1 Overview

What is coppice?

History & what to expect from this edited collection.

The most important characteristics of coppice, as well as the different types.

Help?! Reference the glossary for guidance on the meanings of terms related to coppice.

Visit this chapter for:

Coppice forests in Europe: a traditional landuse with a new perspective

Coppice in brief

Typology of European coppice forests

Glossary of terms and definitions related to coppice

Coppice Forests in Europe - A Traditional Landuse with New Perspectives

Gero Becker and Alicia Unrau

For many people in Europe, the image that comes to mind when thinking or speaking of forests is a landscape with an extensive area of woodland that is permanently stocked with tall trees of medium to large diameter. Depending on the region, these forests may be coniferous or broadleaved, or a mixture of both. When trees are cut, it is done selectively, or in clearcuts, and regeneration occurs either naturally by seed, or through artificial re-planting. Long rotation cycles (often between 50 and 100 years) lead to harvested trees of large dimensions, which are used in sawmilling and for other high-end wood products. All of these traits are typical of the "high forest" management regime.

When traveling across the continent, especially in the middle, south, east and Mediterranean regions, vast areas of the landscape are covered with a completely different type of forest: The broadleaved trees of these regions are often short, crooked, of small diameter and can be quite dense. Many stems originate from the same stump, giving the forest a bush-like appearance. This more or less uniform picture is occasionally interrupted by smaller clearcut patches, where trees have been recently cut and very young shoots are now sprouting again from the old stumps. Short rotation cycles, resulting in harvested trees of smaller sizes, are typical for this "coppice forest" regime.

The origin of coppice management

Historically, coppicing is the oldest form of forest management and utilisation to take place in a systematic and, in many cases, sustainable way. Our ancestors, mostly self-sufficient farmers that settled in small and isolated villages, depended on forest resources for their survival: They used the wood for cooking and heating, fencing, building houses and for all kinds of furniture and tools. They collected the foliage of the trees to feed their animals, used bark for tanning and insulation, and collected fruits, berries and mushrooms from the forest to complement their diet. They did not have the technical means to transport heavy logs over long distances, so trees were harvested close to home, at a younger age and smaller size, using hand tools and transported by hand or draft animals to the nearby settlements.

The people of those times knew very well -and made use of- the natural capability of some tree species to sprout vigorously and repeatedly from the stump that remains after being cut, as is the case with oak, hornbeam, linden, black locust, willows, poplars and others. They deliberately cultivated these species in the vicinity of their villages and developed increasingly sophisticated management rules and techniques to optimise the outputs of coppice forests over generations. It can be observed that the coppice techniques sometimes developed in parallel to specific socio-cultural arrangements, such as common ownership or cooperatives. Thus, rural societies managed and utilised their forests in a way that made the best "sustainable" use of their natural resources.

Corresponding Author: Gero Becker, gero.becker@fob.uni-freiburg.de

It can be stated that throughout Europe, until the end of the medieval period, the majority of accessible forests were very intensively used and managed as coppice forests. The only exceptions were woodlands claimed by kings and other nobles for exclusive use, most often for hunting purposes; these forests were managed by trained forester-hunters. Their utilisation by the local subjects for wood procurement and cattle grazing was strictly limited and controlled, resulting in less pressure on the resource and, as a consequence, in a different type of management.

The influence of the industrial revolution

With the development of early industry in some regions of Europe, technology, markets and social structures changed. Industrial activities such as mining, steel, glass, pottery and textiles appeared, generally close to the places where the respective commodities were found. Wood was the only available source of energy for processing and still the preferred material for building. As a result, the demand for wood increased dramatically. Coppice forests were an appropriate and established way to supply these industries with large quantities of wood in short time and at low costs. Thus, large coppice forest areas were actively managed surrounding those centres of early industries (good examples are the regions of Sauerland, Tuscany, Limoges and England). They were often owned by noble families acting as entrepreneurs and were managed intensively, providing not only wood products, but also labour and income for rural inhabitants. In some cases, forests were over-used beyond their natural capacity, leaving devastated and poorly stocked woodlands.

Coal mining activities began in the middle of the 18th century, prompting industries, as well as the urban households, to meet their growing energy demands by gradually replacing wood with coal. Moreover, once water, road and railroad infrastructure had been improved, it was feasible and economical to transport fossil energy to much more remote areas. In consequence, the demand for energy wood decreased, while that for rural and urban construction wood, along with technical uses of wood, such as mining or paper, increased. Man-made plantation forests were established by planting or seeding, often with relatively fast-growing conifer species, and managed as high forest, applying selective thinning and longer cutting cycles to meet the industrial demand for long and straight trees of larger dimension. Forest science was developed to study and to implement modern silvicultural methods in order to increase the productivity and to guarantee a sustainable use of these high forest systems.

These trends have continued until recent times, leading to the current situation around industrial and urban centres, where coppice forests have either been replaced by high forests or abandoned, depending on the owner and the prevailing socio-economic conditions of the respective region. In rural areas, inhabitants long relied on wood for their daily lives and coppicing was still actively practiced for many decades - in many places it still is today.

Recent developments

All in all, it is estimated that there are currently well over 20 million hectares of European woodlands that are mostly managed as coppice, while many more are of coppice origin. Although the figure is difficult to assess, it comprises over 10 % of the total European forest area. The national and geographic variation is great, ranging from a negligible amount in northern countries, such as Finland and Sweden, to over 50 % of the total forest area in Serbia and Bosnia & Herzegovina.

Despite this relative importance, there is actually quite sparse grey and scientific literature on coppice and it is still stigmatised on many

societal levels. Due to the historical development described above, coppice forest management has been somewhat "out of fashion" or even "forgotten" during the past decades. It was rarely discussed or even recognised in forest science and in national and EU-forest policies and the main emphasis of professional activities is still on high forest management.

Only recently has the idea and concept of coppice forest management gained attention once more. The main reasons behind this new interest have been: (1) the debate on climate change and a CO_2 neutral economy: fast growing, easy to manage and cheap to harvest dendrobiomass from coppice forests are being recognised as a valuable and abundant, but underused natural resource to provide feedstock for green energy and the bioeconomy; (2) new research results on biodiversity and nature protection have identified coppice forests as resilient ecosystems that give shelter to a unique composition of species and are less vulnerable to certain types of biotic and abiotic risks; (3) efforts are being made to acknowledge and improve the situation of those in in rural areas, as it is (re-) discovered that coppice forests and the related wood and non-wood products can be a source of rural employment and income.

Into the spotlight with COST Action FP1301 EuroCoppice

This was the starting point from which FP1301 EuroCoppice, an "Action" within the framework of COST (European Cooperation in Science and Technology), was launched. It brought together researchers and experts from 35 countries together for four years of cooperation on a broad range of themes related to coppice forests.

Action members recognised the pitfalls and opportunities of the topic, such as:

- The geophysical situation, but also the socio-economic backgound in Europe are so diverse, that many different ways and means to practice coppice forestry developed over time at the regional and national level. Thus, there is no common European understanding between officials, scientists and stakeholders, on the role and the future potential of coppice forest management.
- Much coppice-related knowledge exists, but it is regionally/locally scattered and rarely communicated amongst the European scientific and professional community.
- This lack of consistent and common knowledge base prevents the exchange of lessons learned and of new ideas, prohibiting an effective handling and use and further development of this interesting and trendsetting management concept.

