Foreword

Coppicing is a very old and traditional form of sustainable forest management that can provide an array of products and services for households, industry and society. The coppice concept employs short utilization cycles (rotations) to take advantage of the vigorous growth in the early years of certain tree species that are able to naturally (vegetatively) regenerate. Depending on the ecological situation and the actual needs of the society, various types of coppice forest management with different tree species and rotation periods were developed throughout Europe and their neighbouring countries.

As societal needs changed and new technologies developed, coppicing became somewhat outdated in forest science and practice in many regions. However, although most coppice forests were abandoned or converted to high forests in Central and Western Europe, in other areas they are still common and often actively managed, especially in Eastern and Mediterranean countries.

Recently there has been a renewed interest in coppice forests and coppice management: In the context of climate change policy, coppicing may be an attractive way to sustainably produce a large amount of biomass in short time and at limited cost, and the raw material from coppice could also be a resource base for new bio-economy concepts. In the context of biodiversity and nature conservation, coppice forests provide small scale and dynamic patterns of (full) light and shadow situations, which are beneficial for many endangered flora and fauna species.

The COST Action FP 1301 EuroCoppice was approved in 2013 and began its activities in 2014. Its main objectives are to collect, exchange, analyse and disseminate coppice-related scientific knowledge. Given the variety and complexity of forests and their management throughout Europe in general, as well as the even greater differences in perception and management of coppice forests in particular, a detailed exploration of the current situation is the first important and necessary step. Further aims are then to raise awareness and provide recommendations to practitioners, experts and politicians regarding the future management of coppice forests throughout Europe and neighbouring countries.

To date, 32 COST Member States, two Near Neighbour Countries and one International Partner Country have joined the Action. Members from all 35 countries actively cooperate and network within the framework of the Action's five Working Groups (WG). Each WG examines coppicing from a different angle, while cross-sectional tasks add a further element of complexity.

Patrick Pyttel, from the Institute of Silviculture, Freiburg, Germany, the Leader of EuroCoppice Working Group (WG) 2 "Ecology and Silviculture of Coppice Forests", Valeriu-Norocel Nicolescu, and further Members of WG 2 have taken the initiative to ask the experts from participating EuroCoppice countries to draft "Coppice Forest Country Reports". These reports should provide basic information on the status and management of coppice forests, based on the available sources in their respective country.

In this current report from September 2015, 20 Country Reports have been submitted and reviewed by experts from WG 2. The reports give an overview on coppice forests in the respective EuroCoppice countries, and represent a unique and valuable source of information. They are both a useful tool of dissemination and a basis for further coppice related research activities.

I would like to thank all authors of the reports for their valuable contribution, as well as encourage the experts of further EuroCoppice countries to follow this excellent example and to prepare reports on their respective countries. My special thanks go to Valeriu-Norocel Nicolescu and his editing team for the initiative and review of the reports.

Gero Becker

Professor for Forest Utilization

Albert Ludwigs University Freiburg, Germany

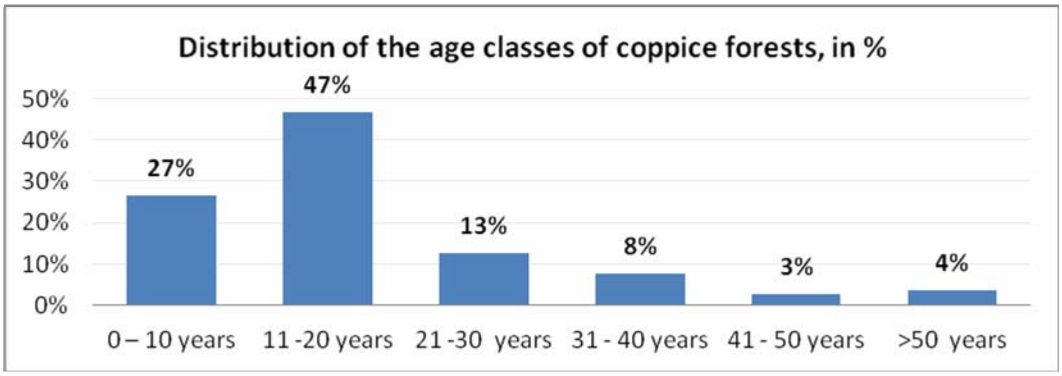
Chair of COST Action FP 1301 EuroCoppice

ALBANIA

Abdulla Diku[1] and Vasillaq Mine[2]

As in all other countries, coppice forests in Albania represent a traditional system of forest management. For centuries until the present times, coppice forests have represented the model of "coexistence" of forests with local communities. These forests have usually had the same purpose; providing firewood for heating and cooking, supplying materials for construction purposes, agriculture, industry, and livestock grazing, for example. Prior to 1944 Albania had a forest area of about 1,379,000 hectares; about 300,000 hectares of this were deforested for agriculture during the socialist period.

The quantity and quality of coppice forest in Albania is variable. Most of the coppice forest is oak, but shrubs species are also managed as coppice across the whole country. Generally, coppice forests are located in close proximity to residential areas. In most of them, coppice forests in Albania are irregularly structured due to their disorganized management. In the last 10 years, there has been a slight increase in the area of coppice forests with coppiced oaks now extending to about 32.5% of the Albanian forest area and comprising 17% of the total volume. The low percentage volume compared to the surface area is attributed to the low quality to these forests and poor management. The average volume per hectare of oak coppice forest is about 43 m^3/ha. There is evidence of an increase in volume per hectare of coppice forests in the country, attributed to the use of alternative sources of energy for heating and cooking (electricity). The distribution of coppice forests by age classes is shown in the chart below:



Source: National Forest Inventory of Albania (2004).

[1] Agricultural University of Tirana, Faculty of Forestry Sciences, Str. Koder-Kamez, 1029 Tirana, Albania, e-mail: adiku@hotmail.com

[2] Agricultural University of Tirana, Faculty of Forestry Sciences, Str. Koder-Kamez, 1029 Tirana, Albania, e-mail: vassilaqmine@yahoo.com

The chart shows that 70% of coppice is 0-20 years old. Based on inventory data, the average annual growth of coppice forests in Albania is estimated at approximately 2.3 cu.m/ha/yr.

Even shrub species are historically treated as coppice forest with this type making up about 25% of the forest area of the country, while in terms of volume; they represent about 10%, with the average volume about 28 cu.m/ha again demonstrating the very low quality of these forests.

The main problems of coppice forests in Albania are as follows;

- Lack of their sustainable management, based on scientific criteria
- Frequent damages due to cutting and fires
- Livestock grazing in the early stages
- Over-use of coppice forests
- Their ineffective use (cutting in short cycles, cutting in breach of technical criteria etc.).
- High demand in the local markets for wood products
- Unfavourable energy policy in the country (at the expense of forests)
- Forest with poor quality (with low volume/ha)
- Various diseases and pests or harmful agents
- Incorrect data in forest cadastres on area surface and volume.

Oak coppice forest in Drini valley.

BELGIUM

Stefan Vanbeveren[3] and Reinhart Ceulemans[4]

In Belgium, the distinction between simple coppice cultures (*hakhout*) and coppice with standards (*middelhout*) is made. Coppice cultures have rotations of 2-30 years and have been the dominant management regime from the middle ages until the start of the 20th century. The earlier and repeat revenue, in comparison to traditional forests, were the main motives for this management regime. The main products extracted from coppice cultures are firewood, oak bark (for tanning), charcoal, pole wood and branches for brooms.

For several years experimental, high density (up to 18,000 trees ha^{-1}), short-rotation (2-4 years) coppice cultures have been established, mainly with *Populus* and *Salix* species. These short-rotation coppice cultures are currently grown on 30 ha, an area expected to expand with the predicted increase in demand for second generation biofuels.

Coppice with standards is more typical on rich soils. The coppiced trees were mainly selected for firewood (e.g. *Carpinus betulus*, *Corylus avellana*, *Fraxinus excelsior*, *Castanea sativa* and *Alnus*), while the uneven-aged standards were selected to produce timber (e.g. *Quercus*, *Populus*, *Fraxinus excelsior* and *Larix*). From the little available productivity information, 2-7 m^3 ha^{-1} yr^{-1} for stem wood has been calculated.

The use of coppice cultures in Belgium declined in the 20th century as a consequence of the decrease in demand for firewood and oak bark, and the increase in cost of management. Most coppice cultures have been converted to oak high forest or abandoned. Conversion to oak forest involved pruning all but one shoot from each stool but this proved to be an unsuccessful management strategy as it led to poor stem quality. The transformation of coppice cultures usually involved inter-planting with different species such as *Pinus sylvestris*, *Pseudotsuga menziesii* and/or *Larix*, although old coppice stools can still be found. Recently, coppice cultures have received attention for their nature, cultural and historical value. Re-coppicing old stools is not usually sufficient to re-establish coppices due to the low regeneration capacity of buds. Even if these are still capable of sprouting stem density will be too low, as a consequence of the self-thinning process

[3] University of Antwerp, Universiteitsplein 1, B-2610 Wilrijk, Belgium, e-mail: Stefan.Vanbeveren@uantwerp.be

[4] University of Antwerp, Universiteitsplein 1, B-2610 Wilrijk, Belgium, e-mail: Reinhart.Ceulemans@uantwerp.be

during past decades. Therefore new planting is often necessary and this requires protection from wildlife and control of competing understorey growth.

Reference

Den Ouden, J., Jansen, P., Meiresonne, L. & Knol, R., 2010. Chapter 24: Hakhout en middelhout. In: Bosecologie en bosbeheer. Den Ouden J., Muys B., Mohren F. & Verheyen K. (editors). ISBN 978-90-334-7782-9, Acco, Leuven, Belgium, 674 pp.

An experimental short-rotation coppice culture in Lochristi (East-Flanders, Belgium) with *Populus* (genotype Bakan, *P. trichocarpa* Torr & Gray (ex Hook) x *P. maximowiczii* Henry).

