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Fire Science

From Chemistry to
Landscape Management

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Case Study 13.1 (continued)

which contain continuous fuels, can be burnt under mild weather conditions in spring or autumn without burning the rock outcrop habitats.

For almost 60 years, prescribed burning has been used in southwestern Australia forests to achieve multiple objectives, supported by applied research into fire behavior and fire ecology, and resulting in a significant reduction in the areal extent of bushfires and bushfire losses without loss of biodiversity or environmental damage. This has been achieved by understanding the role of fire in these environments, by understanding fire behavior and by understanding the importance of continuing with wise anthropogenic planned burning, which commenced with the arrival of Noongar people thousands of years ago. In recent times, prescribed burning has been achieved by good planning, a skilled and adequately resourced workforce, political and community support, and ongoing investment in applied fire research. Climate variability, population growth, air quality concerns, and land-use and use legacies and land use changes present ongoing challenges for forest fire managers to maintain an effective prescribed burning program that protects communities and the environment from damaging wildfires into the future.

13.2.2 *Conserving Biodiversity Using Integrated Fire Management*

Fire is widely used to conserve biological diversity. In the eastern Pyrenees (Case Study 13.2), Eric Rigolot and Bernard Lambert explain how prescribed fires have been instrumental in managing vegetation and fuels with broad implications for biodiversity and social values. In Kruger National Park in South Africa, fires are managed for habitat for the large charismatic animals, the species, and the landscape diversity of the vegetation (Case Study 13.3). There, the lessons learned from long-term experiments using fire at different intervals and seasons have informed integrated fire management. In both areas, scientists have been engaged in assessing and informing the burning program. The landscape scale of these case studies is impressive and necessary for accomplishing long-term ecological, fire management, and social goals.

Case Study 13.2 Prescribed Burning: An Integrated Management Tool Meeting Many Needs in the Pyrénées-Orientales Region in France

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(continued)

Case Study 13.2 (continued)**The Practice of Pastoral Fires in the Pyrenees**

For thousands of years across the entire Pyrenees mountain range, humankind's relationship with the environment has been closely associated with fire. According to the Greek historian Diodorus Siculus, the very name of Pyrenees would come from the Greek *Pyros*, which means fire. Cutting and then burning forests for agriculture and grazing has been carried out for at least several 1000 years, including regular pastoral fires on rangelands encroached with trees and shrubs, burning wood in forges and charcoal kilns, wildfires of various origins, often of low intensity until the middle of the twentieth century but then more devastating in the modern era (Métailié 1981). The use of fire for agricultural, pastoral, and industrial purposes involved highly elaborate methods integrated into a coherent agri-silvi-pastoral system.

Since its creation in the seventeenth century, the French forestry commission has sought to control pastoral fires in order to conserve timber and forests. However, along the last century, the socio-economic decline in the mountainous area and the resulting shrub encroachment led to a significant change in fire-related practices. At the same time, the administrative framework, initially supportive of these agri-pastoral fires, gradually turned against pastoral burning.

Consequently, pastoral society was confronted with a dual dilemma. First, once-grassy areas used for grazing were gradually becoming overgrown by shrubs and trees due to the decline of pastoralism and farming and many areas were purposefully reforested by the national Forest Service. The *breeder-gatherers* needed to reopen their pastoral areas threatened with closure when shrublands grew. The second dilemma was to find a solution to uncontrolled pastoral burns that regularly escalated into wildfires.

Unable to suppress the fires and limit the ecological, economic, and social impacts of changing lands, farmers and herders wished to reintroduce burning practices. This involved setting up an institutional structure to help farmers take back ownership of fire so they could use fire while carefully managing its ecological and social effects. It was in this context that the first institutional European experiment supporting the use of fire by rural communities was carried out in the easternmost part of the French Pyrenees.

The Pyrénées-Orientales Region in France

The Pyrénées-Orientales region (Fig. 13.4) comprises vast wildlands formed at the end of the nineteenth century as land uses changed and many people moved away from rural lands, which allowed a gradual invasion of shrubs and trees (Fig. 13.5). Roura (2002) found that area in grasslands and prairies declined by 70% from 1953 to 2000 as they were replaced by forests and heathland dominated by *Cytisus oromediterraneus*. Today, the biodiver-