EuroCoppice was the first major international cooperation to focus on coppice forest management. Besides many on-site activities and events to collect and exchange coppice related information, the efforts of the members resulted in quite a number of written documents, which have been edited and are communicated in this volume, "Coppice Forests in Europe".

Contents of this edited collection

The volume begins with very broad, general information on coppice, before diving into the details of different coppice themes, related to ecology, management and policy. The second half is then focussed on the situation in different countries, before giving a short summary and conclusion.

(1) The articles in the rest of this chapter, **Overview**, give brief descriptions of the different types of forest, first in a mainly text-based format, then the typology in a table format. Finally, for those unfamiliar with certain terms, the Glossary provides a first point of reference that can be accessed as necessary.

(2) The second chapter on **Silviculture** features comprehensive guidelines on coppice forests in Europe, compiled by a large number of experts

from across Europe, making it a key document for further cooperation and development in both science and practice. The focus then narrows to the role of two particular invasive species, before the final article transitions to the coming chapter by linking silviculture with utilisation.

(3) Having already touched on the topic of **Utilisation** in the previous article, this chapter begins with an overview about the various products from coppice forests, both wood and non-wood. This illustrates that coppice management is a very flexible production system that can be adapted to the actual needs of the population. After this, a second set of comprehensive guideline presents the different possibilities of coppice harvesting. The next contribution is devoted to the interaction between harvesting systems and their impacts to the soil, with recommendations for low impact systems.

(4) Moving on from the products-focussed research, the fourth chapter on **Conservation** encompasses articles on subjects such as the biodiversity, protective function and cultural heritage of coppice forests and their ecosystems. While the first two contributions highlight coppice in Natura 2000, the third is an extensive review of literature related to erosion and rockfall. A case study from the Czech Republic illustrates the effects of changing socio-political frame conditions on coppice in that country.

(5) Continuing on the societal theme, the next chapter on **Governance** outlines the influence of socio-economic aspects on the management of coppice forests in several European regions, then touches on the barriers that prevent small scale landowners from successfully managing their coppice forests. The picture is completed with an example of a community-owned and managed coppice forest in Serbia.

(6) Having finished with theme-related contributions, the sixth Chapter comprises reports on the **Thirty-Five Countries** that were involved in EuroCoppice, nearly all of which are in Europe. They include facts and figures, maps, descriptions and forestry regulations, as well as a summary of a selection of the main data. These contributions are a valuable source of detailed, country-specific information on coppice forests in Europe, which has never before been presented so comprehensively.

(7) After these many theme and country related articles, the **Outlook** summarises the consequences of all the facts and findings that have been gathered throughout the four years of COST Action FP1301 EuroCoppice. Conclusions are drawn and recommendations are given for decisions and activities on EU and national level with the aim to conserve, further develop and promote coppice forests in Europe.

(8) Finally, those interested in the activities and members of the Action should visit the **Annex**. Of particular interest could be the final article on the newly-formed IUFRO Unit on traditional coppice; it is open to any researcher worldwide who has a special interest in coppice forests.

Despite being comprehensive, this volume is not able to address all aspects of coppice in the same depth and it reflects the interests of the contributors. It will hopefully stimulate and encourage further research on the subject.

Closing remarks

Coppice has been –and in many cases still is– an important traditional forest land use across Europe. Its development is closely related to human efforts to establish a sustainable management of forests with a minimal input of scarce resources, such as energy, capital and land. It's still unclear whether this type of forest will again become a recognised, perhaps even prominent, element of European landscapes in the near future… For the time being, read on to discover and explore the many faucets of this fascinating, but half-forgotten land use system and let yourself be inspired, be it on a practical, scientific or political level.

Coppice in Brief

Rob Jarman and Pieter D. Kofman

Introduction

Coppice *(noun): An area of [wood]land (on forest or agricultural land) that has been regenerated from shoots and/or root suckers formed at the stumps of previously felled trees or shrubs.*

[Adapted from IUFRO Silva Term Database 1995]

Coppice is a word that is used to cover many things, including: a type of woodland consisting of trees that are periodically cut; the multi-stemmed trees that occur in such woodlands; the process of felling (i.e. coppicing) the trees; and the production of new shoots by recently-cut stools. The principle of coppicing is simple: it is the ability of many woody plants (trees and shrubs) to regrow from cut or damaged stems or roots. At its simplest, a single-stemmed tree that has grown from a seed or a sucker is cut down and allowed to regrow: several shoots will then sprout. Repeated felling at multi-annual intervals will produce a multi-stemmed tree, growing from a base called a stool. A group of such multi-stemmed stools in one site are what then form a coppice, i.e. 'coppice woodland', or 'coppice forest'.

In some regions/countries, elaborate forms of coppice management have evolved over centuries, designed to produce specific resources from coppice systems of selected species cut on strict rotational cycles. Sweet chestnut (*Castanea sativa*) has been managed in single species coppices for poles; likewise sessile oak (*Quercus petraea*) for tanbark and charcoal; and hazel (*Corylus avellana*) for poles and split-wood products. Coppice woodlands supplied the needs of rural and urban communities for millennia, in a relatively sustainable way, until the Industrial Revolution, at which time the growing population and the demand for fuels and materials exceeded the capacities of the coppices to supply, requiring the importation of fossil fuels and wood products. 'Traditional' coppice management declined during the past century and many coppices were abandoned or converted to high forest, plantations or other land uses.

There is currently a resurgence of interest in coppicing for intensive production of wood for energy or manufactured products, as well as for ecological and cultural objectives. Newly planted short rotation coppices (SRCs) typically rely on species such as *Eucalyptus* or *Robinia*, or vigorous hybrids of poplar, willow or alder; they may be classed as an agricultural land use rather than as forestry.

Restoration of former coppice woodlands may attempt to replicate a traditional system, or adapt management to meet modern requirements for wood production and other societal and environmental benefits. Food production from coppices can be locally important (e.g. fungi, nuts, berries, honey) and artisanal products can also be of local economic interest (e.g. hazel thatching spars, chestnut fencing, limewood turnery, willow basketry).

Corresponding Author: Rob Jarman, robinajarman@gmail.com

Silviculture and Tree Management Systems

Two basic systems of coppice woodland management are recognised: **simple coppice**; and **coppice with standards**. A third, rarer system is **selection coppice**. In addition, there are two management systems that apply coppicing principles of vegetative regrowth to individual trees, rather than to woods: these are termed **pollarding** and **shredding**. Finally, there is a new system of coppice that is often considered a type of agriculture: **short rotation coppice**.

Figure 1 illustrates five applications of coppicing (excluding selection coppice) and the typical landscapes that result from them; each application is described in the following sections.

Simple coppice

This is woodland managed as an even-aged, single-storey structure, typically producing small/medium-sized roundwood for poles or fuelwood. The coppice is cut on a regular rotation, the length of which depends on the product required and also on species, location, rate of growth and environmental/societal interests (though usually between 15 and 30 years). Theoretically, the coppice is managed by sequential cutting of 'coupes' (= compartments) throughout the woodland, with the woodland divided into the number of 'coupes' equal to the number of years in the planned rotation: one coupe is then cut each year. Coppice woodlands managed in this way, are described as 'in-cycle', or 'in-rotation'.

