International Forest Fire News (IFFN) No. 30 (January – June 2004, 2-13)

# The Use of Prescribed Fire in the Land Management of Western and Baltic Europe: An Overview


## Abstract

In the history of land use in Western and Baltic Europe fire has been an important element in forestry, agriculture, hunting and pastoralism. The use of fire has shaped landscape patterns that have high ecological and cultural diversity, e.g. heathlands, open grasslands, meadows, and swidden (shifting) agriculture sites. In the Nordic countries and Scotland historic natural fires caused by lightning and human-made fires have also significantly influenced the composition and structure of forest ecosystems.

The rapid socio-economic changes in the post-World War II Europe led also to a change of land-use systems and landscape patterns, resulting in elimination of traditional burning practises. Due to new air quality standards and a generally prevailing opinion that fire would damage ecosystem stability and biodiversity, government administrations imposed fire bans in most European countries. During the second half of the 20th century traditional fire use in land management survived in a few places only, such as in heathland management in the United Kingdom or in Finland's forestry.

In the 1970s it became increasingly evident that the abandonment of traditional land-use methods resulted in the elimination of the disturbance events that shaped many valuable landscape types and ecosystems. Changing paradigms in ecology and nature conservation are leading to the reconsideration of fire-exclusion policies in certain land management sectors, including: nature conservation, hunting, forestry and landscape management. A number of prescribed burning research projects throughout Western and Baltic Europe and a revival of traditional burning practices indicate a restoration of the functional role of fire in the management of ecosystems and landscapes.

The paper provides a short overview of a number of case studies from Scotland, Germany, the Netherlands and the Nordic countries and the ongoing process of intra-regional co-operation in the frame of the European Fire in Nature Conservation Network. The individual articles in the following provide more detailed and updated information from projects.


## Introduction

The landscape and habitats of Western and Baltic Europe have historically been extensively modified to increase agricultural, forestry, and hunting outputs from the land (Pyne 1997, Goldammer 1998, 2000). Fire has often been a key land management tool that has both prepared the land and maintained it in production. The landscapes of today are therefore largely cultural creations underpinned by the economic and technical capabilities of the people who managed the land. The structural diversity of these fire influenced landscapes and habitats has also allowed significant biodiversity interests to develop over time. The land management influences most closely associated with burning are mowing and grazing. Agricultural systems that involved burning were often only sustainable as long as population growth did not push practitioners towards fire return intervals that were too short to allow the vegetation to recover. When soils became impoverished political strife was often the result.

Political, economic, social and technical influences have changed burning practises over time (Pyne 1997, Bruce 2002). Initially fire was used to develop new land for production. Ancient Norse terms such as *landnam* and *swidden* described the primary development of land for agricultural purposes or for the maintenance of pastoral landscapes. Generally fire practises are part of the oral tradition of land management. Many traditional fire practises continued into the first half of the 20th century.

After World War II the threat of hunger drove agricultural policy throughout Europe towards maximising outputs. This policy drive was supported by research and training in modern agricultural systems. Forestry systems also received similar development support. This support stimulated a rapid uptake of new technology (machinery) and an increasing reliance on external inputs to production systems in the

form of fuel for machinery, fertilisers, herbicides and pesticides. Agricultural, forestry and hunting research has historically tended to avoid fire research as a subject area as it is often associated with damaging wildfires. Fire science, fire ecology and prescribed burning are therefore relatively new terms for land managers in Europe although the underlying concepts have been applied in a traditional way in some cases for thousands of years.

**Figure 1.** Superficial peatland burning for cultivation in Frisia (Northwest Germany) around 1900. Source: Freilichtmuseum am Kiekeberg, Harburg County, Germany.


**Figure 2.** Prescribed burning for regeneration of *Calluna* heather, Randbøl Hede (Denmark), around 1900. Source: GFMC Archive (postcard).

