevertheless, experience suggests that most branch failures do not involve decay as a major factor.

* For information on biomechanical failure in trees see: Mattheck, C. & Breloer, H. (1994) *The Body Language of Trees: A handbook for failure analysis* (Research for Amenity Trees 4), HMSO, London, 240 pp.



Fig. 4.4: Two types of branch union; on the left showing signs of included bark

- **The position and extent of sound wood around any apparently extensive zone of decay:** decay in trees is a potential cause of weakness but it is also a key component of habitat for a wide range of fungi, animals and other organisms (see Chapter 5). Although the strength of the affected wood is reduced, this does not necessarily increase the probability of failure. In any case, the potential failure of a decaying part (e.g. a branch) might merely contribute to the process of natural retrenchment, whereby the crown of a tree becomes smaller and thus more easily supported, both mechanically and physiologically (see Chapter 1).



Fig. 4.5: Projection of branches beyond general outline of the crown (*Sequoiadendron*)

The need for further knowledge: management of trees with decay caused by particular fungi

Since the early 1990s, much has been learned about the colonisation strategies of various decay fungi and the associated effects on the mechanical integrity of trees. This information is helpful in prognosis of the development of decay in trees and thus in long-term management. For example, trees affected by certain root decay fungi can eventually die owing to loss of conductive roots. Physiological dysfunction, induced by pruning such trees, could accelerate fungal development. Fungi which have been studied in some detail include *Ganoderma australe* (= *G. adspersum*), *G. applanatum*, *Meripilus giganteus*, *Inonotus hispidus* and *Ustulina (Kretzschmaria) deusta*. There are, however, other fungi (e.g. *Perenniporia fraxinea*) that occur in veteran trees and that would be useful candidates for similar research.

There is also a need to learn more about other organisms that can have either beneficial or deleterious effects on the health or mechanical integrity of trees. These include mycorrhizal fungi, nematodes and hyperparasitic fungi.

- **Height of the tree and the spread of branches:** the length of the lever arm determines the stresses imposed by gravity and by swaying motions in the wind. The lever arm should be taken into account, together with the other factors in the present list, in order to assess the probability of failure and hence the need for remedial work.
- **Conformation of the crown:** this plays a part in determining how well the crown is likely to hold together in high winds. Features which increase the probability of failure include the following:
 - branches that project beyond the general outline of the crown (Fig. 4.5);
 - branches that have bent downwards so as to be at a different angle to others (Fig. 4.6) in the same part of the crown (see branch angle, above);
 - gaps in the crown (Fig. 4.6), through which gusts of wind can blow, causing the branches on either side to sway apart.
- **The potential for low branches to come to rest on the ground, rather than tearing out or completely snapping:** downward bending branches often come to rest on the ground without snapping or tearing away from the stem (Fig. 4.7) but there might be a need for intervention if failure is likely to occur before ground-contact is attained (Fig. 4.8). The failure of a major branch could lead to extensive physiological dysfunction and decay; enough to shorten the life of the tree.
- **The species, variety or individual genetic characteristics of the tree:** this should be taken into account in the assessment of the strength of a particular kind of union or of wood affected by a particular kind of decay. Evidence of differences between species is largely anecdotal but amounts to a track record for certain species (see Lonsdale, 1999). A few examples are as follows:
 - Tight V-shaped branch unions, which contain bark inclusions (i.e. bark-to-bark contact zones between branches or between branch and stem) are observed to fail frequently in some species (e.g. poplars, willows and beech) but rarely in others (e.g. limes, oaks or Sweet chestnut).



Fig. 4.6: Ash tree, showing a gap in the crown (arrowed), which appears to have developed because of the outward bending of the branch to the left of the gap. Such bending can increase the probability of failure



Fig. 4.7: This ancient tree (the King John Oak), with its open-grown form, has never had its lowermost branches removed. Where close enough to the ground, the branches have touched it without failing and have layered, forming a natural propping system

- Owing to differences in wood properties, decay-related failure is more frequent in some species (e.g. beech or Horse chestnut) than others (e.g. Pedunculate or Sessile oak or Sweet chestnut).
- Decay caused by the fungus *Inonotus hispidus* often leads to branch shedding in ash, but rarely in London plane (this difference is due to the nature of the xylem rays in these two kinds of tree).
- As Ferrini (2004) has pointed out, various tree species have been found to show age-related alterations in the quality of wood laid down. For a given species, such changes should be taken into account where they are associated with an increased incidence of failure.



Fig. 4.8: Severe branch failure; the branch was too high to reach the ground by downward bending before the failure occurred

- **Previous branch failures in the individual tree:** it can be difficult to assess the probability of failure on the basis of general principles (e.g. assessment of the type of branch attachment – see page 77), but the task can be aided by looking for evidence of any history of failures of other branches on the same tree. This could be of particular use in the case of summer branch drop, which is otherwise largely unpredictable.
- **Previous failures of similar trees on the site:** the history of tree failures can be very informative, especially in relation to uprooting, which is related to soil conditions and/or the prevalence of particular kinds of root decay.
- **Abundant cover of climbing plants or**

mistletoe: owing to its dense evergreen foliage, ivy can add significantly to the mechanical forces imposed on branches and on leaning stems. It is less likely to exert such an effect on an upright stem unless it is growing very close to the top of the tree, in which case it is probably also competing with an already-declining crown for light. Also, shading by ivy can suppress the development of a secondary crown, interfering with crown retrenchment and hence with the long-term maintenance of biomechanical and physiological integrity. Other potentially harmful climbing plants include various exotic species that occur in or near built-up areas, such as Russian vine, *Fallopia baldschuanica* or very vigorous species of *Vitis*, such as *V. coignetiae*. There is similar cause for concern about excessive weight and shading where a veteran tree is bearing an abundant growth of mistletoe which, as a hemi-parasite rather than a climber, is additionally making use of the host's supply of water and dissolved nutrients.

Further guidance on the assessment of mechanical integrity has been provided by Mattheck & Breloer (1994), Mattheck (2007) and Lonsdale (1999).

4.3.2.2 The form of the crown

The form of the crown should be taken into account when deciding whether to reduce mechanical loading in any way. If, as in most cases, the work would entail crown reduction, the options for the type and extent of pruning (see 4.4) should be decided according to the form (growth pattern) of the crown. The crowns of certain trees are, for example, not very amenable to pruning since their branches are “leggy”, i.e. they bear their daughter branches and twigs mostly near their tips, so that the leaf-bearing twig structure is confined mostly to the periphery of the crown. Such crowns are, however, sometimes amenable to staged retrenchment pruning (see 4.4.4.1). In some cases, other kinds of work, such as bracing, propping or guying (BS 3998:2010, Clauses 10.5 to 10.7) may be employed as a last resort, either on their own or in combination with pruning.

4.3.2.3 Recognition of functional units

Distinct portions of the crown are likely to differ in their capacity to survive after pruning or natural shedding of branches. An overall assessment of the condition of the crown is therefore not necessarily helpful in deciding where and how much to prune. This decision should therefore be made separately for parts of the crown that can be recognised as functional units (see Fig. 4.9). Although there is usually some interdependence between such units, they can to some extent be regarded as separate trees, each of which provides its own energy requirements from photosynthesis, while absorbing sufficient water and mineral nutrients via its most closely connected portion of the root system. This represents a survival strategy, since a functional unit could stand alone or break free from the original tree.

The phloem and sapwood of each twig or branch form part of a column or pipeline of living tissues, which extends down into the root system. In the stems of many veteran trees, these columns are confined to discrete axial strips, separated by intervening dead strips. In the event of such a column being severed by pruning, it could die all along its entire length, unless it has enough lateral connections to other columns to remain partly functional. Function can be sustained also by the development of new shoots that become connected to the column.

In some instances, new shoots begin to grow but later die back, probably because their supply of water and mineral nutrients has been provided mainly via pre-existing sapwood, which has eventually lost all its physiological function.

Comparison with other guidance: crown shape

It is always good practice to avoid altering the shape of a tree crown in a manner that would increase the probability of branch or tree failure. Provided that this principle is observed, an irregular form in a veteran tree should be accepted whether its crown is already irregularly shaped or will become so as a result of remedial tree work. The conventional objective to maintain a regular and pleasing crown form does not necessarily apply.

1 In certain trees, functional units consisting of individual branches or groups of branches can be recognised as showing greater vitality or vigour than the rest of the tree. They are often associated with well-developed columns of sapwood in the main stem, which connect them with similarly well-developed roots. Vigorous young branches sometimes develop as re-iterative growth (see Fig. 4.12) after a tree has lost part of its crown through mechanical failure. Such branches can sometimes be left to become part of a new crown. If, however, owing to weak attachment to the main stem, they appear likely to fail, some form of pruning could be helpful and is likely to be well tolerated.

2 Another example of recognisable functional units is that of a tree whose entire upper crown shows low vigour and vitality and is distinct from a dense and healthy lower crown. As indicated in 4.4.4, such a tree might respond well to removal of the upper crown in a single operation, whereas a tree that lacks an already-formed healthy lower crown could be killed by such a severe treatment.

3 4.3.2.4 Individual branches: characteristics influencing their survival after pruning

4 Any decision about whether and where to prune a branch should be based on an assessment of its capacity to survive thereafter. Pruning should generally be avoided if the retained portion would lack any strongly developed daughter branches, unless there is good reason to expect that it will form new shoots from dormant or adventitious buds. If so, provision should be made for the management of the new branches that might develop in this way, since they are sometimes



7 Fig. 4.9: Each of the distinct columns of living sapwood and bark in the stem of this veteran Sweet chestnut is part of a functional unit, comprising one or more branches and roots



Fig. 4.10: Ancient oak with epicormic growth on lower stem; this provides capacity for retrenchment

weakly attached, especially in species with relatively weak wood (e.g. willows). In order to assess the capacity of a branch to survive by producing new shoots, the following information should be taken into account:

- Dormant buds originate in leaf axils and therefore occur at a relatively high density if the stem or branch has short internodes owing to slowness of growth when it was a young shoot. Dormant buds can persist for many decades but not for ever and can therefore be very sparse or lacking on very old stems or branches. Also, dormant buds of thick-barked species sometimes fail to form shoots, perhaps because they do not receive enough sunlight to stimulate them.
- In a smooth-barked species such as beech, it is sometimes possible to see the original leaf scars and girdle scars, where dormant buds could be present. The more such scars per metre-length of branch, the more buds there are likely to be.
- If there are numerous epicormic shoots [sometimes known as whiskery or wispy growth (Fig. 4.10)], these will carry recently formed dormant buds. The proliferation of epicormic shoots is thought to be a genetic trait in some trees, or it can be stimulated by a witches' broom agent (e.g. a virus, fungus or bacterium). Epicormic shoots often also occur on trees that have been maintained as pollards.
- Adventitious buds, arising within the bark tissues in response to pruning or branch fracture, are another potential source of new shoots, but they occur far more often in certain species (e.g. poplars and willows) than in others (e.g. beech). There is some evidence that their formation requires stimulation by relatively bright light.

4.3.2.5 Assessment of vitality

In order to plan tree work, the crown of the tree concerned should be assessed for signs of poor vitality (e.g. twig dieback, sparse or undersized foliage or premature autumnal leaf fall). If such signs cannot be attributed to normal retrenchment, the tree should be assessed as probably being in a state of serious decline and therefore unsuited to tree work that would involve a significant depletion of its leaf area. If, however, the crown has a generally good density and colour of foliage,

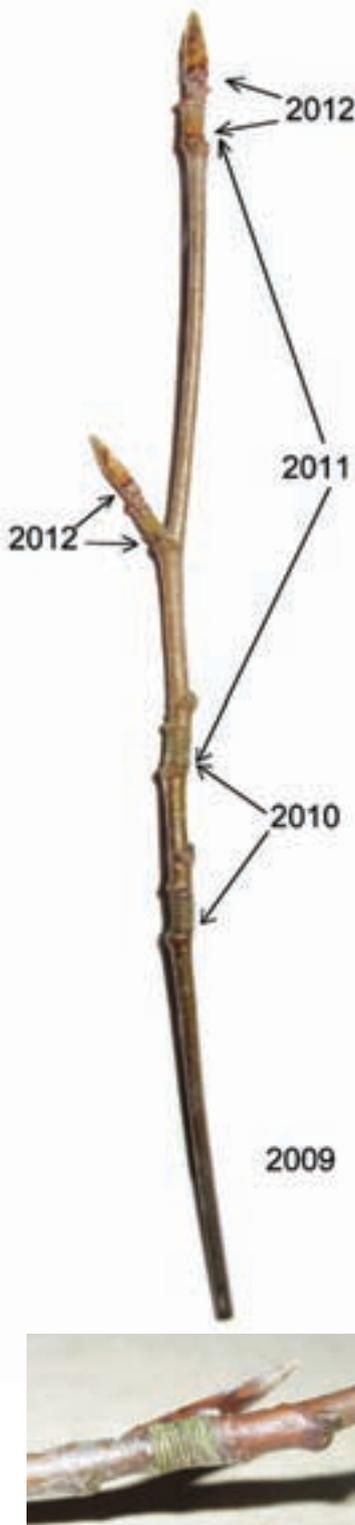


Fig. 4.11: Measurement of twig increments (beech twig) using girdle scars (inset: close-up)

with any signs of poor vitality occurring only in individual branches, the tree should be regarded as probably undergoing crown retrenchment (i.e. its crown is becoming smaller), typically in a series of episodes of branch dieback and/or shedding. Although retrenchment helps to reduce the probability of failure, pruning may be undertaken for this purpose if necessary. Such pruning should, however, be the minimum necessary in the first instance (see retrenchment pruning in 4.4.4.1), since a tree that is undergoing natural retrenchment is likely to develop serious physiological dysfunction if pruned too harshly.

The following features should be assessed, so as to gain some idea of vitality and thus of the prospects for survival after pruning.

- Presence of extension growth (or reiterative growth, following episodic dieback) at the top of the crown:** The most recent year's extension growth of a twig is the distance from the last girdle scar to the base of the terminal bud. Extension growth in each preceding year (in some cases, going back many years) is measured as the distance between successive girdle scars (Fig. 4.11). Rather than attempting to make these measurements precisely, it is usually sufficient to gain a general impression with the aid of binoculars. This assessment should be made at the top of the crown, which is the part of the tree most likely to show the effects of a reduced capacity to conduct water to its extremities. Extension growth in the lower crown is usually very variable and is misleading in the assessment of vitality.
- Colour and size of leaves:** A veteran tree of high vitality should show normal leaf colour. If the leaves are abnormally pale or yellowish, this probably indicates low vitality (perhaps owing to disease, especially a *Phytophthora* root disease*) and/or a nutritional deficiency or imbalance. Very small leaves could also indicate low vitality but rather small leaves are typical of ancient trees, except when a phase of re-iterative growth begins.
- Density of twigs and presence of dieback, especially at the top of the crown:** If twig density is very low for the species concerned, it is probably a sign that vitality has been poor for some time, at least locally within the crown (see stagheadedness and re-iterative growth, below). Sparseness of twigs tends to be a more advanced sign than reduced twig extension or pale leaf colour. The presence of dead twigs is usually a more advanced sign of decline.**
- Pattern of any dieback:** natural retrenchment or reiterative cycles or rapid and extensive dieback:
 - If twig dieback is present throughout the upper crown, there is often cause for concern about the overall vitality of the tree.
 - Rapid and extensive dieback could indicate a major loss of vitality, perhaps because of a sudden onset of root damage (e.g. because of disease), or of a severe deterioration in the growing conditions. Recovery is unlikely unless the cause of the problem is rapidly reversible.

Note: Various canker diseases and also branch girdling by squirrels can lead to scattered twig death, giving the impression of poor density or dieback, even if the tree as a whole has reasonably good vitality.

BACKGROUND

* For further information on defence mechanisms in woody tissues see: Pearce, R.B. (1996). *Antimicrobial defences in the wood of living trees*. (Tansley Review No. 87) *New Phytologist* 132, 203-233.

** For information on tree crown architecture as an indication of tree vitality or vigour see Roloff, A. (2001). *Baumkronen: verständnis und praktische Bedeutung eines komplexen naturphänomens*. Ulmer Verlag, Stuttgart, 164 pp.

- If the dieback is patchy or confined to a distinct peripheral zone of the crown, surrounding a dense, well-foliated inner crown, it is likely to be a feature of natural retrenchment or of a period of adverse conditions. In the latter case, it might be followed by re-iterative growth. [In species whose dead branches persist (e.g. our native oaks), episodic dieback or retrenchment leads to stag-headedness.]

The stem, branches and twigs of a tree are classed respectively as “first-order”, “second-order” and so on. Morphological differences between these successive orders of branching (especially in the orientation of twigs and leaves) contribute to a characteristic shape of crown and twig “architecture” in the species concerned. The growth of a lower-order branch is said to be reiterative if it has the growth pattern of a higher-order branch or a “miniature tree” (Raimbault, 2006). In the natural retrenchment of veteran trees, episodes of branch shedding or dieback are often followed by episodes of growth, which reiterate the shape and vigorous development of the branches of a young tree prior to maturity. The same tends to happen in response to pruning. Apart from episodes of reiterative growth, the twig extension in the outer crown of veteran trees is often very slight.

- **Starch reserves:** The starch content of sapwood samples can be used as an indicator of the vitality of the part of the tree concerned (and perhaps of the entire tree). Allowance should be made for the considerable variations that occur seasonally and between different parts of the tree. For example, a particular part of the crown and its associated zone of the stem could be in a better or worse physiological condition than other parts and is therefore unlikely to be representative of the tree as a whole. Also, as shown by Clair-Maczulajtys *et al.* (1999) the concentration of starch can vary considerably between different anatomical zones of the branch system, especially in response to previous pruning. The starch concentration can be estimated according to the depth of the purple colouration obtained by treating a sapwood sample with iodine (0.3 g), dissolved in an aqueous solution of potassium iodide (1.5 g in 100 ml). Shigo (1991) describes the procedure, including health and safety precautions.

The food reserves of a tree consist of sugars and starch. Sugars, being soluble, are available for growth and other vital functions. When sugars are not immediately required (especially at the end of the growing season), they are converted into starch, which is insoluble and is converted back into sugar at the start of the growing season). The starch concentration in sapwood varies also between different annual increments and between different places along the length of a branch or twig (e.g. nodes or internodes, or near pruning cuts).

4.3.2.6 Vigour

If the recent growth of shoots and of occluding tissues around wounds is vigorous, pruning may be carried out with some confidence that the tree will soon re-establish a dense canopy thereafter. Provision should, however, be made to manage the subsequent growth so that it does not become so long and heavy that the intended biomechanical effect of the pruning is eventually negated.

Since vigorous growth usually depends on high vitality, the two often go together. There are, however, many trees that have high vitality and yet are not growing vigorously. High vigour is often associated with good growth of branches after pruning but it can also lead to the rapid re-establishment of the weight and leverage that has been removed in the interests of preventing mechanical failure.

The need for further knowledge or technical development: tree work for management of veterans

Continuing research is needed in order to evaluate management practices with regard to their long-term effects on trees of various species and of various degrees of mechanical integrity and vitality. Such research should ideally involve properly replicated experiments but these are often limited by practical or financial restrictions. There is, however, an increasing bank of well-documented information, based on “before and after” records at places in the UK, where numerous veteran trees are present, including Burnham Beeches, Epping Forest, Hatfield Forest, Hainault Forest and Windsor Great Park. Also, various methods of pruning beech pollards have been compared in replicated trials in the Basque Country of northern Spain (Read *et al.*, 2011).

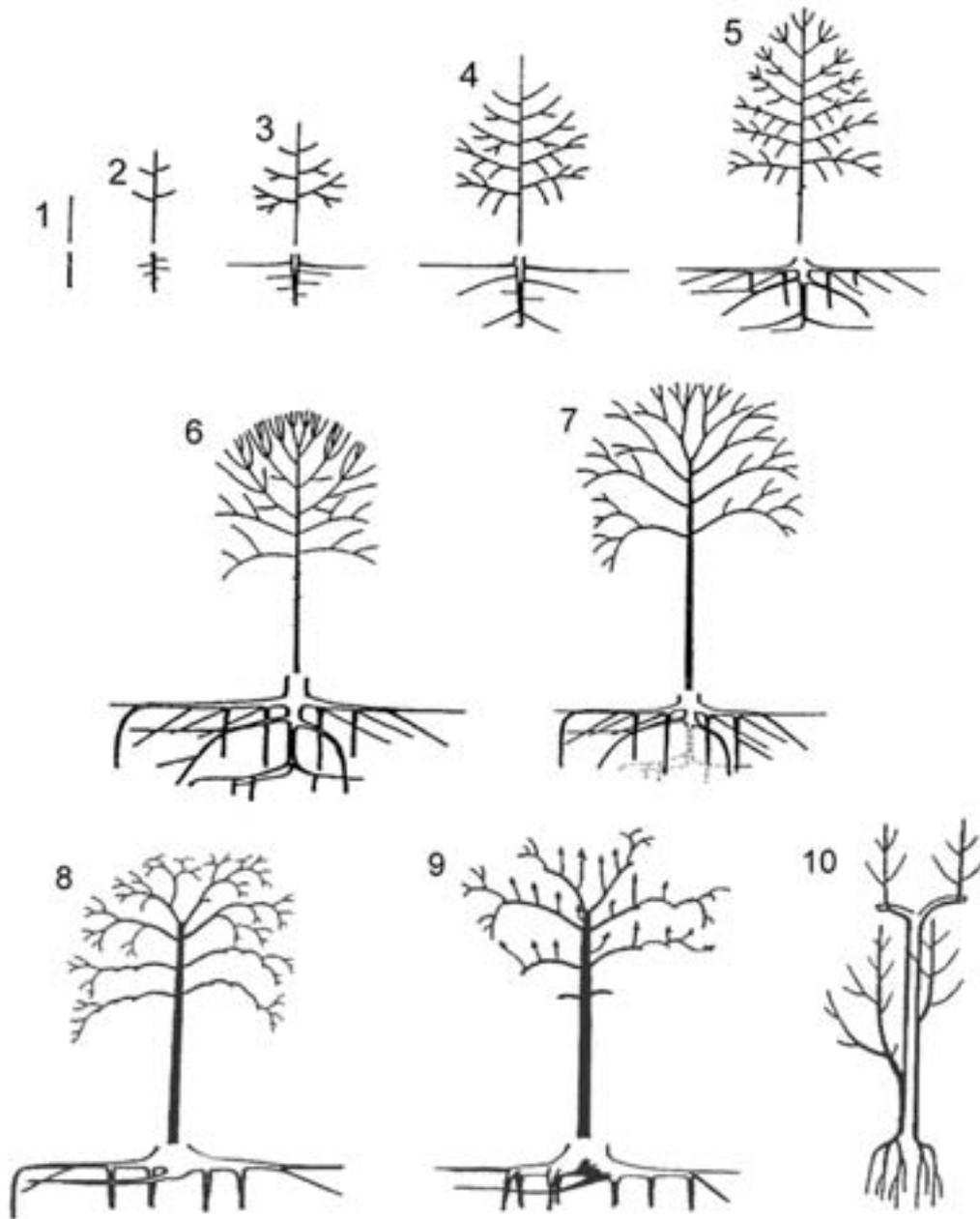


Fig. 4.12: Stages in the life of a tree (from Raimbault, 1995), in relation to cutting

STAGES 1 to 5 (Juvenile expansion of the crown and the root system, with overall apical dominance): Stage 3 is the best for new pollarding – a new branch framework can readily form, and cutting is unlikely to lead to excessive decay.

STAGE 6 (Semi-maturity, with the lower crown becoming free from overall apical dominance): well past the stage when new pollarding would be advisable. If the crown is cut back, the tree will probably grow again until it reaches the mature crown-size that it would have reached if left uncut, but probably with an altered shape in certain species.

STAGE 7 (Maturity): an often prolonged stage, when crown-size increases only very slowly, while a near-equilibrium between growth and localised dieback is reached. If the crown is cut back, it tends to grow back to its former size, but the crown size of an in-cycle pollard can be kept small by regular cutting.

STAGE 8 (Late maturity/onset of early ancient, with

retrenchment increasingly becoming a key feature): overall, dieback of some twigs begins to outpace the growth of others. Increasingly, particular parts of the crown can be recognised as distinct functional units, perhaps linked to particular parts of the root system via columns of sapwood in the main stem. In open-grown trees, a secondary, lower, crown sometimes starts to form and could eventually “take over” if the original crown is reduced in size, either naturally or by cutting.

STAGE 9 (Retrenchment): localised dieback and breakage (or cutting if appropriate) can result in reduction of height and spread, while re-iterative twig growth occurs lower in the crown (or in a secondary crown).

STAGE 10 (Late ancient): Most of the new branch growth is re-iterative, counteracting local dieback and breakage. Selective cutting to reduce excessive leverage can be helpful but needs to be very judicious.



Fig. 4.13: Propping of King Offa's oak; possibly unsuitable for prevention of major splitting, as here

4.4 TREE WORK: THE MAIN OPTIONS FOR VETERAN TREES

When intervention is needed in order to reduce the probability of mechanical failure, the main option is some form of pruning: either a general crown reduction or the removal or shortening of selected branches. [Other options could include bracing, guying or propping (see BS 3998:2010)].

4.4.1 Pruning

Each tree should be individually assessed to help decide how much pruning is required in order to help prevent serious mechanical failure (see 4.3.2). Since pruning is a form of damage, the tree should also be assessed for its capacity to tolerate the intended treatment and to grow in response (see 4.3.2.3, 4.3.2.5 and 4.3.2.6).

Whichever pruning procedure is chosen, the following guidance should be observed:

- Avoid removing more of the crown than necessary, thus ensuring that the tree's leaf area never becomes too small to sustain its survival (Fay, 2008a,b). Conversely, aim to shorten the branches enough to help avoid a response by which the crown would soon grow back to its size before cutting.
- Prune only where required in the interests of biomechanical integrity. Thus, avoid trying to impose any pre-conceived aim of rebalancing the crown of a tree that would benefit only from the selective pruning of parts that would otherwise be likely to fail.

The need for further knowledge: tolerance of trees to pruning

If pruning is required in order to reduce mechanical stress, there can be a difficult balance between removing enough material for this purpose and removing no more than the tree can reasonably tolerate. Even in the initially less severe practice of retrenchment pruning, the tolerance of the tree depends on its subsequent capacity to produce and maintain new foliage, which can then sustain physiological function in the sapwood and inner bark.

Maintenance of a good, well-foliated canopy is favoured if the retained part of the crown already has a good structure of twigs and small branches before pruning. If not, adequate leaf cover can be re-established after cutting only if the tree can produce new shoots on old branches or stems. Its capacity to do so will depend on its reserves of stored energy and its predisposition (partly genetic) to produce epicormic shoots.



Fig. 4.14: Stub retained in crown reduction of a lapsed beech pollard. Dieback has occurred but the lower half of the stub is alive, with some new shoots forming

- When deciding where to prune any part of the crown, try to ensure its future viability as a functional unit (see 4.3.2.3), taking account of the size and viability of the foliage-bearing twig structure that is likely to be present after pruning.
- As far as possible, avoid the creation of large wounds that expose dysfunction-prone central wood in tree species such as beech or hornbeam, which lack durable heartwood [see Table 4.2, Lonsdale (1999) and BSI (2010) for guidance]. Such wounds can become avenues for an overwhelming colonisation by wood-inhabiting fungi.
- If, in order to remove a declining upper crown or to help avoid catastrophic failure, it is necessary to cut large-diameter branches, these should if feasible be shortened, rather than entirely removed, since injury of the parent stem(s) could lead to extensive dysfunction and decay.

Also, allowance should be made for the possibility that future growth might eventually re-establish the former leverage and sail area of the crown or branch (see 4.4.7). For this reason, the following guidance should be followed.

- Try to judge whether the tree is so vigorous that it could grow back to its pre-pruning size within a few years. At worst, such a response will suppress growth lower down, thus leaving no suitable position for further pruning. At best, several stages of pruning are likely to be required to bring the tree down to a mechanically desirable height (see retrenchment pruning in 4.4.4.1).
- Position the pruning cuts so as to retain enough small branches and twigs to produce a good covering of foliage next season. The intention is to stimulate twig growth lower down. This is relatively likely to happen if the stem and major branches already carry a plentiful pre-existing cover of epicormic shoots inside the main canopy. If a further stage of pruning is planned in order to continue reducing the size of the crown (see retrenchment pruning in 4.4.4.1), at least some of this new growth should be retained, since it will help to keep the branch alive (Read, 2000, p. 37).
- If the retained portion of the shortened branch would unavoidably be bare of foliage or lateral branches, use available information to assess whether it is likely to produce new shoots from dormant or adventitious buds. (If not, the branch will eventually die back.) In particular, new shoots are more likely to develop if the bare portion is relatively young (e.g. less than about 60 years old), irrespective of the age of the entire tree or of the base of the branch. Knowledge of previous success or failure, especially on the same site, is also useful.

Unless pruning is urgently required, it should be timed in order to avoid seasonal periods or adverse conditions, when the tree is especially susceptible to wound-induced dieback of the sapwood and inner bark. Thus, pruning should generally be avoided when new foliage is developing and maturing in spring and early summer and also when the tree is entering dormancy in the autumn. Pruning should be avoided also during periods of drought or other episodes of stress. The severity of the stress depends on factors such as soil type and depth, as well as on the tree species. When such episodes have abated, pruning should preferably be deferred further until after the following midsummer.

Summer pruning often gives good results, provided that there is no drought around this time. Pruning in the dormant season is, however, preferable if the intended work would leave substantial areas of bark on the stem or main branches newly exposed to direct sunlight for long periods.

Where it is intended to prune trees that are excessively shaded by nearby trees or scrub, the clearance of the latter (see “haloing” in Chapter 3) should preferably be done two years beforehand. This procedure, which should be followed both for veteran trees and potential new pollards, allows time for the increased penetration of sunlight to stimulate the development of epicormic shoots, which will help to sustain physiological function after pruning (V. Bengtsson, pers. comm.).

Sudden exposure to direct sunlight can overheat the bark and sapwood, not only because of direct heating, but also because the removal of foliage reduces the transpirational flow, together with its cooling effect. Pruning in winter avoids overheating of newly exposed bark but it can lead to dieback around the cuts in the event of freezing weather. Such dieback is thought to occur because water is lost by sublimation from wound surfaces and yet cannot be replenished by translocation.

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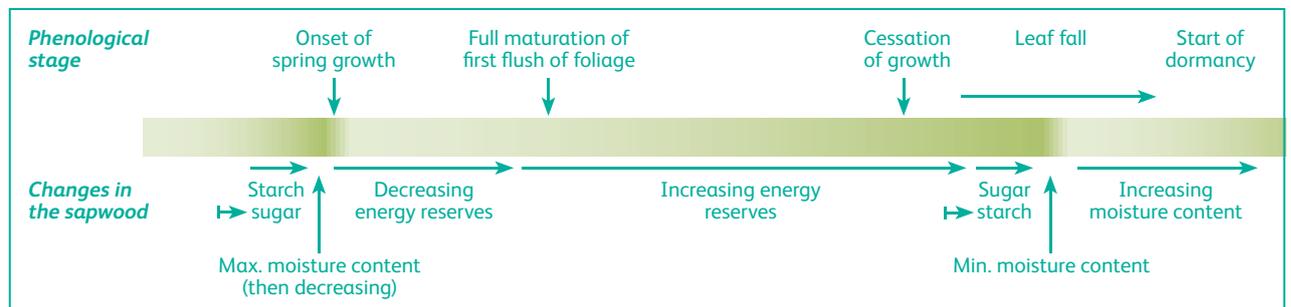


Fig. 4.15: A general guide to relatively “good” and “bad” times of year for pruning deciduous trees. The darker the shading, the better the time for most species

When instructions for work are given, the procedures and timing (including any need to avoid work during unsuitable conditions) should be specified in writing and incorporated in a method statement (see Chapter 7).