Coppice with standards

In this method, the woodland is multi-storied, with an understorey of coppice underwood cut regularly to produce small material, as well as a partial overstorey of standard trees that can be grown from seed or from selected stems on stools and allowed to grow to a sufficient size for timber or tree products. Coppice with standards is more difficult to manage than simple coppice as it is necessary to manage the species, number, age and location of the large overstorey trees, as they will affect the growth of the understorey crop. The underwood is managed as simple coppice: after cutting each coupe, the number and distribution of the standards is adjusted. Over time, some of the oldest trees may be retained for veteran tree interests, whilst younger generations of standards need to be recruited, but at a density that avoids over-shading that would degrade the coppice.

Selection coppice

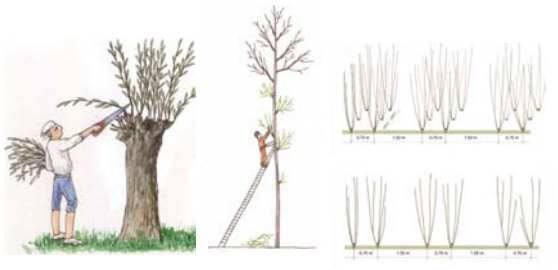
Two or three age classes of stems are rotated on the same coppice stool, to provide specific sizes or shapes of poles for particular purposes. They can be found, for example, in some of the mountain beechwoods and holm oaks of Europe. Hazel coppice is sometimes cut in this way, to provide thin straight rods for thatching spars and, later, larger poles for fence hurdles or building.

Pollarding

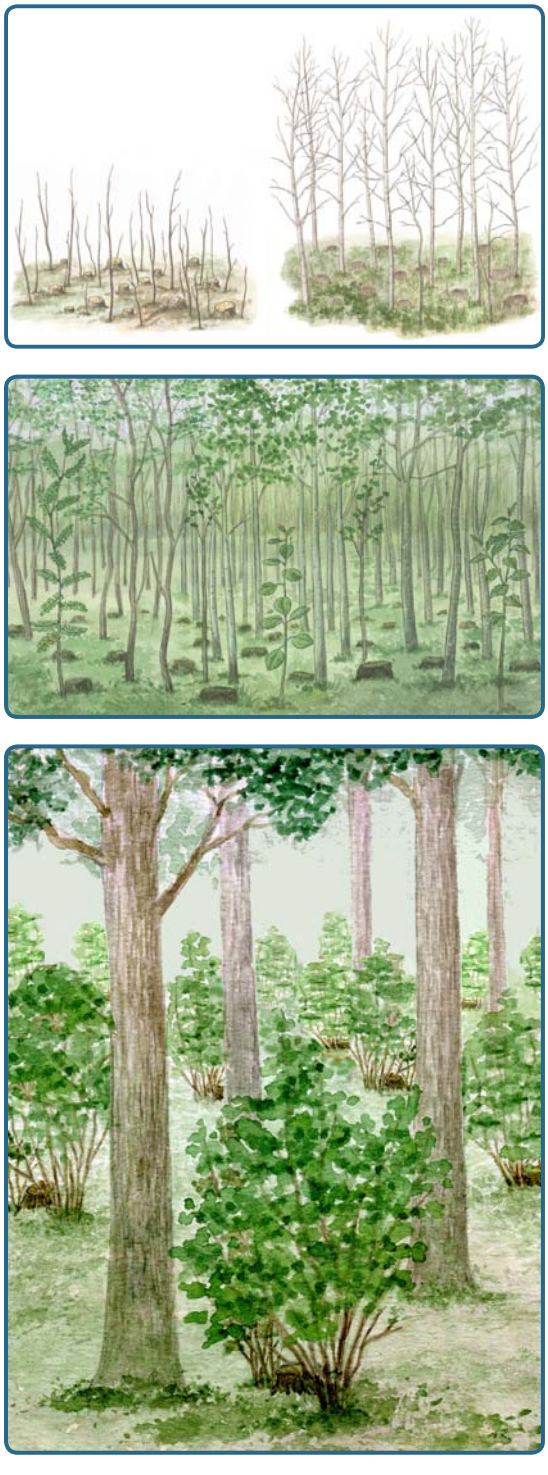
A pollard is a tree that is cut like a coppice stool, but at a height above the ground intended to be out of reach of browsing animals (typically more than one to two metres). New shoots grow from the decapitated trunk and can be harvested periodically in just the same way as from a coppice stool, whilst grazing animals can use the land beneath the tree – multi-purpose land use. Willow and poplar pollards are also widely used to stabilise banks of water courses.

Pollards can grow for centuries whilst being repeatedly cropped for shoots, used for livestock fodder, for poles, firewood or even for small timber. Some of the most ancient trees in

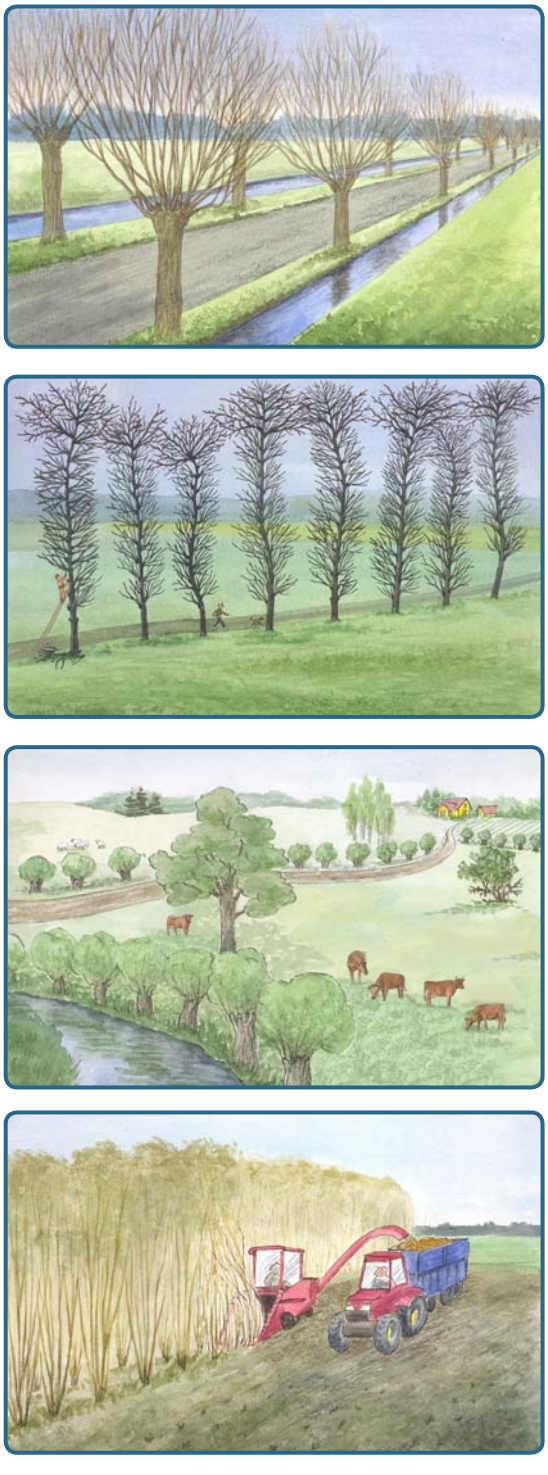
Simple coppice | Coppice with standards



Pollarding | Shredding | Short rotation coppice



Coppice in forest landscapes



Coppice in agricultural landscapes

Figure 1. Types of coppice management and typical landscapes that result from them (Illustrations: Ruta Kazaka)

Europe are pollards. In many regions, pollarding for production purposes has died out, but may be continued for ancient tree management objectives or for landscaping reasons. In some regions, pollarding for firewood and fodder is still practised e.g. on Ash (*Fraxinus*), Lime (*Tilia*) and Elm (*Ulmus*).