Currently both economic and quality of life issues have an increasing influence on fire practises. Due to increased productive capacity and a gradual opening up of markets and reductions in production subsidies, agriculture in Europe is in recession. Marginal land, often with remnant semi-natural vegetation, is being used less intensively or even abandoned. Similarly in forestry there is an over-supply of growing timber in Europe amounting to some 180 million $m^3$ per annum (UN-ECE/FAO1996). Urban populations have also driven a political desire to conserve habitats and species, to have higher air quality standards and to support the increasing use of rural areas for recreation by largely urban populations. Conversely traditional rural activities and societies have never been under more pressure and are contracting rapidly as a result. Along with the decline and changes in rural economies and societies traditional fire practises are under pressure. The new ideas embedded in prescribed burning concepts often implemented to support nature conservation and landscape management objectives are allowing fire practises to develop once more.

Traditional burning practises that are used to support hunting (grouse moor management), most evident in the United Kingdom, are also gradually changing. Empirically based fire modelling research is also being conducted in a number of countries, including the United Kingdom and Germany. Traditionally burning was often a shared activity between neighbours or it drew on other resources within land management units. There are fewer people with appropriate fire knowledge in rural areas to share the task now. The people left are generally older and less prepared to take the risks of wildfires occurring due to escapes. Insurance is becoming more expensive to obtain and so the use of fire is being constrained in many areas due to the significant resource requirements and financial costs. There is a need to increase the productivity of practitioners by implementing training initiatives and developing a professional prescribed burning skill base. Technical developments and research are also expanding the window of opportunity for burning and helping fire suppression efforts (Murgatroid 2002).

**Figure 3.** Slash-and-burn agriculture in Finland in the second half of the 19th Century. Painting by Eero Järnefelt (1873): “Raatajat rahanalaiset”. Exhibition of painting: Ateneum, Helsinki, Finland.

**Figure 4.** Slash-and-burn agriculture ("Reutebrennen") in the Black Forest, Germany, in the second half of the 19th Century. Source: GFMC archive (unknown contemporary newspaper).

It is also being increasingly recognised that both the cultural and natural heritage of many areas needs the intervention of prescribed fire to mimic disturbance events and maintain open and diverse habitats and landscapes. There are now prescribed burning projects in many of the countries of Western and Baltic Europe supporting a wide variety of land management objectives using a variety of techniques. Information on the work being carried out in the United Kingdom, Netherlands, Germany, Sweden and Finland are given later in this paper. The European Fire in Nature Conservation Network (EFNCN) website is an important focus for discussion (EFNCN 2004).

**Climate, Biotypes and Fire Weather**

The main climatic influences on Western Europe are latitude, distance from the Atlantic Ocean, topography and the warm oceanic current known as the Gulf Stream. In terms of fire weather the main variations are a rainfall gradient with high rainfall in the west and low rainfall in the east and a

temperature gradient from low in the north to high in the south. Wind direction is predominately west to east, i.e. from the Atlantic into the drier continental landmass.

Within this general continental scale view there are regional and local variations. For example areas close to the Atlantic but east of mountain ranges or on the eastern side of islands or peninsula's have significantly lower rainfall than the more western facing mountain ranges (Bruce 2002). Also high-pressure anti-cyclonic systems do develop and create dry air conditions for significant periods. There is generally sufficient rain and warmth for vegetation to grow vigorously throughout the area.

The biotypes range from the Arctic associations in the north and at altitude through the boreal zone covering much of Scandinavia to the temperate zone in Germany. Vegetation types are also influenced by soils and other influences such as grazing regimes. Seasonal changes to fuel types also occur with significant quantities of dead fine fuels created over-winter in the form of grasses, heather and other shrub fuels. The litter layer tends to contribute to available fuels only in droughts or in the drier areas of the eastern boreal and temperate zones.

All parts of Western Europe and the Baltic area can suffer droughts. The period of drought that has an impact on fire hazards and risks depends on fuel types and sizes. So short droughts in the spring before the vegetation has started growing can create extreme fire hazards and risks in a short period of time in grass and heather areas. The effect of reduced grazing pressures creating fine fuels, seasonal curing, drought and multiple ignition sources can be seen in the significant number of large fires that occurred this spring in the United Kingdom.

A common feature of nature reserves and national parks throughout Europe is the cultural influence that man has made on these landscapes (Pyne 1997). Often these reserves are small or have been established in remote areas where soils are poor and the remaining rural populations and land use activities are weak economically, politically and socially. The land is therefore relatively cheap to acquire. Military training areas often use similar areas for similar reasons. Many of the biological and landscape features that are now desired as outputs from these areas are in some ways dependent on the preceding land management activities. The gradual loss of the traditional rural communities using traditional burning activities puts many of the conservation interests at risk as well. Prescribed fire may have an important role in maintaining at low cost some of the most important features of these landscapes.