4.4.2 Position of cuts when shortening stems or branches

When there is no reasonable option other than to shorten a stem or branch of a lapsed pollard or

The need for further knowledge: pruning in relation to light and shade

An important factor in the ability of the tree to respond to pruning is the subsequent exposure of its foliage to sunlight. It is difficult to get a good balance between light and shade when pruning veteran trees. New shoots often fail to form or die back after forming if a tree of a light-demanding species (see Table 4.2) becomes heavily shaded when reduced below the height of surrounding trees. The latter could be pruned so as to alleviate shading. On the other hand, in a more open-grown situation, pruning can expose the retained stem and branches of the same tree to sudden, excessive sunlight, which tends to induce severe dieback in almost any tree species. Thin-barked species are, however, especially liable to such damage.

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a maiden tree, the question is whether the cut should be (1) immediately distal to a suitable side branch (if present), or (2) at a more distal point, so that a stub is retained. A stub can produce new shoots, which will help to sustain the stem or branch, but the stub will die back if no strongly growing shoots develop. The decision whether to retain a stub should be based mainly on the following guidance.

- There is generally no need to retain a stub if plenty of foliage-bearing twigs are already borne on one or more healthy side-branches near the tip of the portion of the stem or branch to be retained; i.e., at least a single side-branch with a diameter not less than one-third of that of the parent branch, or an equivalent group of smaller branches. (There might, however still be a case for retaining a stub, in order to create a potential decaying wood habitat: see Chapter 5).
- If the portion of the branch or stem to be retained does not already bear plenty of healthy foliage as described above, a stub should be retained and this should preferably be long enough to be out of the shade of other branches for part of the day and to have a reasonable chance of including plenty of dormant buds or areas of bark from which adventitious buds might develop. It is important to assess whether such shoots are likely to develop, using the criteria set out in 4.3.2.4.

A stub may initially be cut to the maximum length that is consistent with the need to reduce the lever arm. In principle, a long stub will include more potential new growing points than a short one and is more likely to retain adequate moisture in its proximal portion, even though the cut end might dry out. In practice, there is evidence that the longer the stub, the more new shoots tend to develop (H. Read, pers. comm.). Also, a long stub is more likely to extend far enough within the crown to receive adequate sunlight.

When creating a stub, a controlled fracture technique, or perhaps coronet cutting, (see 4.4.5) may be employed instead of conventional cutting, in order to provide a more natural appearance and to expose a larger area of inner bark, from which adventitious shoots could develop. A conventional cut is, however, probably a better option if moisture loss from a large surface area is considered likely to cause excessive dieback, either because the conditions are relatively dry or the stub is relatively short. [The use of a non-toxic paint or wound dressing (Lonsdale, 1999) should in principle reduce moisture loss, even though such treatments have largely been discontinued as a means of preventing decay.] Another method that might stimulate shoot production is to score the bark of the retained portion with a timber scribe or similar tool. After the new growth, if any, has developed, the branch may be shortened further in the course of retrenchment pruning [see 4.4.4.1, Read (2000) and Chapter 7, regarding management plans].

Comparison with other guidance: stubs

For most arboricultural purposes, the retention of stubs is considered undesirable, since (apart from aesthetic considerations) they either die back or produce epicormic shoots. The resulting new branches often tend to be weakly attached and can therefore become hazardous unless they are managed by periodic cutting.

In a veteran tree, the capacity to produce epicormic branches from a stub is a natural survival mechanism, which can provide a better leaf-coverage than if no stub has been retained.

If, having failed to produce healthy new shoots, the stub dies back to its attachment to the parent branch or stem, it might become an avenue for the development of decay. This, in turn, might favour the excessive development of decay in the parent stem, but there will have been an opportunity for natural boundary-setting processes to operate and thus to help “compartmentalise” the decay (Shigo & Marx, 1977).

4.4.3 Position and angle of cut when removing a branch

If there is a need to remove a branch entirely, the final pruning cut should be made in accordance with “target pruning” (Shigo, 1989). This avoids the creation of flush cuts, which involve injury of the branch bark ridge and therefore tend to initiate extensive wound-related dysfunction of the xylem in the parent stem or branch. Exceptionally, a flush cut may be created if the intention is to encourage decay for habitat creation; i.e. by veteranisation (see 4.6.2).

4.4.4 One (or two)-stage pruning for relief of mechanical stress

By assessing the condition of the tree, especially in relation to its vitality, vigour and pattern of branch growth, a choice should be made between (1) pruning in one or two stages and (2) a more gradual and progressive reduction (retrenchment pruning – see 4.4.4.1). The latter is more appropriate for many veteran trees, provided that the required reduction in mechanical stress can be accomplished in time to help avert major failure. An urgent need to alleviate mechanical stress could be fulfilled by a relatively severe crown reduction in one or perhaps two stages. Only certain trees are, however, likely to thrive after such treatment, as it removes a large proportion of the foliage-bearing twig structure and, depending on the species concerned (see Table 4.2), can



Fig. 4.16: Lapsed hornbeam pollard, showing good development of a lower crown

involve the creation of large, dysfunction-prone pruning wounds. Severe reduction is appropriate only if needed to help avoid major failure and if the form of the crown is amenable; i.e. there is already a good lower crown structure (Fig. 4.17).



Fig. 4.17: Oak with a well-formed lower crown. In case of a need for height reduction, the upper portion could probably be removed in a single operation, without significant impairment of physiological function

4.4.4.1 Retrenchment pruning

This should be carried out in order to relieve mechanical stress progressively in trees that would probably not tolerate a substantial removal of leaf-bearing twig structure at any one time. Thus, the aim should be to mimic natural retrenchment by reducing the height and spread of the crown in gradual stages. At the first stage, the pruning cuts should be made in small-diameter, relatively young branches, which will usually have enough growing points to produce plenty of lateral growth in response. The plan should, however, allow for the possibility that they will respond to pruning by producing new shoots near the pruning cuts (owing to apical dominance), more than by diverting its resources to the lower crown. If so, further pruning or other options should be adopted in order to regain the intended biomechanical benefit of the process.

Comparison with other guidance: “dynamic” versus “static mass”

The guidance in BS 3998:2010 concentrates on the need to avoid wounding trees severely, since this can cause so much physiological dysfunction and decay that their health or mechanical integrity becomes comprised. According to related guidance from Shigo (1991), trees with extensively damaged sapwood have too low a ratio between their “dynamic mass” (consisting of sapwood and other physiologically functional tissues) and their “static mass” (consisting of physiologically dysfunctional wood and bark: see Chapter 1 in the present guide). This ratio can, however, be very low in veteran trees, which generally have only a very narrow outer shell of sapwood around a large, often partly hollow, heartwood core. Such trees can be very healthy, provided that they maintain good function in the outer shell of sapwood and underlying phloem.

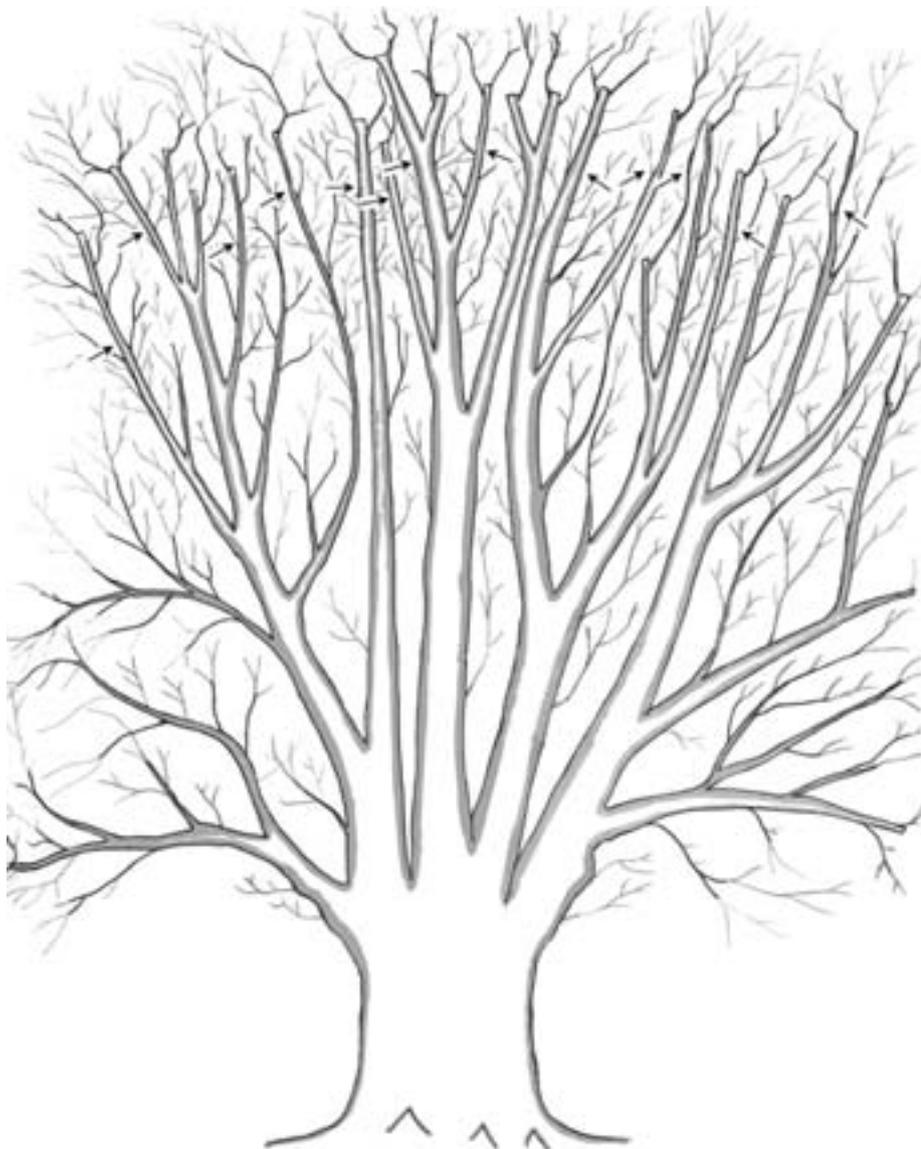


Fig. 4.18: A ripewood-forming species of tree about two years after the first phase of retrenchment pruning. Cut ends show where the branches were pruned. Twigs and small branches that existed before the first cut are shown bold. New twigs are shown faint. Internal shading shows functional sapwood. Aging sapwood and ripewood (including decay columns and cavities) are shown unshaded. Pruning at the first stage was done so as to minimise exposure of ripewood. Later pruning will expose ripewood, but (ideally) only after new growth has enabled a new outer “shell” of sapwood to form unbroken vascular pathways from shoot tips to root tips. Arrows show possible positions for pruning cuts in the next phase, after the lateral branches have grown larger



Fig. 4.19: Beech with crowded pollard branches, some of which are very large. Crown reduction might be the best option in order to avoid catastrophic failure. Removal of large branches near their bases might lead to severe dysfunction

For species that lack durable heartwood (see Table 4.2), the first stage of pruning should if possible be confined to young branches, in which most of the cross-section consists of sapwood, rather than ripewood, and is therefore relatively resistant to extensive fungal colonisation (see text box). Extensive colonisation of ripewood can eventually extend into sapwood that was present before pruning, thus cutting off the supply of moisture to any shoots that might have newly formed in the meantime.

If the final retrenchment cuts are unavoidably going to be large, the work should be done only when the portion of the crown to be retained has become well developed and can therefore help to sustain good physiological function in the stem and roots.

The number of pruning operations, the amounts and locations of material to be removed at each stage and the timescale should preferably be specified in an Individual Tree Management

Plan (ITMP: see Chapter 7), which allows for contingencies such as can occur where the tree does not respond according to initial hopes or expectations. There should at least be sufficient documentation to help ensure that any need for further work will not be forgotten, for example following a change in ownership. In order to decide how to deal with contingencies, an assessment recording form would be helpful.

Trees that repeatedly tend to grow back to their former crown-size

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Damage to fine roots can be caused not only by adverse weather, but also by pathogens such as *Phytophthora* spp. or by mass-feeding by the underground larvae of various insects.

after attempted retrenchment pruning may be managed by means of cyclic cutting, in order to reduce the probability of mechanical failure. Even if the crown begins to undergo retrenchment as intended, the mechanical integrity of the tree should be assessed in order to decide whether further pruning is needed urgently in order to help prevent failure. Otherwise, each successive phase of pruning should be undertaken when the new twigs and foliage have been well established for three or more years, by which time the restoration of energy reserves and of columns of sap flow is likely to be sufficient to enable the tree to tolerate further pruning. Account should therefore be taken of any stress factors, including adverse conditions (e.g. drought or waterlogging) and any loss of leaf area due to pests and diseases. The possibility of damage to physiologically functional roots should also be taken into account, whether this is caused by long-term colonisation by certain decay fungi or the destruction of fine roots.

In addition to tree work, sympathetic site management should be undertaken so as to enhance growing conditions and to encourage processes such as natural layering of branches or phoenix regeneration (see 4.5.3 and Chapter 3).



Until they reach a stage of natural retrenchment, trees of most species can supply enough energy and water to their growing-points to maintain a full crown-size. Thus, they often respond to pruning by growing back to their previous crown-size, without forming a secondary, lower, crown. This growth pattern is the result of apical dominance, which is under hormonal control.

In certain trees, mechanical stress can be alleviated satisfactorily only if the crown is reduced so much that the loss of leaf area and of vascular connections leads to extensive loss of physiological function in the sapwood of the stem and roots (see 4.3.2.4, 4.4.4.1 and 4.5.1). Trees in which such function persists only in discrete axial strips of the stem can, however, sometimes survive for many years.

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Fig. 4.20: Crown reduction of a lapsed pollard ash. This could be scheduled as the first phase of retrenchment pruning if there is a further need to reduce mechanical stress



Fig. 4.21: Relatively severe crown reduction of lapsed ash pollards, followed by vigorous new growth. Such treatment is unsuitable for species that do not readily respond with vigorous new growth

Table 4.1: Potential pros and cons of different options for pruning*

Options (and comments on their practicability)	Shoot production	Dysfunction and decay	Mechanical integrity	Suitability according to tree condition and species
(1) VERY GRADUAL (starting with tip pruning at stage 1) • tree workers need to gain access high in the crown (by climbing or use of platforms), at the first and successive stages	• plenty of buds are available for new shoot growth	• cutting into mainly functional sapwood minimises wound-related dysfunction and decay	• new growth sometimes occurs only near the cuts, defeating the object of height reduction • the growth is often denser than the former crown periphery, shading the lower crown and perhaps adding to the sail-area; this requires a demanding programme of follow-up work	• mainly for trees that are beginning to show natural retrenchment, but not enough to avert major failure
(2) GRADUAL (starting nearer ground-level than in option (1)) • tree workers' access is likely to be less difficult than in (1)	• cutting into older wood might leave rather few dormant buds for new growth	• cutting into non-durable older wood (see species info in Table 4.2) can lead to extensive dysfunction (involving also sapwood), followed by decay • removal of a large proportion of leaf-bearing twig structure depletes energy reserves and hence resistance to excessive fungal colonisation	• new growth, if successful, starts closer to the ground than in (1); the first step towards retrenchment	• useful for trees with good vigour and vitality but impaired mechanical integrity
(3) ONE-OFF (cutting at or near the final desired height and spread of the crown) • easier access for workers in future operations	• cutting into old bark and wood might leave too few dormant buds for new growth, depending partly on species • adventitious buds readily form in certain spp. (e.g. yew), even on old bark	• as in option (2), but more of a risk of massive dysfunction and decay • depletion of energy reserves is greater than in (1) or (2), perhaps accelerating root decay; perhaps a problem if certain fungi such as <i>Meripilus giganteus</i> are present	• new growth (if successful) starts at the desired final height	• mainly for trees already having a good lower crown or showing enough existing shoots to form such a crown

* Note: This table applies only when pruning has been identified as a suitable form of management. Non-intervention is often the best option.

Table 4.2: Species characteristics to take into account before pruning*

Species	Light requirement †	Epicormic shoot production	Decay resistance	
			Type of central, age-altered wood	Resistance of sapwood
Oak (pedunculate and sessile)	★★★★	★★★(★★)	Durable heartwood	High
Sweet chestnut	★★★★	★★★	Durable heartwood	High
Yew ‡	★	★★★★★	Durable heartwood	High
Scots pine	★★★★★		Heartwood of variable durability	Moderate
Ash	★★★★★	★★★	Non-durable heartwood	High
Birch (silver and downy)	★★★★	★	No distinct heartwood	Low
Alder	★★★	★★★	No distinct heartwood	Low
Hawthorn	★★	★★★	No distinct heartwood	Moderate
Willow (all spp.)	★★★★★	★★★★★	No distinct heartwood	Low
Black poplar	★★★★★	★★★★	Non-durable heartwood	Low
Beech ‡	★★	★★(★)	No distinct heartwood	Moderate
Hornbeam	★★	★★★	No distinct heartwood	Moderate
Lime (all spp.)	★★★	★★★★★	No distinct heartwood	High
Field maple	★★★	★★★	No distinct heartwood	Moderate
Sycamore	★★★	★★★	No distinct heartwood	Moderate
Holly	★★	★★	No distinct heartwood	High (?)

* 5 stars = very high; no stars = zero or negligible; brackets indicate considerable variation among individuals or according to age.
 † including information provided by Prof. Julian Evans (pers. comm.) and from an analysis of the international literature by Niinemets & Valladares (2006).
 ‡ **Note:** Although experience in the UK indicates that beech is not quite as shade-tolerant as yew, these species are ranked in the reverse order according to Niinemets & Valladares and to earlier work by Ellenberg (1986).

Examples

Yew (*Taxus baccata*): owing to very high shade tolerance, abundant epicormic production and durability of heartwood, yew is usually very amenable to pruning but can be killed if the subsequent conditions are desiccating.

Beech (*Fagus sylvatica*): despite high shade tolerance, beech is relatively likely to die back after severe cutting, since it often tends to produce relatively few epicormic shoots. Also, its lack of durable heartwood often leads to excessive development of decay.

Lime (*Tilia* spp.): despite lack of a durable heartwood, lime produces sufficient shoots to survive well after pruning and has very well-defended sapwood.

Ash (*Fraxinus excelsior*): ash has a marked capacity to produce new stems or branches after major mechanical failure, by retaining a viable wall of sapwood around a hollow centre and by producing adventitious shoots.

The need for further knowledge: retrenchment pruning

Retrenchment pruning seems to make good sense in principle because it is designed to mimic natural retrenchment. Similar work has been done successfully in various undocumented cases over many years. Retrenchment pruning of veteran trees is, however, a relatively new technique and so there is a need to assess its efficacy and perhaps revise the guidance, if necessary, by monitoring the condition of trees that have been managed in this way.

4.4.5 Mimicking natural breakages when shortening stems or branches

If a stub is to be retained, either for the reasons stated above, or when a tree is to be reduced to a “monolith” (see Fig. 4.24), unconventional methods of cutting or fracturing (not recommended in BS 3998) may be employed, subject to the following considerations:

- The shortening of the structure using a conventional saw-cut helps to prevent catastrophic failure but it will not provide shattered ends, which are thought to enable colonisation by various rare saproxylic species. This potential loss of habitat can be mitigated by simulating fracture.
- The appearance of a sawn surface is unnatural and can therefore detract from the aesthetic value that a veteran tree has for many people.

The methods include natural fracture (rip) cutting (Fig. 4.22) and coronet cutting (Figs. 4.23, 4.24). Rip cutting involves the omission or unconventional placement of an undercut, so that bark



Fig. 4.22: Natural fracture pruning of beech. In this instance, the aim is to mimic natural storm damage and to enhance habitats associated with decay in branch stubs

The need for further knowledge: accelerated crown reduction

Improved guidance is needed regarding trees that appear more amenable to relatively severe crown reduction in the short term than to retrenchment pruning. The former appears to be most successful in trees that already have a good lower crown structure. Apart from the obvious value of reducing mechanical stress sooner rather than later, there could in theory be a physiological advantage in removing or shortening sparsely foliated branches. The thinking behind this idea is that there is some benefit in removing parts of the woody structure that bear too little foliage to “pay their way” in the form of carbohydrates that are essential for maintaining the growth and vitality of the sapwood. The abundance of growth that often follows cutting seems to support this idea to some extent, but could simply be the result of pre-existing reserves being less sparsely distributed and by water being transported along a shortened distance from the roots. Further research would therefore be valuable.

and wood are torn away on the underside of the cut when the severed portion falls. Coronet cutting has been devised mainly for dead trees, which are to be reduced in size for stability but it may also be used on living trees in order to mimic the appearance of a natural fracture, where this is considered important. Also, account should be taken of the suggestion (not currently tested in practice) that the large and dissected surface of a coronet cut is more likely to be colonised by a succession of relatively benign decay fungi, rather than those that have the capacity to colonise functional sapwood. In order to create a coronet cut, the branch or stem should be cut so as to leave a stub. This should then be dissected by several diagonal cuts, leaving jagged points (Figs. 4.23 and 4.24) (Fay, 2003). Despite the term “coronet”, the aim should not be to produce an artificial-looking symmetrical coronet. Also, from an aesthetic point of view, it is arguably undesirable to avoid cutting every branch in this manner. A mixture of coronet cuts, rip cuts and a few conventional cuts is therefore probably more suitable.

Anyone considering coronet cutting should take account of the additional labour costs, the increased use of chainsaw fuel and the need for appropriate training (see 4.7).

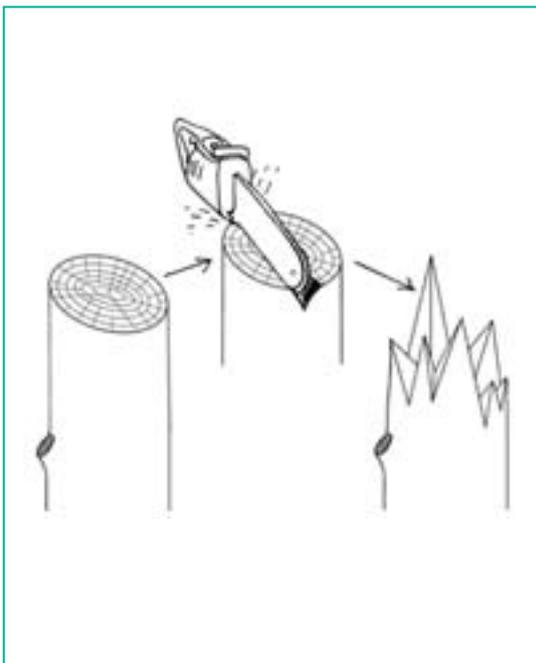


Fig. 4.23: Creation of coronet cuts, following the shortening of a stem or branch



Fig. 4.24: Coronet cuts on a dead tree, reduced in height to a “monolith” to prolong safe retention

In species that contain durable heartwood (e.g. yew or Pedunculate or Sessile oak), the dead branches often persist for many years, since they have a durable core of heartwood. In other species (e.g. beech or ash), decay occurs throughout the branch cross-section, often leading to failure within a few years. Also, the moisture content of the wood, as influenced by climate and micro-climate, influences the pattern of decay in dead branches. Irrespective of the mode of failure of dead branches, it is generally of little concern with regard to the overall mechanical integrity of the tree, since it rarely results in the creation of the kind of “tear-out” wounds that can occur when live branches fail.

Dead branches provide important habitats, which are different to the habitats in the decaying central wood of a veteran tree (see Chapter 5).

4.4.6 Management of dead, attached wood

If a dead branch overhangs an area occupied by people or property, the risk should be assessed and if necessary mitigated by shortening or removing the branch. Otherwise, dead branches should be retained for the habitats that they uniquely provide for many species, some of which are endangered. Habitat should equally be taken into account if living parts of the tree that contain heart-rot are being considered for removal.

4.4.7 Continued management after pruning

After a tree is pruned, it should be monitored in order to decide if and when further work is needed in order to safeguard its biomechanical integrity. This could result (1) from the increasing length and weight of new branches, (2) from the extension of pre-existing decay or (3) from the development of new decay in association with the pruning wounds. Also, further pruning may be scheduled under a programme of retrenchment pruning (see 4.4.4.1).

4.4.8 Pruning or removal of climbing plants or mistletoe

Ivy or other climbing plants should be controlled where they are evidently increasing the probability of tree failure, or shading out epicormic shoots or rare species of lichen or bryophyte. Such plants may be pruned, removed or otherwise cut in accordance with standard arboricultural guidance and with the guidance for habitat protection in Chapter 5 of the present book. Equally, however, care should be taken to minimise the loss of habitats that are associated with the climbing plant concerned.

4.5 MANAGEMENT OF PARTICULAR CATEGORIES OF VETERAN TREE

4.5.1 Management of lapsed and restored pollards

If a pollard has not been managed by cyclic cutting for a period much longer than the traditional cycle (i.e. it is a lapsed pollard), it should preferably never be cut back to the original pollard points, in which case extensive physiological dysfunction would probably develop (see 4.4). Such a tree should be managed by crown reduction if there is a need to help prevent failure. If, however, the tree has already been “restored” by cutting back to the original pollard points, it should be kept under traditional cyclic management. The cuts should then be made only into wood that has developed since the previous cycle, retaining at least a few nodes from which buds could grow into new shoots. A proportion of the branches should be retained all round the bolling in order to sustain

Comparison with other guidance: pole thinning

Pole thinning has sometimes been used traditionally in the cyclic management of pollards. It is used occasionally to manage urban pollards but is otherwise rarely practised in arboriculture. By helping to maintain physiologically functional channels, it is a useful alternative to the removal of all the new growth. The latter practice can, however, be tolerated if the tree has high vitality and vigour, especially if the species concerned readily forms adventitious shoots (e.g. in the case of poplars and willows).



Fig. 4.25: A relatively young beech, several years after initial pollarding. It is better to start a pollard much sooner, thus involving smaller cuts, but the aim was to help fill a gap in the succession of beech pollards

columns of living tissue. This may be achieved by pole thinning, whereby only the larger branches are cut, thus relieving the mechanical load on the bolling and leaving the smaller branches to maintain the functional columns. The length of the cycle should be decided according to the length and weight of the new branches and their strength of attachment to the bolling.

4.5.2 Creation of new pollards

New pollards should be created from maiden trees where this is necessary to provide a succession of veteran pollards. The recommendations in BS 3998:2010 (BSI, 2010) should be followed. Key aspects of those recommendations include the following:

- Pollarding should preferably be initiated when the stem is between 25 mm and 50 mm in diameter at the selected height of pollarding (often 2 m to 3 m).
- In order to maintain physiological function, some of the pre-existing foliage should be retained, preferably by retaining a “candelabra” framework of branch bases, rather than making a single cut across the stem. This precaution should always be observed if the stem is more than 50 mm in diameter, subject to a maximum recommended diameter of 200 mm.

The need for further knowledge: pole thinning of lapsed pollards

Further study is required to find whether pole thinning might be helpful in the management of lapsed pollards that have not yet been cut again. In a small proportion of such trees, the natural failure of individual branches appears to have stimulated the development of epicormic shoots, which have formed a secondary lower crown, thus making the tree more amenable to subsequent reduction of the primary crown. It seems likely that pole thinning could emulate this beneficial process, but further study is required before this can be recommended. In any case, there would often be a need for an accompanying first stage of retrenchment pruning, in order to lessen the probability of failure of the retained pollard branches.

Comparison with other guidance: pollarding

The techniques and skills of traditional pollarding were learnt orally and by example and were therefore largely unrecorded. Now that the last generation of practitioners is no longer alive, it is possible only to make informed guesses about practices that succeeded and those that failed. In the Basque Country of the Spanish Pyrenees, where traditional cutting of beech pollards still continues, studies have been taking place in order to compare the results of traditional cutting and of methods that are used in the UK (Read *et al.*, 2011). Differences in the age of the trees and in climate make comparisons with British pollards difficult, but there is evidence of a positive relationship between stub-length and the production of new shoots.

4.5.3 Intervention to assist layering and phoenix regeneration

Where low branches (Figs. 4.7, 4.26) or the branches of a partially uprooted tree are resting on the ground, new root systems can become established, thus helping to stabilise the tree or to perpetuate its survival (Read, 2000). Intervention may be attempted in order to ensure the success of natural layering (known as phoenix regeneration in the case of fallen stems).

- If low branches have not yet bent down far enough to rest on the ground, try to determine whether they are likely to do so without first snapping or tearing away from the tree.
- Branches that are likely to snap before reaching the ground could be cut partially, just sufficiently to come into ground contact while retaining a good vascular connection with the tree. (But also see below, regarding the prevention of natural ground contact due to browsing by livestock.)
- A possible alternative to partial cutting of branches is to bring them into ground contact by creating mounds into which layering can occur. The mounds should incorporate coarse material such as gravel, so as to help maintain adequate aeration and moisture supply for the tree's existing root system. Also, the material should have a similar pH to the existing soil and should preferably be of local origin.
- If attached branches have naturally come to rest on the ground but have not layered naturally, they could be pegged down so as to restrict movement, which might otherwise be preventing the establishment of roots.
- If less than approximately a third of a fallen tree's root system is still in the ground, action may be taken in order to protect it from desiccation and otherwise to aid its survival until

phoenix regeneration begins. A decision whether to attempt such protection should take account of the following factors:

- the species of tree
- the previous vitality of the tree
- climate and weather
- soil type
- the degree of exposure to direct sunlight.
- If desiccation is a cause for concern, part of the exposed root system may be protected by mounding soil over it. Additionally, artificial shading of the fallen stem and the foliage from strong sunlight may be provided if feasible. Also, in very dry weather, watering at the base of the tree and around the potential area of new rooting may be undertaken if this is practicable and if the water supply is sufficient to maintain moist conditions.
- In some cases, survival of a partially uprooted tree is threatened more by excessive shading than by desiccation. If so, a proportion of overhanging foliage may be removed, provided that this would not harm other valuable trees.

Layering has been observed in many tree species, ranging from hornbeam to yew, and could probably occur in almost any species. However, certain species, such as poplars and willows, produce adventitious roots more easily than others. Also, the requirement for the protection of the phoenix foliage from browsing will depend on the browsing pressure, which in turn depends partly on the type of livestock concerned. Another factor is the time required for the phoenix stem(s) to extend above browsing height.

- Where living branches or prostrate stems are in contact with the ground or just above it, they should be protected from browsing and disturbance by livestock (see Chapter 3), as this often prevents layering and phoenix regeneration.