Shredding

This is the practice of cutting side branches from the main trunk of a tree while retaining the crown, typically to provide wood and fodder for livestock. Unlike pollarding, the tree is not decapitated and continues to grow upwards as a single stem tree, ultimately able to provide large dimension timber. Shredded trees are typically found alongside tracks or field boundaries and also in some pasture-woodland systems.

Short rotation coppice (SRC)

This is a special example of 'simple coppice' that is mainly on agricultural land. The lifespan of any shoots is short compared with those of traditional coppice woodlands (typically between 1 and 3 years): the stools may need to be replanted after only 5 to 7 rotations to maintain site productivity.

Biology of Coppice Shoots

The ability of woody plants to re-sprout is a natural adaptation that enables survival after damage to the tree/shrub from animals, fire, storm or pathogens. Not all tree species can produce coppice shoots – most conifers (gymnosperms) cannot, whilst most broadleaved trees (angiosperms) can. Some species regenerate more readily from stumps, some from root suckers; over centuries, some individual plants can spread to a considerable area in their above ground stool or underground root structures, creating clonal structures covering hundreds of square metres.

Origins of coppice shoots

There are three ways in which coppice shoots form (see box on following page for details):

- **'Stump shoots'** that originate from dormant buds suppressed in the bark;
- **'Stool shoots'** that originate from adventitious buds in callus tissue following cutting or wounding;
- **'Suckers'** that originate from adventitious buds along a tree's roots.

Regeneration of coppice shoots and longevity of stools

The probable number of shoots that will be produced from any one species of tree when coppiced depends on many factors, including stump size, age, condition, site parameters, competition from other plants. It is certainly possible for coppice stools several hundred years old to continue to produce abundant shoots when routinely coppiced, even though the centre of the stool may have completely died out leaving a ring of productive stems several metres in circumference.

It is quite possible that some stools of long-lived species such as *Tilia* and *Castanea* are more than a thousand years old. These species are particularly successful at vegetative reproduction through layering, which is the rooting of branches that are in direct contact with the soil. Layering to produce genetically identical clonal offspring may take place either naturally following collapse of a tree's stem, or as part of a deliberate management procedure to generate new stools within a coppice.

'Stump shoots' are the usual response of a broadleaved tree to cutting, when dormant buds buried in the bark are stimulated to break dormancy and sprout. Dormant buds are the primary source of most coppice (and pollard) shoots and they should be favoured after cutting, as they will form the strongest shoots.

'Stool shoots' grow from adventitious buds that develop from plant tissue growing in the callus wound at the cut wood surface. These buds develop into shoots in the same season as the cut but, unlike dormant buds, they are not directly connected to the plant's vascular system, so have to make a new vascular link. As a result these shoots are often short-lived; and if they survive, they only form weakly attached shoots, so are not desired as coppice shoots.

'Suckers' grow from adventitious buds on the roots. They may be stimulated to sprout from below ground by the cutting of the above ground plant, or by disturbance of the ground, or simply as a natural vegetative reproduction process.

If the rotational cutting of coppice is neglected for a long period, then it is possible that the sprouting response to the next cutting will be poor. Neglected stools can survive for many years, attaining large dimension stems, but they can become increasingly unstable and vulnerable to windthrow, when entire root plates can be uplifted due to the top-heavy growth of stems; or the stool can be destroyed because it is split into many pieces.

Browsing animals

Coppice stools, being close to the ground, are very vulnerable to herbivore damage – new shoots are highly palatable and young bark is easily stripped. Deer, grey squirrels, rabbits, hares and voles can severely restrict coppice regrowth after cutting and also degrade standing coppice: they require strict control. Livestock (cattle, sheep, goats, pigs and horses) should be excluded from coppices, preferably permanently, although some coppice woodlands were traditionally opened for grazing for the final years of the coppice cycle. It is possible for coppices to be managed as a resource for grazing animals and for game, but the strict control of browsing in the first few years after coppicing is crucial and often very costly.

Coppice management

Most coppice woodlands have been intensively managed over several centuries to achieve a high density of stools and a few selected species. Typical coppices are monocultures of hazel, oak, lime, sweet chestnut, or black locust, which are specially selected to meet industrial needs such as bark for tanning, wood for charcoal, poles for fencing and building. Ageing stools would be cut back and replaced with a new plant, by layering from an adjacent stool or by seeding or planting. Deadwood would be cut out and only the favoured species retained. The method of cutting the stool, the type of tool/machine used and the height, angle and season of cut are all factors influencing stool vitality and ecological interest.

Coppices that have been neglected or their rotation cycles abandoned are termed 'overstood', 'stored coppice' or 'over-aged coppice'. This cannot be a long-term strategy for coppice – such woods will inevitably become high forest. There is also a risk of damage to any archaeological features present by stems and root plates being thrown over in high winds. Today, after perhaps decades of neglect, reinstating a coppice management rotation can be difficult, especially in view of the modern requirement for larger dimension poles for fuelwood.

One aspect of modern management that should be given more attention is the effect of mechanised cutting and harvesting on the woodland soil and its essential life-support role for the ecosystem. Compaction of soil is highly damaging to root systems and to the mycorrhizal fungi that are essential in nutrient transport for the trees and shrubs. It is also very damaging to surface and buried archaeology. Timing of operations and selection of appropriate machinery are crucial in the management of sensitive sites (see Chapter 3 'Utilisation' of this volume).

In modern short rotation coppice, stool management might be very different, with the need to maintain production and tree vigour. Mechanically harvested short rotation coppice may require more frequent replanting, at intervals of 12-20 years.

Biodiversity and Cultural Heritage

Coppices of all kinds and ages are of interest for their associated wildlife and for their cultural heritage. The management system of rotational cutting creates structural heterogeneity across a woodland area, providing a range of age-classes and space for a high diversity of plants and animals that prefer open spaces and edge habitats and alternate light and shade conditions. Continuation of coppicing is essential for many species – they cannot tolerate the denser shade of high forest or the lack of spatial diversity therein. Ecological management of coppice can increase the extent of old trees and deadwood habitats beyond that normally found in intensive coppice systems, for example by retaining some trees and shrubs beyond their normal rotation and broadening the diversity of tree/shrub species. Retaining ancient trees in the landscape, as coppice stools (especially the high-cut stools known as 'stubs') in the forest and as pollards and shreds in pasture-woodlands and along watercourses and roads, adds considerably to the flora and fauna.

Cultural heritage interests are found in ancient coppices, where thousands of years of woodland management have created features such as banks and ditches, hollow ways, timber slides, boundary markers, charcoal-making platforms, pollards and veteran trees, often with archaeological artefacts dating back to the prehistoric period. More recent coppice woods may contain pre-woodland features of field systems, habitation sites and other archaeological structures. Both old and new coppices require sensitive management to protect these cultural and ecological interests.