**Prescribed Fire**

The Food and Agriculture Organization of the United Nations (FAO 2003) defines prescribed burning as:

> *"Controlled application of fire to vegetation in either their natural or modified state, under specified environmental conditions which allow the fire to be confined to a predetermined area and at the same time to produce the intensity of heat and rate of spread required to attain planned resource management objectives".*

Often habitats gradually atrophy with a build up of over-mature or semi-decomposed material. To maintain an area in its most productive state or to maintain a full range of species in an area may require intervention by burning. Burning is a disturbance event that allows ecological processes to change. It can be used to either maintain a larger area in a similar condition for example to aid a pastoral system or it can be used on a smaller scale to create a more diverse habitat structure.

The main land management objectives that burning can be used to support include:

- To create firebreaks
- To reduce fuel loads
- To break-in new agricultural land
- To improve grazing, especially the early bite
- To remove surface vegetation, the top litter layer and / or the encroachment of bush and trees to aid the natural regeneration of plant species endangered by succession
- To remove branches and other slash, post tree-felling and prior to re-planting
- To improve habitat mosaics for insects, birds, deer and other wildlife
- To provide a natural fertilization of the ground

- To maintain open cultural landscapes
- To preserve examples of culturally important agricultural systems

The list could easily be made longer but each of the following prescribed burning case studies are trying to achieve some or all of the above land management objectives.

**United Kingdom**

The United Kingdom lies mainly in the oceanic climate zone but there are elements of the sub-arctic communities at higher altitudes in Scotland along with areas in the boreal and temperate zones further south and east. Rainfall also varies significantly between the wet west and the drier east.

Traditional burning techniques are used extensively for habitat management for Red Grouse *(Lagopus lagopus scoticus)* (Miller and Watson 1973, Hudson 1992), an upland game bird that lives in heather *(Calluna vulgaris).* This use of the land developed significantly in the 19th century on the back of the incredible wealth created during the Industrial Revolution in Britain. A lot of this wealth was re-circulated back into the countryside by wealthy individuals buying estates and then managing these estates as hunting reserves. This continues to the present day. Fire is also used extensively to regenerate grazing land for cattle, sheep and deer. In forests, fire is used to clear branches or heather from sites as a ground preparation tool prior to forest establishment by planting or natural regeneration. Firebreaks are also sometimes created alongside forests by burning. Fire is used occasionally on farmland in Scotland to burn straw, a practise that has been stopped in England and Wales. Prescribed burning is used more frequently on private land than on publicly owned land (Bruce 2002). The continuous use of fire by shepherds and gamekeepers provides a continuous cultural link back to swidden practises used when the land was originally brought in to production thousands of years ago.

Fire hazards are increasing in some areas where there is insufficient heather burning. Also where new native pinewoods are being created to fulfil bio-diversity objectives, heather is growing along with the regenerating trees. Heather and grass fuel loads are increasing due to a reduction in grazing pressures caused by the rationalisation of upland farms and pressure from environmental interests and the government to reduce wild deer populations (Deer Commission 2001). The cull of animals during the outbreak of foot and mouth disease in 2002 also contributed to fuel driven fires this spring. Heather also returns to some pine and larch forests after thinning. There has also been a reduction in staff available for heather burning operations due to economic pressures (Hudson 1992). Countering the reduction in available labour resources has been a continuing investment by landowners in fire suppression equipment used for burning operations in the form of all terrain vehicles with small tanks and very high pressure low volume fire fogging systems attached (Bruce 2002).

There have been recent developments with new occupational standards (Lantra 2002) agreed both for heather burning and forest and moorland fire fighting. New best practise guidance (SEERAD 2001) has been developed to support heather burning as well. Training courses are being developed to develop the new skills that are required. Research into appropriate Fire Danger Rating systems and fire behaviour models for the United Kingdom is on-going. Recent research has shown that heather fires in Scotland can produce fire intensities up to 15,000 kW/m. Such high fire intensities have health and safety implications (Bruce and Servant 2003).