Fig. 4.26: Partial breakage of a low branch, now in ground contact and stabilised by a downward pointing side-branch. The branch has capacity for layering but the fracture surface is an avenue for increased development of decay

4.5.4 Management of lapsed coppice

Like the branches of lapsed pollards, the stems of coppiced trees can fail if they become excessively long and end-weighted. Intervention to help prevent failure can, in some cases, prolong the life of the tree or mitigate an unacceptable risk to people or property. The decision whether to intervene rests largely on the same considerations that apply to lapsed pollards or maiden trees, with regard both to the rationale of the objectives and to the prospects of obtaining good survival and growth after cutting.

With regard to the objectives, the values that are specific to veteran coppice cannot be fully protected by reversion to a conventional coppicing cycle, which could break the continuity of various saproxylic habitats (see Chapter 5).

With regard to the development and survival of new coppice growth, the following pros and cons should be taken into account.

- If a coppiced tree loses all its stems by failure at ground level, it is likely to die unless new shoots develop from its root system; such shoots occur in some species (e.g. hazel) but are rare in others (e.g. ash, despite its ability to initiate shoots above ground level).
- Lack of light is likely to be more of a problem for shoots near the ground than for those developing after pollarding or crown reduction, especially in woodland, where most coppiced trees occur.

The term “stored coppice” is sometimes used to describe lapsed or neglected coppice, but is also used in a more restricted sense to describe coppiced stems that are individually retained beyond their normal maximum coppice cycle.

BACKGROUND

INTRODUCTION

SURVEY/EVALUATION

PROTECTION

TREE WORK: ASSESSMENT

HABITAT

LANDSCAPE

PLANS & SPECIFICATIONS

- Shoots arising near the ground (unlike pollard shoots) are highly susceptible to grazing and browsing. Repeated destruction of new shoots in this way can kill coppice stools.

On the other hand, new shoots that develop on a coppice stool are so close to the existing root system that vascular connections can rapidly be formed between them and the roots. If the shoots are partly below soil level, they will probably also produce adventitious roots. This makes them independent of the pre-existing sapwood, which is likely to decay eventually. (In pollards, the greater distance between shoots and roots can increase the probability of dieback.)

4.5.4.1 Assessing the pros and cons of cutting coppice stems

The following items are not necessarily either pros and cons in an absolute sense, but should influence the scale and phasing of the work in relation to the size of the total area being managed. Stand-composition and habitat on the adjoining land should also be taken into account.

Comparison with other guidance: size of coupe

Agate (2002) advises that coupes in coppice woodlands should be as large as possible within the planned rotation (and also roughly square in shape), so that they do not have a high edge to area ratio, which would encourage deer to enter from the surrounding area.

Fuller & Warren (1993) state that, from the early Middle Ages until the late nineteenth century, most woods in lowland England were coppiced, with an interval of cutting ranging typically between five and 20 years. Over those centuries, this traditional practice profoundly influenced the assemblages of plants, animals and fungi now found in many semi-natural woods.

- If a coppice stem appears likely to break away from the stool, try to determine whether there is any need to prevent this from happening; for example to mitigate a risk to people or property. In many cases, the growth of new stems enables the stool to survive without intervention (Fig. 4.27). The remaining stems will cast shade on to the new stems but they probably act as an energy source for the latter, aiding their establishment and survival.
- If coppiced trees occur in woodland, plan their management in the context of the overall structure of the woodland. In particular, when selecting stools for cutting, try to ensure that they do not become excessively shaded, as can happen rapidly if individual stools are cut. Conversely, if relatively large coupes are to be created, take account of the potentially prohibitive cost of protecting the new growth from browsing animals. (If necessary, seek advice or consult handbooks such as those published by the Forestry Commission or the British Trust for Conservation Volunteers.
- Take account of the possible presence of species that are often supported by lapsed coppice in woodland, and that do not occur in actively managed coppice. These species will be adversely affected if the canopy is opened up and if standing decaying wood is cut.
- Allow for the possibility that lapsed coppice woodland will lack enough flowering undergrowth to support the adult stages of saproxylic insects that need nectar and pollen. Bramble, bindweed or thistles could be the main species to respond. They will provide nectar and pollen, but some control of bramble might be necessary to encourage less competitive plants.
- Make allowance also for the many saproxylic and other invertebrates that depend on the “sap runs” that often occur on old coppice stems; it is important to avoid destroying this habitat feature.
- Take account of species of fauna and flora that require the fallen, decaying stems that occur in areas of lapsed coppice. If planning to cut, try to assess the feasibility of keeping such stems shaded so as to remain in a suitably moist condition for the dependent species. Also, these logs should be supplemented by retaining some of the smaller-diameter material that would be cut.

Responses of different tree species to coppicing

Harmer & Howe (2003) tabulated the rates of stool survival and shoot growth in nineteen species in southern England, surveyed 2-3 years after cutting. Mortality was relatively high in birch (36%), alder (32%), oak (25%), beech (16%) and ash (11%), but zero in aspen, elder, Field maple, lime, rowan and Wild cherry. Very little mortality occurred also in hazel (Harmer, 2004).

The presence of dormant buds is an important factor in the response to cutting. Such buds are formed by all species that are traditionally coppiced but some species retain few buds in a viable state by the time that their stems are old enough to have very thick bark. If, however, epicormic growth is present, it will bear a new generation of dormant buds.

Adventitious buds are sometimes the source of new growth after cutting or natural fracture. Most species can produce them but no reliance can be placed on this unless local experience suggests otherwise. Only certain species (e.g. hazel) regularly produce adventitious buds from roots throughout life; these species can therefore survive being cut very close to the ground.

4.5.4.2 Size of coupe

Where veteran coppice stools are present, it is likely that each stool will need to be managed according to its particular condition, in which case the creation of a conventional coupe is likely to be inappropriate. It is, however, essential to ensure that sufficient sunlight reaches any stools that are re-cut. Also, if any veteran pollards or maiden trees have become shaded by lapsed coppice, the cutting of the latter will need to be controlled carefully in order to remove the shade gradually (see the guidance for haloing in Chapter 3).

4.5.4.3 Time of year to cut coppice stems

In principle, coppice stems should preferably be cut during dormancy (between late autumn and early spring), when the most energy is stored in the roots. Available information indicates that this tends to give the best results in practice, with regard to the survival of cut stems and the production and growth of new shoots.

Suppressed buds are usually the source of new coppice shoots. If the stem is cut after these buds have become seasonally dormant, they are unlikely to form shoots until the following year.



Fig. 4.27: Lapsed ash coppice stools often survive episodic fracture by readily producing stems, initiated above ground level. Avoidance of excessive shading or repeated browsing might suffice as far as management is concerned

4.5.4.4 Age and size of coppice stems suitable for cutting

Even if coppicing has lapsed over many years, the stems may be cut, provided that the possible death of some of the stools concerned can be accepted. Experience indicates that this becomes likely when the stems are more than 40 years old in the case of hazel and 50 years old in other species.

4.5.4.5 Where to cut when bringing lapsed coppice into management

If a decision is made to try to prevent mechanical failure, some form of cutting is usually the only practicable option. If, however, the stems are more than 40 or 50 years old (see 4.5.4.4, above), cutting at the conventional height for cyclic coppicing could lead to death of the stools. In order to help overcome a potentially poor response to the cutting of old coppice stems, the following methods may be adopted.

- **Cut higher than would be usual for in-cycle coppice**, unless experience with the site and species shows that the stools are likely to respond well to conventional cutting. As a very rough guide, aim to retain a length of stem (stub) of approx. 450 mm above the stool. Anything shorter than this might be insufficient to carry enough dormant buds for new growth. Longer stubs may be retained if the intention is to manage the tree as a coppard (see below in this Section), rather than to restore a coppicing cycle.
- **If the stool has any stems that are obviously younger than those that formed in response to the last coppice cut, retain these** (perhaps with a reduction in height: see below) in order to help ensure that the stool retains some living growth even if the older stems die back after cutting. (This is akin to pole thinning in lapsed pollards; see 4.5.1.)
- **If, as a result of retaining a proportion of stems, the new shoots would be excessively shaded, shorten the retained stems sufficiently to admit dappled sunlight.** As with pollarding, take into account the shade-tolerance of the species concerned (see Table 4.2).
- **In order to minimise the loss of the saproxylic habitats associated with standing older wood**, initially cut a proportion of the stems at a height of approx. two to three metres and then manage the new growth as for pollards. If this option of creating coppards is

chosen, their exposure to sunlight should be carefully assessed (i.e. in order to avoid desiccating conditions at one extreme or excessive shade at the other). Also, the length of the pollard branches might need to be carefully restricted in order to help prevent failure at the stool.

BACKGROUND Old coppice stems, when cut, tend to produce fewer shoots than relatively young ones. This is probably due to a decline in vigour and/or a thickening of the bark, rather than an inherent effect of aging. Younger stems appear to produce more shoots if they are relatively large in diameter, but information about this seems unclear and inconsistent between species.

BACKGROUND Even when coppice is in-cycle, the death of low-cut stems (e.g. less than 15 cm above ground level) is more frequent than that of high-cut stems (e.g. 75 cm or more). On the other hand, stems cut very close to ground level sometimes show an intermediate frequency of survival, perhaps owing to stimulation of shoot production below ground.

4.5.4.6 Where to cut when managing new growth

- If old coppice stems have been cut near ground level and have then produced new growth, this may be managed according to general guidance for coppice management by cyclic cutting at the height that is usual for the species concerned.
- If long stubs have been initially retained and have then produced numerous strongly developed shoots near ground level, any shoots of higher origin may be removed, either individually or by cutting the portion of the stub that bears them.
- New shoots should not be selectively removed if they have arisen mainly from near the cut ends of long stubs,

with few if any of them arising closer to the ground. In order to help prevent the new stems from becoming unstable, they might require cutting on a relatively short cycle, either as high coppice or as coppards.

- If old coppice stems have been cut in order to create coppards (see 4.5.4.5), their subsequent management should be as for restored pollards (see 4.5.1).



Fig. 4.28: Failure of stems in a lapsed coppice stool of hornbeam. New shoots are developing but might not survive browsing or shading

4.5.4.7 How to cut coppice stems

General guidance on the choice and use of tools in coppicing (e.g. choice of billhooks or saws for different sizes of stem) is provided by Agate (2002).

Coppicing cuts are traditionally sloped. This is probably because sloping cuts are a natural consequence of using a billhook (or axe). If, however, the large-diameter stems of lapsed coppice are to be cut, a saw will usually be the chosen tool. If so, a sloping cut might be more difficult to create than a flat one, but is nevertheless preferable if it slopes downwards towards the outside; this helps to provide a better shape of stool for future cutting. Recommendations for sloping cuts have often been made also on the basis that they are thought to lead to less decay because they more readily shed rainwater. There is no good evidence for any better survival of sloping vs. flat-cut stumps, nor any theoretical reason to believe that drier surfaces will discourage extensive decay.

If, owing to severe dysfunction and decay of the stool, the new growth is likely to break away or die back, it could be layered (see Section 4.5.3), as in traditional coppice restoration.

Comparison with other guidance: cut material

Agate (2002) states that all cut material should be removed from the coupe and the adjacent rides in order to deter browsing damage. Such material would otherwise create shelter where deer would lie up near the stools.

4.5.4.8 Management of the cut material

The sale of the cut material can provide useful income to support conservation management. At least some of the logs should, however, be retained on site if practicable, in order to avoid removing all the potential decaying wood habitat (see Chapter 5), together with all the mineral nutrients that are locked up in the wood and bark. Logs to be sold should either be removed from the site before they

become a “decoy” for saproxylic invertebrates (i.e. not left lying during spring and summer), or after two years, when most of the species concerned will have completed their life cycles (K.N.A. Alexander pers. comm.).

Comparison with other guidance: coppice stub length

In the management of coppice, there are various arguments in favour of retaining either short or tall stubs. Also there is a tradition that coppice cuts are sloped.

Traditionally, hazel is cut as close to the ground as possible, partly to help avoid the formation of stems with curved butt-ends, which are of low value as poles; this is a consideration where income is needed to help finance management.

Also, hazel readily produces new stems from below ground, which are likely to develop their own root systems, by virtue of contact with the soil, and thus less likely to fail by tearing away from the decaying stub. Hazel stools are said to become brittle with age and likely to fail.

In contrast, ash or elm have often been cut traditionally at a height of 300-900 mm above ground (Fig. 4.27).

4.5.4.9 Protection of new coppice growth

Protection of new coppice growth is very important, since grazing and browsing will at least delay the development of new stems and can, at worst, kill stools throughout a coupe. Information on protection of new growth is provided in Chapter 3.

The removal of the cut material, in order to avoid creating lying-up places for deer (Agate, 2002) is compatible with commercial utilisation, but see 4.5.4.8 regarding the retention of logs *in situ* for saproxylic species. If deer are likely to shelter among decaying habitat and if it is impracticable to fence the area as a whole against them, any veteran coppice stools that have been cut should be individually protected.

4.5.5 Management of veteran fruit trees

In most respects, veteran fruit trees should be managed like veterans of other species, in order to ensure continuity of the range of very valuable habitats that traditional fruit orchards provide (Lush *et al.*, 2009). There are, however, a number of special practices and special requirements in orchards that should be taken into account, as follows:

- Regulated pruning is one of the main methods of pruning for fruit production. It involves “*the removal of entire branches, rather than individual laterals and spurs, with the emphasis on the removal of crowded or crossing branches and diseased or damaged wood*” (NE, 2008a).
- The seasonal accumulation of heavy fruit is an additional factor in assessing the possible need for tree work to help prevent mechanical failure.
- There are certain diseases, such as silver leaf and Nectria canker that are especially prevalent in rosaceous fruit trees. Some aspects of pruning practice in fruit trees are designed to minimise such diseases.

- Orchard management sometimes includes crown lifting to allow access for mowers or other machinery; this is generally inappropriate for veteran tree management.
- Some veteran fruit trees represent rare varieties, which are of genetic conservation value.

Since regulated pruning can expose physiologically dysfunctional wood in the centres of large branches, the alternative technique of ‘renewal pruning’ should be chosen in preference for veteran fruit trees. It is “a method of pruning standard trees, effectively a compromise between regulated and spur pruning. It follows a similar approach to regulated pruning, but is applied to each limb individually rather than the tree as a whole”.

Comparison with other guidance: fruit tree management

In some instances, veteran fruit trees are managed for fruit production; in most respects this is compatible with management for other aspects of their value as veterans but involves particular kinds of training and pruning, especially regulated pruning (see the main text for a description).

If the pruning wounds created in regulated pruning are not very large in relation to the parent stem, the extent of any resulting decay is unlikely to present serious problems for future management. In any case, it seems likely that such wounds have often had the beneficial effect of leading to the formation of cavities, which provide habitat for species such as the Noble chafer *Gnorimus nobilis* (see Chapter 5).

In the pruning of fruit trees, stubs are generally not retained, since they tend to become colonised by pathogens such as *Nectria* spp., which cause cankers, and *Chondrostereum purpureum*, which causes silver leaf (NE, 2008d). There is some potential for conflict with objectives for veteran tree management, where retention of a stub can improve the chances of new shoots developing from an old branch that needs to be shortened to help prevent mechanical failure. It is, however, rare for fruit trees to remain unmanaged long enough to have branches in such a condition.

The season of pruning is of particular importance in the management of fruit trees, since silver leaf is least likely to occur in stone fruits (*Prunus* spp.) if pruning is confined to the period mid-May to early September (NE, 2008b). This is somewhat more restrictive than the guidance for the pruning of other kinds of tree.

Another aspect of disease control in fruit trees is sanitation, involving the burning of diseased wood that has been pruned from trees (NE, 2008c). This could conflict with the retention of cut or fallen deadwood for habitat conservation, but it need not be a serious problem if sanitation is practised only when necessary.

4.6 SPECIAL KINDS OF TREE WORK

4.6.1 Tree work for protection against fire and lightning

Methods for protecting trees against fire are outlined in Chapter 3 (tree protection). These include the sealing or filling of open cavities in order to deter arson and to prevent the cavity from igniting if surrounding vegetation catches fire. Since there is no established method of obstructing cavities without also disturbing natural processes, such as the occlusion of cavity openings or access by wildlife, cavities should not be obstructed unless the risk warrants it. Chapter 3 mentions the installation of lightning conductors in circumstances where the risk of harm from lightning is assessed as being exceptionally high.

4.6.2 Veteranisation

Veteranisation (see Chapter 5 in relation to habitat continuity) differs from other practices since it is undertaken in the interests of continuity of saproxylic habitats; not of enhancing the longevity of the tree. Since it might shorten the life of the tree, it should be attempted only where there are enough trees to be left without such treatment and where there is an exceptional need; for



Fig. 4.29: Veteranisation of a semi-mature tree. This is an extreme example; the main objective was to prevent the tree from competing with veteran oaks nearby

example, because the site contains very few existing veterans and no late-mature trees as potential successors in the short to medium-term. The aim should be to mimic natural processes in which decay columns and associated habitats develop as a result of the exposure of wood to fungal colonisation and aeration. The treatment should generally be mild enough to allow the tree to survive for many years. If, however, plenty of relatively young trees are available, some of them may be damaged harshly (e.g., as in Fig. 4.29) in order to develop the kinds of habitat that might develop naturally after major storm damage.

The following techniques, among others, may be used in veteranisation, subject to appropriate safe working practices (see below):

- flush cutting (which is not appropriate in other circumstances: see BS 3998:2010), in order to simulate the damage that can occur when branches tear away from their attachments
- creation of V-cuts into the stem in order to encourage the development of strips of dysfunction and decay
- bruising of the stem base, for example with a sledgehammer, in order to encourage basal decay
- ring-barking at a suitable height, in order to cause dieback and decay higher in the tree
- breakage of branches (e.g. by throwing a cable and hauling on it) in order to create jagged stubs or tear-out wounds.

4.7 SAFE WORKING PRACTICES FOR INNOVATIVE OR SPECIALISED TECHNIQUES

Most of the techniques mentioned in the present guide are used conventionally in arboriculture and land management. Except with regard to the practices itemised below, guidance on safe working practices should therefore be taken from the sources that apply to arboriculture and other relevant industries. The need for special safety measures applies as follows:

- **Protection of veteran trees during work – general:** Since veteran trees and surrounding habitats are often very vulnerable to damage, it is important to avoid incidental harm to the

trees or to other valuable site features. This applies particularly to the need to avoid injuring parts of the tree beneath a working position (e.g. from falling branches).

- **Protection of operators – general:** The branches of veteran trees are often weakened by decay, with a consequent risk of harm to climbers and to operators on the ground below. Assessment of this risk should be done before work starts and should continue during the course of the work, so as to decide whether special precautions are needed.
- **Options for using platforms or cranes in order to protect operators:** If, by climbing the tree, the operator would be unduly at risk of injury or unable to gain comfortable access to parts of the crown that are to be pruned, a mobile elevated work platform (MEWP) should be used instead. If such a platform (or a crane for the safe manoeuvring of cut material) is to be used, the guidance in Chapter 3 should be followed, in order to minimise any resulting disturbance or compaction that might harm the rooting zones of trees or wildlife habitats. Also, if a Scheduled Monument is present within any part of the potential work area, specialist advice should be sought regarding the use of any heavy machinery.
- **Controlled fracture (rip) cutting:** If this method of pruning is employed, control of branch-fall is more difficult than in conventional cutting, since detachment of the severed portion occurs in a less predictable manner. Rip cutting should therefore be attempted only on branches that can be allowed to fall without any significant risk to people, property or parts of the tree beneath the working position. Also, such work should be undertaken only by operators with relevant training and experience, using appropriate equipment. The same applies to the breakage of branches by means of hauling on a cable.
- **Coronet cutting:** Coronet cutting involves the unconventional use of a chainsaw, since the angle of cut is approximately 15° from the axis of the branch, rather than across the grain. This increases the risk of “kick-back” of the saw and there might also be some further loss of control if the operator cannot adopt an optimum body position. The following precautions are therefore appropriate, so as to improve the ease of operation and to safeguard the operator.
 - Special training should be provided, not only for coronet cutting *per se* but also for safety, especially regarding the adoption of a safe working position. For information on sources of training, consult the website of the Ancient Tree Forum (www.ancient-tree-forum.org.uk).
 - A relatively lightweight chainsaw should be used, commensurate with the power and guidebar length required, so as to reduce operator fatigue. Also, a special type of guidebar (a “carving bar”) should be used if practicable; this has a sharp nose and can therefore be used with improved accuracy.
 - A rip chain should be used in preference to a crosscut chain, to help avoid clogging of the chain and thus the risk of jamming and kickback. For convenience, this will usually involve the use of separate chainsaws for making conventional cuts, which are to be converted to coronet cuts.





Fig. 5.1: *Ctenophora flaveolata*, a wasp-mimicking crane fly, which requires soft, decaying white-rotted heartwood of various broadleaved trees

CHAPTER 5

Habitat quality and continuity in wood pasture, parkland, orchards and hedgerows

5.1 PURPOSE AND SCOPE OF THIS CHAPTER

This chapter gives guidance on conserving the habitats of the main groups of organisms that are associated with veteran trees and with the surrounding landscapes. Aspects of this work that form part of a long-term planning strategy (e.g. the spacing of replacement trees) are covered in Chapter 7.

5.1.1 The main types and components of habitat covered in this chapter

Trees and shrubs provide a very wide variety of habitat features and niches. The majority of their associated species (e.g. invertebrates) occur in the canopy (foliage, buds, blossom, etc.) and in or on the decaying parts of the wood and bark of branches, stem and roots. Also, the intact surface of living bark can support a rich assemblage of epiphytes, including lichens and bryophytes, together with a wide range of associated specialist invertebrates.

This chapter is concerned mainly with the following components of habitat:

- decaying bark and wood (including hollows) in trees, especially veterans
- blossom as a pollen or nectar source, required by the adults of many saproxylic insect species (i.e. those that develop in dead and decaying wood)
- bark surfaces, especially (a) water-filled non-decay hollows and (b) sunlit surfaces that support lichens and associated organisms.

This chapter does not include specific guidance on the conservation of habitats provided by the foliage, buds or flowers of veteran trees. These habitats support a very wide range of invertebrates, which in turn provide food for many predators, both invertebrate and vertebrate. Since most of

these species are not specifically dependent on veteran trees, they can persist through periods when an age-gap leads to an absence of such trees. They do, however, include a few foliage-feeding invertebrates that have been found only on ancient trees in the UK.

Definition of saproxylic organisms

According to Alexander (2008), saproxylic organisms are “species which are involved in or dependent on the process of fungal decay of wood, or on the products of that decay, and which are associated with living as well as dead trees. Conventionally, two further groupings of organisms are included within the definition:

- sap-run associates are included within the term saproxylic, i.e. species dependent on fluxes of sap and its decomposition products, and
- organisms other than fungi that feed directly on wood.”

Each of the main habitat types includes a very wide range of sub-types, of which some are wholly or largely confined to veteran trees in general, or to ancient trees in particular. The factors that determine these sub-types are explained in Section 5.5.2.

Wood decay fungi play an essential role as providers of habitat, not only for invertebrates that require partly decayed wood as a food source, but also for others that develop in their fruit bodies. Fruit bodies of litter-degrading and mycorrhizal fungi also support many invertebrates. The management of trees and of sites can, in principle, affect the variety and abundance of fungal fruiting but research is needed as a basis for future guidance.

5.2 GENERAL PRINCIPLES OF HABITAT MANAGEMENT

Management of veteran trees and of the surrounding soil and vegetation should, above all, be guided by the need for continuity of habitat, for the reasons explained in the accompanying text boxes. The aim should therefore be to maintain an unbroken succession of saproxylic habitats, especially those associated with heartwood decay and cavity formation. This succession is best achieved by protecting veteran trees and shrubs from life-shortening events and conditions (see Chapters 3 and 4), while also ensuring that there are enough younger open-grown trees to succeed them. The following objectives should therefore be followed:

- Individual veteran trees should be protected from damaging activities (see Chapter 3), and if necessary pruned (see Chapter 4), so that they continue to contribute to long-term habitat development for as long as possible.
- All dead and decaying wood, both standing and fallen, should be retained if possible, subject to appropriately determined requirements for the safety of people and property (see Chapter 4) or for the control of any new or exotic pests or pathogens that could threaten the survival of standing trees* (Humphrey & Bailey, 2012).
- At sites where ancient and other veteran trees are present, there should be enough younger trees to succeed them as providers of habitat (Gibbons *et al.*, 2008), but not so many as to shade out veteran trees or to create a cool, dark micro-climate.

* In certain situations (e.g. in fruit orchards) the removal of twigs or branches affected by indigenous pathogens is sometimes necessary for sanitation: see the box “Comparison with other guidance: fruit tree management” in Chapter 4).

- There should be abundant sources of nectar and pollen for the insect fauna.
- Major or rapid changes (e.g. in vegetation cover) that might adversely affect any habitat features should be avoided.

According to the last of the objectives in the above list, site management should favour the maintenance of a stable balance between the various types of tree cover and other vegetation. There should, however, be an underlying understanding that stability across a site as a whole is dependent on smaller-scale dynamic processes, especially those of tree growth and decay.

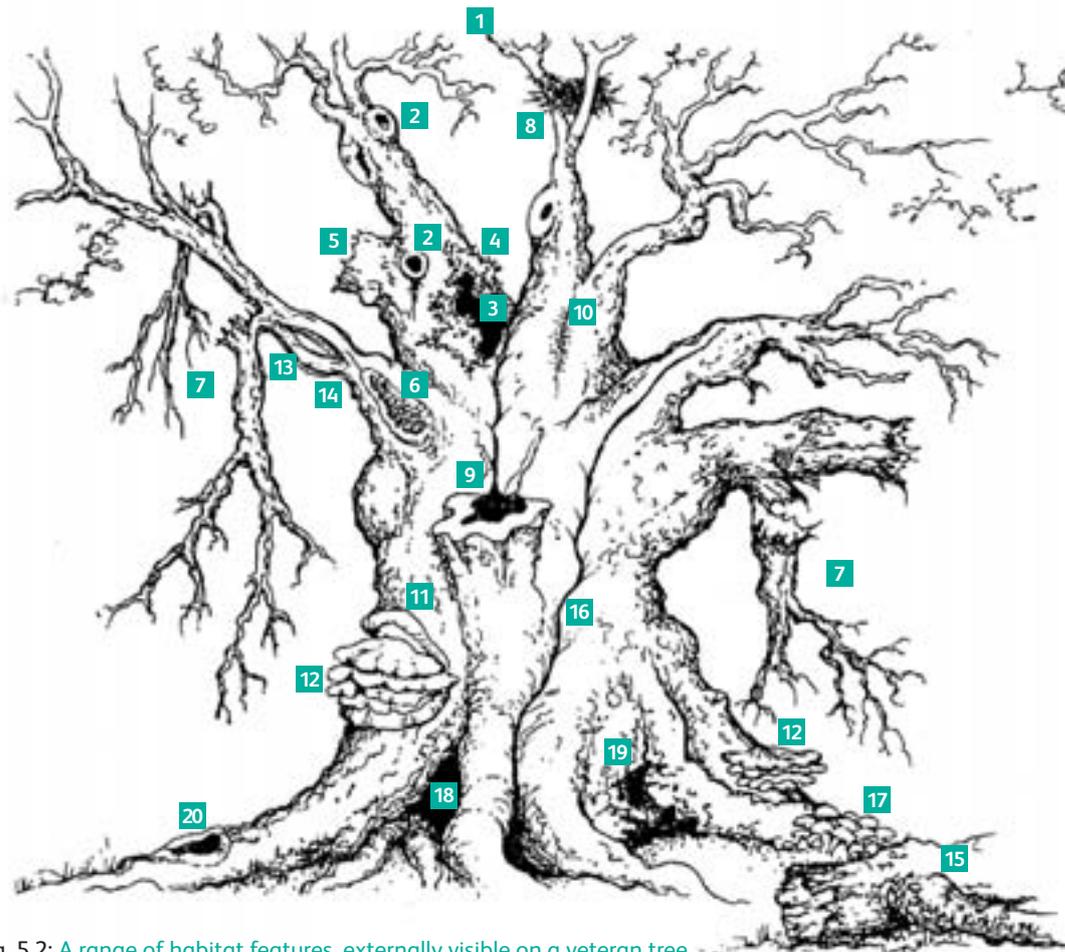


Fig. 5.2: A range of habitat features, externally visible on a veteran tree

- | | | |
|--|---|---|
| <p>1 MAJOR DEADWOOD
Sunbaked, aerial deadwood, desiccated wood (longhorn beetles)</p> <p>2 UPPER CROWN LIMB – SMALL CAVITIES
Dry rot holes – birds, bat roost indicated by urine stain (hornets' nests)</p> <p>3 CROWN LIMB – LARGE CAVITY
Brown-rot (stiletto flies, cardinal click beetle, darkling beetles, barn owl roosts)</p> <p>4 FUNGAL GROWTH ON LIMB
Fungi on bark (wood awl flies, false ladybirds)</p> <p>5 SNAG/STUB
Large surface area for egg laying and fungi (cardinal beetle)</p> <p>6 BARK WITH FUNGAL GROWTH
Fungi on bark (cardinal beetles, wood awl flies, false ladybirds)</p> | <p>7 SUSPENDED BROKEN LIMB
Shattered end provides large surface area for egg laying and fungi</p> <p>8 WEAK FORK WITH INCLUDED BARK
Nest (birds, squirrels, rove beetles, micro-moths)</p> <p>9 WATER FILLED ROT HOLE
Water filled rot hole (hoverflies, water beetles)</p> <p>10 FLUX ON BARK
Established sap run (sap beetles, hoverflies and fungus gnats)</p> <p>11 SCAR TISSUE FROM OLD WOUND
Damaged loose bark (bark beetles, false scorpions and spiders)</p> <p>12 BRACKET FUNGI
Heart-rot prepares wood for invertebrates; (fungus gnats, shining fungus beetles)</p> <p>13 DELAMINATION OF WOOD
Fungi/invertebrates (cardinal beetle, sap beetle)</p> | <p>14 SUBSIDING MAJOR LIMB
Fracture can produce shattered stub habitat</p> <p>15 FALLEN LIMB
Fallen timber habitat: leave in partial shade</p> <p>16 LIGHTNING STRIKE
Burnt wood (flat bugs, false weevil, smoke flies)</p> <p>17 FUNGAL COLONISATION OF ROOT
Damaged loose bark: (bark beetles, false scorpions and spiders)</p> <p>18 BASAL CAVITY
Hollowing trunk (cardinal beetles, lesser stag beetle, crane flies)</p> <p>19 ROT HOLE IN TRUNK
Soft-textured white-rot (lesser stag beetle, rhinoceros beetle, combhorn crane flies)</p> <p>20 ROOT DAMAGE FROM BROWSING
Soft-textured white-rot (stag beetle, hoverflies, combhorn crane flies)</p> |
|--|---|---|



Fig. 5.3: Ancient oak pollard: this tree is host to the legally protected Moccas beetle, *Hypebaeus flavipes*, recorded at only one site in the UK



The most important feature of any site for tree biodiversity is the living tree or shrub, which is essential as the continuing source of new wood that eventually provides the habitats of saproxylic communities. These habitats include different kinds of decay and they range from freshly dead wood to advanced decay or cavities. Some of the most endangered habitats occur only in heart-rot, where specialised fungi can remain active by colonising sapwood as it is converted to heartwood or ripewood. Some of these fungi can also extend into functional sapwood, thereby gaining access to a food source, even when they have utilised all the available heartwood or ripewood. Extensive decay of the sapwood could, however, impair the physiological or biomechanical integrity of the part of the tree concerned. Heart-rot fungi can evidently persist for centuries without being overwhelmed by other kinds of fungi, such as those that provide other kinds of habitats by colonising the physiologically dysfunctional sapwood of dying or fallen trees or branches.