CROATIA

Tomislav Dubravac[5] and Damir Barčić[6]

The total area of coppice forest in Croatia amounts to 533.828 ha, of which 6.4% has a protective function, for example for soil and watercourses, is a designated protected area (e.g. national parks) and has another special purpose. Coppice forests in Croatia represent a significant source of wood products and provide a variety of forest services and functions. There is an almost equal distribution private and state ownership, at 52% and 48% respectively.

Generally coppice forests in Croatia can be divided between the Continental and Mediterranean parts of the country. In the Continental part the characteristic trees are: European beech, hornbeam, sessile oak, chestnut, alder, acacia, while in the Mediterranean area holm oak, Mediterranean oak and hornbeam coppice are found.

Coppicing is the most convenient form of management for owners of small deciduous forests as this allows them to extract firewood, poles, small-sized industrial wood and fallen leaves. It is also possible to organize grazing in these coppices.

Coppice rotation for species from Forest Management Plan regulations:

1. Oaks (*Quercus pubescens, Quercus ilex, Quercus petraea*)....... 80 years
2. Beech (*Fagus sylvatica*).. 80 years
3. European hornbeam (*Carpinus betulus*)..................................... 40 years
4. False acacia (*Robinia pseudoacacia*)... 30 years
5. Soft deciduous (*Populus* sp., *Salix* sp., *Alnus* sp.)…..................... 30 years

Coppices were created by intentional or accidental processes that curtailed the development of a single-stemmed standard tree. A common feature of most coppices is the absence of any silvicultural work during the early stages and throughout their development. This 'spontaneous' development resulted in a graduation from the best quality, with relatively high mass of well populated stands to poor quality, with fewer stems and less overall mass.

It should be mentioned that degraded coppice stands often have high value for habitat characteristics. Conversion of coppice must retain the existing soil fertility in addition to

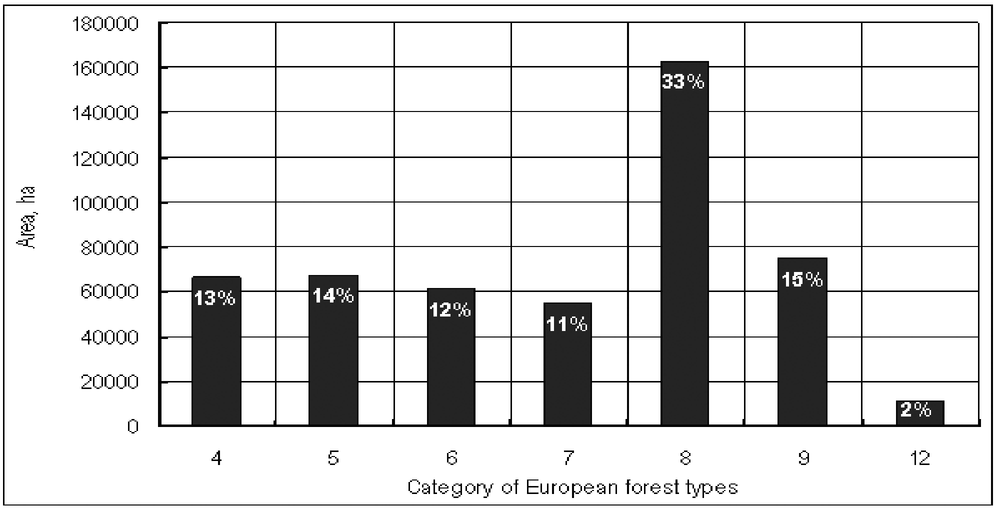
[5] Croatian Forest Research Institute, Jastrebarsko, Croatia, e-mail: tomod@sumins.hr
[6] Faculty of Forestry, University of Zagreb, Croatia, e-mail: damir.barcic@zg.htnet.hr

developing native stands from seed. In accordance with the Forest Act, which applies to all regular forests, including coppice stools, the aim of regeneration must be to produce a high stand. Exceptions to this are alder, poplar, willow and acacia stands which can be renewed by clear cutting, reforestation and shoots from sprouts (false acacia).

As with the high forests, silvicultural works in coppice are divided into two basic groups:

1. Silvicultural work on the clearing and thinning of coppice.

2. Silvicultural work on regeneration of coppice.



Coppice forests in Croatia by categories of European forest types
4 – Acidophilous oak and oak-birch forest; 5 – Mesophytic deciduous forest; 6 – Beech forest; 7 – Mountainous beech forest; 8 –Thermophilous deciduous forest; 9 – Broadleaved evergreen forest; 12 – Floodplain forest.

View on the coppice forest of holm oak on the Croatian Adriatic coast (photo D. Barcic).

CZECH REPUBLIC

Petra Štochlová[7]

In the past most forest cover was in the lowlands, the warm hilly areas and highland areas of the Czech Republic and these were managed as coppice forests to produce firewood. In the 19th century, the decreasing demand of firewood caused coppice forests, including those with standard trees, to begin to be transformed into high forest. The transformation was done in two ways. The direct method was to re-plant using saplings produced from seed after felling coppice. The indirect one was by gradual thinning of the shoots finally leaving only one. Around 1900, coppices in what is now the Czech Republic covered approximately 95,000 ha, representing 4.1% of forest cover (Adamec et al., 2014). Since then, the area had been decreasing.

Recently interest in the coppice forests in order to protect endangered species, enhance biodiversity and obtain a sustainable source of energy has been increasing in the Czech Republic. In the last decade areas of forest coppiced have slowly started to increase. Approximately 9,310 ha (0.36%) of simple coppice forest and 2,393 ha (0.09%) of coppice with standards can now be found in the Czech Republic (ÚHUL, 2014). Most of the coppice forests are situated in the south-eastern part of the Czech Republic.

According to Czech law forests cannot be harvested before 80 years growth. Only in six forest management forest types, it is allowed to manage forests as simple coppice forests. Coppice forests predominantly composed of hard wood trees are preferred, with a recommended rotation length of 40 years (although this can range between 30 and 50 years, an in some cases 60 years). Where soft wood trees are in the majority then the recommended rotation is between 20 and 30 years. Recommended rotation length for willow and black locust is 40 and 70 years respectively, in specific forest management stands. Among recommended tress for coppicing in the Czech Republic are alder, oak, hornbeam, maple, ash, elm, lime, poplar and willow; in addition wild cherry, birch and rowan can be also used.

At the present time, the efforts to restore coppice forest management are viewed circumspectly by some foresters; more information is required in some areas. Although the systems of coppice forest management have been covered extensively in scholarly

[7] Silva Tarouca Research Institute for Landscape and Ornamental Gardening, Publ. Res. Inst., Květnové náměstí 391, 25243 Průhonice, Czech Republic, e-mail: stochlova@vukoz.cz

publications, less is known about the economic effectiveness of coppice forest systems. Recently some research plots were established, converting from quasi-high forest to coppice. But only the long-term results could prevent from considerable losses. Promising results could contribute to positive awareness of coppice forest and this, combined with liberalisation of Czech law could help with coppice forest renewal.

References

Adamec, Z., Kadavý, J., Kneifl, M., Šplíchalová, M., Klimánek, M., 2014. The response of basal area increment in old sprout-origin sessile oak (*Quercus petraea* (Matt.) Liebl.) trees during their conversion to a coppice-with-standards. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 62(5): 837–847.

ÚHÚL, 2014. Informace o stavu lesa (Information about the forest state) [2015-06-08] Available on: <http://eagri.cz/public/app/uhul/SIL>

ENGLAND

Debbie Bartlett[8]

Coppice management has been practiced since the earliest times with archaeological evidence including the remains of trackways laid across boggy ground showing the marks of felling axes. The composition of the woods has varied over time as particular tree species were preferentially encouraged to meet the demands of markets. Similarly rotational cycles were developed to provide roundwood of the required dimensions.

Forestry as a whole has undergone dramatic changes in recent centuries. The demands of oak for ship building, particularly in the 17th and 18th centuries, led to the development of the coppice with standards system. In this oaks were grown over coppice encouraging branching and the development of the 'crooks' or angled branches required by the master ship wrights.

In the immediate aftermath of the First World War the Forestry Commission was set up in response to the shortages of timber and this Government organisation, which still exists today, set about increasing self-sufficiency in timber. This was done by buying woodland, planting conifers and providing financial incentives for private woodland owners to do the same. In many cases this led to previously coppice native broadleaved woods being cleared and over-planted with fast growing conifers.

[8] University of Greenwich d.bartlett@gre.ac.uk

After the Second World War, which again had a major impact on woodlands, particularly coppice, there was a period of agricultural intensification, driven by the food shortages. This led to reduction in the woodland area as land was cleared for agriculture. The rise of the environmental movement and increasing awareness of the effect on native flora and fauna led to a change in forestry policy with a move from coniferisation to encouraging native broadleaves in the mid - 1980s.

So how has this affected coppice woodland management? The area managed as coppice has risen and fallen with changes in market demand, policy and overall woodland area. By the turn of the century it had virtually died out in most part of the UK as an economic activity and was practiced primarily by nature conservation organisations to maintain specific habitats. The exception to this trend was the chestnut industry, concentrated in the south eastern counties, and producing fencing materials. This has remained largely ‘hidden’ as there is no legislation affecting it (i.e. no permissions are required for harvesting roundwood of small diameter). There has been continuity with coppice workers often working in family groups and with skills and knowledge passed from father to sons.

There has been a revival in hazel coppice crafts apparent in the last decades of the 20th century with some choosing to take up this livelihood, often after becoming disillusioned by working in more high powered careers. These tend to sell products directly to their customers, as opposed to feeding produce into ‘coppice merchants’ as is the case for the chestnut industry, and supplement this by demonstrating at craft fairs and country shows.

In addition to these two sectors, based on specific tree species, woods are coppiced for firewood.

FINLAND

Jyrki Hytönen[9]

Forests is Finland

Finland is the most extensively forested country in Europe. Finland's forests are mostly northern boreal. Wooded land occupies 26 million ha or 86% of the land area of Finland. This is divided into forest (66 % of the land area), scrub and waste land. Of the growing stock volume (2357 million m^3), 50% consists of Scots pine (*Pinus sylvestris*), 30% of Norway spruce (*Picea abies*), 16% of birch (*Betula pendula* and *B. pubescens*) and 4% of other broadleaves.