Prescribed burning to improve the habitat of the woodland grouse, the Capercaillie (*Tetrao urugallis*), has started. Areas of pinewoods where heather growth is suppressing blueberry *(Vaccinium myrtillus)* under the pine tree canopy are being burnt. Initial results indicate successful regeneration of blueberry is occurring. No pine trees were killed by initial crown scorch. A fire prescription for this work is gradually being developed using a mixture of American, Australian and European (Rheinhard and Ryan 1988, Wade 1986, AFAC 1996, Uggla 1973, Sirén 1973) material as a basis that will be interpreted along with the results of the monitoring work.

See also contribution" Prescribed Fire in a Scottish Pinewood: a Summary of Recent Research at Glen Tanar Estate, Aberdeenshire" in this issue.

**Netherlands**

The Netherlands lies on the border between the oceanic and temperate zones. The main interest in prescribed fire in the Netherlands is on nature reserves and military training areas. Most of the areas

with semi-natural vegetation is owned by the state (Van der Ven 1973). Over 40% of semi-natural vegetation in the country is heathland. The main objectives are to conserve particular heathland plant species *(Arnica montana)*, black grouse and certain insects (Van der Zee, this volume). Burning is allowed only in the winter and is carried out in dry conditions with low wind speeds. Permission must be obtained from local communities and fire brigades prior to burning. Ignition patterns depend first on whether a deeper slower up-wind fire is desired or a faster down-wind surface fire is the aim. Fire control is maintained by burning within cut control lines and fire suppression support is given by fire brigade units provided by the military.

**Germany**

Germany lies mainly in the temperate zone. Dry lightning does occur occasionally (Goldammer 2000). The main natural vegetation type is deciduous woodland. However there are extensive areas of poor sandy soils where pine would have been the predominate species. It is on the poorer soils that heathland developed largely from man's historic fire interventions. These areas are becoming recolonised by secondary succession.

A few years ago burning was completely banned in Germany. Other techniques such as "Plaggen" or sod-cutting were used to conserve heathlands (Prüter et al., this volume) but these are very expensive techniques. Now a variety of prescribed burning projects are underway. These vary from heathland restoration projects where the grasses and heather are burned to maintain biodiversity, culturally important swidden agricultural sites, open areas in vineyards and open landscapes in tourism areas. A key feature of the all the projects is extensive consultation with stakeholders.

Heathland restoration work using prescribed burning is occurring at: Schleswig-Holstein (Hoffmann and Goldammer, this volume), Lower Saxony (Niemeyer, this volume), Lüneburg (Prüter et al., this volume), and at Lausitz in Brandenburg (Plettenberg et al., this volume). The latter project also has the objective of improving Black Grouse habitat. Grassland and pasture restoration using prescribed fire is occurring at Baden-Württemberg (Page 2000, Schreiber, this volume). A UNESCO World Heritage site in the Middle-Rhine Valley is also treated by prescribed burning (Bonn 2002).

In many areas on steep slopes or on poor soils where agriculture is no longer profitable, such as in Baden-Württemberg the farmland has been abandoned allowing secondary succession to scrub and forest. A number of endangered species have become threatened by this change in habitat and there is a need for secondary disturbance mechanism, such as prescribed fire.

Some long term studies such as at Diepholz in Lower Saxony have shown that prescribed burning in the winter has allowed better nutrient cycling, higher quality feed, a reduction in vegetation height that has helped birds, insects and reptiles.

The unique open landscapes of the wine growing areas in the middle of the Rhine valley, developed over centuries, are under threat from economic changes that are reducing the area of vines under cultivation. Along with this reduction of viticulture is a reduction in associated grazing. As land is laid fallow secondary succession to shrub woodland is gradually dominating this unique World Heritage Site. The species that are dependent on the open xerothermic habitats are being lost. Prescribed burning techniques are being used on the steep slopes to maintain the more open habitats. High intensity upslope fires are being used with some success.

In general the results of the projects are indicating that bio-diversity is stable or increasing after the prescribed burning interventions. They are also achieving most of their direct objectives of heathland regeneration or the maintenance of open landscapes at reasonable cost. Operationally the burns have been successful coping with a variety of fire behaviour including some high fire intensities. Other fire modelling research is being carried out.