The most valuable sites for habitat are those where ancient open-grown trees have been present over several centuries, thus providing the continuity needed by species with low mobility. In the UK, most of the sites that meet these requirements are wood pastures and parklands, with some examples also occurring in fields bounded by old hedgerows and in traditional orchards. The quantity of remaining traditional wood pasture in the UK makes this resource of international importance.

BACKGROUND

INTRODUCTION

SURVEY/EVALUATION

PROTECTION

TREE WORK: ASSESSMENT

HABITAT

LANDSCAPE

PLANS & SPECIFICATIONS

Despite the underlying need for stability, the effects of harmful changes in previous management should, if possible, be mitigated gradually, for example by tree planting where natural regeneration has been prevented, or conversely by the removal of excessive shade cast by non-veteran trees (see haloing in Chapter 3).

5.3 TAKING ACCOUNT OF THE SPECIES PRESENT ON THE SITE

The above general objectives for management should be fulfilled as far as possible, in order to help conserve the habitats of a wide range of species associated with veteran trees. Also, account should be taken of all available knowledge about the particular habitat requirements of species present or likely to be present. Otherwise, the habitats of certain species could be allowed to deteriorate or could even be inadvertently damaged. Thus, as much as possible ought to be known and understood about the fauna and flora of the area concerned. This in turn requires an appreciation, if not a detailed knowledge, of site history (and prehistory), which has shaped the present-day assemblage of species over centuries or perhaps millennia (see Chapter 6).

In theory at least, continuity of habitat for all the species currently present ought to be assured if the trees and the surrounding vegetation are managed according to the principles listed in 5.2. There should then be no need for targeted management of the habitats of particular endangered species. If, however, certain habitat features are in short supply or likely to become so, they may usefully be enhanced or perpetuated by measures such as the re-erection of fallen, hollow branches or stems, as outlined in 5.5.3.

Care should, however, be taken to minimise any resulting harm to populations of species that depend on other habitat features (see 5.3.1).

BACKGROUND

Mobility of species is of key importance in nature conservation. Each species has evolved mechanisms of dispersal in search of the resources that it needs. These include unoccupied space that the species can colonise for its development. Other resources can include fuelling stations for flying insects, or places for mating and for shelter during unfavourable conditions. A variety of resources are generally required according to the life-stage (larvae or adults), gender or environmental factors.

It is thought that habitats associated with the dead and decaying wood and bark of old trees became plentiful in the post-glacial landscape of the British Isles, thus supporting a wide range of saproxylic species, many of which were able to thrive despite being able to disperse over very short distances only. Fragmentation of those habitats by human activity has left only a scattering of isolated populations of long-established species at sites where there has been exceptional continuity of land use, as shown by historical evidence (see Chapter 6). Such evidence is important in support of habitat evaluation and management (see text box on next page – top right).

Many other invertebrates have much greater mobility, including those that can colonise relatively transient and isolated habitats within the overall vegetation matrix.

BACKGROUND

At the time of writing, artificial habitats have been successfully provided for various tree-associated invertebrates, including the following:

- Violet click beetle *Limoniscus violaceus*: re-erected hollow stems, or artificial containers, filled with a mixture of sawdust, pigeon loft sweepings and animal remains in Windsor Forest, Berkshire (Green, 1995)
- Installation of experimental sapro-nestboxes in hollow trees, colonised by numerous beetle species in Sweden (Jansson *et al.*, 2009)

5.3.1 Surveys of the species present and of their habitats

Since species have different requirements, the manager of the site concerned should have information about as many as possible of the species present, in order to achieve a suitable balance at the site. There is a particular need for balance between habitats in full sunshine, semi-shade and continuous shade. This information, together with a conservation assessment of the relevant habitats, should inform a site management plan. Site history, wherever available, should also be used as a guide to

decision-making, since it provides useful clues as to which species might still occur, even where full survey data are not available.

There should not be any radical change in management practices unless required in the light of some level of appreciation of the assemblages present on a site.

The aim of a species survey should be to obtain data in sufficient detail to aid a comprehensive management plan. A formal structured survey, in which all the key types of habitat are identified, is therefore better than a haphazard list of species acquired through casual anecdotal observations. If, however, (as is often the case), only the latter is available, the information is still useful and should be taken into account by the site manager. Advice from one or more ecologists with appropriate knowledge of the species concerned should, however, be sought if possible in such circumstances.

Although it is desirable to know as many as possible of the species that are present, a sound management regime can, and should, be based on an understanding of the requirements of key groups of fauna and flora that are known (or are likely) to be present. In relation to habitats associated with veteran trees, the key species groups that should if possible be included in specialist surveys are as follows:

- fungi (wood-decay and mycorrhizal)
- lichens (epiphytic)
- invertebrates (wood decay, mycorrhizal and epiphyte assemblages)
- cavity-using birds and bats.

Other species groups that are associated with veteran trees, notably epiphytic bryophytes, such as *Zygodon forsteri* on ancient beech trees, should also be surveyed in detail if initial information indicates that they are of particular ecological significance at the site concerned.

Where, as is often the case, there are major gaps in information about species and communities present at a site, management should avoid bias in favour of the species that have fortuitously been surveyed, perhaps to the detriment of many others. In most instances, therefore, habitats should not be micro-managed to the extent of “gardening” in favour of particular species. The latter approach may, however, be followed if it is the only means of restoring certain endangered species to a naturally sustainable population. If habitat manipulation in favour of selected certain species is envisaged, account should be taken of the need to conserve other habitat types, whether or not the dependent species have been recorded at the site concerned. This caution should be observed equally if the proposed management would either involve significant structural change, or if it would lead to minimum intervention where more active intervention would be beneficial for veteran trees. In order to avoid bias, the range of habitats on a site should

Site history can often provide a strong clue to the quality of the biodiversity that is likely to be present. A long-established wood pasture or an historic parkland is likely to be relatively rich in species that have low mobility and require concentrations of large old and open-grown trees and shrubs. In contrast, an enclosed woodland with a long history of management as coppice-with-standards will contain few of these species but can be relatively rich in others that develop in old decaying rootstocks (the coppice stools) or in young coppice stems. A long-abandoned old coppice woodland might well have lost both types of assemblage due to the elimination of continuity-dependent species during earlier management and the loss of “young growth species” during recent neglect. Similarly, studies indicate that species dependent on trees in open-grown conditions have died out in former wood pastures where such conditions appear to have been lost because of cessation of grazing. A resumption of favourable management of coppice or of wood pasture might, however, enable some of the lost species to return if they have persisted in nearby areas.

Despite Britain’s reputation for being well recorded biologically, there are large gaps in knowledge about the species present even at our best-recorded sites. The lack of comprehensive survey data results from a shortage of taxonomic specialists available to carry out the work and of resources to fund surveys. The latter might of course be affected by a failure to appreciate the need to allocate limited resources to such work. The lack of data can result in unbalanced information on the management requirements for a particular site.



Fig. 5.4: Bird boxes (in this case an owl box) or bat boxes can be helpful in areas where natural cavities are in short supply as nest sites. Boxes should, however, not be installed in locations where increased predation by birds or bats could endanger populations of rare saproxylic invertebrates

be identified by reference to the habitat types defined in this chapter. The management regime should aim to ensure that all these habitat types are perpetuated.

Care should, for example, be taken to avoid artificially exposing rare invertebrates to excessive predation by birds or bats in areas where the latter are being targeted for conservation. Boxes should be provided in order to boost populations of birds or bats only if there is good evidence that they will find abundant invertebrate food (e.g. near unsprayed arable field margins) without preying on rare species more than previously. In any case, boxes should not be sited on or near individual veteran trees, which generally provide habitats and shelter both for saproxylic invertebrates and their vertebrate predators.

5.3.2 Requirements for legally protected species

As well as upholding the law in respect of legally protected species, the managers of sites where such species occur should take particular account of their habitat requirements if they are known truly to be endangered. If, because of the presence of any protected species, the management of trees or of the site becomes restricted, managers should take appropriate steps (e.g. by timing

work carefully) to fulfil the objectives, while complying with the law. For example, under UK law, such limitations arise especially often in relation to bats that are using tree cavities. Also, site workers ought to be aware that bats in the UK very occasionally carry a rabies-like virus (though less often than in various other countries), and that anyone who is bitten or scratched by a bat should immediately wash the affected area with soap and water and seek prompt medical attention.

Wherever there is any reason to believe that intended work on or near a tree could affect a protected species, appropriate advice should be sought before the work is started.

An application may be made to the relevant statutory nature conservation agency for a licence to work on a tree or fallen wood used by a protected species. (The current UK laws which protect species and which are relevant to tree work are listed in Appendix C.) The grant of a licence is not a forgone conclusion and it could require special measures, such as the employment of personnel licensed to handle bats.

It is an offence in Britain to uproot any plant without the permission of the landowner. Also, more stringent forms of protection apply to certain listed plants, lichens and fungi. Protected fungi, of which there are only a few, include wood-decay species such as the Oak polypore *Piptoporus quercinus* and mycorrhizal species such as the Royal bolete *Boletus regius*. Protected lichens include several epiphytes, such as the New Forest beech lichen *Enterographa elaborata*. Among other legal provisions, it is effectively an offence to remove or destroy a tree or part of a tree (whether standing or fallen), which is colonised by a protected fungus or lichen.

Under current UK laws, it is an offence to capture, injure, kill or disturb any bat in the wild, or to damage, destroy or obstruct access to a place of rest or shelter being used by bats. If an otherwise lawful activity such as tree work is the cause of any of these damaging actions, an offence is nevertheless deemed to have been committed.

The Forestry Commission shows current guidance about bats on its website. Also, the Bat Conservation Trust provides a helpline: tel. 0845 1300 228 (www.bats.org.uk). Advice on birds can be obtained from the Royal Society for the Protection of Birds (www.rspb.org.uk).

Laws that protect bats also apply to certain other animal species, which are individually scheduled for protection against stated activities, such as killing, disturbance and possession. Some of these are associated with trees (e.g. the hazel dormouse *Muscardinus avellanarius* and the violet click beetle *Limoniscus violaceus*). Birds are more comprehensively protected in the UK, according to a principle that all species are protected unless listed otherwise.

5.4 MANAGEMENT OF TREE COVER AND OTHER VEGETATION

5.4.1 Tree cover: maintaining a suitable density

Tree cover should be maintained (see Chapter 7), or if necessary modified, in order to fulfil the following objectives.

- There should be enough ancient trees, together with potential successors, to provide a varied and continuous saproxylic habitat in the long term; i.e. over hundreds of years.
- The spacing between trees prior to maturity should be great enough for most or all of them to develop an unrestricted open-grown habit (Green, 2010) with sunlit stems (except in existing high forest that is to be maintained as ancient woodland).
- Tree spacing should also be great enough to provide sunny conditions where shrubs and forbs can flourish as pollen and nectar sources.
- The density of trees should preferably be uneven, so that some of them (while remaining open-grown) are in lines or groups, so as to provide habitat linkage, together with the heterogeneity of habitat that is required by different invertebrates, fungi and lichens.



Fig. 5.5: Tree planting should be planned to ensure that the new trees do not eventually shade existing veterans and that they develop an open-grown form. Trees should therefore be thinned if they have been planted as closely as shown here

Biodiversity in relation to the age, species-range, density and number of trees or shrubs

In general, biodiversity is favoured if the tree and shrub population is rich in species (Alexander *et al.*, 2006) and includes old individuals. Ancient trees are uniquely important in providing the niches and habitats that certain specialised and rare species require.* Owing to their requirements for continuity of habitat (see 5.3), such species are usually found only where a population of ancient trees has been present in favourable surroundings (especially in wood pasture) for several centuries or more. Ancient trees can also be a reserve of important genetic traits such as a propensity for long life or for disease resistance.

Relatively young trees, especially those with veteran characteristics, can provide certain habitats that develop in decaying wood and on bark and other surfaces. Such trees can support a range of species but many of these are relatively unspecialised and common.

With regard to the density of the population of trees and shrubs, biodiversity is generally favoured at sites where large open-grown individuals have had enough space to develop. At a yet lower density, however, invertebrates with very limited mobility might tend to die out, owing to excessive distances between suitable items of habitat. Provided that the density is favourable both for habitat development and for colonisation, biodiversity tends to be positively related to the overall size of the population of trees or shrubs within the area concerned (Harding & Rose, 1986; Butler *et al.*, 2001).

* **Note:** Ancient trees can support certain species that are found nowhere else, but younger veterans sometimes provide habitats for a wider range of species.

Effects of soil type on vegetation

Soil type has direct impacts on the tree and shrub composition, and so indirectly affects the associated biodiversity. Land management that alters soil conditions can therefore have a dramatic impact on veteran trees and their associated biodiversity. Attempts to improve forage productivity for commercial livestock enterprises can result in premature decline and even death of trees and shrubs. Inorganic fertilisers (NPK) and lime encourage the development of roots lacking a protective sheath of mycorrhizal fungi. Such roots are more exposed to potential threats from soil-borne pathogens and stress from drought, etc. In contrast, retention of fallen dead wood enables the roots of the trees and shrubs to benefit from its decay: fallen wood has been described as a natural slow-release fertiliser.

5.4.2 Scrub and herbaceous vegetation

The management of vegetation around veteran trees should be designed not only to protect the trees from life-shortening influences, but also to maintain the quality and range of habitats in the long term. Key aims should include the following:

- to encourage a diverse range of plants that provide the nectar and pollen required by many saproxylic insects
- to maintain and enhance the habitats of species that are not directly associated with trees, including the plants, invertebrates and fungi of grasslands or heathlands
- to ensure a suitable balance in the provision of shaded and sunlit habitats.

5.4.3 Vegetation in relation to light and shade

Since many of the species associated with veteran trees are very sensitive to light and warmth, a suitable balance of sunshine and shade should be maintained; if necessary by managing the vegetation around the trees, including ivy or other climbing plants.

If ivy is increasingly shading rare lichens (e.g. because the exclusion of livestock is preventing it from being browsed), its stems may be cut near the bases of the supporting tree stems and then left *in situ* to die, decay and fall off naturally. Old ivy stems should not be pulled from the



Fig. 5.6: A rare lichen, *Lobaria pulmonaria* (lungwort), dependent on unshaded bark of old trees, especially ash

BACKGROUND

It is now widely accepted that most invertebrates associated with heart-rot in the UK can develop only in tree stems or branches that are warmed internally by exposure to sunshine, at least for part of the day. The amount of shade is therefore an important factor in determining the composition of biodiversity. There is also anecdotal evidence that many wood-decay fungi fruit more prolifically when growing on sun-exposed stems. The oak maze-gill fungus *Daedalea quercina* specifically requires its oak timber to be well seasoned.

Many wood-decay flies reputedly prefer shaded habitats, where the air is relatively humid, although this has not been adequately documented. On this basis, guidelines for management have conventionally indicated that wood should generally be left in shade (Stubbs, 1972). However, it is very clear that many wood-decay beetles actually prefer their dead wood to be at least partially exposed to sunshine and to be relatively dry. The present guide takes account of a small-scale study, which compared the insect species using wood lying in shade, partial shade and full sunshine at Ashton Court near Bristol. Each category was used by a range of the scarcer species as well as more widespread ones (K.N.A. Alexander, unpublished).

BACKGROUND

Most species of epiphytic lichen are light-demanding, and so their colonies decline and can die out when increasingly shaded, either by tree foliage or by a covering of ivy, which is thought to have become more prolific in the UK owing to changes in management and perhaps climate change. Shading of lichens has become a serious concern, especially when it involves lichen communities that have taken centuries to develop.

stems of veteran trees, except under advice from a lichen specialist, since this can damage rare lichens.

Additionally, ivy may be controlled where it is found to be harming veteran trees by shading their foliage or by increasing the probability of structural failure (see Chapter 4). Since ivy is generally beneficial to wildlife, it should be retained where this is compatible with the management of veteran trees and their associated species.

Scrub or tall herbage should be controlled by cutting if, having been allowed to grow as a result of the necessary exclusion of livestock, it is shading out lichens.

5.4.3.1 Vegetation management in wood pastures

The guidance in this section should be observed when managing long-established wood pastures or historic parklands, in order to help sustain species – typically of very limited mobility – which require concentrations of large old and open-grown trees and shrubs (Green, 2010). According to the precautionary principle, such sites should be managed with sedentary species in mind, even where species lists are incomplete.

BACKGROUND

Since many of Britain's ancient trees occur in wood pastures, the management of these areas is of key importance. Many of them exist because of long-established land management that has maintained a structure arguably comparable with the savannah-like conditions that are thought to have occurred extensively in post-glacial Britain (Vera, 2000; Rackham, 1998).

In Britain, wood pastures are most common in the south and are sparsely scattered elsewhere. They are important aesthetically, culturally, for natural history and for forest ecology. They are very important not only for ancient trees but also for a great variety of rare and specialised wildlife associated with such trees.

Wood pastures typically contain large, open-grown or pollarded trees at varying densities, in a matrix of grassland or heathland, sometimes with areas of denser or closed-canopy woodland. Such trees sometimes also occur in similar surroundings in coppiced woodlands where grazing animals are excluded for periods following coppicing. In general, the trees are old and their density is low enough to admit direct sunlight, which is favoured by many associated species. Other key components of a wood pasture habitat are grassland, shrubs, open and dense woodland areas in a small-scale mosaic. These provide valuable habitat for the associated species at different stages of their life cycles. A dense growth of younger trees can, however, adversely affect habitats by excessively shading both the ancient trees and the surrounding ground vegetation.

A key aspect of managing wood pastures is grazing for maintaining the openness required by the ancient trees, together with the mosaic of grassland, scrub and woodland that is also a key part of the habitat. [Detailed guidance is provided by Read (2000; Chapter 5)]. Grazing should, however, be light enough and controlled enough to avoid serious or widespread damage to trees, e.g. by compaction (Chapter 3) and to allow the flowering of shrubs and forbs sufficiently to provide ample nectar and pollen sources. Suitably controlled grazing, together with the retention of bramble patches and intact fallen branches *in situ*, will also help to allow the regeneration of trees at an appropriate rate. These objectives should be achieved by choosing suitable breeds of livestock and by using them at an appropriate stocking density.

Grazing is the ideal method for maintaining a balance between tree/scrub cover and open areas that will favour the species associated with ancient trees. Other management might, however, be necessary if this balance is initially unfavourable. If scrub does not develop naturally or if tree seedlings fail to become established, scrub-forming species such as hawthorn may be planted in small clumps. They will provide nectar and pollen sources and might also emulate a natural succession, in which the scrub protects seedling trees from grazing and browsing. Trees, as well as scrub, should be planted if they fail to regenerate naturally, preferably using seedlings or cuttings raised from the existing population of ancient trees.

5.4.3.2 Grazing near watercourses

In intensively grazed land, the banks of rivers or other watercourses are often fenced to help prevent erosion and other disturbance by livestock, which would otherwise lead to turbidity of the water, with potential harm to various aquatic invertebrates. Also reduction of disturbance and of deposition of dung and urine might help to reduce the incidence of the often lethal *Phytophthora* disease of alder, which appears to be particularly prevalent on excessively disturbed river banks. With regard to veteran trees and their associated species, the exclusion of grazing might in principle help to allow natural regeneration of the trees and the growth of plants that provide nectar and pollen for invertebrates.

Although exclusion of livestock from watercourses could have certain benefits, in most cases it seems to have a negative effect overall, by allowing a dense growth of trees and shrubs (e.g. willow), which suppresses natural regeneration and the flower-rich herbage (Alexander *et al.*, 2010). If there is an overriding need to fence riverbanks, active intervention will probably be needed in order to deal with these undesirable consequences.



Fig. 5.7: The hoverfly *Criorhina floccosa* (nationally scarce in the UK) is one of many saproxylic insects that require nectar and/or pollen in their adult stages

The surfaces of living or dead bark, together with areas of exposed dead wood, can support a wide range of fungi, plants and invertebrates. A large proportion of these invertebrates feed on the hyphae, spores or fruit bodies of parasitic or saprotrophic fungi or on epiphytic lichens, mosses or ferns.

The species of tree is important in determining assemblages of lichens and other epiphytes. Those with a relatively alkaline bark, such as ash and elm, support a particularly wide range of lichen species. Sycamore is an important lichen tree, e.g. for the *Lobaria* community, whereas beech is much less so.

Water-filled hollows, which occur mainly in branch crotches and between buttresses, provide aquatic habitats for a range of invertebrates.

5.5 HABITATS ASSOCIATED WITH WOOD AND BARK

These habitats include the following main categories:

- Surface habitats on bark and wood
- Habitats associated with decay in wood and bark
 - Heart-rot habitats in standing trees
 - Habitats associated with deadwood (as defined in 5.5.4)

The key principles for managing these habitats at any particular site are as follows:

- to maintain continuity of habitat, by safeguarding veteran trees and deadwood and by ensuring a succession of future veterans
- to maintain and, if appropriate, restore the historic variety of habitats in these categories (for example by controlling the amount of shade).

5.5.1 Surface habitats on bark and wood

When managing trees and their surroundings, the requirements of the many species that use the surfaces of bark and wood, whether living or dead, should be given as much attention as those of the species that develop in decaying wood. The key requirements include the following:

- habitat continuity for lichen communities that are found only on ancient trees (this should be assured by suitable tree management and, if necessary, planting of appropriate species)
- avoidance of atmospheric pollution, which is harmful to lichens [if this is a regional problem, there is probably little that can be done, but local sources such as emissions from intensive agriculture should be curbed or screened by vegetation buffering (see 5.6.2)]
- avoidance of major changes in cover by ivy, other trees or undergrowth, which would greatly alter the incidence of sunshine (and hence of light and micro-climate) on tree surfaces (see 5.4.3)
- maintenance of a stable environment (e.g. in respect of sunlight and shade) for rainwater-filled, non-decay hollows.

With regard to water-filled hollows, land use should promote stability also of water quality, as affected by factors such as the input of dung and urine from livestock. Specialist advice, based on species surveys, should be obtained where appropriate.

5.5.2 Habitats associated with decay in wood and bark

The management of veteran trees and their associated decaying wood should be based on an understanding of the very wide potential range of “saproxylic habitats”, as determined by factors such as the following:

- the species of tree
- the part of the tree concerned, together with its position and size
- environmental conditions, including moisture gradients, climate and micro-climate (especially exposure to sunlight)
- the type(s) of decay*
- the stages of decay that are present at a particular time.

In order to ensure that the full range of saproxylic habitats is taken into account when managing a site, the following habitat features, where present, should be recognised:

* There are other types of wood decay, in addition to those described on the next page, but these are more difficult to distinguish in the field by non-experts and their value for habitat quality is much less well known.

- heart-rot in the stems and boughs of standing trees, including cavities and wood mould
- exposed deadwood in the crowns of living trees, especially open-grown veterans
- rot holes and tree pools, in the buttress zone as well as further above ground
- fallen stems and large branches
- fallen small branches and twigs
- stumps and buried roots
- the bark surfaces of stems and branches, especially in full sunlight.

Habitats associated with decay in wood and bark

Relatively few invertebrate species utilise living sapwood but there are many (saproxylic species) that depend on decaying wood or bark. For example, nearly seven per cent of all invertebrate species (i.e. around 2,000, representing a significant proportion of total biodiversity in Britain) have been shown to depend directly on the decay of these dead tissues (ATF, 2009). Wood decay cavities add to the structural diversity of habitats and can be used by larger animals, including roosting bats and hole-nesting birds. The decay on which all these species depend is caused by a range of micro-organisms, especially wood-decay fungi. In the UK, these comprise about 6.4 per cent of all fungal species and about 32 per cent of all mushrooms, bracket fungi and crust fungi combined.

5.5.3 Heart-rot habitats in standing trees

The key requirement is to ensure that these dynamically developing habitats remain continually present in the locality concerned, in all their phases and variations. The range of habitats should preferably be surveyed by someone with specialised knowledge of the requirements of saproxylic organisms (see Chapter 2). Continuity should be achieved (a) by protecting the trees from harmful activities (Chapter 3), (b) from life-shortening failure (Chapter 4) and (c) by ensuring that there are enough younger trees in a suitable condition to provide a continual succession.

As explained in Chapter 4, pruning should normally be kept to the minimum required to protect a tree from life-shortening structural failure, since it is important not to deplete the volume of branch-wood containing heart-rot habitats. Heart-rot continues after heavy pruning but often so rapidly that the potential resource is soon exhausted. If, according to risk assessment, additional pruning is required to safeguard people or property, this should also be kept to the minimum required for the purpose.

Where the remaining trees do not contain a good range of heart-rot habitats, the guidance in Section 5.5.4 should be followed, regarding the possibility of re-erecting lengths of recently

Decay can affect any part of the dead woody tissues of a tree or shrub. There are two main types of decay: i) brown-rot (aka red-rot), and ii) white-rot. In the former case, only the cellulose is broken down by a fungus, whereas both cellulose and lignin are broken down in white-rot, either simultaneously or at different rates.

Various types of decay can occur in the dead heartwood or ripewood in the centre of a tree but sapwood is more typically affected by white-rot. White-rot and brown-rot (together with another variant known as soft-rot) can be classified into many sub-types, which are determined mainly by the species of decay fungus, rather than by the species of tree. However, each fungus tends to occur mostly in a certain range of tree species, and so there is a partial association between tree species and the type of rot. In the UK, the most widespread brown-rot (or red-rot) fungus is chicken-of-the-woods *Laetiporus sulphureus*. It is often seen on yew, oak and on a wide range of other broadleaved trees, including those regarded in the UK as non-native such as Sweet chestnut and robinia. Oak polypore *Piptoporus quercinus* has, in contrast, been found only in decaying oak.

Since the type of decay is determined by the fungus species rather than the tree species, non-native tree or shrub species can be as valuable for decaying wood habitat as species regarded as native. Ancient Sweet chestnut trees in Kensington Palace Gardens in London support a population of the Red Data Book Cardinal click beetle *Ampedus cardinalis*, which develops in heartwood affected by brown-rot (red-rot).



Fig. 5.8: Habitat continuity management: re-erection of part of a hollow beech stem, which accommodated the Violet click beetle before it fell. The log is secured near its upper end

fallen or pruned sections of branches or stems that contain such habitats. Re-erection may also be undertaken if a recently fallen tree had been providing locally scarce habitats associated with standing deadwood. This might be of benefit not only to invertebrates, but also to certain specialised epiphytes.

Additionally, for the conservation of species that live in hollow trees and that are otherwise likely to die out for want of suitable habitat, artificial habitat features may be constructed, using methods that have been tried and tested for the species concerned.

5.5.4 Habitats associated with deadwood

In this book, the term “deadwood” refers to stems, branches or roots either that have died while remaining attached to the tree (see 5.5.4.1) or that are lying on or in the ground, having become detached by breakage or severance (see 5.5.4.2). All types of attached and detached deadwood can provide habitat for a wide range of species, especially after they have started to decay. Deadwood is arguably a rather negative description of something that is often teeming with life. When managing habitats, however, there are practical reasons for differentiating between deadwood, as defined here, and wood that is undergoing decay inside living parts of the tree. Various other publications, however, (e.g. Humphrey & Bailey, 2012), use the term deadwood also to include dead, decaying wood inside living parts of trees. The term “decaying wood” obviously applies to both these categories.

5.5.4.1 Standing deadwood

Dead branches and standing dead stems should be retained as much as possible, to conserve the special values of standing deadwood habitats. Ideally, this means not interfering at all. Compared with living parts that contain heart-rot habitats, attached deadwood rarely needs to be removed in order to protect a tree from life-shortening structural failure. If this is necessary, it should be kept to the minimum required. This should usually entail the shortening of the stems or branches concerned, as opposed to their removal. The same applies to any attached deadwood that needs to be managed in order to mitigate an unacceptable risk to people or property.

If deadwood falls or has to be cut, it should usually be retained as recommended in the following section. Also, if dependent species would be at risk because of an impending gap in the succession of any category of standing deadwood (especially hollow stems), selected items of fallen or cut deadwood should be re-erected, subject to the availability of resources and expertise to do this safely.



Fig. 5.9: Violet click beetle, *Limoniscus violaceus* (protected in the UK). Its larvae live in detritus that occurs in a very small number of hollow trees



Fig. 5.10: The decay fungus *Laetiporus sulphureus*: an important provider of habitats for rare invertebrates, in its fruit bodies and in the brown-rot (red-rot) that it produces



Fig. 5.11: Sweet chestnut with brown-rot and hollowing, showing accumulated wood mould in base

No decay-related habitat is static – all habitat features are progressing through a natural succession from undecayed wood or bark through to the final products of decay. This succession involves dynamic phases of colonisation and decline of the associated assemblages or communities of invertebrates, fungi and other organisms. These processes represent a natural dynamism of biodiversity, which can be sustained only if adequate concentrations of all the types and stages of decay are somewhere present within the immediate locality where the dependent species occur.

BACKGROUND

Wood-decay fungi are very important not only because they are essential providers of habitat for a great number of specialised invertebrates and other forms of wildlife, but also because they include rare species that are worthy of conservation in their own right.

BACKGROUND



Fig. 5.12: Deadwood affixed to a standing tree; in addition to providing habitat for saproxylic invertebrates, this can be used by woodpeckers as a food source and as a perching platform

In order to support re-erected items of deadwood, they should normally be attached to standing trees by a suitably qualified arborist. In addition to being secure, the attachment should be made so as not to cause any harm to the standing tree.

Where sections of hollow stem are to be re-erected, their lower ends should normally rest on the ground for support and for the maintenance of a moisture gradient. Lengths of dead branches may be attached to living branches in the canopy, in order to provide standing deadwood habitat and cavity habitats in trees that are not yet providing such habitat in their own right.

5.5.4.2 Fallen deadwood

The main principle for managing fallen deadwood is to leave it *in situ* and intact if at all possible. (In the case of an uprooted tree, this might be the only way of retaining the habitats provided by its upturned rootplate.) If there is no alternative but to move an item of deadwood, this should ideally be done over the minimum distance, and with minimal cutting of the item, in order to conserve local populations of species with little mobility.



Fig. 5.13: Decay cavity, exposed by the break-out failure of a major branch. A variety of open and closed cavities can provide a wide range of habitats

For the same reason, the new location should be chosen so as to provide environmental conditions (e.g. soil, shade, exposure to wind) that are as close as possible to those of the original location. In order to keep the wood as intact as possible, suitable machinery for handling it should be hired if necessary.

The relative merits of standing and fallen timber are often debated but the differences cannot generally be quantified, since the available scientific data cover only a very limited range of circumstances. The removal of fallen deadwood through tidiness should be avoided for the sake of the many decay fungi and invertebrates that it can sustain, and of the tree seedlings and saplings that it can shelter. It should be retained also in order to avoid removing valuable nutrients, which are gradually released by the decay process, providing benefit to the source trees.