Traditional coppice forests

Even though coppicing is a traditional silvicultural management system widely used in Central and Southern Europe its application in Finland has been very limited. Most of our native deciduous tree species are not considered very suitable for coppice management. In some special cases, such as mountain birch (*Betula pubescens* spp. *tortuosa*) stands in Lapland, were recommended to be coppiced for firewood. Historically hazel (*Corylus avellana*) and linden (*Tilia cordata*) were grown as coppice for timber and other products in the south of the country. In small areas lopparding was used to produce fodder for cattle.

Today traditional managed coppice forests don’t exist in Finland. However, in normal forests there are trees of coppice origin, especially birches, but also other species such as rowans. Growing coppiced trees is not encouraged but they may fill up the stand.

Short rotation forests

The use of bioenergy is increasing rapidly due to the need to reduce greenhouse gas emissions. Wood based fuels are playing a leading role in Finland in attempts to reach national and European Union targets to increase the use of renewable energy. The National Climate and Energy Strategy aims to increase annual wood chip production in Finland to 13.5 million m^3 by the year 2020. Even though woody biomass is mainly harvested from existing forests (small sized trees, slash and stumps) in future growing ‘energy forests’ may become economically viable. Energy plantations based on fast growing deciduous tree species, grown in dense stands, and renewed by coppicing have been studied in Finland, with the focus on short-rotation willow. This research was begun in Finland in the late 1970’s with extensive studies of cultivation methods. However due to a

[9] Natural Resources Institute Finland (LUKE), Silmäjärventie 2, 69100 Kannus, Finland, e-mail: jyrki.hytonen@luke.fi

combination of falling oil price and the high production costs of willow energy this practice has not been widely adopted. Currently there are only around 200 ha of willow plantations in Finland. This may increase with the growing demand for energy and increasing prices of other fuel sources.

Due to Finland’s northern location other native deciduous tree species have been the subject of short-rotation forestry research. The rotation for coppicing native birches, alders and aspens is, at between 20 and 30 years, considerable longer than for willow. Downy birch (*Betula pubescens*) growing on peatlands (of which there are 572,000 ha) is receiving increasing interest. The grey alder (*Alnus incana*) also has several good qualities, such as capacity for binding atmospheric nitrogen, good coppicing ability and fast growth. These characteristics are appreciated as they directly affect the economics of biomass production. A further advantage of alder is that it is not susceptible to insect damage and is not as palatable to mammals (vole, moose, hare) as birches, willows, aspen and poplar. Aspen (*Populus tremula*) and hybrid aspen are also subject for research for SRC potential.

Future challenges

The future expansion of wood biomass production systems has many challenges and depends on economical, ecological and policy. As well as producing bioenergy cost-effectively and in an environmentally sustainable way SRC is also expected to provide employment opportunities and support the cultural landscape. Research and development investment is needed to promote the expansion of new renewable energy systems.

One-year growth of energy willow in south Finland (left) and four years old downy birch coppice in northern Finland (right).

GERMANY

Patrick Pyttel[10] and Achim Dohrenbusch[11]

Coppicing is a traditional silvicultural management system applied all over the world. Until recently coppice stands often represented important elements of the cultural landscapes in rural environments of Central Europe. These forests were traditionally used for the production of firewood and various non-timber forest products. Across Central Europe this practice was largely abandoned in the first half of the last century due to socio-economic changes and this absence of periodic coppicing led to the passive transformation of the remaining stands. In this process the stands lose their typical coppice characteristics and increasingly resemble high forest. Subsequently the specific ecological values of coppice forests decreases and this important element of the cultural landscape gradually disappears.

Today managed coppiced forests (i.e. younger than 40 years) only cover 75,000 ha of Germany which represents 0.7% of the total forest area (BMELV, 2004), while the forest assessment of 1961 reported 3.5% of German forests as coppice. One way of preserving the ecological, cultural and historical value of coppice forests would be to resume coppicing in over stood, formerly coppiced forests with the additional benefits of promoting light and warmth demanding species. This could also increase biodiversity.

Ongoing initiatives by the European Union (EU) call for a substantial increase in the use of renewable energy sources. The objective is to provide one fifth of the European energy consumption from renewable sources by 2020. Currently 47% of the renewable energy consumed in the EU is generated from forest biomass (i.e. wood and wood waste). This demand for biomass as energy source has stimulated interest in resuming coppicing of forests that had undergone this management in the past.

Coppice forests are now regarded as cultural heritage features, and with potential as a source of fuel wood as well as being recognised as valuable habitat for many plant and animal species. Despite this restoration by coppicing, particularly of aged, over stood, coppice forests, has proceeded slowly for various reasons. There are broad public concerns over the ecological sustainability fostered by the media’s focus on perceived environmental damage through clear felling. The fact that remnant coppice forests are

[10] Institute of Silviculture, Freiburg, Germany, e-mail: patrick.pyttel@waldbau.uni-freiburg.de
[11] Silviculture and Forest Ecology Temperate Zones, Georg-August-Universität Göttingen, Germany, e-mail: adohren@gwdg.de

often found on sites with low growth potential, such as steep slopes, makes economic justification difficult. The potential to convert over stood coppice stands into high forest has contributed to the current situation. One obstacle to resuming coppicing is the belief, held by some forest managers over stood oak coppice will not re-sprout vigorously enough from the stump to ensure successful regeneration combined with the view that coppicing causes reduction in soil fertility.

Although most of these assumptions lack scientific evidence some doubts are certainly justified. However, the fact that coppicing is the oldest type of regulated forest management can be considered as a clear indicator of its environmental sustainability. Resent research has shown that aged, over stood coppice forest can generally be managed in accordance to the pan-European criteria for a sustainable forest management and that a careful coppice management can preserve valuable and rare tree species such as *Sorbus torminalis* and *Sorbus domestica*. For all forest managers it is necessary to identify the basic situation, from stand to landscape level, at which coppicing is economically justified and needed in order to meet nature conservation goals. It is therefore important to conserve the remaining coppice forests and to continue their sustainable use and management.

Along the big rivers Rhine and Moselle aged coppice forests are dominating the landscape until today.

GREECE

Gavriil Spyroglou[12]

Coppice forests in Greece make up 65% of the forested area and 12% of the whole country (13,200,000 Ha). The main species are oaks (*Quercus* spp.) followed by chestnut (*Castanea sativa*), beech (*Fagus* sp) and the evergreen broadleaves that make up the maquis. Other than chestnut, which can produce good quality wood in coppice rotations, the coppiced forests are characterized by very low growth rates producing very low-value products such as firewood and charcoal. Most are grazed, either legally or illegally, and trees are still being pollarded by farmers and residents who keep a few domestic livestock animals. The aesthetic value is small because of the large clear cut areas created by this management. As a result many of these forests are not serving their required purpose, providing economic (wood production), protective (protection of soil erosion), and aesthetic benefits. However the great contribution of these forests is in mitigating climate change and the fight against global warming.

Coppice silviculture is a purely man-made management system that has been implemented in Europe since Roman times based on the re-sprouting ability of broadleaf tree species. Coppice management was, in the past, the "*child of necessity and easy management solution*" but today it presents numerous ecological and environmental problems which, in the context of sustainable, multifunctional, forest management should be directly addressed by a wide program of conversion to high forest. In Mediterranean environments, coppicing remains importance because, despite the exhaustive logging, uncontrolled grazing and fires, intact ecosystems have been preserved in the coppice forests. Where forests are degraded this is not necessarily linked to coppice management and this practice can contribute to improving both habitats and biodiversity with appropriate management. Other species such as conifers or fast growing species can co-exist in coppices, combining a mixture of trees regenerating from seed and those sprouting from coppice stools.

Conversion of coppice into high forests represents a change in management and can be achieved in two ways. Indirectly, by extending the rotation time so it equates with that of a high forest and managing the coppice stand as if it was of seedling origin. Alternatively this can be achieved directly by changing the species, which usually takes place on very

[12] Forest Research Institute, 57006 Vasilika, Thessaloniki, Greece, e-mail: spyroglou@fri.gr

degraded sites, and is achieved by planting conifers (pines). Coppice conversion in Greece has been going on for more than 90 years with many fluctuations. The current coppice regime is based on the views of the 1950s and earlier. It is therefore appropriate to reconsider it under the current legislative framework, and to develop a new strategic plan for a modern holistic approach that will meet today's challenges.

Mediterranean ecosystems in general and coppice forests in particular, have been used through time not for woody products alone. Non timber forest products such as bark, forage, soil protection, mushrooms, fruits, honey and recreation are important. A critical evaluation of the whole spectrum of uses gives the real value of coppice forests. In this context, the Mediterranean coppice forests contribute to rural development, contribute value with respect to maintaining biodiversity and the economic values associated with this, contribute to ecosystem functions and services and last – but not least – are of considerable cultural importance.

Typical coppice forest in Taxiarchis, Chalkidiki.

IRELAND

Ian Short[13]

This report is regarding coppicing in Ireland and excludes short-rotation coppice of willow (*Salix* spp.) for biomass.

It is unclear whether coppicing and coppice-with-standards were historically important in Ireland. All the known ironmasters in Ireland were Englishmen and were likely familiar with coppicing, which was practiced to ensure a continuous supply of the best charcoal (Neeson, 1991) derived from twenty-five-year-old oak coppice. McCracken (1971) argues that, except in Wicklow County, no such management was carried out in Ireland and that, if it had, the woods could have been preserved. This resulted in ironworks moving from place to place as local fuel supplies became exhausted. However, Rackham (2010) posits that coppice woods could have been present in a large scale at one time because Viking buildings in Dublin were made extensively of wattle and daub. House walls, wooden pathways and property fences would all have been made of woven hurdle panels and would have required vast quantities of long, straight hazel (*Corylus avellana* L.), willow (*Salix* spp.) and ash (*Fraxinus excelsior* L.) rods or underwood (O'Sullivan, 1994). The Civil Survey (1654-6) records "underwood" and "copps" (Tomlinson, 1997), indicating that some form of coppice management was being carried out. The earliest record of coppice management (i.e. rotational felling of underwood in fenced woods) from the Watson-Wentworth estate in County Wicklow was 1698 (Jones, 1986). Young (1780) also mentions coppicing in the accounts of his travels around Ireland in the 18th century, some with forty-year rotations. The coppice-with-standards system was also being employed on some Kilkenny estates early in the 19th century (Tighe, 1802), though this appeared to have decreased in popularity, with some former coppices having been abandoned or neglected by this stage. A survey of County Wicklow woodlands in 1903 demonstrated that the system was still popular there, with almost 60% still being managed as coppice-with-standards (Nisbet, 1904). Attentive landlords would fence copses to protect the regrowth from grazing animals. One of the first laws enacted on forest management was in the 16th century, which required enclosure for four years following coppicing (Bosbeer et al., 2008).