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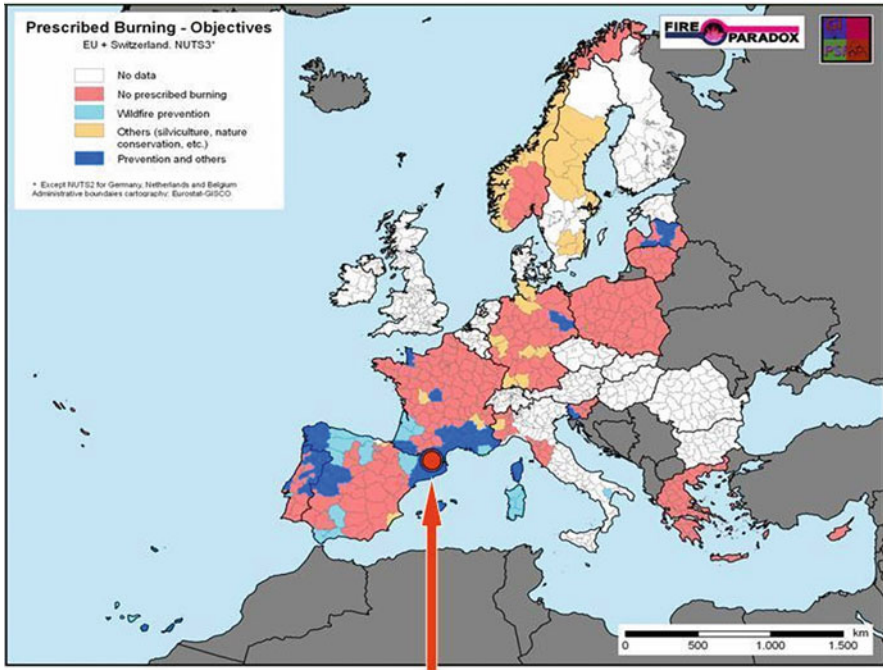


Fig. 13.4 Location of the Pyrénées-Orientales region at the eastern extremity of the Pyrenees mountain range (*arrow and red dot*). This map shows the type of prescribed burning objectives in Europe following the Nomenclature of Territorial Units for Statistics 3 scale. (Adapted from Lazaro and Montiel 2010)

Case Study 13.2 (continued)

sity of the open grasslands of these Mediterranean mountains is threatened and shrub encroachment constitutes a formidable source of fuel favouring large fires.

Agri-silvi-pastoral activities have always been the matrix of biological diversity in open areas, as well as contributing to the diversity of the landscapes in this French region, which extends over a wide altitudinal gradient from sea level to 2921 m, thus presenting a wide range of environments of major interest for their cultural and biological heritage. This region is home to 12 natural habitats of European interest including three priority ones, and a quarter of the heritage flora of the Catalan Pyrenees. Moreover, among the heritage vertebrate fauna, 40% of nesting birds use these open and semi-open habitats to breed. Regulatory measures aimed at protecting the environment are now gaining increased public support locally and nationally.

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Fig. 13.5 In many areas, grasslands have been invaded by shrubs and trees such as broom (*Cytisus oromediterraneus*) and mugho pine (*Pinus mugo*). (Photograph by B Lambert)

Case Study 13.2 (continued)

The invasion by shrubs and trees coupled with the decline in traditional uses for pastoral, agricultural, forest, and hunting purposes, these vast spaces have also seen their social functions diversify with the explosion of nature-related tourist activities. At the crossroads of uses and expectations, many farmers, shepherds, foresters, fire fighting services, and “environmentalists” have joined forces to invent a common use of fire in order to satisfy new social demands in these culturally important and biodiverse environments.

Creation and Purpose of the Prescribed Burning Unit

To this end, an action research initiative was set up between 1984 and 1987 to pool the efforts of the scientific community and the agricultural profession to “relearn” fire control and the response of ecosystems. This experimental pilot programme totalizing on the whole 150 ha, comprised ten plots of land reflecting the diversity of the heathland and rangelands in the fire-sensitive

(continued)

Case Study 13.2 (continued)

area. Given the positive results of the initial trials and the increasing demand for pastoral fires by farmers, in autumn 1986, the agricultural profession and the local authorities decided to support the creation of the first prescribed burning unit in France to be project managed by the agricultural profession (Lambert 2010). The unit is a departmental entity run by a pastoral agency, with active participation of national forest service personnel over the first 10 years, then replaced by local fire fighters, with support from time to time by national military units of civil protection. In this part of the Pyrenees, local beneficiaries do not participate directly in prescribed burns, but can achieve safety fuel-breaks beforehand.

The aims of the Pyrénées-Orientales' prescribed burning unit were to (1) train and raise the awareness of farmers on the use of fire, (2) possibly replace them to perform pastoral burnings that were difficult to control, (3) carry out, as a priority, burnings in areas susceptible to major fires, (4) provide training to departmental fire fighters, as well as national reinforcements, (5) provide a training school for future bosses of prescribed burning units, (6) add burning to the range of tools used to manage heritage species, including grey partridge (*Perdix perdix*) and Pyrenean chamois (*Rupicapra rupicapra*), and natural habitats of European interest, (7) ensure technical exchanges with Spanish fire fighters in the framework of the European programme and, in particular, the Generalitat of Catalonia, and Vila Réal University in Portugal, and, since 2006, (8) train local fire fighters in the use of backing fire techniques for wildfire suppression.