Although cut or fallen deadwood should generally be left in its place of origin, there are circumstances where its removal to another part of the site or to a different site (translocation) may be considered. These arise mainly when the destination site either has potential value for specialist biodiversity but lacks a natural source of colonisation, or where its future is more assured with regard to the provision of habitat.

A decision to translocate deadwood should be made only if the likely benefits are considered to outweigh the following possible negative consequences:

- the removal of deadwood from the source site represents a drain both on the resource and on the communities of species that might already have colonised it
- owing to the difficulties of handling large items, there is usually a temptation to cut them into smaller pieces to facilitate handling
- conditions at the destination site might be less suitable for colonising communities than at the source site.



Fig. 5.14: If fallen deadwood cannot be left *in situ*, it should if possible be retained uncut, as in this instance, where it has been piled in an area where its retention for habitat is compatible with other aspects of site use

If cut or fallen wood (including wood from non-veteran trees) has to be moved, this generally should be done before there has been any opportunity for species to colonise it (i.e. in spring and early summer for many insect species) and thus to be subjected to the potential removal of a generation from its source area. Colonised wood may, however, be moved if there is a clearly determined objective to translocate such species to a locality that they would probably not have reached on their own, owing to the distance involved.

The practice of cutting up deadwood and placing it in “habitat” piles should be avoided if possible, since this is generally less beneficial than leaving the material intact and *in situ*. Piles may be created as a tidy option, but only where this is completely unavoidable in the interests of other aspects of site use.

5.5.5 Prevention of spread of aggressive pests and pathogens from dead wood to living trees

Certain alien pests and pathogens have the potential to cause very serious harm to veteran trees of various species. In the context of tree protection, Chapter 3 includes some information about harmful organisms that have been, or might become, introduced into the UK. The present section is concerned only with pathogens that could be present in dead wood that is retained for habitat.

At the time of writing, there is generally no need in the UK to remove or otherwise deal with attached or fallen dead wood as a potential source of pathogens that could cause serious disease in nearby trees. There are, however, occasional situations where such action might be appropriate, even though habitats would thereby be depleted. Also, managers should keep up to date with guidance on the control of particular pathogens that might warrant such control measures, including those that might cross international boundaries in the future. Such guidance is beyond the scope of the present book, but is available from the website of Forest Research and, from time to time, in arboricultural and silvicultural journals*.

Some of the more important diseases that could be of concern in relation to the retention of diseased veteran trees or the deadwood derived from such trees are as follows:

- **Silver leaf disease:** the causal fungus *Chondrostereum purpureum*, is widespread in the UK, but poses a significant risk only in situations where high-value trees (mostly fruit trees in the family Rosaceae) are regularly pruned and can therefore be readily colonised by spores of the fungus. In old orchards, where silver leaf could be a problem, retained deadwood should be checked for the presence of fruit bodies of the fungus.
- **Dutch elm disease (DED):** in the UK, there are now only a few areas where large elm trees have survived, following the spread of the aggressive fungus *Ophiostoma novo-ulmi*. In order to protect susceptible species of elm from DED in these areas, the emergence of adults of elm bark beetles (*Scolytus* spp.) from any DED-affected stems or branches in the year should be prevented. This could be achieved by stripping and removing all the bark from such material before the following emergence period in the spring and summer of the next year.
- **Acute oak decline**, believed to be caused by one or more species of bark-infecting bacteria, can kill native oak species in the UK. In theory, the control measures that are outlined below

Comparison with other guidance

According to various sources of guidance for the care of fruit trees, all pruned material and dead branches should routinely be destroyed or removed as a means of sanitation for the control of diseases such as silver leaf and Nectria canker. The guidance in this book emphasises the habitat value of decaying wood, while also taking account of the need for some degree of sanitation where necessary for the general health of fruit trees or for crop production.

COMPARISON

* As mentioned in Chapter 3, additional precautions should be taken when carrying out tree work in areas where certain pathogens are, or could be, present. These precautions include the cleaning and/or sterilisation of tools. Useful information is available from the Forestry Commission website: [www.forestry.gov.uk/pdf/FC_Biosecurity_Guidance.pdf/\\$FILE/FC_Biosecurity_Guidance.pdf](http://www.forestry.gov.uk/pdf/FC_Biosecurity_Guidance.pdf/$FILE/FC_Biosecurity_Guidance.pdf)

for bleeding canker of Horse chestnut might help to prevent the bacteria from spreading but this is highly uncertain at the time of writing, since nothing specific is known about the biology of the disease.

- **Sudden oak death**, caused by the fungus-like organism *Phytophthora ramorum*, can affect a diverse range of tree and shrub species. For control of the pathogen, infected plants should be cut down and the spore-bearing material (twigs and foliage and/or bark) destroyed as described in current guidance.
- **Bleeding canker of Horse chestnut**, caused by the bacterium *Pseudomonas syringae* pv. *aesculi*, could have implications for the role of Horse chestnut as a relatively rapid provider of saproxylic habitat in places where habitat continuity would otherwise be lacking. Current guidance may be followed in order to try to reduce the spread and survival of the bacteria. This could involve the destruction of infected bark and the minimisation of on-site cutting up of diseased trees in order to reduce the production of bacteria-laden aerosols. Too little is, however, known about the biology of the disease to validate such measures.
- **The fungus that causes ash dieback**, *Hymenoscyphus pseudoalbidus* (anamorphic state, *Chalara fraxinea*), can extend into woody parts of affected trees. Current guidance on prevention of its spread should be observed when dealing with such material. At the time of writing, the fallen remains of diseased leaves are thought to be the main source of infective spores.

5.6 OPTIMISATION OF HABITAT IN RELATION TO SURROUNDING LAND

5.6.1 Connectivity of habitats

Owing to the very limited mobility of many of the species that are associated with veteran trees, opportunities should be sought to enable them to colonise habitats beyond the immediate confines of the relatively few sites where they still occur. It is uncertain whether any such species could thereby become less rare, but they might at least spread sufficiently to improve their prospects of re-colonising sites after chance local extinction.

Where the present day sites of veteran trees are remnants of larger areas of wood pasture or wooded common land, surveys should if possible be undertaken to locate any such trees that still exist on the surrounding land. If such trees are not already protected in some way (e.g. by Tree Preservation Orders), the possibility of obtaining protection, or at least an agreement for sympathetic management (e.g. under an agri-environment scheme in the case of agricultural land) should be explored.

Wherever feasible, a programme of tree protection and tree planting should be established on the properties that surround any site that is being managed for its veteran trees and their associated species. The choice of species for planting should be based on the need for continuity of habitat. Where an age gap in the existing tree population is likely to break the continuity, the choice of species could usefully include some that tend to reach a large size and then to undergo decay when relatively young. These can include non-native species such as Horse chestnut. Detailed guidance on the choice of species and on methods for establishing and protecting new trees is provided by Read (2000; Chapter 8). Sources of grant aid for tree planting can be found on the internet. Also, a helpful compendium of sources in the UK has been published (RFS, 2009).

5.6.2 Protection of habitats and their dependent species by buffering

Veteran trees should be protected as far as practicable, according to the guidance in Chapter 3, from potential harm related to land use on adjacent properties, as well as on the property where the trees are growing.

If the roots of the veteran trees extend into neighbouring land, where they are being affected by compaction or chemical contamination, an agreement should if possible be sought, preferably with grant aid under an agri-environment or other scheme, whereby the damaging activities could be excluded from a root protection area at least as large as defined in British Standard 5837:2012 (BSI, 2012). Protection of veteran trees and their associated habitats within the boundaries of conservation sites is covered in Chapter 3.

5.7 RECONCILIATION OF POTENTIALLY CONFLICTING OBJECTIVES

Adherence to the guidance regarding the density of trees and shrubs should help to sustain the natural recruitment of future ancient trees, the succession of saproxylic habitats, and an abundance of flowering shrubs and forbs. At some sites, however, certain objectives might conflict with the need to allow these processes to take place. In such circumstances, site managers should strive to maintain the full range of decay stages at all times, in order to help ensure the survival of all the dependent species at the sites concerned. Complexity is not a justifiable excuse for inaction.

5.7.1 Habitat management versus economic objectives

Objectives for habitat management should, as far as possible, be reconciled with any relevant economic objectives. The inherent difficulties of doing so can be partly overcome by evaluating conservation gains and losses in a manner that allows comparison with commercial gains and losses. Equally, commercial management can have indirect benefits, which should be taken into account. However, when the intention is to use wood as a product (e.g. fuel), it should be removed before invertebrates can colonise it; otherwise they or their offspring are likely to be later removed along with the produce and destroyed.

Commercial grazing, fruit production, forestry, or management for amenity are among the kinds of site usage that might need to be reconciled as far as possible with managing ancient trees and their surroundings for wildlife. There might also be an underlying management policy such as the establishment of minimum intervention woodland or the promotion of traditional practices such as pollarding or coppicing. With such a variety of situations and circumstances, it is important that the biodiversity resources provided by each tree and shrub, or each group of trees and shrubs, are appreciated in sufficient detail to guide appropriate conservation management.

5.7.2 Potentially conflicting objectives for conservation

Different biodiversity interests might demand different approaches to management. For example, the known presence of specialised epiphytic lichen communities might mean that attention needs to be given to maintaining certain light and humidity levels around the tree stems, perhaps by ensuring that canopy closure does not take place, nor that extensive opening up occurs, such that exposure to winds and aerial pollution increases. Such situations can be dealt with in a variety of ways, e.g. using either livestock grazing or manual cutting to maintain structural conditions; clearly minimum intervention management

As an example of relative values, the price of firewood (at the time of writing) is relatively low, whereas the value of the same wood for biodiversity could be very high. The example of firewood or biofuel is equally relevant to indirect benefits of land use, since these products provide an incentive for retaining a sustainable resource of trees alongside agricultural and other crops. Also, if enclosed ungrazed woodlands are cut for fuel, the opening up of the otherwise dense canopy will be beneficial for warmth-loving saproxylic invertebrates.

BACKGROUND

INTRODUCTION

SURVEY/EVALUATION

PROTECTION

TREE WORK: ASSESSMENT

HABITAT

LANDSCAPE

PLANS & SPECIFICATIONS

BACKGROUND

would be damaging in this situation.

One particular area of potential conflict in conservation is the retention or removal of ivy. Its retention is important for the conservation of many invertebrate species. For example, it provides shelter and a source of nectar and pollen in the late summer and autumn, when many other plants have ceased flowering. It can, however, cause rare bark-inhabiting lichens to die out by shading them, and so it is important to control it in such circumstances. Guidance on its control is given in 5.4.3.

RESEARCH

The need for further knowledge: a sustainable density of trees

It is currently not feasible to give a firm recommendation for the average optimum numbers of trees of various ages per hectare. Suggestions can, however, be made. For example, on the basis that the crown footprint of a single Pedunculate oak can occupy about 700 square metres, an average of one ancient oak per hectare has been suggested as a sustainable density in southern Britain, provided that there are enough younger trees to succeed them without shading them or each other. If, on this basis, the younger trees are too many or too few, a programme of planting or felling should be planned.

In Sweden, an average density of 2.8 ancient oaks per hectare has been proposed as desirable (Bergman, 2006), taking account of the need to sustain a population of ancient trees, while also allowing space for regeneration and for the retention of open areas.

Survey data in Sweden indicate that there is one tree of 1.25 m or more in stem diameter for every 10 trees up to 0.7 m in diameter (V. Bengtsson, pers. comm.). The same survey also indicated, however, that certain types of habitat might be provided only by a relatively small proportion of ancient trees within the dispersal range of the species concerned. Also, there is uncertainty about factors affecting the long-term survival of successor trees. Continued research might help to provide better guidance about maintaining a suitable density of trees in various age groups.

RESEARCH

The need for further knowledge: invertebrate-fungus associations

There is still much to be learnt about the associations between particular invertebrate species and the species of fungi in which they develop, and it is therefore not known whether any invertebrates depend specifically on fungi that are found only in ancient trees.





Fig. 6.1: Veteran trees and continuity planting at Richmond Park, Greater London

CHAPTER 6

Ancient trees in the landscape: advocacy for holistic and landscape-scale management

“Ancient trees are not only objects of beauty, wonder and delight; they are historical monuments and witnesses to past activities of plants, animals, and people”

Oliver Rackham (2003)

6.1 PURPOSE AND SCOPE OF THIS CHAPTER

This chapter gives guidance on recognising the values of our veteran trees in relation to landscape and heritage. It also sets out options for integrated management whereby these values (see Chapter 1) can be conserved together with all others associated with veteran trees.

6.2 AESTHETIC, HISTORICAL AND CULTURAL BACKGROUND

It is widely perceived that most people have a liking, if not a love, for trees. Large, old trees appear to be especially valued, and so there is evidently plenty of scope for raising awareness of the special importance of ancient and other veteran trees in the landscape. The following information and ideas are intended as an aid to inspiring and enthusing members of the public and those with particular interests and responsibilities towards trees.

6.2.1 Trees in relation to people

People can be inspired by the realisation that trees can span many human generations and can thus give us a sense of continuity within landscapes. The value of old trees can be better appreciated when people understand how they change shape as they age, thus developing characteristics that are aesthetically valued. It is inspiring to realise that, through ancient trees, we can often peel back the layers of history. Exceptionally long-lived individual trees, such as certain yews and oaks, might help us to glimpse the furthest into the past – sometimes as far as Anglo-Saxon landscapes or even further back in association with religious burial sites.

When seeking to enthuse members of the public, it is helpful to be aware that there is already widespread appreciation of historic landscapes that contain veteran trees. A UK government

study (*Taking Part*) showed that, of 27.7 million adults who had visited an historic site in 2006-07, approximately 38 per cent, i.e. 10.5 million of them, had visited historic parks and gardens open to the public. More visits were made to such sites than to castles and ruins or other historic buildings.

As individuals, certain trees are venerated for their size, ancient appearance or special historic or cultural associations. There is a history of measuring the trunks of such trees, in which one of the first references concerns the ancient churchyard yew at Crowhurst in Surrey, as shown in the parish records of 1630. Thirty-four years later, John Evelyn in his book *Silva* described a number of remarkable trees for the first time in print. Interest in recording trees has grown subsequently and there is now a partnership between the Ancient Tree Forum and the Tree Register of the British Isles, which seeks to record ancient trees as well as other veteran and notable trees on the Ancient Tree Hunt database www.ancienttreehunt.org.uk

6.2.2 Origins of veteran trees within various kinds of landscape

In order to promote care for old trees, it is necessary to overcome a widespread misconception that trees have a more-or-less fixed lifespan like humans. This is often quoted as a supposed reason for getting rid of old trees that are becoming difficult to manage because of their size or an increasing tendency to shed branches. Such difficulties should not be ignored but there is a need to realise that trees of many species can live for a very long time if they are not harmed by serious damage, much of which is caused by human activities. In this context, it is possible to explain why

ancient and other veteran trees are predominantly found in certain kinds of landscape.

Trees that are both veteran and ancient (see Chapter 1 for definitions) have attained great age by resisting, tolerating or escaping changes or events that can reduce longevity. These include disturbance of soil or drainage, serious disease, overwhelming storms or felling for various purposes. In areas where such factors have been prevalent, ancient trees are rare, except perhaps as isolated individuals. Younger trees that are veteran but not ancient are, however, more frequent. In less disturbed environments, such as certain wood pastures, former hunting areas, commons, parkland and old hedgerows, trees are more likely to have survived to become ancient.



Fig. 6.2: Interpretative plaque for an ancient oak tree, retained within urban development in the London Borough of Bromley

Paradoxical as it might seem, they are rarely found in ancient woodland converted to high forest plantations or to coppice woods (except in the form of coppice stools or boundary pollards).

Within the lifetimes of many of today's ancient trees, surrounding landscapes have changed substantially, albeit in ways that have often allowed a proportion of ancient trees to survive. For example, in designed landscapes there are certain trees that pre-date the design, having perhaps originated through natural regeneration rather than through planting. In some instances, such trees originated in old deer parks. Trees that were planted within designed landscapes are in some instances now old enough to be ancient, or at least veteran, but some of these landscapes have, in turn, been put to new uses. We can sometimes gain insight into former landscapes by taking account of the characteristics of different species of tree; the ways in which they become established, grow and respond to light.

In other northern European countries, there are very few surviving historic forests and deer parks that retain ancient trees in any significant number. This makes our UK historic landscapes and parks almost unique in their origin, appearance and character. In comparison, traditional management by pollarding has survived in some countries and is still practised. In the UK, pollarding to produce firewood declined significantly with the expansion of the coal industry.

Changes in land management since the middle of the 20th century have been rapid, intensive and geographically wide-ranging across the UK; probably more so than at any other time in our history. These changes have affected our traditional and designed historic landscapes and we have lost millions of mature and ancient trees in the process. In some instances, only an isolated individual ancient tree might remain to tell us of the past use of the surrounding land area. A study in 2005 for Heritage Counts showed that 46 per cent of historic parks recorded by the Ordnance Survey in 1918 had disappeared by 1995. Of those that survive, it is estimated that as few as 25 per cent have been managed in such a way as to preserve and sustain the ancient and other veteran trees.



Fig. 6.3: Urban development adjacent to veteran trees, with resulting impact from increased public access. This tree has since been encircled by further development, impinging on the minimum root protection area recommended in BS 5837:2012

6.2.2.1 Wood pasture

Wood pasture is an important part of our social history but it is far less well understood and documented than historic parkland. It represents a form of land management in which open areas, interspersed with trees and scrub, are grazed by wild and domestic animals. This system clearly dates back to Anglo-Saxon times and is extensively recorded in the Domesday Book as *silva pastilis*. The trees were originally either cut regularly as pollards or left as maidens for timber. Scrub that was unpalatable or thorny was a specific feature and protected new trees from grazing and browsing animals until they could become established.

Wood pasture systems often became integrated into forests, deer parks, commons and designed landscapes. Also, hedgerows sometimes incorporated trees that had originated in wood pasture. Such areas often contain other historical or natural features, including relatively undisturbed soils and pastures, water bodies and wetlands, geological formations and archaeological artefacts. They can be many-layered landscapes, reflecting the changes in their history and land use over the centuries.

6.2.2.2 Forests, chases, deer parks and hunting

Many of our most important concentrations of ancient trees can be found in hunting forests (e.g. Windsor, New Forest, Savernake, Sherwood), the history of which can be traced back to mediaeval times (Cantor, 1983; Cantor & Hatherly, 1979) and in some cases to the Norman Conquest. A “Forest” was an extensive tract of land, owned by the Crown and governed by special laws mainly to protect deer for the King. A “Chase” was a similar hunting area. Not all these areas had trees but Rackham estimates that there were 80 wooded Forests, containing 400,000 acres of wood pasture, equivalent to 10 per cent of the woodland recorded in the Domesday Book. The current use of the word forest, including plantations, which rarely contain any ancient trees, dates back only to around 1650.

Parks originally were areas of private land, which were enclosed under licence from the Crown by their owners; the nobility, gentry, bishops and religious houses. Deer were kept in these enclosures and have been retained to the present day in many of the parks that still exist. Some parks also support other stock, including rare breeds. The management of grazing animals and of trees and scrub is covered in Chapter 3. Some deer parks are thought to pre-date Norman times and at least 35 are mentioned in the Domesday Book. Others were emparked as late as the reign of Charles I. Also, modern examples are still being created.

Many deer parks have supported populations of ancient trees to the present day and some of them are believed to have included trees that existed in woods or wood pastures before enclosure. In many instances, mansions were later built in parks where the presence of old trees contributed to a parkland setting, which enhanced the architecture and provided an impression of long establishment.

Designed landscapes were often created in ancient parks that had become the settings for mansions, but pre-existing trees were often preserved (see 6.2.2.3). Ancient trees can still be found in some of these woodlands but many were lost during the 20th century, especially with the establishment of the Forestry Commission and the push for forestry production after World War 1. There was then widespread planting and tidying up of woodlands within emparked areas. Ancient trees and dead wood were, often mistakenly, seen as harbouring diseases which might harm the final crop and were usually treated accordingly.

6.2.2.3 Designed landscapes

Designed landscapes can represent examples of the work of a famous landscape designer or a specific design style. Britain is associated with the birth of the landscape park fashion and



Fig. 6.4: Trees in the historic landscape of Battle, Hastings

contains parks of international significance for their design or their assemblages of historic and ancient trees.

The creation of ornamental and recreational landscapes, often to enhance the setting of a house, started as early as the 14th century. Some developed out of mediaeval deer parks but others were newly created. The creation of public parks for fresh air and recreation developed in the 19th century and continued throughout the 20th century.

Today, there are many parks and gardens that represent several layers of development or design over centuries and that sometimes contain archaeological remains. These earlier layers contribute to the value of such landscapes, alongside the most recent designs. As mentioned in Section 6.2.2, trees are often among the elements of a landscape that pre-date a particular design. Sometimes pre-existing veteran trees were incorporated into the design, especially under the influence of the 18th century Picturesque movement (West & White, 2011), which brought a growing interest in the aesthetics of ancient trees.

During the 20th century, many parklands went into decline and many more were sold and split up. The severe damage that occurred in many historic parks in the Great Storm of 1987, and in further storms two years later, helped to stimulate thinking about the restoration of these designed landscapes and also a better understanding of the natural regeneration of habitats. Even before those events, many of the older trees in designed landscapes were perceived as being past their best with regard to the designed visual effect. Nevertheless, the distinctive visual qualities of species such as Cedar of Lebanon (*Cedrus libani*), are greatly valued beyond the peak

of maturity. Also, the value of veteran planted trees for biodiversity is often very considerable, especially since they are the successors to earlier generations of ancient trees in the localities concerned. They can therefore be essential for the survival of species that depend on dead and decaying wood, most of which are not specific to particular species of tree.

6.2.2.4 Commons and hedgerows

Commons are unfenced areas of land where commoners have specific rights to graze animals. In many commons, pollards have been retained because the commoners had rights to cut them but the timber belonged to the owner of the common. Traditional pollards or veteran maidens, some

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Fig. 6.5: First Epoch map, showing the same trees as in the photograph (Fig. 6.6)



Fig. 6.6: Old ash pollards on a field boundary at Ablington, Gloucestershire (2012). All these trees were mapped in the First Epoch Series of the Ordnance Survey

of which might have stood within former wood pasture systems, occur also in old hedgerows. Various old maps show individual trees that are still standing, as in the case of the ash pollards shown in Figs. 6.5 and 6.6. All these trees were mapped in the First Epoch Series of the Ordnance Survey, which dates back as far as 1840.

Pollarding is an ancient management practice. Sub-fossil pollards from the River Trent have been dated as 3,400 years old and indicate that Neolithic humans were already cutting trees. They are therefore of great archaeological value. Pollards were cut to provide a sustainable supply of food, fodder and building materials for everyday use. Across Europe there are many different forms of cutting that clearly reflect the wide variety of products that were required. Very little has been documented about tree management of this type and this has perhaps led to pollards being overlooked by academics in other disciplines.

6.2.3 Trees associated with historic characters or events

Individual trees have, throughout history, been used as important landscape features such as boundary landmarks or waymarks or have been the focus of significant historic events such as uprisings, military actions or commemorations. Some trees, like the Boscobel Oak, have become celebrities in their own right but this can have negative consequences, where visitor pressure appears to have contributed to their demise in extreme cases.

6.3 PRINCIPLES AND OBJECTIVES OF EVALUATION AND MANAGEMENT

6.3.1 Overriding principles

Ideally, any population of veteran trees should be maintained in the long term for all the values that it provides, whether these were intended as part of a landscape design, or have been accrued during the growth and aging of the trees. Since trees are living organisms, as well as objects of cultural and aesthetic value, their management as individuals or groups will usually involve a complex and highly sensitive multidisciplinary approach, with the aim of halting and reversing declines in value and of ensuring that beautiful and historic landscapes are sustained in perpetuity.

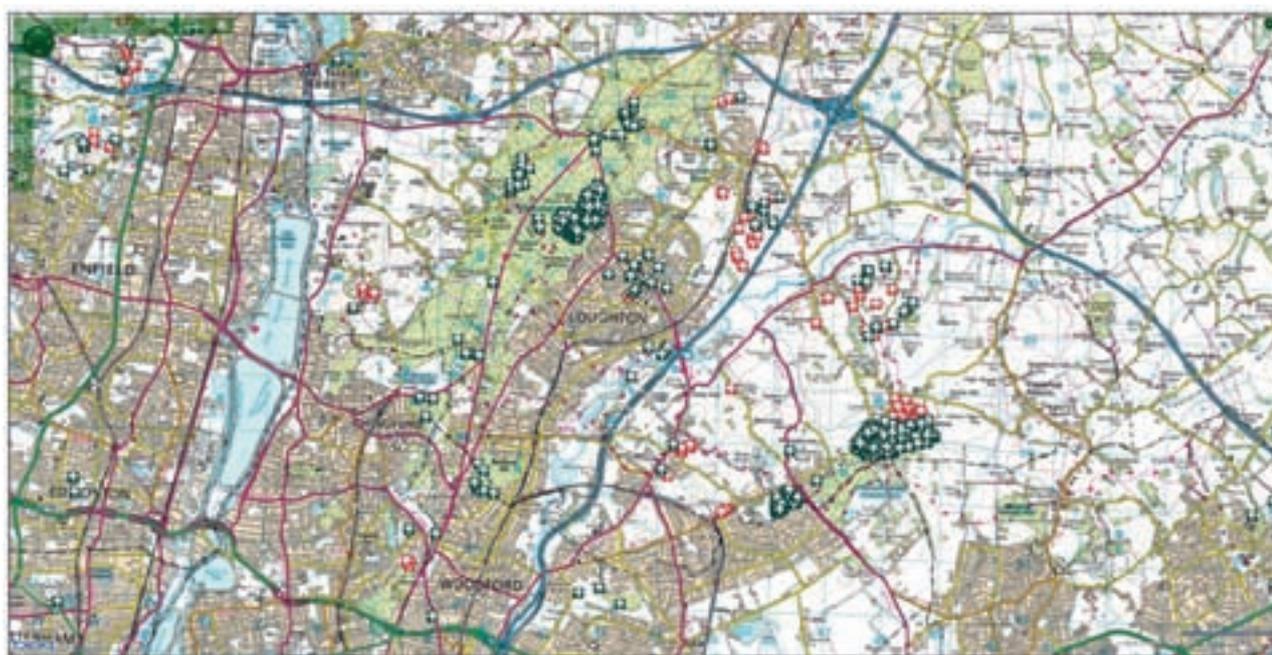


Fig. 6.7: Above: a modern map, including Epping and Hainault Forests, Essex, with veteran tree data superimposed. Facing page: an historic map, showing tree cover in and beyond the currently protected areas



6.3.2 Resolution of conflicting objectives

Conflicting objectives can arise at sites where the restoration of certain aspects of value (e.g. in a designed landscape) could lead to the loss of others that have accrued as a result of changes in the tree population, such as the decline of trees that were planted as a component of landscape design. It is essential to identify any conflicts and to resolve them as far as possible when drawing up plans for management.

It is important to be flexible to resolve conflict; for example, if value that would be lost by the removal of a few veteran trees from a large population would be decisively outweighed by a resulting benefit for other heritage values. On the other hand, certain individual trees can be exceptionally rich for biodiversity, even amidst a concentration of old trees. Also, our veteran trees are so rare on a wider geographic scale that the loss of any is likely to represent a significant overall loss to landscape and biodiversity. It is therefore necessary to evaluate the environmental impact of removing even a single veteran tree and to avoid such action if the loss cannot be justified. Even dead standing or fallen trees are important, and so owners should be encouraged to be untidy-minded and to leave monoliths or fallen dead wood *in situ*.

6.3.2.1 The main sources of potential conflict: some suggested solutions

The following list summarises the main potential sources of conflict and mentions a potential basis for reconciling each of these.

- **Divided ownership of the land**

Many of our known historic landscapes used to extend far beyond their current boundaries of ownership. In many instances, neighbouring properties still contain veteran trees of the former landscape but are managed in ways that conflict with the objective of managing the entire tree population appropriately. Recognition of the former extent of such a landscape is an essential first step towards seeking co-operative management agreements.

- **Current versus former management: differing concepts of what is appropriate**

Ancient trees that once stood in a traditional landscape are sometimes now being harmed by current management, for example where a former wood pasture is reverting (or has been

converted to) high forest, or where intensive farming is now practised. The current management might, however, be regarded as the only economically viable option.

- **Objectives for managing lapsed ancient pollards**

Restoration of a traditional pollarding cycle for such trees might be desired, but the best way of ensuring the long-term survival of the trees could be a non-traditional form of crown reduction.

- **Habitat versus design**

As stated in guidance notes issued by the National Trust (Walmsley, 2007) and by English Heritage (West & White, 2011), it is appropriate both to maintain the features of a designed landscape and to protect veteran trees and their associated habitats. The concept of conserving decay-dependent habitats might be seen as conflicting with a formal design. It is, however, necessary to realise that, by using trees in their plans, the original designers must have known that they were establishing a living entity that would inevitably change with time and that could not be preserved like a man-made structure. There is therefore a basis for weighing the precedence of the formal design against other aspects of value that change with time, such as the habitat value. The latter imposes a need for continuity; i.e. an age structure in the tree population that enables the dependent species always to find habitat when individual trees are lost.

- **The changing value of trees in a designed landscape**

Trees that were planted as a feature might have lost much of their intended aesthetic value while gaining other kinds of value, especially habitat value or evidential value*. The value they have gained will be reduced or lost if they are removed to make way for replanting or if they are pruned in ways that have aesthetic purposes but a life-shortening outcome (see Chapter 4).

- **Attitudes towards trees not belonging to a particular design**

Later plantings or natural regeneration can detract from an historic layout. Removal of the trees concerned can help to restore the intended landscape design but detracts from the economic and other value that they have attained.

- **Replacement of individual trees: potentially differing objectives**

Replacement of dead or fallen veteran trees within a distinct landscape feature (e.g. an ancient boundary or a designed avenue) will often be desirable but different options could apply, depending on the overall integrity of the feature and arguments for restoring it. For restoration, replacement trees should be in keeping with the original design. For continuity of habitat, however, there should be a succession of trees in different states of growth and decline. Continuity will be lost if the replacement regime does not maintain such a succession.

- **Tidiness**

Despite a wider awareness of the habitat value of items such as fallen deadwood, there might still be a concept of tidiness, whereby such items are considered not to have a place in a designed landscape. There is, however, a need to take into account the sculptural values of dead wood that were sometimes originally seen as contributing to the design (West & White, 2011).

- **Protection of archaeological features**

Trees growing on archaeological features might pose a risk of damaging such features by potential uprooting. Their removal could help to protect the features concerned but could also lead to a loss of ecological and other kinds of value.

* As defined by English Heritage (EH, 2008), evidential value derives from the potential of a place to yield evidence about past human activity.



Fig. 6.8: The Remedy Oak, an ancient historic tree in an area where target occupancy has increased because of present day land use. The tree has been guyed against the angle of its lean towards the road and has thereby been retained in accordance with safety requirements

- **Safety of people and property**

In certain areas, potential tree failure might pose a significant risk of harm to people or property. In order to keep risk within acceptable limits, there is sometimes a need to fell trees or to cut them more severely than would be consistent with prolonging their survival. Moreover, unnecessary conflict can be caused by a desire to reduce risk more than would be deemed reasonable in a legal context.