Other aspects of cultural heritage associated with coppices include the food and artisanal products mentioned in the introduction, as well as the social history and art/literature and language so inextricably tied up with coppicing as a long-established practice in most rural communities. The evident popular interest across many European regions in community woodlands, woodland crafts, use of wood instead of artificial materials, switching to woodfuel, and local food festivals is highly encouraging – woods will survive if their products are in demand.

Conclusions

Coppicing is a venerable practice – it can, when practised ecologically, be a very effective way of managing trees and shrubs to produce wood and food required by society, in a repetitive manner without undue depletion of natural resources. It creates valuable habitats for many species of plants, fungi and animals and also safeguards and perpetuates landscapes and aspects of high cultural importance.

The long-established coppices hold some of Europe's most ancient trees and archaeology. Conservation of semi-natural ancient woodland by the continuation of coppicing is one way to protect and promote these assets, provided that management objectives are widened to encompass these less-productive features.

Traditional coppicing can be promoted for multi-purpose production and conservation objectives, whilst new wooded areas on agricultural land managed as short rotation coppices can be designed and managed to replicate some of the most important elements of traditional coppice. They have the potential to produce large volumes of wood for energy in a short time, whilst diversifying the landscape and creating habitats that support wildlife and game.

Conversion of ancient coppices to high forest or non-wooded land should be avoided wherever possible. The task for all of us is to ensure that we can manage woodlands (old and new) to integrate all of society's needs, within the capacity of the environment (economical, natural and cultural) to supply them.

Acknowledgements

This text is based on the Harmer (2004) text and has been modified to suit the context of COST Action FP1301 EuroCoppice. We are grateful to Ralph Harmer for allowing the use of the text and for the constructive comments on an early draft of this document.

References

Harmer, R. (2004). Coppice silviculture practiced in temperate regions. In Burley, J., Evans, J., Youngquist, J.A., (Ed.), *Encyclopaedia of Forest Sciences*. Academic Press, Elsevier Ltd., Oxford.

IUFRO (2005). *Multilingual pocket glossary of forest terms and definitions.* IUFRO SilvaVoc terminology project.

Nieuwenhuis, M. (2000). *Terminology of Forest Management.* IUFRO World Series Vol. 9-en. IUFRO 4.04.07 SilvaPlan and SilvaVoc.

Typology of European Coppice Forests

Valeriu-Norocel Nicolescu, Debbie Bartlett, Gero Becker, Gheorghe F. Borlea, Peter Buckley, Pieter D. Kofman, Dagnija Lazdiņa, Natascia Magagnotti, David Rossney, Raffaele Spinelli and Alicia Unrau

Coppice forests are an important component of European woodlands, with over 20 million ha of the productive forests in Europe being managed as coppice (UN/ECE-FAO, 2000, cited in Zlatanov and Lexer, 2009). Over millennia, the development of coppice forests has been influenced by many factors, such as regional climate, eco-physical conditions, wood market requirements and owners' interests. This has led to a very large variety of coppice forests in terms of their distribution, structure, legal status and management.

This document describes the basic types of coppice in Europe: simple coppice, coppice with standards, selection coppice, pollarding, and short rotation coppice (Figures 1 to 5), the latter being a more recent phenomenon. It is important to note that the above-mentioned diversity of coppice in Europe can never be captured in a categorisation. In practice, there are no distinct boundaries between types and within each type there are exceptions to each described element. Nevertheless, *coppice* is a common denominator of all these types, and there are typical "trends" to be found across Europe.

The five coppice types and their most important characteristics are summarised in the following figures and table.

Figure 1. Simple coppice of sweet chestnut (Photo: D. Rossney)

Figure 2. Coppice with standards (Photo: V.N. Nicolescu)

Corresponding Author: Valeriu-Norocel Nicolescu, nvnicolescu@unitbv.ro

Table 1. Typology of European coppice forests

	Simple coppice (fig. 1)	**Coppice with standards** (fig. 2)	**Coppice selection** (fig. 3)	**Pollarding** (fig. 4)	**Short rotation coppice** (fig. 5)
Definition	A coppice system in which all shoots in a stand are cut at each felling (Nieuwenhuis 2000)	A coppice system in which selected stems are retained as standards at each felling to form an uneven-aged overstorey which is removed selectively on a rotation constituting some multiple of the coppice rotation (Burley et al. 2004)	A coppice system in which only selected shoots of merchantable size are cut at each felling (Nieuwenhuis 2000)	A coppice system in which the crowns of trees are cut back, in a more or less systematic fashion, with the object of producing close heads of shoots (pollards) (Burley et al. 2004, modified)	Production of woody biomass, generally on agricultural land, by regenerating new stems from the stump or roots after harvesting and relying on rapid growth, generally over a 1 to 5 year cycle (ISO EN 16559)
Regeneration method	Stool shoots, root suckers	Stool shoots and seeds	Stool shoots	Stem shoots (at various heights)	Cuttings (willow, poplar) or seedlings (eucalypt, black locust) followed by stool shoots
Structure	Even-aged	Uneven-aged	Uneven-aged	Even-aged	Even-aged
Species	Most broadleaved species: oaks, sweet chestnut, hornbeam, linden, eucalypts, ash, alders, black locust, poplars, birch, European beech, hazel	*Upper storey* (standards): oaks, elms, ash, sycamore, Norway maple, wild cherry, wild service tree, service tree, black walnut, pines, larches *Lower storey* (coppice): hornbeam, field maple, European beech, linden, sweet chestnut, hazel	European beech, holm oak	Poplars, willows, ash, plane-tree, beech, chestnut, mulberry, oaks, linden, elms, black locust, maples, hornbeam, hazel	Willows, poplars, black locust, eucalypts

(Table 1 continued)

	Simple coppice (fig. 1)	Coppice with standards (fig. 2)	Coppice selection (fig. 3)	Pollarding (fig. 4)	Short rotation coppice (fig. 5)
Typical rotation period	15 – 30 years	15 – 30 years (coppice)	15 – 30 years	1 – 5 years (up to 25)	1 - 5 years
Potentially occurring in the forest vegetation types... (according to EEA, 2007)	4. Acidophilous oak and oak-birch forest (types 4.1 and 4.2) 5. Mesophytic decidous forest (types 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7) 6. Beech forest (types 6.2, 6.5, 6.6, 6.7) 7. Mountainous beech forest (types 7.1 and 7.8) 8. Thermophilous decidous forest (types 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8) 9. Broadleaved evergreen forest (type 9.1), 14. Plantations and self-sown exotic forest (type 14.2)				Not applicable; mostly on agricultural land
Size of product	Small-sized roundwood	Small-sized roundwood and timber	Roundwood of different sizes	Small-sized roundwood	Small-sized (whole) stems
Wood products	Firewood, charcoal, industrial roundwood, basketry, hoops, fascines, pea and bean sticks, fencing, poles, tannin, tool handles...	See simple coppice + timber	See simple coppice + timber	See simple coppice + sometimes timber (historically used as fodder)	Wood chips, pulp, basketry, fencing
Management options	Commercial exploitation Conversion Restoration Maintenance for biodiversity and as an element of landscape and culture				Commercial exploitation

Figure 3. Coppice selection with European beech (Photo: O. Cardoso)

Figure 4. Pollard of white willow (Photo: V.N. Nicolescu)

Figure 5. Willow clone treated as short rotation coppice (Photo: V.N. Nicolescu)

References

Burley, J., Evans, J., Youngquist, J.A. (2004). *Encyclopaedia of forest sciences.* Elsevier and Academic Press, Amsterdam-Boston-Heidelberg, vol. 4, pp. 1873-1928.