Today there is little coppicing being practiced in Ireland. Anecdotally there are a few owners that have small areas of coppice for household fuelwood production or for producing raw material for crafts and minor products. Some coppicing is also being

[13] Teagasc, Food Research Centre, Ashtown, Dublin, Ireland, e-mail: Ian.Short@Teagasc.ie

practiced with biodiversity and conservation objectives. In a survey of native woodlands conducted during the period 2003 - 2008, 18 % of the sites surveyed had mature coppice whilst only 1% had recently cut coppice (Cross, 2012). Coppicing is not recorded by the National Forest Inventory (Government of Ireland, 2013)

Coppicing is being investigated by the B-SilvRD[14] project as a means to bring poorly-performing pole-stage broadleaf stands into productive use. Coppice-with-standards may also have renewed potential in the current economic climate with high oil prices and increasing demand for fuelwood (Short and Hawe, 2012).

Rehabilitative silviculture coppicing pilot study in pole-stage sycamore (*Acer pseudoplatanus*). The coppice is in its fifth growing season and was initiated when the trees were 15 years old.

References

Bosbeer, S., Denman, H., Hawe, J., Hickie, D., Purser, P. and Walsh, P. 2008. *Review of Forest Policy for the Heritage Council.* May 2008.
http://www.heritagecouncil.ie/fileadmin/user_upload/Publications/Landscape/Forest_Policy_Review_05-08.pdf [Accessed June 2015].

Cross, J. 2012. Ireland's native woodlands: A summary based on the National Survey of Native Woodlands. *Irish Forestry* 69(1&2): 73-95.

Government of Ireland, 2013. *National Forest Inventory – Republic of Ireland – Results. Covering the National Forest Inventory, 2009 to 2012.*
http://www.agriculture.gov.ie/media/migration/forestry/nationalforestinventory/2012/NFI%20Ireland%20Results_v12%20V%20Final.pdf

Jones, M. 1986. Coppice wood management in the eighteenth century: an example from County Wicklow. *Irish Forestry* 43(1): 15-31. McCracken, E. 1971. *The Irish Woods Since Tudor*

[14] Broadleaf Silviculture Research and Development project: www.teagasc.ie/forestry/research/B-SilvRD/

Times: Their Distribution and Exploitation. David and Charles (Publishers) Ltd., Newton Abbot.

Neeson, E. 1991. *A History of Irish Forestry.* The Lilliput Press: Dublin.

Nisbet, J. 1904. *Interim Report Regarding Inspection of Woods and Plantations in County Wicklow. Dublin.* Cited in Carey 2009. *If Trees Could Talk. Wicklow's Trees and Woodlands Over Four Centuries.* COFORD, Dublin. p. 58.

O'Sullivan, A. 1994. Trees, woodland and woodmanship in early Mediaeval Ireland. *Botanical Journal of Scotland* 46(4): 674-681.

Rackham, O. 2010. *Woodlands.* Collins, London.

Short, I. and Hawe, J. 2012. Possible silvicultural systems for use in the rehabilitation of poorly performing broadleaf stands – Coopice-with-standards. *Irish Forestry* 69(1&2):148-166.
http://t-stor.teagasc.ie/handle/11019/317

Tighe, W. 1802. *Statistical Observations Relative to the County of Kilkenny Made in the Years 1800 and 1801.*

Tomlinson, R. 1997. Forests and woodland. In *Atlas of the Irish Rural Landscape*, Eds. Aalen, F.H.A., Whelan, K. and Stout, M., Cork University Press, pp. 122-133.

Young, A. 1780. *A Tour in Ireland: With General Observations of That Kingdom: Made in the Years 1776, 1777, and 1778. And Brought Down to the End of 1779.* Vol. II. 2nd ed. Printed by H. Goldney for T. Cadell, the Strand, London.

ITALY

Francesco Neri[15]

Coppice management is the most common silvicultural system in Italy. Within the approximately 8,500,000 ha of Italian forests the area managed as coppice is about 3,000,000 ha. Coppicing is practised as a clear cut, leaving standards to produce seed for stool replacement, and the most commonly coppiced species are various oaks, chestnut and beech.

Until some 50 years ago management criteria were based on short rotations, removal of all biomass, including deadwood and litter, with occasional introduction of agricultural crops following coppice harvesting and irregular grazing. Since this time coppice has undergone a crisis, leading to reduction in active management, due to major changes in energy sources and labour costs, with some converted to high forest. Harvesting has increased since the 1970s with different exploitation criteria. These include reduction in grazing, longer rotations and with no collection of the minor products. Old forestry practices had a stronger impact on nutrient exploitation than the present method of coppicing. Co-existence of forestry and pastoral activities is somewhere difficult and in some parts of the country wildlife is heavily damaging young shoots and reducing regeneration. Coppice woods satisfy the rural economy; their use requires little investment in machinery and no special professional skills. Vegetative regeneration takes place in a very short time.

Harvesting can be carried on small areas. Coppice does not guarantee satisfactory protection from soil erosion and organic matter loss, and there is no negative impact on the water cycle. Degraded coppices are frequently the outcome of older style exploitation systems, but may also be the result of forest fires. Forest degradation is therefore the result of inappropriate management combined with the peculiarities of a harsh environment. New and old environmental constraints and human activities can locally represent an obstacle to a sustainable management.

Coppice promotes a simplified stand composition and the vegetative propagation causes a 'genetic stagnation'. While this can be useful when environmental conditions are stable, it is potentially dangerous in a dynamic environment. Clear-cuts favour herbaceous vegetation, which is good habitat for wildlife, especially insects. The negative attitude toward coppice in the past was mainly motivated by how it was implemented in a different

[15] University of Florence, Department of Agricultural and Forest Economics, Engineering, Sciences and Technologies, Via S. Bonaventura 13, 50145 Florence, Italy, e-mail: francesco.neri@unifi.it

social, technical and economic context. New exploitation criteria can support coppice management as a sustainable source of energy, an environment rich in biodiversity and a relevant part of the cultural landscape.

The main products from coppice in Italy are: firewood, poles, fencing, sawlogs (chestnut and black locust) and woodchips (produced from logging residue).

Coppice with standards in central Italy.

REPUBLIC OF MACEDONIA

Pande Trajkov[16]

As a result of traditional forest management, combined with the extensive cattle breeding practiced until the middle of 20th century, with cruel environmental conditions, primarily climate, large areas of the forests in the Republic of Macedonia are coppiced and degraded. In previous times the landscape in the lower and middle parts of the mountains mainly comprised coppiced forests. In order to improve condition and prevent further degradation of forests an Act was introduced in 1948 prohibiting the breeding of goats (Nikolovski, 1955). The result was a rapid reduction in the goat population of about 1.2 million. During the second half of the 20th century the recommendation was for coppice to be transformed into high forest (Nikolovski, 1955, 1958 1960, 1964, 1966; Mircevski, 1977, 1989). Direct conversion combined with replacement of tree species was recommended for degraded coppice forests, while the preserved stands were subjected to indirect conversion. The most common species used for re-forestation was black pine. This has a low growth rate on poor sites and suffers damage from the frequent occurrence of forest fires and pests (Trajkov, 2007). This, combined with lack of knowledge about the growth of other species has resulted in the transformation of coppice forests over recent decades applied only in restricted areas.

Today the total area of managed coppice forests is about 618,000 hectares or about 68.5% of the total managed forest. 54,000 hectares of this are shrubs and pseudo-maquis. The coppice forests consist mainly of beech (*Fagus moesiaca)* and several species of oak: sessile (*Quercus petraea),* Hungarian (*Q. conferta),* Turkey (*Q. cerris),* Macedonian (*Q. trojana),* downy (*Q. pubescens)* and kermes *(Q. coccifera*). Several types of hornbeam: the European (*Carpinus betulus),* Oriental (*C. orientalis)* and hop hornbeam (*Ostrya carpinifolia)* as well as maples (*Acer campestre*, *A. monspessulanum*, *A. obtusatum*), manna ash (*Fraxinus ornus*) and aspen (*Populus tremula*), are also found. Oak coppice forests cover a wide range across the vertical distribution of vegetation. As a result of human influence almost all the oak forests occurring up to an altitude of 1100 meters, are coppiced, except for small areas around religious objects or are deep in the mountains far from human settlements. Both beech and oaks stands re-spout well from coppiced stools

[16] Ss Cyril and Methodius University in Skopje, Faculty of Forestry, 16th Makedonska brigada str bb, 1000 Skopje, Republic of Macedonia, e-mail: ptrajkov@sf.uki.edu.mk

until they are very old; these are managed on a rotation of 50 years. The wood from the coppice forests mainly is used as firewood.

As a result of the large coppice resource and despite the continuation of coppicing, there are now over-aged stands, older than 50 years, whose regeneration is debatable. In private coppiced oak forests thinning has been practiced in order to provide continuous annual yield. This approach has led to a reduction in the canopy and emergence of a vigorous understorey that now obstructs transformation to high forest. On the other hand, the reduced number of stools in these stands means that the classic coppice system cannot be applied and economics prevents owners from performing direct transformation. As a result of all these factors oak coppice stands are being quietly transformed into hornbeam and ash stands.

Environmental and political development in the country is increasingly threatening the existence of the coppice system. The public comment negatively on large areas of clear cut near settlements, close to recreation centers or along roads.

Oak coppice stands in the stage of regeneration.