- **Funding-led objectives**

Major restoration projects can lead to loss of value if they are funded over short timescales. Incentives for long-term management are far more conducive to perpetuation of value.

If different objectives currently seem irreconcilable, some aspects of restoring the designed landscape could be deferred until such time as this can be achieved alongside a veteran tree population that has been brought under sustainable management; for example, when younger trees in the vicinity are beginning to contribute to the values associated with veterans.

6.3.3 Principles for a management plan

The general principles for management plans are outlined in Chapter 7. There are a number of further principles that can be applied where there is a need to balance the heritage and landscape

values of trees with the other benefits that they provide. These can be summarised as follows:

- Manage access so as to balance the needs and desires of people with a policy of keeping target occupancy low enough to avoid the need for remedial tree work that would have a negative impact on the trees.
- Identify and engage representatives of all relevant interest groups (stakeholders), including people who have specialist knowledge covering all relevant fields.
- Integrate management to conserve, restore, sustain and enhance the historic, social and natural values of the trees and the landscape.
- Safeguard the trees and their setting within historic landscapes from inappropriate development, whether this would involve informal, small-scale change or a major proposal requiring planning permission.
- Identify measures for assessing whether management is providing short- and long-term conservation benefits and for reviewing it where appropriate.
- Improve interpretation of the trees and their historic environment where possible.
- Record management activities so that successors have documents to help them understand and evaluate previous decision-making and management practices.

There is a need to ensure that management remains affordable through changing economic circumstances. If, however, the measures for safeguarding a population of trees are well planned over the lives of the trees concerned, the average cost per annum will usually be low.

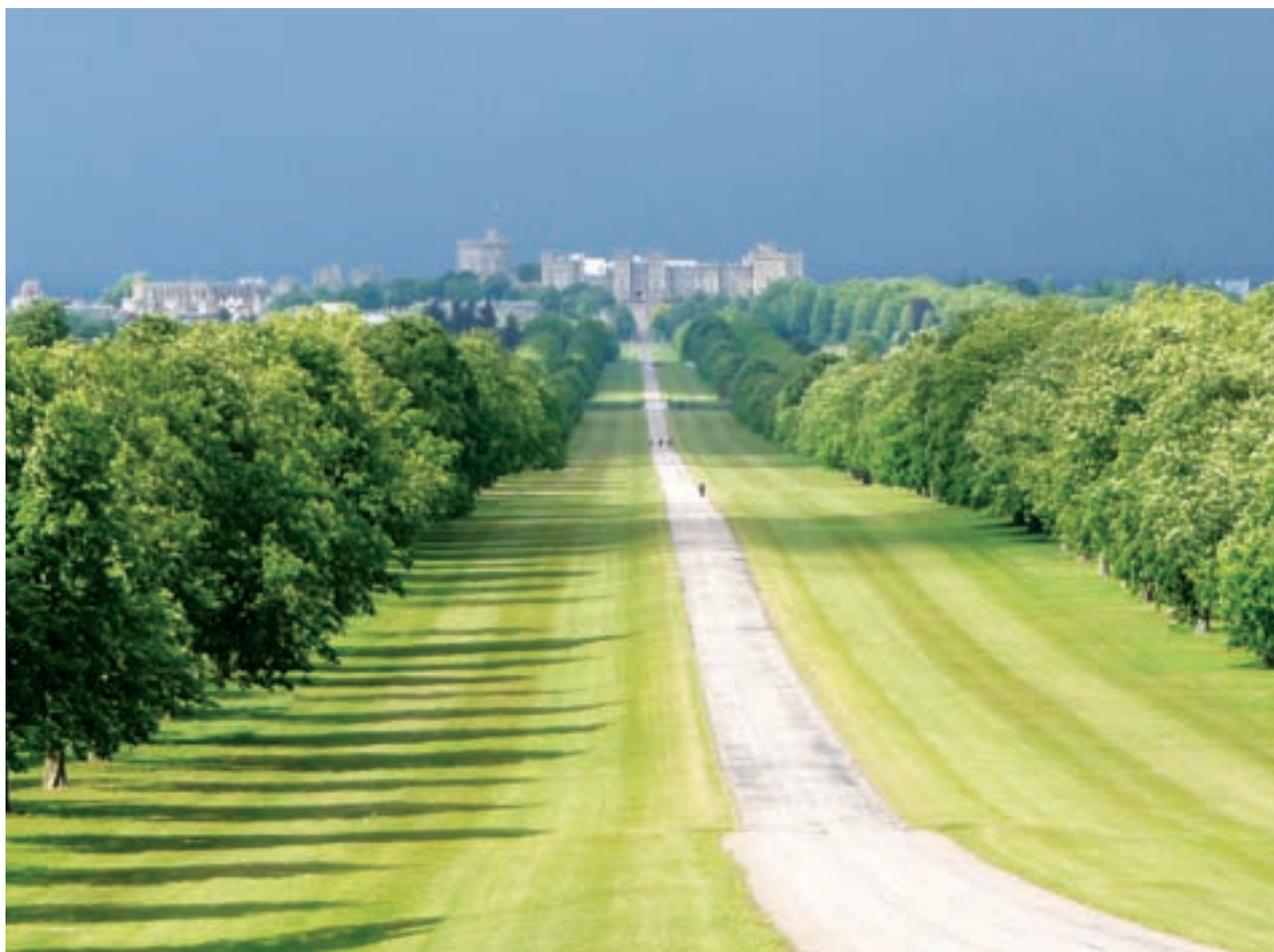


Fig. 6.9: The Long Walk at Windsor: maintenance of the designed landscape is a key objective, while also managing an area of international importance for saproxylic species

Careful, integrated conservation management is required to sustain and enhance the cultural, ecological and amenity values of trees, with regard not only to routine maintenance but also the need to plan for change and to renew the tree population in the long term. This management should be based on a proper understanding of the morphology or personality and significance of the individual trees as a component of the historic landscape.

Where new ideas are being presented, do not underestimate the time and commitment that might be necessary to win round owners or land managers. They might be receiving conflicting or out-of-date information from other advisers. It should, however, be helpful to try to reach consensus with people who, faced with the same situation, might be considering different and well-reasoned approaches. Try to think of the situation from their position and be prepared to be creative in finding a solution.

In some circumstances, specialists can become very focused on their particular area of interest at the expense of the other aspects of sustainability. Be well prepared with your arguments.

The sorts of interest groups that might need to be included in any management decision making could include the following: owners, their employees or tenants, landscape advisers and historians, local communities and local authority staff, government agency staff, heritage or conservation non-governmental organisations (NGOs).

6.3.4 Assessment of values

When planning any aspect of management, every effort should be made in order to understand the nature of the resource so that key decisions can be based on good knowledge. Guidance on the assessment and conservation of various aspects of heritage value is provided by English Heritage (EH, 2008). It is essential to include trees in any assessment, in order to take full account of their value and their setting in the landscape. This should be done in a series of steps, which can be summarised as follows:

- Identify, through research, survey and consultation, all the recognisable features of landscape value within the area concerned, including those of special cultural, religious, archaeological, historic, artistic, ecological, visual or other significance.
- Map or document the above features, including all ancient, other veteran and notable trees (see Chapter 2), and identify any such trees that pre-date a designed landscape or that occur on land that has been transferred to ownership outside the boundaries of the property primarily concerned.
- Assess the rarity and replaceability of each tree or assemblage of trees on a regional, national and international scale.
- Identify any management practices or kinds of access that have the potential to damage trees, scrub and their regeneration.

The objective of this assessment is to consider all aspects of the landscape so that management values are perpetuated through management and are not lost by focusing solely on restoration to a specific time in history. Established methods for evaluating the aesthetic or amenity value of trees are listed, with brief descriptions, in Chapter 2.

6.3.5 Specific management practices

6.3.5.1 Wood pasture and parkland

Guidance on wood pasture management is given in Chapter 3, which sets out the need to avoid harmful agricultural practices and, in particular, to retain or establish a regime of careful grazing



Fig. 6.10: Ponies and cattle in wood pasture: conservation grazing in order to maintain open-grown conditions for veteran trees

in order to retain – or to help restore – the character of wood pastures and parkland. Chapter 3 also suggests options for the protection of individual trees or groups of trees, whether planted or naturally regenerated, from grazing and browsing animals.

In both wood pasture and parkland, it is important to ensure a succession of trees, not only for their visual impact but also in order to maintain continuity of habitat for dependent species (e.g. many invertebrates) of very limited mobility (see Chapter 5). The planting of replacement trees in these settings does not create the same dilemmas that can arise in the case of avenue trees. Also, it is sometimes possible to encourage natural regeneration in wood pasture, rather than relying totally on replanting. As explained in Chapters 5 and 7, allowance should be made for the intended eventual spacing of trees that are to be newly planted or established by the protection of self-sown saplings. Where an already established tree is affecting the crown of a veteran tree, there might be a need to prune, fell or transplant it in order to avoid competition.

As an example, the Bodfach Estate, near Llanfyllin, Powys, includes an historic park, where the owner is working to restore the landscape (in partnership with the Woodland Trust) by establishing new trees as eventual successors to the remaining 11 ancient oaks, which are more than 500 years old (Woodland Trust, 2012).

6.3.5.2 Avenues

Avenues undoubtedly represent one of the greatest challenges facing managers of historic landscapes. Each mature avenue, typically planted centuries ago, is a unique feature. Avenues vary in their design objectives and species composition and they embrace an enormous range of scale and form. The character and drama of an avenue is achieved largely by its scale or uniformity, created by the spacing and height of the trees and by the morphology of a particular clone of tree that was planted. Species like limes were used to create long cathedral-like

perspectives with arching canopies. There are a host of permutations: single species, mixed species, double lines, quadruple lines and so on. In some cases, avenues that were planted as features of a designed landscape are now used as public highways, and thus present a particularly complex range of requirements for management (Toussaint *et al.*, 2002).

When deciding to what extent the original design should be reflected in future management, care should be taken to determine whether a plan was ever fully implemented. In any case, account should be taken of the reality that perfection, as represented on a plan, is not fully achievable where it depends on the growth of trees as living entities.

Arguably, the desired visual effect was not fully attained until the trees reached maturity and was sometimes compromised by undesired growth patterns or by the loss of individual trees. Later, when the trees become uneven and gappy due to damage, decay or death, their grandeur and impact are reduced. There is then a dilemma as to the best steps to restore the avenue as a feature. There are many options, ranging from interplanting to clear-felling and replanting.

In the first instance, the avenue should be assessed in order to determine its design objective and its role in the landscape. Historic maps, documentary materials and references such as the English Heritage *Register of Parks and Gardens of Special Historic Interest in England* will be useful, together with site evidence. The restoration of an avenue should always be considered in the context of a conservation management plan for the whole historic designed landscape. The assessment should take account of the following:



Fig. 6.11: Management of an avenue by retention of veteran trees and replacement of individuals that have died or fallen (Burghley Park)

- Intended function (e.g. vista or drive)
- Changes affecting intended function (e.g. severance of land from the estate or loss of the focal feature)
- Known history, including management
- Length and width of the avenue
- Planting pattern(s) (e.g. single, double, quadruple)
- Planting distance between trees – regular or erratic
- Species (and perhaps varieties or clones) of trees – single species or mixed
- Number of trees
 - Existing
 - Missing
- Age class of trees – single age class or varied because of piecemeal replacement
- Condition of trees and likely remaining lifespan
- Ecological value of individual trees – taking account of fungi and lichens, of animals such as insects, birds and bats and of plants such as epiphytes and mistletoe
- Ecological value of the avenue as a whole – in the context of the surrounding area
- Visual integrity of the feature – does the avenue “read” as an avenue or not?

Additionally, the risk of tree-related harm to people and property should be assessed as explained in Chapter 4.

The survey will assist a thorough understanding of the whole value of the avenue and will be useful when making management decisions. For example, avenues that consist of mixed species at a wide spacing, like those that frame the Pagoda at the Royal Botanic Gardens, Kew, can have individual trees replaced without any loss of the visual aspect. Similarly, replanting might be relatively non-contentious if the avenue is of mixed age but consists mostly of young trees with only a couple of veterans and if it lies within a parkland containing numerous veterans. The situation is likely to be more difficult if half the trees in the avenue comprise almost the only veterans in a park full of young trees.

Visual integrity needs to be considered as objectively as possible. An avenue of mixed-age trees will not have complete uniformity of crown height and trunk size, but still functions as an avenue by drawing the eye down a vista.

Once the overall value and importance of the avenue is understood, a number of options for repair and restoration can be considered, as summarised below. Choice of an option is never an easy decision, since the visual and arboricultural issues are complex, even before ecological factors are taken into account. The historic designed landscape context is an important consideration and the aim of management is always to sustain the values of the asset. Authenticity and accuracy are important in renewal and restoration but the original fabric – i.e. the original trees – is also highly valued. The principles for conservation and management of historic assets are set out in guidance published by English Heritage (EH, 2008). Once the ecological significance is taken into consideration, management choices are further restricted and management further complicated. There is no simple right answer: all cases are different and managers should be urged to consider all aspects of importance and all possibilities before setting a management strategy.

Certain management options for restoring an avenue containing veteran trees are not suitable for retaining the resource provided by the veterans. Of these options, the most drastic is:

- Clear felling and replanting the entire feature – choice of this option will usually lead to severe loss of biodiversity.

There are other options but these might still entail significant loss of veterans. These options include:

- Clear-fell and replant sections of an avenue – if spaced out over decades this at least retains some value over a period of time.
- Cut out every other tree and replant – this might also require some selective pruning of older retained trees to provide sufficient light for new trees to become established and to grow properly. This strategy is likely to be more successful with shade-tolerant species such as beech or lime.
- For double avenues, remove the inner or outer row and replant – as in the previous option, this might require some selective pruning, especially if the rows are close.

Options which are suitable for retaining the veteran tree resource include:

- Plant a new avenue on the inside or the outside of the existing line (McGowan with Dingwall, 2011) – this can be very effective if there is sufficient space inside or, more likely, outside the existing avenue but it is important to be aware that it could change the design form.
- Replace trees individually as they fall – this was the most common remedy until recently and probably remains the best option for retaining our veteran trees and providing a range of mixed-aged trees for the future. Some selective pruning of older retained trees might be needed to provide sufficient light for new trees to become established and to grow properly. Careful use of retrenchment pruning (see Chapter 4) could help to maintain a degree of evenness in the avenue. It is important to ensure that new trees match the species and, where necessary, also the particular cultivar of those existing.
- Enjoy the old avenue for as long as possible, and use the conservation management plan to identify a new location to plant a new feature.
- Accept the gradual loss of the avenue effect and plan for the (very) long-term replacement of the avenue only when all the existing trees have been lost naturally.

Finally, there are two important philosophical issues to consider with regard to avenues. First, while it is quite clear that the great designers planned their overall designs with maturity in mind, there are no clear indications of their long-term visions. Did they anticipate periodic replacement in order to maintain the perfect symmetry or did they expect that over the long term this would be lost or blurred at the edges as some trees were lost and others slowly deteriorated? Repton (1805) was certainly known to appreciate the beauty of old trees.

Second, the great designed landscapes were an expression of the power of individuals who made them and were for the enjoyment of the few. For the most part they are now for the enjoyment of the many, who are using the landscape in completely different ways and therefore might not be able to appreciate the original design. With ever-increasing environmental awareness, it could be argued that the maintenance of an ecologically diverse but irregular avenue is more appropriate than design perfection. The aged trees have enormous aesthetic and artistic appeal and reinforce the sense of history of a place.

6.3.5.3 Boundary, landmark and commemorative trees

When considering the replacement of missing trees on an ancient boundary, there is a rationale for planting the new trees on the boundary line, as when replacing missing trees in an avenue. This rationale exists, however, only if the boundary or other linear feature is regarded as worth preserving. Also, the stability of the soil (e.g. on a bank) should be taken into account, so as to help avoid risks associated with potential uprooting.

In some cases, by virtue of the special status of an individual, isolated tree, there is a need to

plant a replacement only on the same spot (i.e. not until the tree has died). If permissible in such circumstances, other trees of the same species should be established nearby in order to help avoid a break in the continuity of habitats for species of limited mobility.

Comparison with other guidance: assessment of trees in relation to other landscape features

The guidelines published by English Heritage (EH, 2008), define the kinds of heritage value that should be assessed in order to provide information for management. These are as follows:

- evidential value
- historical value (illustrative or associative)
- aesthetic value (designed or fortuitous)
- communal value (commemorative, symbolic, social or spiritual).

Since heritage values are implicitly associated with the past, it could be argued that assets on a site ought also to be valued according to the concept of precedence, whereby the heritage value of an asset is related to its age; i.e. older is more valuable than younger. Precedence is not included in the guidelines cited above (EH, 2008) but it could rationally be invoked in order to aid a process of conflict resolution. Precedence could therefore be advanced as a basis for the following arguments or observations:

- On many sites, the continuity of ancient trees and their associated organisms on a site is one of the oldest recognisable features.
- Depending on the species concerned, the visual effect of trees at the peak of maturity in a designed landscape can be of rather short duration in relation to the entire sequence of growth and eventual decline. The desire to replace trees when they start to show signs of decline is not necessarily consistent either with the intended design or with the appreciation of all the aspects of value (including visual) that trees provide throughout their lives.
- There is evidence that pre-existing ancient trees were valued and retained within certain designed landscapes.
- Features of fairly recent origin (e.g. natural regeneration of trees with potential to replace their ancient neighbours) can be regarded as a continuing part of the most ancient asset of the site.

Comparison with other guidance: tree evaluation methods

Living veteran trees can be ranked in categories according to British Standard 5837:2012, or assigned pecuniary values according to systems such as CAVAT (see Chapter 2). No method of tree evaluation has, however, been tested rigorously to determine its suitability for veteran trees in a range of circumstances. Also, as noted in Chapter 2, one particular drawback is already apparent; i.e. dead veteran trees are not appropriately categorised by any of the tree evaluation methods that are widely used in the UK.

Fay & de Berker (1997) developed the Specialist Survey Method (SSM) as a basis for recording detailed information specifically about veteran trees. SSM Level 1 is the basis of the information captured for each tree on the Ancient Tree Hunt database and map. The SSM has been further developed in order to quantify various kinds of value in individual trees (Forbes *et al.*, 2004).



CHAPTER 7

Plans and specifications

7.1 PURPOSE OF THIS CHAPTER

This chapter explains why and how the management of trees and of tree populations should be planned in order to maximise and perpetuate the benefits that they provide. In the context of maintaining continuity of habitat, there are recommendations for the spacing of trees established by planting or natural regeneration.

With regard to tree work, this chapter explains the principles that should be applied in order to achieve the desired results (see Chapter 4 for guidance on the choice of various types of tree work). Most of these principles apply to tree work in general, and so the following guidance focuses on particular aspects of the work that require special consideration where veteran trees are involved.

7.2 THE NEED FOR MANAGEMENT PLANS

The management of veteran trees and their environment is essentially long-term and therefore requires planning as a record of what has been done and what has been envisaged for further action (perhaps over many human generations). More specifically, a plan should:

- impose the discipline needed in order to identify the best options and to integrate tree management with other objectives
- provide a basis for discussing management objectives and methods with paymasters, site users and others
- maintain long-term objectives during changes of personnel.

7.3 PRINCIPLES, AIMS AND OBJECTIVES OF MANAGEMENT PLANS

Since veteran trees are a very valuable but vulnerable resource, a key aim is to manage them and their surroundings so that they live as long as possible. Many of them have, however, lived for centuries amidst everyday land usage, apparently without planned protection. They might continue to do so but their survival is often threatened by increasing rates of change in the type and intensity of land use and perhaps also by climate change and by alien “pests” and pathogens. Due to these adverse factors, the need for management plans is greater than in the past but does not necessarily impose a major commitment of resources. Every plan should, however, identify the objectives for management and the types of intervention that might become necessary during the period concerned, perhaps due to changing circumstances. Also, the plan should allow for revision in the light of potential improvements in knowledge.

The objectives should take account of the following needs:

- to safeguard the mechanical integrity of the tree and (so far as is considered reasonable) the safety of people and property
- to protect not only the tree, but also the habitats it provides, which could include:
 - decaying wood (saproxylic habitats) in a wide range of states, as produced by the activities of fungi and micro-organisms
 - decay cavities
 - sap runs
 - bark and bare wood as substrates for lichens and bryophytes

- the foliage and other living parts of the tree, providing habitat for phytophagous invertebrates and their dependent organisms
- tree water pools or water pockets, which could be subject to eutrophication
- to ensure that the surrounding vegetation includes essential nectar and pollen sources, such as hawthorn, bramble and tall herbs, for the adult stages of saproxylic insects
- to address contingencies, such as the following, since these could compromise the achievement of the objectives
 - risk of mechanical collapse of trees
 - disease or other causes of impaired vitality
 - potentially damaging factors, related to management of the surrounding land
 - gnawing or rubbing by animals
 - compaction (from machinery or trampling)
 - excavation (e.g. from site development or trenching for drainage etc.)
 - nutrient enrichment (e.g. from fertilisers)
 - pesticide contamination
 - fire risk (e.g. from bracken).

7.3.1 Specific actions and contingencies to be planned on a site basis

The overall plan for the site should include the following targets for management.

- The tree population within the area concerned (assuming that there is more than one tree within the particular ownership or that there are other trees within the surrounding landscape), taking account of the following:
 - age structure (including younger trees which could become veterans) and hence the rate of mortality and of recruitment (see below and Chapter 5)
 - factors which might affect the rate of mortality, compared with the past rate (e.g. diseases, disorders, climate change, pollution, changing land use)
 - continuity and connectivity of habitats associated with the trees and the surrounding land (see Chapter 5).
- The environment within which the trees are growing: this part of the plan should address any need to continue or modify aspects of land management which are important for the survival of the trees and for the continuity or enhancement of habitats.
- Each individual tree: as individual veteran trees are very variable (for example, with regard to age, form, mechanical integrity and vitality) each one should if possible be allocated an individual tree management plan (Fay, 2008b).

7.3.2 Planning for the population of trees

7.3.2.1 Information from age structures as an aid to management strategy

Age structure analysis (see Chapter 2) generally shows that relatively few young trees live long enough to become ancient. By the time that they reach maturity, they have, by definition, already survived long enough to be potential recruits to the ancient category but they can still sometimes suffer high mortality, for example because of severe weather events or fire. If, on the other hand, the young trees are too close together to develop an open-grown habit, or if they compete for light with existing veterans, there will be a loss of many of the habitats associated with ancient trees (see Chapter 5). Thus, the strategy should be to strike a suitable balance; avoiding overcrowding but ensuring that the population of young trees remains high enough to allow for losses during their maturation and aging.

When planning for an unbroken succession of ancient trees, there is not necessarily a

requirement to establish new trees on a continuous basis. There are many sites where a succession can probably be maintained, and yet where an age structure analysis reveals that trees have been recruited to the populations in one or more peaks. Such peaks have often resulted from planting schemes or from episodes of good seedling establishment (e.g. during heavy seed production or a reduction in grazing.) The information from a survey might show that there is little prospect of natural regeneration without intervention. If so, the management strategy could be developed to help reduce a future age gap. The appropriate measures could include the protection of seedlings and saplings from grazing and browsing (see Chapter 3) or, if necessary, tree planting. Guidance on a planting strategy for habitat continuity is given in *Ancient Tree Guide No. 6* (ATF, 2009).

If, owing to a lack of mature trees, a future gap in the succession of veterans cannot be avoided, the management strategy should aim to maintain continuity of habitat features as far as possible. In particular, if the habitat is dependent on a declining population of ancient pollards, younger maiden trees may be cut in order to provide a new generation of pollards. Or, subject to the precautions stated in Chapter 4, habitat development may be speeded up by “veteranising” trees that do not yet have veteran characteristics.

In any case, the management strategy should generally be to prevent avoidable harm (see Chapter 3) or life-shortening biomechanical failure (see Chapter 4) among the cohort of ancient and other veteran trees, since they represent the greatest current value in the ecological and other contexts. If, however, there are very many such trees within the cohort, there will usually be a need to decide which of them can benefit most from the use of the available resources. Resources might not be much needed for trees that are mechanically very sound and growing in good conditions, or for those that are likely to die or collapse soon even with intensive management (see Chapter 4).

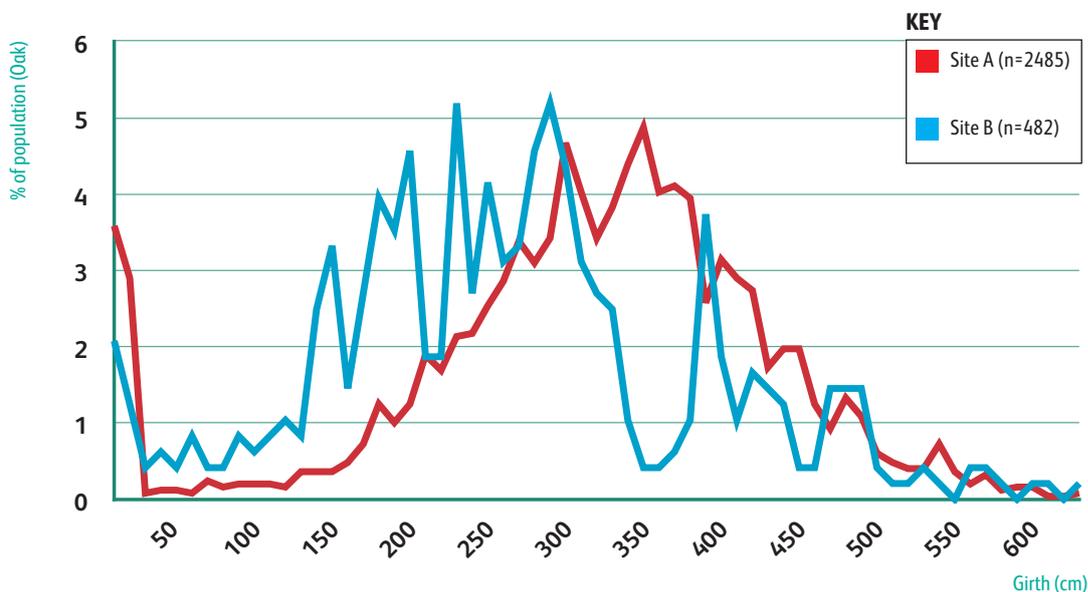


Fig. 7.1: This chart shows age class distribution recorded from parkland tree populations at two Sites. The population at Site A is in good condition with no large gaps between generations. At Site B, there is a lack of trees between 340 and 390 centimetres girth, representing an age gap roughly in the range 160-210 years. Site B also has relatively few very young trees, of which there should ideally be more individuals, since mortality is high in early years

The above graph shows the use of data gathered in the short term. For planning purposes, there is also a need to record mortality over a given interval of years in order to estimate a mortality rate, as explained in Chapter 2 and Appendix B (Gibbons *et al.*, 2008). This is important.

7.3.3 Establishment of new trees

The establishment of new trees is obviously essential to maintain continuity of the population and of the associated value for biodiversity, visual quality and heritage. The rate at which trees should be established can, to some extent, be estimated according to the demographic criteria set out in Chapter 2, which can help to identify any serious age gap in the population. For the reasons mentioned in Chapter 5, however, there is currently no clear basis for guidance regarding a suitable density of successor trees of various ages.

Natural regeneration of trees may be encouraged by the control or local exclusion of grazing if seedlings and saplings are not already being adequately protected by accumulations of fallen deadwood or by patches of bramble or thorny scrub (see Chapter 3). If necessary, trees should be planted for succession and should be protected by means of suitable tree shelters.

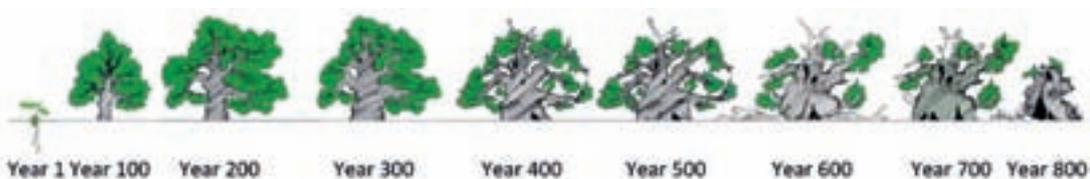


Fig 7.2: Stages in the life of an ancient tree

Whatever the means of establishment, trees in wood pasture or parkland should never be allowed to become so crowded as to lose their open-grown habit or to encroach on existing trees. Otherwise, there are likely to be adverse effects on the composition and abundance of associated species, including rare invertebrates and lichens. When deciding how much space to provide for a future ancient tree, account should be taken of the available information about the species and the effects of soil type and climate. In most parts of lowland Britain, for example, an area of at least 15 metres radius (700 m²) should be allowed for the development of an open-grown oak. A smaller distance between a new tree and an existing veteran might, however, be appropriate where the latter is expected to die within a few years.

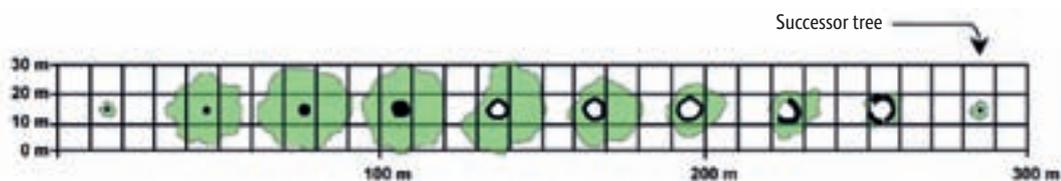


Fig 7.3: Space required for a large-crowned tree at different stages of its life and for a successor tree

In principle, it might seem appropriate to establish the potential successors of ancient trees at a density that makes allowance for some of them not to survive to maturity. It is, however, generally advisable to adopt the final intended spacing between newly established trees so that they are open-grown in character from the earliest stages. If any of them fails to thrive, it can be replaced as necessary. This approach is preferable to the reality whereby trees are planted more closely and later lose their open-grown habit because of a failure to maintain a suitable programme of thinning. Also, the planting of occasional replacements over many years helps to improve the age diversity.

7.3.4 Choice of trees for planting or selective retention

Where a survey indicates a need either to plant new trees or to remove trees in order to make space for others, decisions should be taken regarding a suitable choice of trees to become potential future veterans and thus potential providers of habitats that could be lost with the demise of the current veterans. In this context, the potential contribution of these trees in later life should be taken into account for the following reasons.

- Species that form a non-durable heartwood or ripewood (see Chapter 4) are typically affected by central white-rot after maturity. They thus often provide a different range of habitats to those that form in tree species that are more often affected by brown-rot (red-rot).
- Some of the above tree species develop heart-rot, with its associated saproxylic habitats, at a relatively early age. The planting of such trees can help to avoid a continuity gap, provided that they are never allowed to compete with existing veterans or their long-term successors. For example, the red-rot habitat most often provided by the native British oak species might develop somewhat earlier in Sweet chestnut and occasionally much earlier in other species; also white-rot can develop in a wide range of species (including poplars, willows and Horse chestnut) earlier than in beech or hornbeam.
- Species with durable heartwood tend to live longer and also to provide continuity of a range of saproxylic habitats (including brown-rot aka red-rot) in a single tree for a relatively long time; sometimes several centuries.
- The potential for great longevity in individual trees can sometimes be recognised when they are not yet past maturity; the signs could include the development of epicormic shoots (useful as potential successors to branches that are shed later in life) and an absence of very large branches that could be involved in life-shortening failure (Read *et al.*, 2011).