ISO EN 16559: *Solid biofuels. Terminology, definitions and descriptions.* International Organization for Standardization, Geneva, Switzerland.

EEA (2007). *European forest types. Categories and types for sustainable forest management reporting and policy.* 2nd edition. EEA Technical report No. 9/2006, European Environment Agency, Copenhagen, 111 pp.

Nieuwenhuis, M. (2000). *Terminology of Forest Management.* IUFRO World Series Vol. 9-en. IUFRO 4.04.07 SilvaPlan and SilvaVoc.

Zlatanov, T., Lexer, M.J. (2009). *Coppice forestry in south-eastern Europe: problems and future prospects.* Silva Balcanica 10(1), pp. 5-8.

Glossary of Terms and Definitions Related to Coppice

Dagnija Lazdiņa, Kristaps Makovskis, Pieter D. Kofman and Alicia Unrau

Term	Synonyms	Definition	Reference
adventitious	adventitious root; adventitious bud; adventitious shoot	1. (of buds) those produced elsewhere than normal, such as leaf axils, shoot apices (e.g. those appearing with wounds). 2. (of roots) lateral roots coming from organs other than main root system, such as the stem.	Beentje & Williamson (2016)
afforestation		Establishment of a forest or stand in an area where the preceding vegetation or land use was not forest.	Ford-Robertson (1971)
bioenergy		Energy derived from biomass.	ISO EN 16559
biological diversity	biodiversity	The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.	UNEP (1992) via SilvaVoc
browsing		Feeding on the buds, shoots and leaves of shrubs and trees by livestock or wild animals.	Kaennel & Schweingruber (1995)
bud		A meristem (either apical or lateral) in early development or resting stages, with its protective coverings; immature shoot, usually protected by scales or prophyll(s), or immature flower, protected by bracts, bracteoles and/or perianth segments.	Beentje & Williamson (2016)
canopy		The foliar cover in a forest stand, consisting of its upper layers.	Helms (1998)

Corresponding Author: Dagnija Lazdina, dagnija.lazdina@silava.lv

Term	Synonyms	Definition	Reference
canopy closure	canopy cover	Ground area covered by the crowns of trees or woody vegetation as delimited by the vertical projection of crown perimeters and commonly expressed as a percent of total ground area —note crown cover measures the extent to which the crowns of trees are nearing general contact with each other.	Ford-Robertson (1971)
clones		A group of plants produced from cuttings, stump or root sprouts, tissue culture, or some other method that produces offspring genetically identical to the original plant.	Maynard (1996) in FAO (2002)
conversion		A change from one silvicultural/management system to another, e.g. from clearfell to selection forest. Sometimes also used for a change from one (set of) species to another.	Nieuwenhuis (2000) via SilvaVoc
coppice		1. A plant derived by coppicing. 2. Any shoot arising from an adventitious or dormant bud near the base of a woody plant that has been cut back.	Burley et al. (2004)
coppice conversion by aging		The low coppice is no longer cut so that stands reach a maturity in which they are able to regenerate naturally by seed. During the waiting period, tending operations (e.g., cleaning, thinning) are applied depending on the stage of development. These interventions are halted after 60-80 years, after which silvicultural systems typical to high forests can be applied in order to regenerate the stands naturally by seed.	Nicolescu et al. (2017)
coppice conversion by replacement		The restoration of such coppice stands for their conversion to high forest is done either by (1) Clear-cutting, followed by planting, mostly of conifer tree species such as pines or Norway spruce; (2) Clear-cutting, followed by manual/mechanical seeding of species such as oaks; (3) Use of high forest silvicultural systems, such as uniform shelterwood cutting.	Nicolescu et al. (2017)

Term	Synonyms	Definition	Reference
coppice forest		Forest which has been regenerated by allowing regrowth from cut stumps or root suckers, or both, i.e., by vegetative means. Normally grown on a short rotation for small poles, but sometimes, e.g. some eucalypt species, to a substantial size.	IUFRO (2005)
coppice selection system	coppice selection	A coppice system in which only selected shoots of merchantable size are cut at each felling, giving uneven-aged stands.	Nieuwenhuis (2000) via SilvaVoc
coppice stand		Forest stand composed of stools that produce coppice shoots which form the major part of the crop.	Harmer (1995)
coppice system		Silvicultural system in which crops regenerate vegetatively by stump sprouts and the rotation is comparatively short.	Young (1982)
coppice with standards	compound coppice; coppice with standards system	A coppice system in which selected stems are retained as standards at each felling to form an uneven-aged overstorey which is removed selectively on a rotation constituting some multiple of the coppice rotation; a crop partly of vegetative and partly of seedling origin.	Burley et al. 2004
coppicing		1. The production of new stems from the stump or roots. 2. To cut the main stem (particularly of broadleaved species) at the base to stimulate the production of new shoots for regeneration.	Burley et al. (2004)
cutting(s)		A small shoot taken from near the end of a branch or the stem of a plant. It is placed in the ground and will produce roots and develop into a new plant which will be genetically identical to the original plant.	Nieuwenhuis (2000) via SilvaVoc
dieback		A term often used to mean 'death'. More correctly, it means a progressive death of a tree or a branch from its extremities towards the roots. Dieback can be reversible.	Burley et al. (2004)

Term	Synonyms	Definition	Reference
direct conversion of simple coppice		A transition from low coppice to high forest that does not involve another silvicultural system. The method of direct conversion includes (i) conversion by ageing (conversion by full cessation of low coppice cuttings), (ii) mixed conversion (conversion by partial cessation of low coppice cuttings), and (iii) conversion by replacement/restoration.	Nicolescu et al. (2017)
dormancy	dormant bud; latent bud; preventitious bud; latency	A special condition of arrested growth in which the plant and such plant parts as buds and seeds do not begin to grow without special environmental cues.	Young & Giese (1990)
epicormic growth		Growth of lateral buds after the apical bud is damaged.	Young & Giese (1990)
epicormic shoot	water shoot; water sprout; epicormic branch	A shoot arising spontaneously from an adventitious or dormant bud on the stem or branch of a woody plant often following exposure to increased light levels or fire.	Ford-Robertson (1971)
fodder		Coarse food that is composed of entire plants or the leaves and stalks of a cereal crop, and is fed to cattle and horses.	Park & Allaby (2013)
fuel wood	firewood	Any wood source that is used, without alteration, as a type of fuel for heating, lighting or cooking purposes.	Grebner et al. (2013)
high forest		A stand of trees, generally of seedling origin, that normally develop a high, closed canopy.	Ford-Robertson F.C. (1971)
high forest system		Silvicultural system in which forest is managed on rotation sufficient to produce trees large enough for timber production.	IUFRO (2005)
indigenous		Native to a specified area or region, not introduced.	Ford-Robertson (1971)
indirect conversion of simple coppice		This method removes all current species and introduces new species to the area.	Nicolescu et al. (2017)