References

Mirċvski, S. 1977. Biostructural relations in the low trunk wood of the beech in Macedonia. Forest Review, No. 3-4, pp.12-26, Skopje (in Macedonian).

Nikolovski, T. 1955. Situation of bushes and guidance for their management. Forest Review, No. 1, Skopje (in Macedonian).
Nikolovski, T. 1958. The forest vegetation types in Dub Mountain near Dojran Lake. Forest Review, No. 5-6, Skopje (in Macedonian).
Nikolovski, T. 1960. The conversions problem of degraded hardwood forest in PR Macedonia. Forest Review, No. 5-6, Skopje (in Macedonian).
Nikolovski, T. 1964. Low incam forest in SFR Yugoslavia and possibilities for transformation into high income ones. Forest Review, No. 3-4, Skopje (in Macedonian).
Nikolovski, T. 1966. Contribution to the results of operation of the ban on keeping goats on the development of forest, soil and moderate erosion. Forest Review, No. 3-4, Skopje, pp. 3-13 (in Macedonian).
Trajkov, P., Kolevska, D.D., Zlatanov, C., and Trajanov, Z. 2007. Growth of artificial black pine (Pinus nigra Arn.) stands established in different climate-vegetation-soil regions in the Republic of Macedonia. Proceedings of International Symposium Sustainable forestry – Problems and challenges, Ohrid October 2007 (in Macedonian).

PORTUGAL

João P. F. Carvalho[17], Helder Viana[18] and Abel Rodrigues[19]

Coppice is a silvicultural system that has been commonly used in Portugal for decades. This produces a range of small and medium sized materials, such as firewood, poles, charcoal, raw material for basketry and cooperage, on short (10 to 30 year) rotations. It is one of the oldest forms of management in semi-natural forests.

Different types of coppicing, with regeneration by stool shoots, has been practiced for many species such as common oak (*Quercus robur*), Pyrenean oak (*Quercus pyrenaica*), Portuguese oak (*Quercus faginea*), holm-oak (*Quercus rotundifolia*), chestnut (*Castanea sativa*), ash (*Fraxinus* spp.), poplar (*Populus* spp.), willow (*Salix* spp.) and eucalyptus (mainly *Eucalyptus globulus*).

While coppicing of some species has declined over the years, eucalyptus coppice has expanded enormously in recent decades grown on 10 to 12 year rotations for pulpwood production. *Eucalyptus globulus* is now dominant over approximately 812 thousand hectares (National Forest Inventory, 2013) and, as this is 23% of the total forested area of the country it is currently the main Portuguese species. Eucalyptus makes up nearly 94 % of the total area in coppice management.

Most of the other formerly coppiced species have been converted into high forest. Most of Common oak (*Q. robur*) occurs as high-forest with coppice retained only in small patches. Pyrenean oak (*Q. pyrenaica*) forests have been improved to high-forest for quality timber production and conservation purposes (Carvalho and Loureiro, 1996). Oak forests are very rich ecosystems and in some regions are important for the survival of rare and threatened plants. Silvicultural practices have been used to improve tree growth and so the production of better quality, larger dimension wood. Portuguese oak (*Q. faginea*) was previously coppiced for firewood and charcoal but nowadays coppicing this species is not common. There are residual patches of holm oak (*Q. rotundifolia*) in the north and center of Portugal maintained to produce firewood and charcoal. In the southern most of holm oak areas are now part of a silvo-pastoral system known as *montado,* where trees and livestock husbandry activities are combined. The majority of chestnut (*Castanea sativa*) is in

---

[17] University Tras-os-Montes Alto Douro, Dep. Forestry, CITAB, PO Box 1013, 5000-501 Vila Real, Portugal, e-mail: jpfc@utad.pt
[18] Escola Superior Agrária, Instituto Politécnico de Viseu. CITAB. PO Box 1014, Quinta da Alagoa-Ranhados, 3500-606 Viseu, Portugal, e-mail: viana.h@gmail.com
[19] INIAV, Lisboa, Portugal, e-mail: abel.rodrigues@iniav.pt

orchards for nut production. Only small areas exist for wood production and there is little coppice.

Coppice rotation for oaks (*Q. faginea*, *Q. pyrenaica* and *Q. robur*) varies between 10 and 30 years, depending on the species, site quality and final tree diameter. Previously coppice had many uses but during recent decades much has been abandoned and converted into high-forest (Carvalho and Loureiro, 1996). Nowadays, only a few oak coppices are maintained for firewood production. In certain areas, it is common to find oaks as small groups and at the edge of fields. Generally they have a secondary production role forming a reserve to meet occasional needs (e.g., firewood, poles). Some of these areas are also managed for biodiversity, conservation and soil protection.

Pollarding may be found in some areas. Traditionally oak (*Quercus spp.)* and ash (*Fraxinus angustifolia*) foliage was cut for cattle feed, in rotations of 2 to 4 years; this is not common nowadays.

As result of the strategy for climate change mitigation and for secure energy supply (European Commission, 2014) European Union members have been implementing projects for energy production from biomass (e.g. Viana et al., 2010). The biomass needed by the power plants will generally be supplied from forest residual biomass, but this can be complemented by short rotation woody crops, specifically grown for their energy value. Coppice systems work well with short rotations to produce wood for energy from species such as willows, poplars, and Eucalyptus; as well as lignocellulosic crops such as reed canary grass (*Miscanthus)* and switch grass. Currently, short-rotation coppices (SRC) to produce raw material for energy purposes are very scarce, but several studies are in progress. According to some evaluations there is a potential for these to be used in Portugal, primarily on abandoned, previously agricultural, (Abel, 2012). These SRC would involve eucalyptus (mostly *E. globulus, E. maideni* and *E. camaldulensis*) and poplar (*Populus x euroamericana* clones) in rotations of 3 to 5 and 2 to 3 years, respectively. Yield may range between 8 and 40 tons dry weight/ha/year for eucalyptus (85% stands between 8 and 30) and 8 to 20 ton dry weight/ha/year for poplar.

Eucalyptus (*E. globulus*) coppice stand in Portugal.

References

Abel, R. 2012. Modelos potenciais de talhdia de curta rotação (SRC) para choupo e eucalipto em Portugal, no contexto do potencial global da biomassa. INIAV, Oeiras.

Carvalho, J. and Loureiro, A. 1996. Stool and root resprouting according to different cutting seasons in a *Quercus pyrenaica* Willd. coppice. *Annali Istituto Sperimentale Selvicoltura* 27: 83-88.

European Commission, 2014. Communication from the Commission to the European Parliament and the Council, The European Economic and Social Committee and the Committee of the Regions. A policy framework for climate and energy in the period from 2020 to 2030. COM(2014) 15 final, Brussels, Belgium.

National Forest Inventory, 2013. Autoridade Florestal Nacional, Lisbon.

Viana, H., Cohen, W.B., Lopes, D., Aranha, J. 2010. Assessment of forest biomass for use as energy. GIS-based analysis of geographical availability and locations of wood-fired power plants in Portugal. Applied Energy 87:2551-2560.

ROMANIA

Valeriu-Norocel Nicolescu[20] and Cornelia Hernea[21]

Coppice forests have always been a major component of Romanian forest land as:

- it is a ”country” of broadleaved tree species, dominated by oaks (e.g., sessile, pedunculate, Turkey, Hungarian, pubescent) and European beech but also including maples, ash, hornbeam, lindens, alders, poplars, willows, etc. Even decreasing in the last two millennia as a result of major human transformations, the share of broadleaves in the national forest land still reaches over 70%.

- the share of rural population of Romania, decreasing strongly since mid-19th century (over 89%) down to about 46% at present, is still one of the highest in Europe.

Before the nationalization of all forests at the end of Second World War and beginning of Communist period, coppice forests have covered important areas in Romania: 1.9 million ha (30 % of forest land) of low coppice in 1948 (Costea, 1989), over 0.229 million ha (3.5 % of forest land) of coppice-with-standards in 1928 (Ionescu, 1930). In 1948, the application of coppice-with-standards was completely forbidden, all coppice forests of this kind being converted towards high forests. Owing to the same process of conversion, the share of low coppice in Romanian forests has continuously decreased so that they currently cover only 5 % of national forest land. According to the current Forest Law (2015), low coppice system can be applied only to native poplars (i.e. black, white) and willows in floodplain area, and black locust forests. Yearly, about 3,500-4,500 ha of low coppice stands are harvested in Romania (www.insse.ro); the maximum size of coppice areas is 3 ha.

The application of coppice forest management in Romania is also possible in the floodplain willow forests, which are pollarded (high coppiced) with a rotation of (15) 20 to 30 (35) years when targeting the production of sawn timber. Logging areas in high coppice stands are located perpendicular to the watercourses, with a size of maximum 10 ha. Rotation of cuttings: annual.

[20] Faculty of Silviculture and Forest Engineering, University ”Transylvania” of Brasov, Sirul Beethoven 1, 500123 Brasov, Romania, e-mail: nvnicolescu@unitbv.ro
[21] Banat's University of Agricultural Sciences and Veterinary Medicine from Timisoara, Calea Aradului no. 119, 300645 Timisoara, Romania, e-mail: corneliahernea@yahoo.com

Since 2005, the application of short rotation coppice management has started in Romania exclusively on agricultural, non-forest land; currently over 800 ha of willow cultures, as well as ca. 1,000 ha of poplar cultures are established.

Coppice forests, mostly of black locust (the species cover over 250,000 ha) are a major supplier of firewood in many rural areas of Romania. They are also important for the protection of river banks (poplars and willows), on sandy soils (black locust), in the honey-related industry, etc.

As about 800,000 ha of Romanian forests, consisting mostly of broadleaved tree species with a high potential of vegetation reproduction, are owned by over 700,000 small forest owners (average size of forest estate 1.1 ha), the management of such lands as high forests as practiced currently owing to the legal requirements is a major challenge in technical and economic terms. Unfortunately there is no political commitment for re-defining their economic/ecological targets and re-converting these forests into low coppices or coppice-with-standards, which affects the ownership rights as well as the freedom to manage them in a more dynamic and profitable way.

Pollards of white willow are a specific feature along the banks of Danube River.