**Sweden**

Sweden lies mainly in the boreal zone, with Scots Pine the main species. Fire has been a key agent shaping the structure of this largely forested country. The term for the type of traditional slash and burn agricultural system developed here was "svedjebruk"(Pyne 1997). However since the early 1800's Swedish land use interests have been dominated by industrial forestry. The road network used to support timber extraction and efficient fire suppression systems have restricted the area of forest burnt to between 300 - 5,000 hectares per annum. In the past it is estimated that the fire return interval was

58 years when 1.7% of the forest burned annually. The level of burning today is a fraction of this (Niklasson and Granström, this volume).

The absence of fire has pushed several hundred of fire-adapted and fire-requiring species, predominantly invertebrates, from being common to being rare or even extinct in the country. A few of these species are strictly dependent on fire *per se* while the major part of this group depend on structures and processes that fire events provided in the past such as: openness and sun-exposure, dead wood, damaged trees with lowered vitality, fire scars and burnt ground. Another strongly negative effect of the combination of intensive forestry and fire suppression is the lack of seral stages dominated by deciduous trees such as *Betula, Populus* and *Salix.* The reproduction from seeds of *Populus* and *Salix* is strongly promoted by fires and is now a rather rare event. The flagship species white-backed woodpecker *Dendrocopus leucotos* is now on the verge of extinction in Sweden as it has been confined to older deciduous dominated forest, typically created by fire. Only a hundred years ago this bird was common all over the country.

Burning was used extensively between 1950 – 1970 when around 10,000 hectares was burnt annually. The objective of this burning was to prepare the forest floor for natural regeneration in areas that had been clear felled. The gradual mechanisation of the forest industry reduced labour availability and at the same time labour costs grew rapidly so the practise stopped.

More recently Swedish industrial forestry has been coming under increasing pressure both economically and from the environmental movement. The awareness about fire has increased dramatically among foresters and public but this interest has not yet been turned into action when it comes to using prescribed fire as a tool. The structures, substrates and effects of fire has influenced the design of alternative management regimes. For example. The Swedish Forestry Stewardship Council (FSC) certification scheme indicates that 5% of felled areas must now be burnt. This level of burning has not been achieved. This is largely due to a lack of practitioners, anxiety over the risk of escapes, and a lack of resources.

Fire research in Sweden is mainly concentrated in Umeå University in the north of Sweden with studies on succession, fire behaviour, fire history. plant-plant interactions ecosystem functioning and paleoecology. Uppsala University has a strong tradition in entomology. In southern Sweden, some paleoecological research has been done and fire history studies have just started along with some pilot studies in fire behaviour and flammability. A lot of the research in other fields of ecology can be ascribed to fire or has fire a common denominator.

**Finland**

Finland lies in the boreal zone. The landscape is dominated by pine and spruce forests. It was not always so. According to pollen analysis, slash-and-burn swidden agriculture started in eastern Finland about 2000 years ago. It was estimated that about 4,000,000 hectares of forest land was affected by the slash-and-burn agriculture by the end of 19$^{th}$ century. By the beginning of the 20th century, some 50 to 75 percent of Finland's forest area had been exploited in this manner. In the eastern part of Finland, shifting cultivation was practised longer and more intensively than anywhere else in the country. Industrial forestry however became increasingly important and in the 1929 burning was restricted (Sirén 1973, Goldammer 1998).

With the end of the era of shifting cultivation in the early part of this century, methods derived from this practice began to find use in the regeneration of under-productive forests. Burning of logging waste and the raw humus layer was recommended as a means of promoting the natural restocking of regeneration sites. Broadcast-seeding-on-snow in spring, with prescribed burning preceding it, found widespread use in the 1920s. Prescribed burning in those times amounted to approx. 8,000 ha per year. With time, however, this method's popularity declined; in the 1930s, the annual area burnt in this manner was only a few hundred hectares a year.

Prescribed burning enjoyed a comeback after World War II and the peak of over 30,000 ha was reached in the mid-1950s. This was because the displacement of people from areas of Karelia annexed by the Soviet Union, created a need for new farmland to be created. It was also useful in assisting with the regeneration of northern Finland's spruce stands to pine, characterised by their thick layer of raw humus. However, this prescribed burning's second coming came to an end in the latter half of the 1960s when it was replaced by mechanized site preparation. The area annually treated fell to 500-1000 ha a year and stayed at that level up to the recent past.