Scientific Support to Meet Multi-Functional Objectives

The prescribed burning unit came about in close collaboration with the research community. Since the winter of 1984/1985, the pastoral improvement programme on the use of fire was created with the Inra Ecodevelopment Research group of Avignon, the first experimental burning operations were supervised by the Cemagref of Aix en Provence (now INRAE) following a visit to North America, and monitoring vegetation as temperature measurements thanks to the Cnrs-Cefe experiment carried out in the Montpellier heathland. Later, information collected from each site was compiled and organised by Inra (now INRAE) Ecology of Mediterranean Forest research group (URFM) as part of the European FireTorch programme (Botelho et al. 2002).

This long-term collaboration made it possible to demonstrate the effects of repeated burnings on heathland dynamics in order to determine the most appropriate management scenarios and the most relevant development indicators (Rigolot et al. 1998) and to redefine the use of fire in technical sequences to manage pastoral environments in the Mediterranean mountains. The impacts of prescribed burning on fauna were analysed, as well as the benefits

(continued)

Case Study 13.2 (continued)

of using fire to conserve the habitats of birds (Pons et al. 2003) and the management of game birds. The relationships between institutional uses (prescribed burning) and traditional fires (pastoral fires) were analysed (Fernandes et al. 2013).

After 30 years of operation of the Pyrénées-Orientales' prescribed burning unit, an audit was conducted by an independent research group following a request from the administration to identify the main points of success from an organisational point of view and to report any threats to the system's sustainability (Métailié et al. 2017).

Strong Points of the Prescribed Burning Unit

The Pyrénées-Orientales' prescribed burning unit plays a key role in maintaining rangeland resources and open landscapes. For 32 years, the unit annually treated between 600 and 1200 ha (40–80 plots of land) totaling 26,000 ha and participating in the maintenance of 14% of the 120,000 ha of areas used for livestock grazing (Fig. 13.6). The size of the plots of land varies

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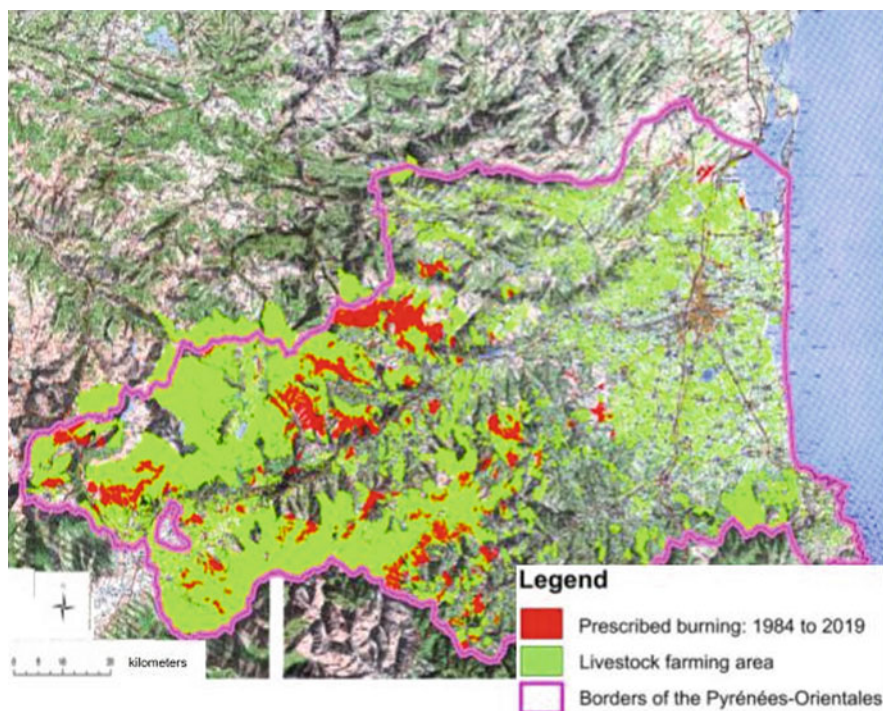


Fig. 13.6 Map of the livestock farming area in the Pyrénées-Orientales (120,000 ha) and zones treated using prescribed burning between 1984 and 2019. (Map made by B Lambert)

Case Study 13.2 (continued)

between 0.5 and 179 ha with an average size of 9 ha. The prescribed burning projects are split evenly between the fire-sensitive Mediterranean area and the montane and subalpine zones.