References

Costea, C. 1989. Economia şi conducerea întreprinderilor forestiere. Editura Ceres, Bucureşti, 339 p.

Ionescu, A.I. 1930. Contribuții la studiul culturii și tehnicii crângurilor compuse în România. Revista pădurilor, no. 12, pp. 1256-1282.

www.insse.ro/cms/files/Anuar%20statistic/14/14.Agricultura%20si%20silvicultura_ro.pdf

*** 2015. Codul silvic.

SERBIA

Milun Krstic[22]

The dominant form of silvicultural in Serbia is coppice forests, which make up 1,456,400 ha, or 64.7% of the country's land area, and 50.0% of volume. Most of the coppice forests, 61.4%, are in private ownership. 48% have oak dominant, 25% beech as the principle species. Representation of coppice forests by preservation from their surface is follows: preserved coppice stands with 76.3% over the area; Share of under-stocked coppice stands is 21.3%; devastated coppice stands are 2.4%[23]. Volume per hectare in preserved coppice forests is 133.0 m3/ha; under-stocked 102.7 m3/ha; devastated 42.5 m3/ha. The age structure in the coppice forests is not favourable with the proportion of young, middle-aged and mature being 10:78:12. Coppice forests classified as energy coppice forests are not recorded as such in Serbia. Coppice forests produce a variety of products from small poles, used for fuel, to larger timbers and similar.

The forestry silvicultural methods used are those close considered close to nature, in other words promoting permanently sustainable and economically justified activities limited and conditioned by natural processes. Selection and application of suitable silvicultural or ameliorative methods depend on the precise degree of forest degradation (production, quality, condition, composition, origin, etc.) and the habitat and site conditions (the degree of degradation of soil, etc.), based on scientific criteria.

Precise silvicultural measures appropriate for application to coppice are divided into the following basic groups:

- Quality coppice forests of valuable tree species and preserved habitat - *Indirect conversion* into high forest. Young stands are extensively cultivated in the respective stages of development; at maturity they shall be naturally regenerated. According to Forest Law harvesting cannot take place before the trees are 80 years old.
- Where forests have been degraded then *direct conversion* processes should be applied, with the land preserved and the degraded forests removed. Amelioration is carried out either by artificial restoration of the same species (restitution) or, where

[22] University of Belgrade, Faculty of Forestry, Kneza Viseslava 1, 11030 Belgrade, Serbia, e-mail: milun.krstic@sfb.bg.ac.rs

[23] Current forests state in Serbia. National Forest Inventory (NFI) – Presentation 2009, Belgrade (in Serbian).

stands and habitats are degraded, then appropriate species of trees that can grow successfully in such habitat conditions is carried out (substitution).

- Where stands are unequally degraded over the site area then the amelioration procedures of indirect methods of conversion, restitution and substitution, can be combined.

References

Aleksić P., Krstić M., Milić S., 2011. Silvicultural needs and measures aimed the realization of the national forest action program of the Republic of Serbia. First Serbian forestry congress – future with forest. Belgrade, Republic of Serbia, November 11-13. University of Belgrade, Faculty of Forestry, Belgrade. Congress Proceedings, pp. 87-96.

Krstić M., Stojanović LJ., Rakonjac Lj., 2010. The tasks of siviculture in regard to the curent climate shange. International Scientific Conference "Forest ecosystems and climate changes". Institute of Forestry, Belgrade, March 9-10th, Plenary lectures, pp. 117-130.

Typical coppice situation.

SLOVAKIA

Alexander Fehér[24]

The extent of coppice forests in Slovakia is 34,463 ha (1.8 %) and 76,216 ha (3.9 %) in the first generation on conversion to high forest (according to the Country Act nr. 453/2006, § 19). The area of traditional coppice is decreasing due to conversion to high forest (in 1920 there was 208,438 ha).

Species used in diferent types of coppice are *Quercus cerris, Quercus petraea* agg., *Carpinus betulus, Fagus sylvatica* and *Robinia pseudoacacia.* The most accepted coppice management is coppice-with-standards. Rotation of *Quercus* coppice stands is 20 to 40 years, the cutting season in winter. Pollarding was historically common, but is now only carried out by individuals and this is usually illegal and mostly practiced with *Salix*, although previously both *Morus* and *Robinia* were pollarded. In the 19th century oaks were pollarded in the Upper Nitra region.

Short rotation coppice is a new challenge. The total area of SRC on Slovakian forest land is 520 ha, although the potential area is 15,000 ha. The anticipated annual production is10 t per ha dry matter. According to estimates by the National Forest Centre the theoretical potential for SRC on agricultural land is 45,000 ha, although currently there is only about 150 ha on agricultural land. The main tree species used in SRC are *Salix* and *Populus*. Rotation time is three (*Salix*) to twenty (*Populus*) years, with expected annual yield 12 to18 t fresh biomass per hectare (6 to10 t dry matter under good conditions and management).

The Slovak legislation does not include coppicing in future plans but there is no clear regulation of coppice management.

After beech, oaks are the most important deciduous woodland trees in Slovakia but restoring oak stands is more difficult than restoring beech forests. Oak forests are unstable and the abundance fluctuates depending on human activities. Coppicing usually increases plant diversity. Oak stands are light-demanding (if there are no clearings created, the oak seedling die in the shade) and without traditional coppicing, which prevented full canopy closure and so the dominance of shade-demanding species, the oaks decline. Hornbeam, which is more shade tolerant, can proliferate creating a shrub layer under the oak storey and suppress oak seedlings. In places where foresters remove hornbeam as 'weed' tree, forests were light and this led to a vigorous herb layer with weeds, grasses and shrubs,

[24] Slovak University of Agriculture, Dept of Sustainable Development, Marianska 10, SK-949 76 Nitra, Slovakia, e-mail: Alexander.Feher@uniag.sk

and these also prevented effective natural regeneration of oak from seed. Therefore, the best way to support the oak is by coppicing but this requires further study to provide evidence to counteract currently fashionable views and opinions; these are not always based on facts. Reduction of oak cover was also caused historically by the planting or spontaneous growth of other, often invasive species, especially *Robinia pseudoacacia*.

Coppice forests are considered an important part of the landscape pattern, require protection and the NATURA 2000 areas include 10 coppice forest types (91G0*, 91H0*, 91I0*, 91M0, 9170, 9180*, 9110, 9130, 9140, 9150) although the 'best practice' manuals do not recommend future coppicing, except for habitat 9180*. In the context of nature conservation, decision making is a challenge. It is unclear whether forests should be preserved by less intensive management, although this risks oak decline as well as the light demanding components of the herbaceous layer or, alternatively, whether forests should be managed more intensively, even in protected areas, so there would be more light and so the rare (and often protected) species would be retained. Drier areas require a simple management with thinning, wetter forests require more frequent management.

Planting new black locust (*Robinia pseudoacacia)* forests is prohibited. This plant was registered on the official list of invasive plant species in 2011 but has now been has now been removed from the list (Announcement of the Ministry of Environment SR Nr. 158/2014).

Coppice forest: *Quercus petraea* and *Q. dalechampii* at Nitra (SW Slovakia) (photo: Alexander Feher).

SOUTH AFRICA

Keith M Little[25]

Within South Africa, the forestry sector contributes 1.2% to the Gross Domestic Product of the country. Of the total land area, about 1.1% (1.275 million ha) is planted as exotic plantation forests, with less than 0.9% occupied by indigenous forests. The main tree species planted for commercial purposes include pines (51%), eucalypts (42%) and wattle (7%) which supply timber products (sawlogs, veneer, pulpwood, mining timber, poles, matchwood, charcoal and firewood) to both the local and export markets.

Most of the plantation forests are located along the eastern seaboard of South Africa, where various eucalypts and/or their hybrid combinations are matched to the site conditions. *Eucalyptus nitens*, *E. macarthurii* and *E. smithii* are planted in the cooler temperate regions, *E. grandis*, *E. dunnii* and *E. grandis* x *E. nitens* in the warmer temperate regions and *E. grandis* x *E. urophylla* in the sub-tropical regions. These eucalypts are grown over short rotations (typically 8 to10 years), predominantly for pulpwood production, and to a lesser extent mining timber. Intensive silvicultural regimes are practised to maximise production volume, with mean annual increments ranging from 15 to 60 m^3 ha^{-1} $annum^{-1}$, dependent on site quality. Although eucalypts are planted at various inter- and intra-row distances, the target density at felling age is 1,300 to 1,600 sph.

One of the notable attributes of eucalypt species is their ability to survive and produce new growth following adverse environmental conditions, and this is largely a function of their bud systems being able to coppice. This survival mechanism is exploited in commercial plantations for re-establishment following felling, where the coppice shoots are selectively thinned over time and managed as a coppice stand for the production of pulpwood.

Previous research on coppice management in South Africa focused primarily on optimising the number of stems remaining on the stump, and on the effects of frequency and timing of reduction (or thinning) of the shoots on timber volume and properties. This produced robust recommendations which are still used today, and state that coppice should be reduced in two operations: first to two or three stems per stump when the dominant shoot height is 3-4 m, and later to the original stocking when the dominant shoot height is 7- 8 m.

[25] Nelson Mandela Metropolitan University, George Campus, Private Bag X6531, 6530 George, South Africa, e-mail: Keith.Little@nmmu.ac.za

Dependent on a number of factors, eucalypt stands may be coppiced once, or a maximum of twice, before being replanted. Decisions on whether to replant or coppice include determining whether the:

- correct species is growing on the site (for example is the species the best in terms of potential yield, genetic improvement, disease resistance, drought tolerance, frost and snow tolerance ?),
- trees were planted at the correct spacing (matching stand density to site productivity),
- stocking of the originally planted stand when harvested is adequate, or if there is high tree mortality?
- planted species have the ability to coppice?