Term	Synonyms	Definition	Reference
introduced tree species		An established (not nec…) plant or animal not native to the ecosystem, region, or country.	Ford-Robertson (1971)
invasive tree species		An organism that is non-native (or alien) to an ecosystem and whose introduction causes or is likely to cause economic or environmental harm or harm to human health = invasive pest species.	Ford-Robertson (1971)
lateral shoot		Lateral means 'at the side', 'towards the side', 'from the side', 'axillary', 'farther from the midline of the body', 'situated towards or at the side of the body'. E:... (4) lateral shoot.	Klein (2008)
layering		The rooting of an undetached branch (= a layer) lying on or partially buried in the soil, which is capable of independent growth after separation from the mother plant.	Nieuwenhuis (2000) via SilvaVoc
leading shoot		The leading shoot is the main shoot which develops from the terminal bud at the top of a tree each year.	Klein (2008)
mixed conversion (coppice)		Conversion to high forest by partial cessation of low coppice cuttings. Every 10 years (production of a new management plan), a part of low coppice stands are no longer exploited, while the rest of stands are treated as low coppice. The area of low coppiced stands continuously decreases until they no longer exist, while the area covered with high forests increases and these stands form successive age classes.	Nicolescu et al. (2017)
mixed forest		Forest or woodland consisting of different species either between or within specified areas.	Nieuwenhuis (2000) via SilvaVoc
monoculture	pure stand	A stand of a single species, generally even-aged.	Ford-Robertson (1971)
multi-stemmed tree		"multi-": comb. prefix meaning many.	Gray (1967)

Term	Synonyms	Definition	Reference
over-aged coppice	abandoned coppice; aged stools; derelict coppice; neglected coppice; neglected stools; overstood coppice; stored coppice	Coppice woodlands that have been left to grow substantially beyond the normal rotation and developed stools with stems having the characteristic sizes and lengths of high forest trees.	Harmer & Howe (2003)
overmature stand		1. A tree or even-aged stand that has reached that stage of development when it is declining in vigor and health and reaching the end of its natural life span - not nec end of life... 2. A tree or even-aged stand that has begun to lessen in commercial value because of size, age, decay, or other factors.	Ford-Robertson (1971)
plantation		A stand composed primarily of trees established by planting or artificial seeding —note 1. a plantation may have tree or understory components that have resulted from natural regeneration —note 2. depending on management objectives, a plantation may be pure or mixed species, treated to have uniform or diverse structure and age classes, and have wildlife species commensurate with its stage of development and structure —note 3. plantations may be grown on short rotations for biomass, energy, or fiber production, on rotations of varying length for timber production, or indefinitely for other values.	Ford-Robertson (1971)
pole		A straight, bark-free, tree-length log with one end embedded in the ground that supports power and communication wires, highway sound barriers, and similar structures.	Burley et al. 2004
pole stage	pole phase	Still-young tree larger than 10 cm dbh, up to about 20-23 cm dbh.	Young (1982)

Term	Synonyms	Definition	Reference
pollarding		Cutting back, in a more or less systematic fashion, the crown of a tree, with the object of producing a close head of shoots (a pollard) beyond the reach of browsing animals.	Burley et al. (2004)
provenance	geographic origin	Natural origin of seeds or trees, usually synonymous with "geographic origin", or a plant material having a specific place or origin.	Young & Giese (1990)
pruning		The removal, close to the branch collar or flush with the stem, of side branches (live or dead) and multiple leaders from a standing tree —note 1. pruning is generally done on plantation trees to improve the tree or its timber, or on urban and rural trees to improve their aesthetics or health —note 2. green pruning is the removal of live branches, dry pruning is the removal of dead branches, and chemical pruning is the application of chemicals, e.g., plant-growth regulators, to the living tree to kill, suppress, or inhibit lateral shoots.	Ford-Robertson (1971)
regeneration		The natural or artificial process of re-establishing tree cover on forest land.	Nieuwenhuis (2000) via SilvaVoc
rotation period	rotation age	Period of years required to establish and grow timber crops to a specified condition of maturity. Applies only to even-aged management.	Young (1982)
seed tree		A tree selected and often reserved for the collection of seed or for natural seeding of a (understocked) regeneration area.	Nieuwenhuis (2000) via SilvaVoc
shelterwood system		A harvesting system in which most of the trees are felled but some are left to provide protection for the new forest by providing either shade or wind protection.	Helms (1998)
shoot	coppice shoot; sprout; spring	A shoot arising from an adventitious bud at the base of a woody plant that has been cut near the ground. In the case of a sucker, the shoot arises from the root of the plant.	Nieuwenhuis (2000) via SilvaVoc

Term	Synonyms	Definition	Reference
short rotation coppice		Production of woody biomass, generally on agricultural lands, by regenerating new stems from the stump or roots after harvesting and relying on rapid growth, generally over a 1 to 5 years cycle.	ISO EN 16559
shredding	lopping	The repeated removal of side branches on a short cycle, leaving just a tuft at the top of the tree.	Burley et al. (2004)
shrub		Woody perennial plant, seldom exceeding 3.0 m in height, usually having several persistent woody stem branching from the ground.	Young (1982)
simple coppice	low coppice; simple coppice system	A coppice system in which all shoots in a stand are cut at each felling, giving even-aged shoots and stands.	Nieuwenhuis (2000) via SilvaVoc
singling	stored coppice	To reduce the regrowth from a coppice stool to allow a single pole to grow on to form a standard tree.	Park & Allaby (2013)
site index		A species-specific measure of actual or potential forest productivity (site quality, usually for even-aged stands), expressed in terms of the average height of trees included in a specified stand component (defined as a certain number of dominants, codominants, or the largest and tallest trees per unit area) at a specified index or base age. —note site index is used as an indicator of site quality.	Ford-Robertson (1971)
site quality class		The maximum quantity of material, of given species, that an area is capable of producing under normal conditions, so long as the factors of the locality remain unchanged.	Nieuwenhuis (2000) via SilvaVoc
sprouting		Type of asexual vegetative reproduction in which sprouts arise (i) from the side of a stump (developed from dormant buds) or (ii) between the bark and wood, on the surface of the stump (originated from adventitious buds).	Fujimori (2001)

Term	Synonyms	Definition	Reference
stool	stump	A living stump (capable of) producing coppice shoots.	Burley et al. (2004)
stool shoot	stool sprout; stump shoot; stump sprout	1. A shoot or new stem/branch emerging from (near) the base of the plant, especially when the stem has been cut; 2. Several stems arising from the same root.	Beentje & Williamson (2016)
sucker	root sucker	A shoot arising below group from the roots some distance from the main stem.	Beentje & Williamson (2016)
thinning residues		Woody biomass residues originating from thinning operations.	ISO EN 16559
vegetative regeneration	vegetative propagation; vegetative reproduction	Nonsexual reproduction.	Burley et al. (2004)
veteran tree		1. Trees of interest biologically, aesthetically or culturally because of their great age; 2. Trees in the ancient stage of their life; 3. Trees that are old relative to others of the same species.	Read (2000)
virgin forest	semi-natural forest; semi-natural ancient woodland	Areas (or forests) that have never been disturbed by human intervention, showing natural development in structure and dynamics. The soil, climate, entire flora and fauna and the life processes have not been disturbed or changed by timber management, cattle grazing, or other direct or indirect anthropogenic influences.	Schuck et al. (2002)
windbreak	shelterbelt	A line of trees or shrubbery planted or managed in such a way as to protect a building or crops, or to alter climate or wind.	Helms (1998)

These terms and definitions can be found in the online Multilingual Forestry Glossary, along with illustrations and translations into many European languages.