The reasons behind the decline in prescribed burning have primarily been technical. The success of prescribed burning depends on weather conditions and this leads to difficulties in organising the operation. The risk of fire getting out of control, the increasing popularity of mechanised site preparation, the risk of nutrients being leached from the soil, and the increased risk for fungal or insect epidemics in the dense young pine stands are the most common forest regeneration problems associated with prescribed burning.

The cultural importance of burning in Finland is very significant (Pyne 1997). The eastern part of Finland was one of the last areas where the slash-and-burn agriculture was carried out in Europe. The Koli national park in eastern Finland was established in 1991 where there are still many deciduous mixed forests and slash-and-burn meadows (in Finnish: aho) on burned sites in the park. In addition, there are stone constructions related to slash-and-burn culture still visible in the old slash-and-burn sites (Lovén and Ääismaa, this volume).

Since the year 1994, every year a small area ranging from 0.3 to 2.5 ha of forest has been cut down and traditionally burned and cultivated to maintain the cultural tradition. Other objectives include creating a better habitat for endangered species that require fire sites and meadow sites. There is also an extensive information programme for the project. So far more than 5 hectares has been managed by the slash-and-burn activities. In the future, the slash-and-burn activities will be extended in the national park using up to 150 hectares. Constraints on the prescribed fire activities include the conservation of old growth forest, mixed forests with high bio-diversity, distance from heritage dwellings and the resources required for burning operations. Another goal is to make it possible to practise different slash-and-burn methods with local people to maintain the cultural heritage and to avoid political controversies extensive consultations have been made with stakeholders.

**Discussion**

It is said that the seeds of failure are sown in success and the swings in the use of fire in land management in Western and Baltic Europe have been significant. There have been periods when fire has been used skilfully and sustainably. There have been other periods, when often due to excessive population growth, fire has been used too intensively and ecological damage has resulted.

The rise of “rational“ thinking in the Enlightenment from the 18th century led to an emphasis on manurial systems rather than fire based systems of agricultural fertilisation in most of Europe. Fire was regarded at best as a necessary evil. The rise of input dominated production systems further drew land management away from the use of fire except in pastoral or hunting areas. Some use of prescribed fire continued as part of forestry practise. Politically fire was not popular. The potentially positive ecological value of fire was rarely considered.

There has also always been an economic and a technical influence on the use of fire. It has a cost and it has extensive risks. In some places it has a positive influence and in other situations a negative influence. With the upsurge in interest in heritage issues, both ecological and cultural, over the last 30 years there has been a gradual re-evaluation of the role of fire. Sometimes this has produced a constraining influence such as in the production of Best Practise Guidance in the United Kingdom. In other parts of Western and Baltic Europe where the use of fire had all but died out some of the positive uses of fire are being re-established. A key difference in approach from the past are the extensive consultations that are carried out with stakeholders, especially environmental organisations, at different levels in society.

Practical safety issues relating to the build up of fuel loads, especially fine fuel loads, have yet to be addressed by policy makers. There will always be ignition sources and this leads to significant fire seasons occurring when there are droughts such as happened in the spring of 2003 in the United Kingdom.

**Conclusions**

The history of the use of fire in land management provokes mixed reactions, usually a negative one, from people who are not closely associated with the need for fire. The development of the full panoply of support systems for prescribed burning such as: fire ecology, fire science, fire models, fire danger rating systems and modern fire suppression systems has been slower than in more fire prone and fire adapted parts of the world such as Australia, the USA and Canada but progress is now being made.

Prescribed fire is developing a new language and framework that will support a better dialogue between stakeholders and a more targeted use of fire in the management of land in many parts of Western and Baltic Europe. The key benefits of the developing European Fire in Nature Conservation Network is the improvement in communication between people managing similar bio-types in similar climates bridging the old barriers of language and culture. The improved dialogue and the new prescribed fire projects will also help to inform policy makers about the factors that influence fire behaviour and consequent fire effects. Thereby hopefully leading to the creation of a more sustainable policy framework for prescribed fire in Western and Baltic Europe.

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