7.3.5 Plans for individual trees: general requirements

As advised in Chapter 1, any individual trees that are assessed as being vulnerable either to damaging activities or to catastrophic failure should, if possible, be covered by individual tree management plans (ITMP). An ITMP should specify a series of assessments and possible actions over a period of up to, say, 30 years. For example, a tree might be assessed as being amenable to a phased retrenchment pruning (Chapter 4), whereas other trees might be suited either for minimal intervention or for relatively radical short-term treatment. In all cases, periodic or opportunistic monitoring should be a key aspect of the plan. More specifically, the plan should ensure that the following actions are undertaken over an appropriate timescale (Fay, 2008b).

- Assess the vitality of the tree (see 7.3.6.1), so as to decide whether it is likely to live for the 30-year duration of the plan and beyond. On this basis, the need for, and timing of, possible tree work can be included in the plan. (If unfavourable site conditions are the cause of poor vitality, they should be ameliorated; see 7.3.1 in the context of the plan and Chapter 3 in the context of methods.)
- Assess the mechanical state of the tree so as to decide how soon (if at all) any tree work is required for prevention of serious failure. Although this is an ITMP, this assessment should be done in the context of the tree population. (For example, if the population of veteran trees is large, with a good supply of potential future veterans, resources might be best spent by allowing the least mechanically sound trees to break up or die, while planning a programme of tree works for those that are more likely to survive until recruitment of younger cohorts. If, however, there are very few trees, urgent action may be taken so as to prolong the life of any which are in a state of imminent collapse.)
- Decide the type of tree work, if any, that is needed to help avoid catastrophic failure in the short term (see Chapter 4).

- Tailor and specify the tree work according to the characteristics and species of the individual tree (in particular, decide whether a single action or a progressive series of actions is needed).
- If a series of actions is needed, specify the details and timing of these, allowing room for adjustments in the light of monitored events and/or increased knowledge.

7.3.6 Development of an individual tree management plan

7.3.6.1 Taking vitality and vigour into account

The vitality of a tree, as defined in the present book, is the adequacy of its physiological functions, which include photosynthesis, storage of sugar and starch, growth and the translocation of water and dissolved nutrients. A tree can have good overall vitality, even though some of its parts might have low vitality, with signs of dieback or disease. Localised dieback, together with localised mechanical failure, is part of the process of retrenchment, whereby the crown of an old tree becomes smaller while retaining good vitality overall.

When planning the management of a tree, the assessment of its vitality is essential in order to gain some idea of its survival during and beyond the duration of the plan. Vitality also underpins its likely response to tree work that might be needed for biomechanical reasons.

Vigour, which for present purposes is the capacity for growth, is related to vitality but it is possible for a tree to be growing slowly (as in the case of many veterans) and yet to have good vitality. Assessment of vigour is important in order to gain some idea of the future growth of the tree and hence its capacity to maintain its crown after episodes of mechanical failure or pruning. Growth rate is also important in relation to the increase in length and weight of potentially weak parts. Conversely, the radial growth rate of wood by annual increments is important in maintaining strength where it is required (i.e. by adaptive growth).

The principles of assessing vitality and vigour are outlined in Chapter 4, in the context of assessing any current need for tree work. For the purpose of a management plan, the same assessments should be made, but in a predictive context. For convenience, the key features to be assessed (as explained in Chapter 4) are summarised below, as follows:

- presence of extension growth
- colour and size of leaves
- density of twigs and presence of dieback, especially at the top of the crown
- pattern of any dieback and/or new growth.

7.3.6.2 Potential for new branch development after cutting or natural breakage: factors to consider for an individual tree management plan (ITMP)

The survival of cut or broken branches, and sometimes of the entire tree, sometimes depends on the formation or enhanced development of daughter branches. Even though some of the bark and sapwood near the wounds could become physiologically dysfunctional, this process is often confined to discrete strips, provided that new or continued shoot growth is supporting the survival of intervening channels of functional bark and sapwood (Chapter 4). Trees vary a great deal, as individuals and between species, regarding their ability to produce or maintain viable shoots in response to wounding. Factors to be taken into account in an ITMP include the following:

- **The existing branching pattern;** this is an indication of the availability of healthy branches for retention in retrenchment cutting.
- **The age of the tree,** or more particularly of the branches involved; the capacity for shoots to develop from dormant buds (or from adventitious buds in species which can form them) tends to diminish with age.
- **Weather and soil moisture:** if the conditions are currently (or have recently been)

physiologically stressful – especially in the case of drought – the growth or initiation of shoots will often be impaired. Moisture stress additionally increases the drying of the bark and sapwood exposed by a wound, thus exacerbating dysfunction and perhaps dieback of the entire branch.

- **Past occurrences of growth** following natural breakage or cutting (as a possible indication of growth after future cutting).
- **Presence/abundance of epicormic growth** and/or burrs on the trunk or scaffold branches (Chapter 4); such growth is often a natural survival strategy, as it can readily develop into new branches when a limb is lost.
- **The species** (or local provenance) of the tree, for which there is often a track record of its response to cutting or breakage.

7.3.6.3 Mechanical integrity: factors to consider

The mechanical integrity of the tree is no less important than its ability to maintain a healthy crown, since catastrophic break-up can end its life. In the first instance, any current requirements for remedial tree work should be assessed by reference to relevant guidance (e.g. Mattheck &

Comparison with other published guidance: tree management plans

Guidance on conventional arboriculture emphasises the management of trees for their amenity value. This can in principle apply to ancient and other veteran trees but it is more concerned with the care of trees up to and including maturity. This involves either the attainment of a good visual form in maturity or the manipulation of size and shape so as to ensure that trees fit within parks, gardens, streets and other spaces designed for human use. In cases where older trees are retained, they are sometimes managed so as to maintain for as long as possible the shape and size which idealises their mature state, rather than a phase of retrenchment. Guidance in forestry emphasises the need to grow timber and/or other wood products. The crop usually consists of trees which are biologically immature or in early maturity. Older trees tend to be less productive and eventually begin to develop decay, which represents an economic loss. The retention of a proportion of older or commercially defective trees, especially for their habitat value, is, however, now an objective of forestry policy in the UK and an increasing number of other countries.

The present guidance emphasises the protection of trees, so that they continue for as long as possible to live and to provide saproxylic and other habitats. Visual amenity is an important consideration, but with emphasis on maintaining the natural appearance of trees which are undergoing retrenchment, rather than a concept of perfection in maturity. In comparison with other forms of tree management, there is therefore more emphasis on the following principles and practices:

- the cutting of trees so as to perpetuate longevity and habitat, rather than conventional visual amenity, involving in particular:
 - a comparatively wide variety of techniques for reducing mechanical stress, ranging from phased retrenchment pruning (see Chapter 4) to the shortening of stems or major branches (sometimes so as to leave irregular crown forms)
 - the retention of live stubs so as to encourage new shoot formation (and hence survival) on branches which require shortening so as to reduce mechanical stress
 - the partial retention of deadwood when trees are managed for the safety of people and property
 - the use of techniques to simulate natural fracture, including deliberate tearing and coronet cutting (see Chapter 4)
 - intervention to encourage low branches to rest on the ground and to undergo layering
- integrated management of trees and their surroundings, for the benefit not only of the trees but also of associated habitats, including those provided by decay cavities, tree water pools, water pockets and sap runs
- conservation of the fungi and other organisms which are involved in wood decay or which depend on it.

Breloer (1994), Lonsdale (1999) and Mattheck (2007). The main principles for such an assessment are set out in Chapter 4. For longer-term planning, the same principles should be applied on a prognostic basis. For example, if any branches are likely to become significantly longer and heavier, the plan should make allowance for a possible need for tree work on particular branches within a predicted number of years. The same could apply to structures that are liable to become weaker because of decay or morphological processes.

The main biomechanical factors to be taken into account when formulating an individual tree management plan are set out in Chapter 4, together with an outline of the signs that might indicate a propensity for mechanical failure. For convenience, the factors are summarised below as follows:

- length and weight of branches in relation to possible tearing out or snapping
- the probability of low branches coming to rest on the ground, rather than failing completely
- size and residual strength of any dead branches
- types of branch attachment
- decay or damage near branch attachments
- height of the tree and the spread of branches
- conformation of the crown
- the species, variety or local provenance of the tree
- previous branch failures in the individual tree
- previous failures of similar trees on the site.

7.4 GENERAL PRINCIPLES FOR SPECIFYING TREE WORK

A specification is a document, which describes the work that is to be done, stating any details of tools, materials and standards of workmanship that are required. It forms part of a contract between an employer* and a contractor. If drawn up properly, it will be understood and unambiguously agreed by everyone involved in the process of commissioning and doing the work. When specifications are prepared for each of a number of trees on a site, it may be appropriate also to prepare a schedule of works, which summarises the work to be done. If the work is to be done or administered by a professional arboriculturist, he or she will normally incorporate the employer's requirements (the particular schedule of works) into a standard contractual framework. In Great Britain, an accepted framework for drafting the detailed specifications is provided by the Arboricultural Association, together with guidance on setting out the legal and other safeguards and conditions that are necessary to protect trees, people, property and wildlife etc. These conditions should normally be set out in a method statement (see Appendix D).

7.5 SAFEGUARDS AND CONDITIONS: THE METHOD STATEMENT

In addition to a specification of the work to be done, there should be a clear description of the conditions under which it is to be done. These include, in particular, the following:

- who (with regard to competence) is to do the work
- how it is to be done
- when it is to be done
- any other safeguards that are necessary, including legal requirements.

* In this context, the employer is the person or organisation that commissions the work. This is the word used in the cited guidelines of the Arboricultural Association.

The conditions have important implications for the care of the trees, the soil, wildlife and the workers. They should be set out in the method statement. Also, the contract documents should include a declaration that the contractor has appropriate insurance and any certificates of competency, equipment checks or licences that are required (e.g. a waste carrier's licence).

The method statement sets out how the specifications are to be implemented and in what order. It could be very short if the work is simple and straightforward. It should, however, at least have a title, a date (and a revision number if appropriate) and should be supported by site-specific assessments of the various risks that can be identified. As a step-by-step guide, it enables contractors and all relevant parties to understand who is doing what, where and why. For example, it could specify that work is not to be done under certain conditions, such as during very dry or very wet weather, when unintentional harm could be done to the tree(s) or the soil. Also, it could emphasise certain requirements that are not yet widely understood; for example, the importance of retaining as much of the cut material *in situ* as possible. If certain safeguards, like ground protection, need to be established before particular stages of the work are started, this requirement should be included in the method statement. Also, there should be provision for contingencies (and for associated costs), as might arise if a protected species is unexpectedly discovered during the work. A copy of the specifications should be appended to the method statement.

A method statement will usually include several items that are important in relation to the conduct of the work but do not form part of the specification of work. The list of items for possible inclusion, mentioned in 7.5.1, is derived mainly from BS 3998:2010 and/or from Part 2 of the standard conditions published by the Arboricultural Association.

7.5.1 Provisions for possible inclusion in a method statement for tree works

Appendix D lists some headings that may be included in a method statement. The list might be helpful when ensuring that a contractor's draft method statement includes all relevant safeguards and conditions. Most of these can be implemented through standard arboricultural operating practices but there are a few that require special consideration in relation to veteran trees or sensitive sites. For these particular safeguards, some options for implementation are set out below.

7.5.2 Health, safety and pollution control

Hazell *et al.* (2008) mention dust or fungal spores as a potential hazard. This might be more significant where veteran trees are concerned and could usefully be taken into account when stipulating any precautionary measures.

The AA guidance states the need for the contractor to comply with any statutory requirements* regarding the use of any substances potentially harmful to human health, such as oils, fuels and lubricants. The option of using relatively safe products such as the low-emission fuel Aspen® and vegetable oils for lubrication could be considered in the interests of the operator's health, but there is currently no evidence of any benefits for the care of veteran trees or the surrounding habitats.

It is highly advisable to require workers to have a spill kit available at all times during the works, to enable prompt mopping up of any spilt fuel or oil in the vicinity of vulnerable trees.

7.5.3 Choice of tools for pruning

Due to the slow growth rate of most veteran trees, their dead, central wood can be exposed even in relatively small pruning wounds. If there are numerous such exposures, the rate of decay could

* In the UK, this requirement is laid down under the Control of Substances Hazardous to Health Regulations (COSHH).

Comparison with other guidance: specification for choice of saws

In the standard specifications that are set out by Hazell *et al.* (2008), cuts less than 50 mm in diameter are to be made with a handsaw, rather than a chainsaw. In the present guide, the suggested use of handsaws for cuts up to 75 mm in diameter depends on factors such as the species of tree concerned.

increase enough to become detrimental, especially in species that do not form durable heartwood (see Chapter 4). The choice of the exact position – and hence the diameter of the cut – is normally left to the operator and can be influenced in favour of large-diameter cuts if a chainsaw is available. It is therefore advisable to stipulate the use of handsaws, except for removal of individually identified branches above a certain diameter – perhaps 75 mm.

7.5.4 Timing of operations

Since veteran trees are likely to support vulnerable species, there is a need to emphasise the importance of making allowance for the seasonal activities of such species, whether or not they are legally protected. Seasonal changes in the sensitivity of fragile habitats in the area around the trees should also be taken into account.

Another aspect of timing is that there can be implications for the health of the trees concerned, as stated in BS 3998. Since veteran trees are often especially sensitive to pruning injury or to removal of leaf area, the following conditions should be considered for inclusion in the method statement:

- site management
- avoidance of major phenological changes (e.g. shoot growth in spring or leaf abscission in autumn) if other considerations (e.g. potentially imminent tree failure) allow
- requirement to take account of the current and previous weather conditions, especially in order to avoid cutting during or after a period of drought
- provision to alter the specification for the amount of leaf area to be removed if the work has to be done when sun-scorch is of concern, especially when the tree is a thin-barked species or is of very low vigour.

7.5.5 Protection of the soil and of tree roots from compaction during tree work [see BS 5837:2012 (BSI, 2012) in relation to construction sites]

The guidelines for vehicle access should be clearly stated when tenders for the work are submitted. According to Hazell *et al.* (2008), the tenderer should have first investigated the site in order to determine what may be required with regard to protection of the soil, sensitive habitats, ground vegetation or root zones, taking account of the access route, the extent, character and accessibility of the site and working area and all other conditions affecting the works. When the route has been agreed, the contractor shall normally have free access to the site for the duration of the works unless he/she is told otherwise by the contract administrator. Similarly, the contractor is responsible for making any arrangements for access across land belonging to another party. Thus, for any land to be used by vehicles, the method statement should show what should be done in case a need arises to restrict access (e.g. during wet weather to protect the soil or habitats).

7.5.6 Conditions and options that could be specified to protect the soil from compaction

- the type(s) of vehicles and other machinery to be used (e.g. consideration of vehicles with low ground pressure, especially with balloon tyres or rubber tracks, or the use of a boat if a river runs through the site)
- timing of access (time of year or weather), if necessary restricting this to times when the ground is hard either in the summer or when frozen in a very cold winter

- allowable distances from trees (restriction of vehicular access, at least within the drip line of any veteran tree and preferably within 15 times the diameter of the trunk)
- exclusion of all compacting activities within areas of particular sensitivity (maps to be provided by the employer)
- possible use of ground protection, including home-made options such as a dense brushwood mat, as well as proprietary products
- minimisation of impacts from dropping cut material on to the rooting area of veteran trees (this could involve specifying the use of rigging or a maximum permissible size of material to be dropped; it could also involve specifying the ring-barking or monolithing of trees that might otherwise be felled for haloing)
- use of a crash mat (e.g. of brushwood) as an alternative to rigging or the minimisation of the size of material to be dropped.

7.5.7 Communication and access

Where well-known veteran trees are involved, it is especially important to ensure good communication between all parties, including potentially interested members of the public. Everyone involved should clearly understand the purpose and scope of the works and of any need for restriction of access. Alternative routes should be made available and clearly explained to the general public. Hazell *et al.* (2008) advise that such provisions should be discussed at pre-tender and pre-contract meetings.

7.6 WORK SPECIFICATION

7.6.1 Principles for drawing up a specification

General principles for tree work in Britain are laid down in British Standard (BS) 3998, while the requirements for specification are set out by the Arboricultural Association (Hazell *et al.*, 2008). Those sources of guidance include specific provisions for veteran trees, together with general provisions that are relevant to trees in general. In order to complement those sources, rather than to reiterate their content, the present chapter focuses on aspects of tree work that should be specified with extra care if veteran trees are involved.

The specification of a schedule of work for trees and sites should include all the items of work required to fulfil the relevant objectives. Items for possible inclusion are named in BS 3998:2010 (BSI, 2010), and a few additional ones are named in the present book (AVM) or by the Arboricultural Association (Hazell *et al.*, 2008). These items are listed below, showing the relevant clause numbers or chapters of the cited publications (BS, AA or AVM) in brackets.

7.6.2 Items of work that could be included in a specification

Surveys and inspection

- Preliminary investigations: e.g. for site-specific risk assessment or for legally protected species (AA: 2.3)
- Tree inspection (BS 3998: Clause 6.2)
- Reporting (BS 3998: Clause 6.3)

Crown management by pruning

- Deadwood management (BS 3998: Clause 7.3)
- Formative pruning (BS 3998: Clause 7.4)
- Crown thinning (BS 3998: Clause 7.5)
- Crown lifting (BS 3998: Clause 7.6)

- Crown reduction and re-shaping (BS 3998: Clause 7.7)
- Extreme crown reduction and topping (BS 3998: Appendix C.4)
- Retrenchment pruning of ancient trees and lapsed pollards (BS 3998: Appendix C.2)
- Shoot renewal pruning (BS 3998: Clause 7.7.3)
- Selective pruning (BS 3998: Clause 7.8)
- Pruning for infrastructure (BS 3998: Clause 7.9)
- Pollarding (BS 3998: Clause 7.10)
- Cutting overgrown hedges (BS 3998: Clause 7.11)
- Climbing plants (BS 3998: Clause 7.12)
- Removal of inappropriate objects (BS 3998: Clause 7.13)

Wounds and other injuries to trees

- Prevention of wounds that could lead to decay (BS 3998: Clauses 4.4 and 7.2)
- Treatment of bark wounds (BS 3998: Clause 8.2)
- Treatment of wounds that penetrate the wood (BS 3998: Clause 8.3)
- Exudations (BS 3998: Clause 8.4)
- Cankers (BS 3998: Clause 8.5)
- Root wounds (BS 3998: Clause 8.6)

Decay, cavities and water pockets

- Management of cavities and water pockets (BS 3998: Clause 9.2)
- Control of access to cavities (BS 3998: Clause 9.3)
- Veteranisation to accelerate habitat development (BS 3998: Appendix C.4.2)

Management of weak structures

- Flexible restraint systems (BS 3998: Clause 10.4)
- Rigid bracing (BS 3998: Clause 10.5)
- Propping (BS 3998: Clause 10.6)
- Guying unstable trees (BS 3998: Clause 10.7)
- Other attachments to trees (BS 3998: Clause 11)
- Encouragement of layering and of ground support for branches (BS 3998: Appendix C.3)

Tree roots and their environment

- Protection of the soil and of tree roots from compaction during tree work (AVM: Chapter 3)
- Mulching (BS 3998: Clause 6.2)
- Aeration/decompaction (BS 3998: Clause 6.3)
- Removal/replacement of soil (BS 3998: Clause 6.4)
- Irrigation/drainage (BS 3998: Clause 6.5)
- Nutrient deficiency (BS 3998: Clause 6.6)
- Other treatments (BS 3998: Clause 6.7)

Tree felling and stump management

- Tree felling (BS 3998: Clause 12.2)
- Stumps for retention (BS 3998: Clause 12.3)
- Tree stump to be removed/destroyed (BS 3998: Clause 12.4)

Fallen trees

- Re-erection, with propping or guying (BS 3998: Clause 10.8)
- Phoenix regeneration (BS 3998: Clause 10.8)
- Retention for saproxylic habitat (BS 3998: Clause 10.8; AVM: Chapter 5)

Completion of work

- Disposal/utilisation of arisings (BS 3998: Clause 13.2)
- Burning (BS 3998: Clause 13.2)
- Follow-up work (BS 3998: Clause 13.3)

7.6.3 Specifications with particular relevance to veteran trees

Standards for most aspects of tree work are laid down in BS 3998:2010, while detailed technical guidance is provided in various arboricultural books and leaflets. The following guidance concerns aspects of the work that might need particularly careful specification where veteran trees are involved.

7.6.3.1 Preliminary investigations

A survey should be undertaken to identify any species and habitats that have statutory protection or that could be affected by tree or site management. If such species or habitats are present, the specification for any work should be formulated to avoid harming them. The survey should also be designed to identify any features of the site (e.g. a potential problem of compaction if work is done when the soil is wet) that could influence the timing of the work and hence the provisions of a method statement.

7.6.3.2 Management of arisings

Specifications for the treatment, use or retention of arisings should be based on a selection from the following options:

- whether to cut any of the material into smaller pieces (preferably not) and, if so, to what extent
- where to leave the material (preferably *in situ*, as far as permitted under safe working practices)
- whether to stack any of the material, and if so, how (and in any case ensuring that logs to be used as produce are not stacked at a time and place where they would become a decoy for egg-laying by vulnerable saproxylic invertebrates)
- whether to set aside any material to be removed from the immediate vicinity (e.g. logs for sale, leafy fodder for livestock or thorny material to be used as a barrier to livestock), and if so, to specify one or more of the following options (see Chapters 3 and 5 for a description of these options):
 - stacked *in situ* in deadwood piles (see Chapter 5) in as large pieces as possible
 - corralled
 - dead-hedged
 - left where it falls, but cut to prevent it being a hazard (by toppling or by being climbed) in public areas

Comparison with other guidance: specification for management of arisings

The AA guidance (Hazell *et al.*, 2008) includes clauses which emphasise the potential value of retaining arisings on site for various purposes, including habitat creation. However, the general clause on site management states that the working area is to be left clean and tidy when the contractor goes off site at the completion of the day's work. Also, there is a worked example of a particular schedule of works (i.e. a schedule based on an employer's stipulations), which specifies that no arisings are to be left on site overnight because of the risk of damage caused by the deliberate misuse of those arisings, or the risk of vandal damage to stacked arisings. There is, therefore, a need to ensure that such provisions are not specified in a context that is inappropriate for sites where veteran trees are present.

- chipped (an option that can be considered in areas where unchipped material would tempt arsonists or other vandals)
 - chips blown into vehicles and removed
 - chips blown into heaps *in situ*, to be used later as a mulch
 - chips blown around *in situ*, but levelled (except if the amount is so small as to get lost)
- whether to burn any twiggy material which cannot readily be accommodated on site, but if so:
 - specify how to control the burning (e.g. using a burning trailer: see Chapter 3) and in any case ensuring that fire sites are pinpointed in advance and are well away from the roots of the veteran trees
- whether to remove any material from the site, and if so:
 - state what is to be removed
 - stipulate use of a forestry-style forwarding trailer with low pressure tyres or rubber tracks to help alleviate soil compaction.



APPENDIX A

SPECIALIST SURVEY METHOD FOR RECORDING TREES: DATA SECTIONS IN THE SURVEY FORM

The handbook for the Specialist Survey Method states that all the data sections should be completed. These are as follows:

SITE DETAILS

- Site (name of estate or farm etc.)
- County (as in the postal address)
- Postcode
- Grid Reference (six-figure, for the whole site)
- Location (within the named site)
- Ownership
- Site records (categories of relevant biological or other site records)
- Site status (National Park, SSSI, TPO, etc. etc.)
- Access and visibility (to the public)
- Site notes (type of site and special features)
- Date (D | M | Y)
- Recorder (name)
- Organisation (on whose behalf the survey is being undertaken)
- Map (whether one is available and if the trees are plotted)

TREE DETAILS

- Tree number (to be unique within the site)
- Grid Reference (at least six-figure, for each tree)
- Species (code, as in SSM Handbook)
- Dimensions (girth at 1.3 m or other suitable height; also height of bole of a pollarded tree)
- Number of trunks (as in SSM illustrated guidance)

TREE FORM AND VIGOUR*

- Tree form (e.g. maiden tree, pollard, coppice, coppard, phoenix regeneration, etc.)
- Standing/fallen (various categories stages of upright, leaning and fallen)
- Live growth (proportion and pattern within the crown)
- Crown loss (percentage of the original that has been shed)
- Epicormic growth (position/s of such growth, if vigorous, within the tree)

TREE HABITAT

- Bark condition (location and abundance of large areas of dead bark)
- Bark fluxes (category: e.g. wet, dry, bubbly)
- Split limbs (categories and number of any split limbs: e.g. firmly supported or hanging)
- Tears/scars/lightning strikes (presence of such features)
- Live stubs (stubs of live branches, left by natural fracture: number of those >150 mm diam.)
- Hollowing: trunk and mature crown (extent and height within the trunk of hollowing, defined in categories)

* **Note:** The SSM uses the term vigour in the same way that vitality is used in this book. According to another definition that is often used in arboriculture, vigour is purely a genetically determined characteristic [Shigo, A.L. (1991)].

Holes: trunk and mature crown (number of apertures 50 to 150 mm across)
 Water pockets (number of non-decayed pool-forming areas)
 Rot (number of zones of decay of each type (e.g. white, brown, dry, wet))
 Deadwood attached (number of attached branch lengths >150 mm diam. and >1 m long)
 Deadwood fallen (number of fallen lengths of the above size)

TREE ASSOCIATES

Fungi (number of fruit bodies in each of various categories: e.g. brackets)
 Epiphytes and hemi-parasites (presence of lichens, ferns, mistletoe, ivy etc.)
 Invertebrates (presence of activity associated with substrates such as deadwood or fungi)
 Birds and mammals (presence of various signs of activity, droppings, etc.)

TREE MANAGEMENT

Context (category of landscape around the tree: e.g. arable field, heathland, parkland)
 Management (work done to tree or surroundings in the last two years: e.g. pollarding, weeding)
 Damage (categories of major damage: e.g. lightning, ploughing, inappropriate pruning)
 Shade (category of intensity)
 Photographic number (code numbers of photographs, preferably based on tree number and year)
 Notes (any other information or comments)

For all levels of survey, the SSM Handbook states that the following precautions should be observed:

- Any necessary permissions are obtained from landowners or other relevant bodies prior to surveying.
- Surveyors should take all reasonable precautions to avoid risk of personal injury and if possible should not work alone.
- The survey is to be undertaken from ground level only.
- No damage to the tree or its surroundings should occur in the course of surveying.
- If the survey is done on behalf of an organisation, all conventions laid down by that organisation (e.g. for the collection of sample material) should be strictly observed.

APPENDIX B

ESTIMATION OF MORTALITY RATE IN A TREE POPULATION

As shown in Chapter 2, the rate of future mortality can be estimated from mortality over a given number of previous years, provided that mortality factors do not change significantly. The following worked example uses the formula as shown in Chapter 2, which is as follows:

$$x(t) = a \times b^{t/r}$$

where:

- a** = number of live trees at the starting point
- b** = mortality rate, which is the unknown
- r** = the unit of time over which the mortality rate is to be estimated: usually, mortality is measured annually, so that r will be equal to 1
- t** = number of units of time elapsed
- x(t)** = number of live trees present after the above number of time units elapsed

The above values, other than the unknown value for "b", are as follows:

Time unit over which mortality is measured:	1 year	[r]
Starting year:	1962	
Ending year:	2012	
Number of time units (years) between start and end:	50	[t]
Number of live trees counted in 1962:	29,900	[a]
Number of live trees counted in 2012 (after t years):	14,950	[x(t)]

This leads to the following equation:

$$14,950 = 29,900 \times b^{50/1}$$

from this equation "b" is calculated as: $b^{50/1} = 14,950/29,900$ ($b^{t/r} = y$)

An equation of the form $b^{t/r}=y$ is solved via the law of logarithms stating that:

$$\log b^{t/r} = \log y \quad \text{or:} \quad t/r \times \log b = \log y \quad \text{or:} \quad t/r = \log y / \log b$$

In our example $y = 14,950/29,900$

The equation can then be written*:

$$50/1 \times \log b = \log 14,950/29,900 \quad \text{or} \quad \log b = \log 0.5/50 \quad (\{\log 14,950/29,900\}/50)$$

In our example, the answer should be 0.9862327 (meaning that the annual mortality rate is $(1-0.9862327) \times 100 = \text{approx. 1.4\%}$).

When calculating an exponential series (for example in MS Excel®), it is the value 0.9862327 that should be entered as "step value".

* **Note:** This equation can be solved using a suitable electronic calculator. For example, if using the MS Windows® Advanced Calculator, press 0.5 then log / 50 = inv then log. Then mark the "inv" square and press log.

APPENDIX C

UK LAWS THAT RELATE TO THE MANAGEMENT OF TREES*

Felling of trees: general

In Great Britain, felling is subject to legal restrictions both in general and where a specific condition such as a Tree Preservation Order (see below) is in force. The general restriction exists under the Forestry Act 1967, whereby a Felling Licence is required unless there is an exemption for the category of site (e.g. a designated Open Space), or the volume of timber felled in a particular property would be less than five cubic metres in a calendar quarter or composed only of small trees of specified stem diameter. The licensing authority is the Forestry Commission (www.forestry.gov.uk).

Additionally, in Great Britain, the felling of trees in hedgerows can be subject to the Great Britain Hedgerow Regulations 1997. Where required, consent may be sought from the Local Planning Authority.

Tree work (including felling) and other work affecting trees

Throughout the UK, site-specific legal restrictions apply to work on trees in the following categories:

- a) covered by a Tree Preservation Order (planning laws)
- b) in a Conservation Area (planning laws)
- c) on a construction site and protected under conditions for planning consent (planning laws)
- d) being used by a scheduled protected species, including European Protected Species (Habitats Regulations)
- e) on a scheduled conservation site, such as a Site of Special Scientific Interest (Habitats Regulations)
- f) on a Scheduled Monument (regulations for archaeological areas and historic monuments).

For category (a), where tree work is not expressly permitted under a statutory exemption, consent may be sought from the Local Planning Authority (LPA). For category (b), the LPA must be given prior notice (currently six weeks) of intent to carry out tree work.

For categories (a), (b) and (c), the relevant laws (as administered under the associated regulations) are as follows:

England and Wales: Town and Country Planning Act 1990

Scotland: Town and Country Planning (Scotland) Act 1997

Northern Ireland: The Planning (Northern Ireland) Order 1991

For categories (d) and (e), consent for tree work or for work near trees is required under specified circumstances and may be sought from the relevant statutory nature conservation agency. Currently, the relevant laws and agencies in the UK are as follows:

England and Wales: Wildlife and Countryside Act 1981; Conservation of Habitats and Species Regulations 2010; Countryside and Rights of Way Act 2000. The licensing authorities are Natural England (www.naturalengland.org.uk) and Natural Resources Wales (www.naturalresourceswales.gov.uk)

* This list is intended only as a general guide to laws that relate directly to trees at the time of writing. It does not give information on Common Law, which relates to trees and hedges in many respects. Authoritative and up-to-date sources of information, including amendments to laws, should be consulted by anyone intending to carry out work that might be subject to legal restriction.