Current challenges in terms of coppice management centre mainly around issues associated with increased mechanisation of forest operations, and the incidence of pests and disease. Until recently, South Africa made extensive use of manual labour for both silvicultural and motor-manual harvesting operations. Planting densities (especially between tree spatial arrangements), thinning (reduction) operations, and the remaining number of stems per hectare (based on manual operations), will need to be optimised for mechanisation. This will ensure that the currently higher harvesting costs associated with felling coppiced stands is optimised. The impact of recently introduced pests and disease into South Africa has meant many susceptible eucalypts have been replaced with more resistant, alternative eucalypts and/or hybrid combinations. The coppicing potential and subsequent silvicultural management of these eucalypts will need to be tested.

A coppiced stand of six-year-old *Eucalyptus grandis* x *E. camaldulensis* clones in the sub-tropical region of Zululand, South Africa.

SPAIN

Míriam Piqué[26] and Pau Vericat[27]

Coppicing has been widely applied for centuries to almost all hardwood species with re-sprouting ability in Spain. Several coppice methods and rotations have been used in order to obtain a wide range of products, depending on the species. Coppice was the most usual management to obtain fuelwood, charcoal and tannins, medium sized saw wood (e.g. staves, poles, stakes) or rods for basketry. Pollarding was also applied to some species in order to combine grazing with fuelwood production, and to obtain fodder from the branches.

The rotation length used for coppices in Spain varies widely depending on geographic areas, dominant species, type of coppice, site quality and desired characteristics of the products. The most usual rotation is around 30 years (between 20 and 40), but shorter rotations were not unusual, especially for pollards.

Coppice forests in Spain cover around 4 million ha, which constitutes around 50% of the total area covered by spontaneous hardwood, and more than 20% of the total forest area. The most important species are *Quercus*, mainly *Quercus Ilex* and *Quercus pyrenaica*. Since 1950 coppice forest management has been gradually abandoned all across Spain and, at present, only particular species and regions still maintain a significant use of coppices (e.g. *Quercus ilex* in the North East, *Quercus pyrenaica* in the North West and *Castanea sativa* in the North of Spain).

Because of this general abandonment all current coppices have exceeded the usual age of rotation, most of them doubling that age. The excessive density of these abandoned coppices, combined with much of the photo synthetically derived energy being used to maintain the significant underground biomass, has caused a reduction in growth and loss of vitality.

The main emerging risks are related to global change. In this context, abandoned coppices are very vulnerable to water stress and forest fires, both great threats to Mediterranean forests. In addition low seed production and reduced gene flow can compromise the ability to adapt to new scenarios. Furthermore, the dense and homogeneous stands resulting from abandonment become simplified in terms of structure and specific composition, and so tend to be very unfavourable from the viewpoint of biodiversity.

[26] Forest Technological Center of Catalonia (CTFC), Solsona, Spain, e-mail: miriam.pique@ctfc.es
[27] Forest Technological Center of Catalonia (CTFC), Solsona, Spain, e-mail: pau.vericat@ctfc.es

Finally, some specific types of coppice, such as pollarding of beech or ash, are very interesting from their historical, social and environmental values, and are at risk of disappearing,

So, in general, the priority is to recover the management of the large area of abandoned coppice in order to ensure the provision of economic, environmental and social services. For this, it will be necessary to reintroduce the traditional management, enhancing this when necessary, or using other silvicultural approaches such as conversion, where it is economically, environmentally, and socially sustainable. Integrating fire prevention and improved habitat conditions is an imperative in all cases.

A major challenge is to improve the profitability of management and exploitation. The current scenario of increased demand for biomass as an energy source is favourable in this respect. Finally, social awareness is also needed to facilitate the acceptance of coppice management, which involves clear felling in many cases.

Major areas of research on Mediterranean coppices in Spain are:

- Silviculture: developing, assessing and transferring new management alternatives is a priority to achieve a real multi-functional management. Improving harvesting techniques;
- Ecology and dynamics of Mediterranean coppice forests;
- Eco-physiology of coppiced species and relationship of this to silvicultural practices and ecological conditions (carbon balance, stump lifespan, re-sprouting ability in relation with age/size of regrowth);
- Seedling regeneration and genetics of coppice systems, in order to understand the effects and the long term sustainability of the coppice system.

***Quercus ilex* and *Quercus suber* uneven-aged coppice with standards in Catalonia, Spain.**

SWEDEN

Ioannis Dimitriou[28], Magnus Löf[29], Tomas Nordfjell[30] and Martin Weih[31]

In Sweden there are limited areas where traditional coppice forest management has been applied. Coppice with standards does not exist in Sweden and the national statistical authority of Sweden (Forest Statistics - Riksskogstaxeringen) does not even register these types of forest. The same concern regarding recording applies to pollards, although there are several sites in Sweden, and recent restoration of pasture with pollarded trees of *Tilia cordata, Sorbus aucuparia* (mountain ash), *Fraxinus excelsior*, alder (*Alnus* sp.), aspen (*Populus tremula*), willow (*Salix* sp.), poplar (*Populus* sp.).

There are a number of sites of simple (low) coppice managed forest in the South (Scania) and in the mountainous areas of Sweden, however these are not very extensive (as compared to 'conventional' forestry). The species used for simple coppice are alder (*Alnus* sp.), birch (*Betula* sp.), aspen (*Populus tremula*), willow (*Salix* sp.), poplar (*Populus* sp.). Forest statistics (Riksskogstaxeringen) do not record these types of forests which is indicatively of the status and condition of coppice forest management in the country.

The most common coppice system in Sweden is willow (*Salix* sp.) short rotation coppice system used to produce biomass for energy. Today, approximately 11,500 ha of this are being grown. Willow cultivation is fully mechanized, from planting to harvest. In the initial phase approximately 12,000 cuttings per hectare are planted in double rows, to facilitate future weeding, fertilization and harvesting. Conventional inorganic fertilizers have commonly been applied in the years following planting. The willows are harvested every three to five years, during winter when the soil is frozen, using specially designed machines. The above-ground biomass is chipped on-site, and then stored or directly burned in combined heat and power plants. After harvest, the plants re-sprout vigorously, and replanting is not therefore necessary. The estimated economic lifespan of a short-rotation willow coppice stand is between 20 and 25 years. Average yields from commercial

[28] Swedish University of Agricultural Sciences (SLU), Department of Crop Production Ecology, Ullsväg 16, 75007 Uppsala, Sweden, e-mail: Ioannis.Dimitriou@slu.se
[29] Swedish University of Agricultural Sciences (SLU), Box 49, 230 53 Alnarp, Sweden, e-mail: magnus.lof@ess.slu.se
[30] Swedish University of Agricultural Sciences (SLU), Department of Forest Resource Management, Skogsmarksgränd 1, SE-901 83 Umeå, Sweden, e-mail: tomas.nordfjell@slu.se
[31] Swedish University of Agricultural Sciences (SLU), PO Box 7043, 75007 Uppsala, Sweden, e-mail: martin.weih@slu.se

SRC willow plantations in Sweden are between 6-10 tons dry matter per hectare each year.

There is an increased interest in using willow SRC in phyto-remediation systems to clean soils from, for example heavy metals, especially Cadmium, and waste water that is nutrient-rich. Several plantations have been established specifically for these purposes. At the same time, there is an interest for coppice plantations designed to promote biodiversity (such as birds and wild game) and this can also be a reason for implementing willow coppice systems.

The ambition for future coppice sites in Sweden is to consider how new forms of production can be designed to produce biomass for energy and also enhance biodiversity, landscape diversity and cultural values. It is important to incorporate new ideas on modifying coppiced stands to meet current needs and designing systems that will satisfy societies requirements in an economic, environmental and energy efficient way. Trees in, for example, urban forests, urban environments, corridors under power line corridors as well as strips within 5 to 7 meters of forest roads and agricultural fields, should all be seen as a resource. Production systems could be designed so that they fulfill the requirements mentioned above. Some specific thinning regimes dense young stands, around 5 to 7 m in height, might be considered as a relevant ‘coppice approach’ to forestry.

SWITZERLAND

Josephine Cueni[32] and Patrick Pyttel[33]

As in many other European countries coppice forests with and without standards were brought to Switzerland by the Romans around four centuries B.C. Over centuries both forest types have been characteristic elements of the Swiss landscape. Due to socio-economic changes most coppice forests, both with and without standards, were abandoned or converted into high forests during the 19th century (Schuler et al., 2000; Meier, 2007; Imesch et al., 2015).

Today coppice forests (excluding coppice with standards) cover 35.000 ha and 2.8% of the total Swiss forest area (Abegg et al., 2014). The majority of the remaining coppice forests were last harvested between 1959 and 1963. Today these forests show slow growth (ca. 5.6 m^3 ha^{-1} a^{-1}), low mean annual harvesting rates (0.5 m^3 ha^{-1} a^{-1}) and increasing dead wood volumes (ca. 1/3 of the annual increment; Abegg et al., 2014; Häfner et al., 2011). They occur in all regions of Switzerland (Jura, Midland, Pre-Alps, Alps, South), although the majority are located south of the Alps (20% of total regional forest area; Abegg et al., 2014). Most are found on fertile sites and at elevations ranging from <600 m to 1000 m. Coppice forests in and to the north of the Swiss Alps are dominated by beech, oak, ash and alder. In southern Switzerland, sweet chestnut is the main tree species (Bachofen et al., 1988).

Due to the prevailing orography, protection is a key role of Swiss forests. Around 16.900 ha or 66% of all coppice forests in Switzerland are located in the area of protection forests. In the Alps and in southern Switzerland 71% and 86% respectively of all coppice forests serve as protection forests (Abegg et al., 2014). This management type is thought to be suitable for this function under only for certain circumstances, i.e. only: where slopes are short (<75 m), and rocks likely to fall are less than 40 cms diameter (Frehner et al., 2005; Gerber and Elsner, 1998). Consequently coppicing is not suitable in the majority of protection forests and (the naturally occurring) conversion of coppice stands into high forest is welcomed (Frehner et al., 2005).