Visit the EuroCoppice website for details:

www.eurocoppice.uni-freiburg.de

Acknowledgements

We are very grateful to the following COST Action FP1301 EuroCoppice Members for contributing to and reviewing the Glossary: Rob Jarman, Jyrki Hytönen, Valeriu-Norocel Nicolescu, Radomír Klvač, Ivailo Markoff, Enrico Marchi, Gero Becker, David Rossney, Peter Buckley, Debbie Bartlett, Marko Condera and Raffaele Spinelli.

References

Beentje, H. & Williamson, J. (2016). *The Kew plant glossary: an illustrated dictionary of plant terms.* Richmond, Surrey, UK: Kew Publishing.

Burley, J., Evans, J., Youngquist, J.A., (2004). *Encyclopedia of forest sciences.* Elsevier and Academic Press, Amsterdam-Boston-Heidelberg, vol. 4, pp. 1873-1928 (Glossary).

Dublin, R., Manubay, G., (Ed.) (2007). *Glossary of Urban Forestry Terms for Citizen Foresters.* Tree Trust Community Tree Planting Guide ESRI Press Department of Natural Resources, Parks & People Foundation.

FAO (2002). *Glossary on forest genetic resources (English version).* Forest Genetic Resources Working Papers, Working Paper FGR/39E, Forest Resources Development Service, Forest Resources Division. FAO, Rome (unpublished).

Ford-Robertson F.C. (Ed.) (1971). *Terminology of forest science, technology practice and products.* Washington D.C., Society of American Foresters. 370 pp. (2nd printing)

Fujimori, T., (2001). *Ecological and silvicultural strategies for sustainable forest management.* Elsevier, Amsterdam-London-New York-Oxford-Paris-Shannon-Tokyo, 398 p.

Gray, P. (1967). *The Dictionary of the Biological Sciences.* Reinhold, New York.

Grebner, D., Bettinger, P. & Siry, J. (2013). *Introduction to forestry and natural resources.* Amsterdam Boston: Academic Press.

Harmer, R. (1995). *Management of Coppice Stools; Research Information Note 259*. The Forestry Authority, Surrey.

Harmer, R., Howe, J., (2003). *The silviculture and management of coppice woodlands.* Forestry Commission, Edinburgh, 90 p.

Helms, J.A. (ed.), (1998). *The Dictionary of Forestry.* The Society of American Foresters. CABI Publishing, Bethesda & Wallingford, 210 p.

Hocker, H. (1979). *Introduction to forest biology.* New York: Wiley.

ISO EN 16559: *Solid biofuels*. Terminology, definitions and descriptions, International Organization for Standardization, Geneva, Switzerland.

IUFRO (2005). *Multilingual pocket glossary of forest terms and definitions.* IUFRO SilvaVoc terminology project.

Kaennel, M., Schweingruber, F.H. (1995). *Multilingual glossary of dendrochronology: terms and definitions in English, German, French, Spanish, Italian, Portuguese and Russian.* Berne u.a: Haupt.

Klein, E. (2008). *Bilinguales Wörterbuch Biologie.* München: Verb. Biologie, Biowiss. und Biomedizin in Deutschland.

Maynard, C. (1996). *Glossary of forest genetics.* Unpublished.

Nicolescu, V.-N., Carvalho, J., Hochbichler, E., Bruckman, V., Piqué-Nicolau, M., Hernea, C., Viana, H., Štochlová, P., Ertekin, M., Tijardovic, M., Dubravac, T., Vandekerkhove, K., Kofman, P.D., Rossney, D., Unrau, A. (2017). *Silvicultural guidelines for European coppice forests. COST Action FP1301 Reports.* Freiburg, Germany: Albert Ludwig University of Freiburg.

Nieuwenhuis, M., (2000). *Terminology of Forest Management.* IUFRO World Series Vol. 9-en. IUFRO 4.04.07 SilvaPlan and SilvaVoc.

Park, C. & Allaby, M. (2013). *A dictionary of environment and conservation.* Oxford: Oxford University Press.

Read, H. (2000). *Veteran Trees: A guide to good management.* English Nature, 176 p.

Schuck, A., Päivinen, R., Hytönen, T., Pajari, B., (2002). *EFI Internal Report 6: Compilation of Forestry Terms and Definitions.* European Forest Institute, Joensuu.

UNEP (1992). *The Convention on Biological Diversity.* Article 2.

Young, R.A. (ed.) (1982). *Introduction to forest science.* John Wiley & Sons, New York-Chichester-Brisbane-Toronto-Singapore, 554 pp

Young, R. & Giese, R. (1990). *Introduction to forest science.* New York: Wiley.

Funded by the Horizon 2020 Framework Programme of the European Union

www.cost.eu

COST (European Cooperation in Science and Technology) is a funding agency for research and innovation networks. Our Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. This boosts their research, career and innovation.

Published by:
Albert Ludwig University Freiburg
Chair of Forest Utilization
Werthmannstr. 6
D-79085 Freiburg
Germany
www.uni-freiburg.de

This chapter is part of the volume

"Coppice Forests in Europe"

Printed by: Albert Ludwig University Freiburg Printing Press

Contact:
www.eurocoppice.uni-freiburg.de
eurocoppice@fob.uni-freiburg.de
0049 (0)761 203 3789

Coppice Forests in Europe

Editors: Alicia Unrau, Gero Becker, Raffaele Spinelli, Dagnija Lazdina, Natascia Magagnotti, Valeriu-Norocel Nicolescu, Peter Buckley, Debbie Bartlett and Pieter D. Kofman

ISBN 978-3-9817340-2-7

Recommended citations:

For the full volume: Unrau, A., Becker, G., Spinelli, R., Lazdina, D., Magagnotti, N., Nicolescu, V.N., Buckley, P., Bartlett, D., Kofman, P.D. (Eds.) (2018). *Coppice Forests in Europe*. Freiburg i. Br., Germany: Albert Ludwig University of Freiburg.

For individual chapters/articles: List of author(s) with surname(s) and initial(s). (2018). Chapter/article title. In A. Unrau, G. Becker, R. Spinelli, D. Lazdina, N. Magagnotti, V.N. Nicolescu, P. Buckley, D. Bartlett, P.D. Kofman (Eds.), *Coppice Forests in Europe* (pp. xx-xx). Freiburg i. Br., Germany: Albert Ludwig University of Freiburg.

The articles in this volume were developed within the context of COST Action FP1301 EuroCoppice (2013-2017). Numerous contributions were published as single, independent booklets during the course of the Action; they were subsequently reviewed and updated for this volume. A digital version of this volume, further results and more are available on the website: www.eurocoppice.uni-freiburg.de

Design, layout & formatting: Alicia Unrau

Coppice image acknowledgements: Simple coppice (grey) based on a drawing by João Carvalho (pp. 46); Leaf vector originals designed by www.freepik.com (modified)