Scotland: Wildlife and Countryside Act 1981; Conservation (Natural Habitats etc.) Regulations 1994; Conservation of Habitats and Species Regulations 2010; Nature Conservation Act (Scotland) 2004. The licensing authority is Scottish Natural Heritage (www.snh.org.uk)

Northern Ireland: Wildlife (Northern Ireland) Order 1985; Conservation (Natural Habitats, etc) Regulations (Northern Ireland) 1995; Environment (Northern Ireland) Order 2002. The licensing authority is the Northern Ireland Environment Agency (www.ni-environment.gov.uk)

For category (f), the relevant law in Great Britain is the Ancient Monuments and Archaeological Areas Act 1979. In England and Wales [and also in Northern Ireland, under the Historic Monuments and Archaeological Objects (NI) Order 1995] consent is required if the intended work would involve tree planting or could result in any damage to a Scheduled Monument. In Scotland, where the above law is amended by the Historic Environment (Amendment) (Scotland) Act 2011, tree work on a Scheduled Monument requires consent and is subject to certain conditions except where it would involve only very small-diameter stems, as defined by regulations.

The relevant licensing authorities for trees in category (f) are as follows:

England: English Heritage (www.english-heritage.org.uk)

Wales: Cadw (www.cadwwales.gov.uk)

Scotland: Historic Scotland (hs.smc@scotland.gsi.gov.uk)

Northern Ireland: Northern Ireland Environment Agency (www.ni-environment.gov.uk)

Work near power cables*

Under the Electricity Act 1989, there is a requirement to notify the electricity company or licence holder of any tree work to be undertaken within specified distances of overhead power cables.

Plant health regulations

Among the many other laws that occasionally apply to trees in the UK, the Plant Health Act 1967 [or, in Northern Ireland the Plant Health Act (NI) 1967] is particularly relevant with regard to veteran trees. Under this Act, Orders can be made for the control of specified pests and pathogens. Such an Order might, for example, require the destruction, or prohibit the movement of, plant material. Orders are made in the light of the current status of the harmful organisms concerned. Information on this can be found on the websites of the Plant Health Service (www.fera.defra.gov.uk/plants/plantHealth/) and the Forestry Commission (www.forestry.gov.uk/forestry/HCOU-4U4J4J).

* **Note:** Appropriate precautions should be observed where power cables or other services might lie buried in a work area.

APPENDIX D

ITEMS FOR POSSIBLE INCLUSION IN A METHOD STATEMENT FOR WORK ON A SITE WHERE VETERAN TREES ARE PRESENT

The following list includes procedures and provisions that could be included in the method statement, together with questions that could be addressed by the statement.

Cover page

- Site name, title, date, any revision details. Grid Reference
- Contractor's name, logo and contact details
- Client's name, logo and contact details
- Consultants involved: name, contact details, etc
- Tree Officer: name, contact details, etc
- Landowner: sub contractors, etc.

Scope of works

- A clearly defined, easily understood, jargon-free, step-by-step description of the works that will take place
- Who will be on site, and what their responsibilities are, and what their qualifications are
- A copy of the specification of works, and all relevant drawings
- Duration of works: (e.g. one day, one week, one month, with proposed dates)
- Sequence of works, specifying all the precautionary work that must precede other work (e.g. installation of tree and/or ground protection before access is allowed for machinery)
- Hours of working: e.g. 8:30 a.m. – 4:00 p.m.

Personnel register

- List all parties and staff who are on site
- Enclose copies of all their site relevant qualifications, including photo ID cards
- Provide an organisation diagram, showing the company structure and list staff members' responsibilities and contact details.

Training

- Provide a schedule of relevant training certificates and refresher training for all members of staff on site.

Supervision

- Provide a detailed organisation diagram, showing who is responsible for what, and include their contact details.

Briefing register

- The last page of this document should include a briefing registration form
- The requirements of this method statement should be read to all concerned parties by the person in charge, and everyone should sign it to say that they have understood it
- Any new members of staff who join the site at a later date should also have the statement read to them, and should sign to say that they have also understood it.

Personal Protective Equipment (PPE)

- Minimum requirements must be stated, e.g. combination hard hat, safety footwear, high-visibility vest
- Specialist equipment should always be listed, e.g. chainsaw trousers, gloves, boots
- Does the method statement explain the principles and maintenance procedures in respect of PPE?
- Is general and specialist training covered with regard to the PPE?

Plant and equipment

- List what plant and equipment will be used on site
- Provide copies of relevant statutory test/examination certification for the plant
- List any specialist equipment to be used in conjunction with the works, e.g.:
 - fire fighting equipment
 - spill kits
 - decay detection equipment
 - soil decompaction equipment
- Provide copies of relevant training/competence certificates for plant/equipment operators.

Access to and egress from site

- Clearly define the means of entering and exiting the worksite
- Define what vehicles and machinery are allowed on site
- Will other routes onto site be blocked as a result of the works, and if so, how will this be managed?
- Define alternative arrangements which will be provided in order to maintain emergency escape routes
- Identify any emergency rescue arrangements that could be required.

Materials

- Provide a list of materials or substances to be used on site
- Identify any materials or substances that may be deemed hazardous to health
- Identify any materials that may be classed as highly flammable
- Provide all relevant COSHH* data sheets for any of the above.

Risks and controls**

- Provide a schedule of the risks to health and safety associated with the works
- Provide a method of control to mitigate those risks, including any first aid requirements and the training/experience of workers in hazard recognition
- Identify any interface works which, by potentially presenting a risk to any other contractors, will require co-ordination
- Identify any works which will pose a risk to third parties and will require co-ordination
- Identify any works that require permits; those that do should be attached to this document
- Identify any trees that are covered by planning law and arrange any necessary permissions. Attach copies of relevant approval notices to this document.

* COSHH stands for Control of Substances Harmful to Health (under UK law).

** Assurance should be obtained that the documents listed here have been produced according to an approved risk assessment and risk management procedure. Guidance on risk management should be sought where necessary; e.g. from a professional body and/or from the Health and Safety Executive.

Housekeeping and welfare facilities

- What arrangements have been made for the removal of waste or arisings from site if required?
- Who is responsible for removal of waste or arisings, and how often will this be done?
- What storage arrangements have been made for waste or arisings in the short term?
- What provision is there for welfare: e.g. is there provision for protection against (or avoidance of) severe weather conditions and does a site toilet need to be arranged?

Third party protection

- Does the method statement identify the need to protect others?
- Are temporary provisions detailed, e.g.:
 - temporary walking routes
 - adequate warning signs and banks men
 - possible traffic management or traffic control?

The environment

- Has there been an assessment of the potential impact of the proposed operations on the immediate environment, including:
 - noise
 - air emissions, smoke or dust
 - waste generation (with provision to remove it or to dispose of it on-site, and with a statement as to whether the contractor has a waste carrier's licence)?

Monitoring

The following are all considerations for monitoring:

- Contractual obligations
- Health surveillance
- Noise/vibration.

Communications

- What mode of communications is necessary? How will managerial decisions reach the work force?
- When dealing with emergencies what communications are in place?
 - radio
 - mobile telephone
 - oral
 - visual (hand signals).

Climbing and use of mobile elevating work platforms (MEWPs)*

- What are the criteria for deciding whether to climb trees and/or to use a MEWP?
- If climbing is to be used, what climbing system (e.g. two climbing lines plus lanyard) will be used in order to ensure appropriate safety?
- What type, if any, of platform will be used, i.e. tracked, vehicle mounted, single boom etc?
- What height will the platform reach, both vertically and horizontally?
- What provision will be in place to ensure against falls of operatives?

* Assurance should be provided that workers involved in climbing or use of MEWPs are familiar with Working at Height Regulations.

- Provision for access and egress to site during work at height
- Maintenance, inspection and reporting
- Emergency contingencies.

Control measures

In all cases:

- Have you attempted to eliminate the identified risks prior to defining the control measures?
- Are the control measures clearly defined in the method statement?
- How will compliance monitoring be achieved, and who is responsible for it?

General

- Contingency arrangements will be needed in order to cope with foreseeable emergencies, i.e.:
 - injury requiring first aid or emergency services
 - fire
 - exposure to hazardous substances
 - adverse weather conditions
 - spills.

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GLOSSARY

- abscission:** the shedding of a leaf or other short-lived part of a woody plant, involving the formation of a corky layer across its base. (Some tree species shed twigs in this way.)
- adaptive growth:** in tree biomechanics, the process whereby the rate of wood formation in the cambial zone, as well as wood quality, responds to gravity and other forces acting on the cambium. (This helps to maintain a uniform distribution of mechanical stress.)
- adventitious:** describing shoots which develop neither from terminal nor axillary buds (see *also* epicormic *and* dormant bud), or roots which form other than through primary development.
- anchorage:** in trees, the holding of the root system within the soil, involving the flow of forces from the stem through the branches of the root system to the cohesive root/soil interface.
- ancient tree:** see Section 1.2.
- ancient woodland:** in the UK, a site which has been woodland since at least 1600 CE.
- annual increments (rings):** the annual increments of wood in a tree or shrub as seen in transverse sections of stems, branches or roots. (As the increments are three-dimensional, they are hollow cylinders or cones, rather than rings; also, they are not always strictly annual, especially in minor roots and in tropical species.)
- apical dominance:** the hormone-induced regulation of the development of a tree or a branch, whereby the apical shoot(s) grows more than the laterals.
- apoplast:** the non-living portion of plant tissue, including the cell walls, the intercellular spaces and the lumina (hollow centres) of water-conducting cells such as vessels (cf. symplast).
- arboriculture:** formerly all aspects of the culture of trees, especially for forestry (see *also* silviculture; latterly, the art and science of cultivating and managing trees as groups and individuals, primarily for amenity and other non-forestry purposes.
- architecture:** in a tree, a term describing the pattern of branching of the crown or root system.
- assessment:** in relation to tree hazards, the process of estimating the risk which a tree or group of trees poses to persons or property. This involves a visual inspection for defects and contributory site factors, and sometimes also a detailed investigation of suspected defects.
- avermectins:** a group of neurotoxic drugs, derived from a soil-dwelling microbe (*Actinomyces avermectinius*), which are administered to domestic animals and humans for the control of parasites, including threadworms, roundworms and mites. (Avermectins are said to show no significant antibacterial or antifungal activity but they persist in the dung of treated livestock, rendering it toxic to non-target invertebrates.)
- axial:** along or parallel to the axis of a structure, such as a root or shoot.
- axil:** the place where a bud is borne between a leaf and its parent shoot.
- axis** (pl. axes): the direction in which a structure is orientated; useful for defining the relative orientations of different parts of a tree or of cells within it.
- bacteria:** microscopic single-celled organisms, including many species that break down dead organic matter, together with others that can cause diseases in other organisms.
- bark:** a term usually applied to all the tissues of a woody plant lying outside the vascular cambium, thus including the phloem, cortex and periderm; occasionally applied only to the periderm or the outer corky layers (phellem).
- bark inclusion:** see included bark.
- biomechanical:** pertaining to the mechanical functions and properties of living organisms, such as trees.

- body language:** a term, when applied to trees, which describes the outward display of their growth responses and/or failures in response to mechanical stresses.
- bolling:** a term used to describe pollard heads or sometimes the entire permanent framework of a pollarded tree.
- bracing:** the use of rods or cables to restrain the movement between parts of a tree (*see also* cable bracing).
- branch:** a limb extending from the main stem or parent branch of a tree.
- branch bark ridge:** the raised arc of bark tissues that forms within the acute angle between a branch and its parent stem.
- broadleaf** (broadleaved tree): a tree belonging to one of the families of angiosperms; i.e. not a conifer or other gymnosperm.
- brown-rot:** a type of wood decay in which cellulose is degraded, while lignin is only modified (*see* Section 1.5.1).
- bryophytes:** mosses and liverworts, some of which grow on the surfaces of trees.
- buckling:** an irreversible deformation of a structure subjected to a bending load.
- bundle planting:** establishment of more than one tree (usually of the same kind) in the same planting hole, in order to provide a visual effect sooner than a single tree. (In later life, such trees often fuse together and can be mistaken for a single specimen.)
- burr:** a term for various kinds of atypical woody protuberances, especially those derived from the mass proliferation of adventitious buds.
- buttress zone** (root flare): the basal part of a tree, where the major lateral roots join the stem, with buttress-like formations on the upper sides of the junctions.
- cable bracing, cabling:** *see* bracing. (When cables or ropes are used for bracing, the system is usually designed to prevent the braced parts from causing damage in the event of failure.)
- canker:** a lesion in which bark and cambium have been killed, sometimes exposing the wood and often showing a swollen appearance owing to the encircling growth of new tissues.
- canopy:** the topmost layer of twigs and foliage in a woodland, tree or group of trees.
- champion tree:** *see* Section 1.2.3.
- co-dominant:** in trees, a similarity between two or more stems or branches with regard to their size and their position within the canopy.
- cohort:** in a population (e.g. of trees), a subset or group of a particular origin or age-range.
- column:** in the wood or phloem of a tree, an axially elongated zone of tissue that is distinguished from the surrounding tissue; e.g. live versus dead or decayed versus non-decayed. (A transitional zone between the two is called the column boundary layer).
- compartmentalise (-ation):** the confinement of disease or other dysfunction within an anatomically discrete region of plant tissue, due to passive and/or active defences operating at the boundaries of the affected region.
- conformation:** in a tree, the structure and shape of the entire tree, or part of the tree or of its pattern of branching.
- coppard:** a hybrid word (from coppice and pollard), describing a tree consisting of several coppice stems, each of which has been pollarded.
- coppicing:** the cutting of a woody plant near ground level to encourage the development of multiple stems; in some regions of the UK, this term is partly interchangeable with pollarding.
- coronet cutting:** *see* description in Section 4.4.5.
- coupe:** an area of woodland that has been (or is about to be) selectively clear-felled or coppiced.

- crown:** in arboriculture, the main foliage-bearing portion of a tree.
- crown architecture:** the structural features (e.g. branching angle and twig density) that determine the appearance of the crown of a tree.
- crown lifting:** the removal or shortening of the branches that form the lower part of the crown of a tree.
- crown reduction:** pruning in order to reduce the size of the crown of a tree.
- crown thinning:** pruning inside the crown of a tree in order to reduce its density.
- defence:** in trees and other plants, any system or process which defends tissues against damage. Defences in woody tissues can be pre-formed and passive, or responsive and active.
- demographic:** pertaining to the characteristics of a population (e.g. of trees).
- dieback:** the death of part of a plant, usually starting from a distal point and often progressing proximally in stages.
- diffuse-porous:** one of the two main types of wood structure in broadleaved trees (cf. ring-porous), in which the diameters of the vessels show a gradual decrease from the springwood to the latewood of each annual increment.
- disease:** a malfunction in or destruction of tissues within a living organism, usually excluding mechanical damage; in trees, usually caused by pathogenic micro-organisms.
- distal:** within part of a tree or other living organism, the region furthest from the main body of the organism, i.e. towards the tip (cf. proximal).
- dominance:** the tendency of a tree to maintain a taller crown than its neighbours (*see also* apical dominance).
- dormant bud:** an axillary bud which does not develop into a shoot until after the second season following its formation. Many such buds persist through the life of a tree and develop only if stimulated to do so.
- dynamic mass:** a term proposed by the late Alex Shigo to describe the mass of the physiologically functional parts of a tree, including sapwood, phloem, foliage and fine roots (*see also* static mass).
- dysfunction:** in woody tissues, the loss of physiological function, especially water conduction.
- earlywood:** wood that forms early in the growing season in association with budburst and shoot extension. In broadleaved trees and shrubs, the vessels of earlywood are larger than those of wood formed later in the season (latewood); very much so in ring-porous species.
- ecosystem services:** the benefits that a particular species or range of species bestow upon others (including humans) through ecological relationships (e.g. by pollination or by the breakdown of dead remains of plants and animals). Such services can sometimes be estimated in a form that allows them to be included in financial accounting.
- endophytes:** micro-organisms which live inside plant tissues (sometimes beneficially) without causing overt disease but which might later do so if the tissues become physiologically stressed; for example by lack of moisture.
- energy:** in physics, the capacity to do work. (Through photosynthesis, green plants absorb energy from sunlight and store it in the form of chemical compounds which are used in energy-dependent processes such as growth.)
- epicormic:** pertaining to shoots or roots which are initiated on mature woody stems; shoots can form in this way from dormant buds or they can be adventitious.
- epiphyte:** an organism (e.g. a lichen, moss or fern) that lives on the surface of a tree or other plant (adj. *epiphytic*).
- eutrophication:** enrichment, often through human activity such as agriculture, of water with plant nutrients such as nitrogen and phosphorus, leading to ecological change.

- failure:** in connection with tree hazards, a partial or total fracture within woody tissues or loss of cohesion between roots and soil. (In total failure, the affected part snaps or tears away completely. In partial failure, there is a crack or deformation which results in an altered distribution of mechanical stress.)
- flush-cut:** a pruning cut close to the parent stem which removes part of the branch bark ridge.
- forb:** a broadleaved herbaceous plant (usually in grassland).
- Forest:** (historical term): a designation of certain areas of land that were reserved as royal hunting areas after the Norman Conquest of England and that were subject to special laws.
- forestry:** see silviculture.
- forwarder:** in forestry, a vehicle on to which logs are loaded for transport within the forest.
- functional wood:** a term usually applied to sapwood which is living and conductive; more properly applied to physiologically functional wood, since other functions (mainly mechanical) remain after death; see *also* dysfunction.
- fungi:** organisms of several evolutionary origins, most of which are multicellular and grow as branched filamentous cells (hyphae) within dead organic matter or living organisms. (Wood decay fungi are specialised forms which have co-evolved with woody plants.)
- genetic recombination:** the new combination of genes that results from sexual reproduction between two parents of different genetic constitution.
- girdle scar:** a ring of minute scars encircling a shoot, which is left by the abscission of bud scales at bud-burst; useful for demarcating increments of shoot extension. (The scar expands with the girth of the stem unless or until it is obscured by fissuring of the bark.)
- guying:** a form of artificial support with cables for trees with a temporarily inadequate anchorage.
- habitat:** the place where a organism lives, including all the essentials such as food and shelter.
- haloing:** in veteran tree management, the phased thinning or clearance of non-veteran trees or shrubs that are harming one or more veteran trees by shading or other competition.
- hazard:** a thing, a process or a potential event that has the potential to cause harm (cf. risk).
- heartwood:** the dead or predominantly dead central wood of various tree species whose outer living wood, sapwood, has a finite and pre-determined lifespan.
- heritage:** the assemblage of things that are inherited (especially by humans) from the past, including the landscape and the trees that often form a major component of it.
- hormones** (growth substances): chemicals synthesised within a plant, which influence the growth of other parts of the plant to which they are translocated.
- included bark** (ingrown bark): bark of adjacent parts of a tree (usually forked stems, acutely joined branches or basal flutes) which is in face-to-face contact; i.e. without a woody connection. Such a structure lacks inherent strength but is in many instances strongly reinforced by a surrounding "shell" of wood.
- indefinite** (indeterminate): of the growth pattern of an organism, not limited to an ultimate shape or size, though generally limited by environmental conditions.
- infection:** the establishment of a parasitic micro-organism in the tissues of a tree or other organism.
- insects:** a class of invertebrate animals with jointed appendages (i.e. members of the Phylum Arthropoda), most of which have three pairs of walking legs and two pairs of wings.
- inter-fibrillar:** in the cellulose contained within a woody cell wall, pertaining to the space between the microfibrils.
- internode:** the part of a stem between two nodes; not to be confused with a length of stem which bear nodes but no branches.
- lapsed coppice:** a tree (or a stand of trees) that has been coppiced but not cut again within the conventional timescale.

- latent:** in respect of organisms that develop in the tissues of trees, a state whereby the organism shows no overt signs of its potential activity (e.g. as a cause of wood decay).
- layering:** the development of new roots and ascending shoots from a stem or branch that has come into contact with the ground.
- leaf scar:** the slight bark ridge left by the abscission of a leaf. The scar enlarges with the growth in girth of the stem, until obscured by formation of bark fissures.
- lever arm:** a mechanical term denoting the length of the lever represented by a structure that is free to move at one end, such as a tree or an individual branch.
- lignin:** the hard, cement-like constituent of wood cells. (Deposition of lignin within the matrix of cellulose microfibrils in the cell wall is termed lignification.)
- maiden tree:** a tree grown other than from a coppiced stump and not itself coppiced or pollarded.
- microfibril:** the smallest unit making up the cellulose filaments within a cell wall.
- microflora:** the assemblage of microscopic plants, fungi and bacteria in a particular location. (An arguably better term is “microbiota”, since the use of “flora” in this context dates back to a time when micro-organisms were all classified either as animals or plants.)
- mitigation:** a term used in this book to describe the use of remedial action to lessen risk associated with foreseeable failure; also among other uses, a circumstance that might lessen the gravity of an offence in law.
- mulch:** material laid down over the rooting area of a tree or other plant to help conserve moisture, suppress weeds and encourage a beneficial microflora. (A mulch can consist of organic matter or a sheet of plastic or other artificial material.)
- mutation:** an alteration in the sequence of nucleotides within a gene, sometimes affecting genetic fitness.
- mycorrhizal:** pertaining to an intimate symbiotic association between plant roots and specialised fungi.
- node:** the point where a leaf is joined to a shoot and where an axillary bud could develop into a side-shoot.
- notable:** a category of tree in tree recording (see Section 1.2.3).
- nutrients:** substances absorbed by living organisms for the maintenance of metabolic processes; usually not regarded as including water or oxygen. Green plants absorb inorganic forms of elements such as potassium, nitrogen and phosphorus as nutrients, while manufacturing food (carbohydrates) by photosynthesis. This process provides organic nutrients for fungi, animals and many types of bacteria which cannot manufacture their own food.
- occlusion:** the process whereby a wound in a tree is progressively closed by the formation of new wood and bark around it.
- parasitic:** pertaining to an organism that derives its nutrition from another living organism.
- pathogen:** a micro-organism that causes disease in another organism (adj. *pathogenic*).
- phenological:** pertaining to the seasonal cycle of activity, including the growth and reproduction of trees and other organisms.
- phloem:** conductive tissue of trees and other plants, via which dissolved sugars are translocated from the foliage to tissues where they are needed for growth or for storage. (In trees, phloem makes up the innermost layer of the living bark.)
- phoenix regeneration:** development of a “new tree” by the layering of one that has fallen or bent down to the ground while still remaining rooted.
- photosynthesis:** the process whereby plants use light energy to split hydrogen from water molecules, combining it with carbon dioxide to form the molecular building blocks for

synthesising carbohydrates and other biochemical products.

physiological: pertaining to the functions of life in an organism.

pollard (poll): a term for a pollarded tree (see definition of pollarding: below).

pollard head: the swollen region of a stem or branch that forms behind a pollarding cut.

pollarding: the complete or partial removal of the crown of a young tree so as to encourage the development of numerous branches; also, further cutting to maintain this growth pattern.

primary woodland: woodland that has developed naturally on an area that, owing to naturally occurring conditions (e.g. glaciation), was previously treeless.

probability: a statistical measure of the chance that a particular event (e.g. a specific failure of a tree or a specific kind of harm to persons or property) might occur.

provenance: the place of origin, e.g. of a regional genetic variant of a tree species.

proximal: in the direction towards the main body of a tree or other living organism (opp. "distal").

pruning: the removal or cutting back of twigs, branches or roots; in some contexts applying only to twigs or small branches, but more often used to describe all kinds of work involving cutting.

radial: in the plane or direction of the radius of a circular object such as a tree stem; *see also* rays.

rays: radially orientated strips of parenchyma cells within wood and bark. (Rays are involved in food storage and the radial translocation of materials in solution. They also contribute to the strength of wood.)

reaction zone: a defensive zone (usually dark in colour) within the wood of a living tree, which forms a boundary between fully functional sapwood and dysfunctional or decaying wood.

red-rot: a term inconsistently applied either to (a) types of white-rot in which the inherently light colour of the decayed zone is masked by reddish pigments or (b) to types of brown-rot which have a reddish-brown colour.

regulated pruning: *see* definition in Section 4.5.5.

reiterative growth: on a mature or old tree, the secondary development of twigs or branches in a form which resembles that of a young tree or of its primary branches.

remedial action: in tree hazard management, action to remove or mitigate the risk of injury to persons or damage to property.

renewal pruning: *see* definition in Section 4.5.5.

resistance: in tree health assessment, the ability of a tree to withstand particular adverse conditions or attack by a specific pest or pathogen.

retrenchment: progressive reduction in the size of the crown of an old tree, by means of the dieback or breakage of twigs and small branches, accompanied by the enhanced development of the lower or inner parts of the crown.

rhizome: a modified root-like stem (for example in bracken), from which roots and shoots develop.

ring-barking: a form of girdling, involving the cutting of bark and cambium.

ring-porous: one of the two main types of wood structure in broadleaved trees (cf. diffuse-porous), in which each annual increment includes two distinct bands when seen in cross-section; of earlywood with wide vessels, and of latewood with narrow ones.

ripewood: the older central wood of those tree species in which sapwood gradually ages without being converted to heartwood.

risk: in risk assessment, a value derived by combining the magnitude of a hazard and the

probability of harm being caused by the hazard; also sometimes taken to denote the probability alone. “Significant risk” is deemed great enough to warrant detailed assessment and/or remedial action in the interests of prolonging the life of the tree or protecting people or property from harm.

root protection area: a protected area of ground around a tree or group of trees (usually surrounded by a barrier for the exclusion of access or activities that could harm roots, especially by soil compaction).

rootplate: the central part of the root system of a tree, consisting of the large-diameter main roots and a dense mass of smaller roots and soil.

sap: a general term for fluids in plant tissues, whether in living cells or in the hollow water-conducting cells of the xylem.

saproxylic: pertaining to organisms that depend on decaying wood for their habitats.

sapwood: the living xylem of a woody plant, which either loses viability gradually over a number of years or decades or becomes converted into a distinct, largely dead heartwood.

shedding: in woody plants, the normal abscission, rotting off or sloughing of leaves, floral parts, twigs, fine roots and bark scales. (Often applied also to branches.)

shoot: in a tree, the elongating region of a stem or branch.

shrub: a woody plant which typically has a number of similarly-sized stems arising at or near ground level and is often less than four metres high.

skidder: in forestry, a vehicle for dragging logs for transport within the forest.

silviculture (silviculture): the planting, tending and management of woods and forests (see also arboriculture).

Site of Special Scientific Interest (SSSI): a designated area in the UK, at which specified activities are controlled by law for the purpose of conserving wildlife or other natural features.

spores: propagules of fungi and many other life forms. (Most spores are microscopic and are dispersed in air or water.)

springwood: see earlywood.

staged cutting: see Section 4.4.4.1 for a description of pruning in order to mimic crown retrenchment.

stag-headed: in a tree, a state of dieback in which dead branches protrude beyond the current living crown.

starch: a food storage carbohydrate in plants, which is insoluble in water at normal growing temperatures.

static mass: a term proposed by the late Alex Shigo to describe the mass of the parts of a tree that are no longer physiologically functional, including heartwood (or ripewood) and outer, corky bark.

stem: in a tree, the principal portion of the woody structure (i.e. the trunk), or one of a number of such portions with similar size and status.

stored coppice: see lapsed coppice.

strength: the resistance of a structure or material to fracture under a particular type of stress (tensile, compressive, shear, torsional etc.).

stress: in plant physiology, a condition under which one or more physiological functions are not operating within their optimum range, for example owing to lack of water, inadequate nutrition or extremes of temperature.

stress: in mechanics, a force acting on an object, measured per unit area of the object.

stub cut: a pruning cut which is made at some length distal to the branch bark ridge.

- sub-dominant:** in trees, a description of a stem or branch which is relatively small or of lesser status in comparison with neighbouring stems or branches (cf. co-dominant).
- sugars:** water-soluble food storage carbohydrates.
- symbionts:** organisms that live in an intimately and mutually beneficial relationship, as in the case of trees and mycorrhizal fungi.
- symplast:** the living protoplasm in plant tissue, connecting adjacent cells in the form of fine strands (plasmodesmata), which pass through pits in the cell wall (cf. apoplast).
- target pruning:** the pruning of a twig or branch so that tissues recognisably belonging to the parent stem or branch are retained and not damaged.
- targets:** in tree hazard assessment (and with somewhat incorrect use of English), persons or property or other things of value which might be harmed by mechanical failure of the tree or by objects falling from it.
- topping:** in arboriculture, the removal of the crown of a (usually mature) tree, or of a major proportion of it.
- tracheids:** narrow, tapering water-conducting cells in the wood of trees; much shorter and narrower than most vessels. (They are the predominant type of axial wood cell in conifers.)
- translocation:** in plant physiology, the movement of water and dissolved materials through the body of the plant.
- transpiration:** the evaporation of moisture from the surface of a plant, especially via the stomata of leaves; it exerts a suction which draws water up from the roots and through the intervening xylem cells.
- tree:** a woody plant which typically has a single main stem and reaches a height of at least four metres.
- Tree Preservation Order:** in Great Britain, an order made by a local authority, whereby the authority's consent is generally required for the cutting down, topping or lopping of specified trees.
- trunk:** the single main stem of a tree.
- vessels:** water-conducting cells in plants, usually wide and long for hydraulic efficiency. They are generally not present in coniferous trees.
- veteran tree:** see Section 1.2.
- veteranisation:** tree work by which tissues are injured in order to accelerate the development of wood decay habitats in standing trees; this is usually done only where essential and sustainable.
- vigour:** in tree assessment, an overall measure of the rate of shoot production, shoot extension or diameter growth (cf. vitality).
- vitality:** in tree assessment, an overall appraisal of physiological and biochemical processes, in which high vitality equates with near-optimal function (cf. vigour).
- white-rot:** various kinds of wood decay in which lignin, usually together with cellulose and other wood constituents, is degraded.
- wildwood:** primary woodland that has not been significantly modified by human intervention.
- wood:** the main structurally supporting and water-conducting tissue of trees and shrubs (see *also* xylem).
- wood pasture:** see the descriptions in Chapters 1, 3 and 6.
- xylem:** plant tissue with the special function of translocating water and dissolved mineral nutrients. (The wood of trees and shrubs consists of heavily lignified xylem, laid down in radial increments, which provides structural support as well as water conduction.)
- xylem rays:** see rays.

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Ancient and other veteran trees: further guidance on management

Ancient and veteran trees are increasingly appreciated for their iconic and inspiring qualities, as living links to the past with intimate connections to our humanity. They function as ecosystems in themselves; as “arks” carrying a myriad of species through time. We recognise that, alongside the appreciation of old trees, there are responsibilities for their continuity, protection and care. This new guidance is an expression of the passion of the Ancient Tree Forum, which is dedicated to ensuring that this wonderful heritage, in all its forms, continues to thrive. The book brings together the collective wisdom of the membership and the contributions of colleagues in many disciplines and countries, for the benefit of owners, advisers and practitioners.



About the editor

David Lonsdale is a consultant, author and lecturer, with a lifelong fascination in ancient trees. His many publications include *Principles of Tree*

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