Since 1991 the Swiss Government has offered monetary incentives for the supply and use of fuel wood (BUWAL, 2005). Within this context the resumption of coppicing and the need for short rotation plantations has been the subject of controversy (Schmidt et al., 2008;

32 Pro Natura, Basel, Switzerland, e-mail: josephine.cueni@pronatura.ch
33 Chair of Silviculture, University of Freiburg, Germany, e-mail: patrick.pyttel@waldbau.uni-freiburg.de

Zimmermann, 2010). Since regional fuel wood needs can be satisfied by day-to-day forest management and because of concerns regarding landscape esthetics, coppice forests and short rotation plantations are not considered important for fuel wood (Oettli et al., 2004; Meier, 2007; Ansprach and Roesch, 2014). The Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) has investigated the economic potential of chestnut coppice forests for valuable wood production (e.g. Zingg and Giudici, 2006) and there are some innovative enterprises that are trying to market assorted products form over-aged coppice forests (Castagnostyle 2015, online).

The Swiss Ministry of Environment (BAFU) considers coppice forests (with and without standards) as valuable forest types important for biodiversity, culture and history. The ministry promotes the preservation of these by paying subsidies for restoration and tending of coppice forest with and without standards (4000.-CHF ha^{-1} per intervention; Imesch et al., 2015; BAFU, 2011). Between 2004/06 and 2009/13 re-coppicing occurred on 400 ha (Abegg et al., 2014). To date between 600 and 700 ha of simple coppice and 400 to 800 ha of coppice with standards were designated parts of forest reserves (WSL, 2015). It can be assumed that these forests are being - or will be - managed traditionally (WSL, 2015). Some of them also serve as study sites for the WSL (e.g. Rothenfluh BL; WSL, online).

To conclude, few previously coppiced forests continue to be managed in this way. The exceptions are some study sides and as parts of some forest reserves. The unsuitability of coppice for protection forest and the production of enough fuel wood as by product of day-to-day forest management do not encourage the continuation of this ancient management system. There is probably more managed coppice, both simple and with standards in the context of nature conservation and the preservation of cultural historical landscapes. It is possible that increasing fuel wood prices will encourage more coppicing in the future.

References

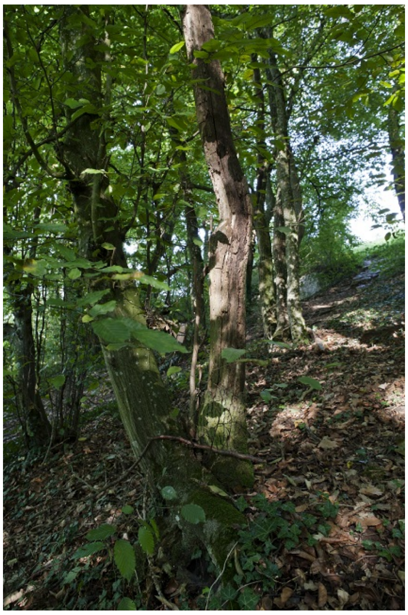
Abegg, M.; Brändli, U.-B.; Cioldi, F.; Fischer, C.; Herold-Bonardi, A.; Huber M.; Keller, M.; Meile, R.; Rösler, E.; Speich, S.; Traub, B.; Vidondo, B. 2014. Fourth national forest inventory - result tables and maps on the Internet for the NFI 2009-2013 (NFI4b). [Published online 06.11.2014] Available from World Wide Web <http://www.lfi.ch/resultate/>. Birmensdorf, Eidg. Forschungsanstalt WSL.

Ansprach, V.; Roesch, A. 2014. Wirtschaftlichkeit der Energieholzproduktion durch Kurzumtriebsplantagen in der Schweiz. GEWISOLA 2014. Poster Anlässlich der 54. Jahrestagung der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues e.V. „ Neue Theorien und Methoden in den Wirtschafts- und Sozialwissenschaften des Landbaus“.

Bachofen, H., Brändli, U.-B., Brassel, P., Kasper, H., Lüscher, P., Mahrer, F., Riegger, W., Stierlin, H.-R., Strobel, T., Sutter, R., Wenger, C., Winzeler, K., Zingg, A. 1988. Schweizerisches Landesforstinventar. Ergebnisse der Erstaufnahme 1982-1986. Eidgenössissche Anstalt für das forstliche Versuchswesen. Bundesamt für Forstwesen und Landschaftsschutz, Bern, 375 p.

BAFU (Bundesamt für Umwelt) (Hrsg.) 2011. Handbuch Programmvereinbarungen im Umweltbereich. Mitteilung des BAFU als Vollzugsbehörde an Gesuchsteller. Bundesamt für Umwelt, Bern. Umwelt-Vollzug Nr. 1105: 222 S.BUWAL (Bundesamt für Umwelt, Wald und Landschaft) (Hrsg.) (2005): Waldbericht 2005 – Zahlen und Fakten zum Zustand des Schweizer Waldes. Bern, Bundesamt für

Umwelt, Wald und Landschaft; Birmensdorf, Eidg. Forschungsanstalt für Wald, Schnee und Landschaft, 152S.
Castagnostyle, online 2015. Accessed 29.6. 2015 over: www.castagnostyle.ch
Frehner, M., Wasser, B., Schwitter, R. 2005. Nachhaltigkeit und Erfolgskontrolle im Schutzwald. Wegleitung für Pflegemassnahmen in Wäldern mit Schutzfunktion, Vollzug Umwelt. Bundesamt für Umwelt (BAFU), Wald und Landschaft, Bern. 564 p.
Gerber, C., Elsener, O. 1998. Geeignet oder nicht geeignet? Niederwaldbetrieb im Steinschlaggebiet. Mittelungen aus dem Gebirgswald. Wald und Holz 14:8-11.
Häfner, R.; Hug, U.; Gordon, R.; Bettelini, D.; Hess, H. 2011. Das Schweizerische Landesforstinventar aus Sicht einiger Kantone (Essay). Schweizerische Zeitschrift für Forstwesen 162:282-289.
Imesch, N.; Stadler, B.; Bolliger, M.; Schneider, O. 2015. Biodiversität im Wald: Ziele und Massnahmen. Vollzugshilfe zur Erhaltung und Förderung der biologischen Vielfalt im Schweizer Wald. Bundesamt für Umwelt, Bern. Umwelt-Vollzug Nr. 1503: 186S.
Meier, U. 2007. Die Rolle des Energieholzes in der Waldpolitik beider Basel (Essay). Schweizerische Zeitschrift für Forstwesen 158 (7):201-205.
Meier, U. 2015. Personal communication. 17th June 2015.
Oettli, B., Blum, M., Peter, M., Schwank, O., Bedniaguine, D., Dauriat, A., Gnansounou, E., Chételat, J., Golay, F., Hersnere, J.-L., Meier, U., Schleiss, K. 2004. Potentiale zur energetischen Nutzung von Biomasse in der Schweiz. Forschungsprogramm Energiewirtschaftliche Grundlagen. Bundesamt für Energie (BFE), Bern, 293 p.
Schuler, A., Bürgi, M., Fischer, W. und Hürlimann, K. 2000. Wald- und Forstgeschichte. Skript zur Vorlesung 60-316. ETH, Eidgenössische Technische Hochschule Zürich, Departement Forstwissenschaften, Professur für Forsteinrichtung und Waldwachstum, Arbeitsbereich Wald- und Forstgeschichte. http://e-collection.ethbib.ethz.ch/view/eth:28539
WSL 2015. Schweizerisches Landesforstinventar LFI. Spezialauswertung von Daten der Erhebungen 2004-06 (LFI3) und 2009-13 (LFI4b). Urs-Beat Brändli 17.6.2015. Eidg. Forschungsanstalt WSL, Birmensdorf.
WSL, online: Brennholz produzieren und Biodiversität fördern. Last update: 15.9.2011. Accessed on the 30th of June.
Zimmermann, N.E. 2010. Biodiversität im Zeichen des Klimawandels. Hotspot (21): S.18-19.
Zingg, A., Giudici, F. 2006. Wertholzproduktion mit Kastanien-Niederwald. Versuchsanlage und erste Ergebnisse. DVFF – Sektion Ertragskunde, Jahrestagung 2005.



Aged coppice forest on steep slopes in the Untersiggenthal, canton of Aargau. Fotos: Pro Natura, Christoph Oeschger.

TURKEY

Halil Barış ÖZEL[34]

There are 21.7 million hectares of forest in Turkey, 20.4% of this is coppice. These coppice forests are distributed in the Marmara, Aegean, and the Western and Eastern Black Sea Regions of Turkey. These coppice forests have an estimated total volume of 69.9 million cubic meters and a mean annual increment of 3.4 million cubic meters. The main coppice product is firewood in Turkey, especially in rural villages. The coppice forests are damaged by fire, storm and snow but there are no risk assessments for them. The coppice forests are comprised of *Fagus orientalis, Sorbus torminalis, Sorbus domestica, Alnus glutinosa, Acer pseudoplatanus, Robinia pseudoacacia, Carpinus orientalis, Carpinus betulus, Platanus orientalis, Quercus petraea* and *Quercus robur.*

There are coppice forests on the north and northwest slopes and on the 500-650m altitude gradient level. The productivity is generally very low but the highest volume increment is found for *Fagus orientalis, Alnus, Salix, Platanus and Populus* coppice near rivers as gallery forests type. *Buxus* coppice is used for hand-made kitchenware, but this coppice type is currently in a degraded state.

There is no breeding programme for coppice forests undertaken by the General Directorate of Forests in Turkey. The public forest service wants to convert all current coppice to high forests. But this is not a successful conservation measure and is adding to the area of degraded coppice forest annually. There is potential for coppice forests to be used for energy but there have not been any studies on this subject; specific clones would be required. Coppice forests near rivers are damaged because of water pollution in Turkey. This caused the destruction of about 500 hectares of *Platanus* coppice forest between 2008 and 2014.

Coppice forest vegetation is continually being destroyed. Research has shown that about 130 plant species have been lost from the coppice forest resource in Turkey. Coppice is necessary for the long-term productivity of the forest but breeding and silviculture planning is required. Protected stands to be converted to coppice forests should be properly identified in Turkey. Coppice forests should be protected for ecology as the ecological balance has been damaged over a long period of both legal and illegal harvesting.

---

[34] University of Bartın, Faculty of Forestry, Department of Silviculture, Bartın, Turkey, e-mail: halilbarisozel@yahoo.com

Castanea sativa **coppice in Turkey.**