Prescribed burning is now recognised as a tool that promotes biodiversity. Managers frequently combine prescribed burning with mechanical or other techniques to achieve vegetation management and social goals. Increasingly, fire is perceived by scientists and managers of natural areas as an integral part of the evolutionary cycle of certain ecosystems. Managers use fire in technical sequences and specify the appropriate regime for each context. Mosaic burning comprising burned patches of a few acres to one hectare, carried out in several phases over one or more seasons, has become standard practice in the upper heathlands of the Pyrénées-Orientales (Rigolot et al. 1998).

The extensive practice of prescribed burning in the Pyrénées-Orientales has also been a success in terms of suppressing wildland fires. Thanks to prescribed burning practices, we have observed a strong decline in fires of a pastoral origin since the 1990s. In addition to contributing to fuel management, prescribed burning also acts on the causes of forest fires. Prescribed burning now receives institutional recognition via a body of laws and regulations, as well as being accompanied by a well-established training programme. Fire fighters implementing prescribed burning follow a highly effective training programme, which they put into practice fighting forest fires and, in particular, by familiarising themselves with suppression fire practices. Fire fighters working in the Pyrénées-Orientales, thanks to their high levels of involvement and regular practice of burning in the winter, since 2004 have been systematically using backing fires during the local summer wildfire suppression campaigns, as well as supporting their colleagues elsewhere in France and Catalonia, and even Sweden in the summer of 2018.

The systematic recording of costs on prescribed burning intervention worksheets shows that these costs are acceptable. The least expensive operations are those carried out in pre-mountainous areas (i.e., in non-wooded heathland) where the estimated costs are between €50 and €100/ha. Forest fire prevention operations carried out in wooded areas are generally more expensive costing between €100 and €600/ha compared to €800 to €2400/ha for mechanical clearing and €2000–€4000 for manual clearing. Therefore, prescribed burning, as carried out by the Pyrénées-Orientales prescribed burning unit, is economically viable.

The prescribed burning unit is led by the Pyrénées-Orientales' livestock breeding society, a professional organisation that ensures that fires are properly used. Their work includes consultations with a large number of local, regional, and even cross-border partners to develop recommendations and guidelines suitable for all stakeholders. With the aim of greater transparency

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Case Study 13.2 (continued)

and to reach a wider audience, a real-time information website has been developed (www.risque-incendie.com).

Due to its seniority, the Pyrénées-Orientales' prescribed burning unit is a reference not only in the pastoral network of the Pyrenees mountain range but also at the national level where it has acted as a facilitator of the national prescribed burning network for 15 years (Lambert 2010).

Weaknesses and Threats

Despite this success, the programme faces climatic and social pressures (Rigolot and Lambert 2017). Increasingly variable weather conditions require greater responsiveness and high levels of professionalism: after years of logistics implementation (1987–1989) followed by a long period of consolidation (1990–2002), recent trends show a marked shortening in the periods suitable for prescribed burning due to climate change. With a late autumn season that is too dry and too hot, the most favourable winter period is between the end of January and the beginning of March (the campaign period is now under 30 days compared to over 70 days in the 1990s). Faced with increasingly volatile and unpredictable weather patterns, it is necessary to demonstrate increasing levels of professionalism and responsiveness to take advantage of these unpredictable time windows. This means adopting a strategy that is both flexible in terms of its implementation and its ability to carry out several simultaneous operations during these increasingly short time windows.

The demand for more consultations has led to a reduction in the size of the worksites. Burning prescriptions are now the domain of a more complex and larger group of stakeholders compared to the erstwhile forester/farmer. This means lengthier consultations, increasingly complex specifications, more limited burning practices, and increased higher costs.

Social acceptance of prescribed burning has always been challenging, even more so today as opposition to this practice by urban groups is growing. Excellent results in terms of fire prevention have led to a loss of awareness on the risks of these new urban groups. These groups increasingly dominate local commissions and municipal councils, and pressure elected officials to reject practices they consider unsightly, a source of dissatisfaction for holidaymakers who get dirty, and which some see as being dangerous, inefficient, responsible for erosion, deforestation and, more recently, air pollution. This last point is of particular sensitivity during high-pressure conditions in and around populated areas on the plain and the coast, including ski resorts. The sharp drop in the number of wildfire areas in recent years is reducing the motivation of elected officials to support prescribed burning. While objectively the risk of wildfire remains, elected officials, faced with significantly improved annual reports, are tempted to support less prescribed burning thus reducing public funding. Public funding currently provides more than 75% of

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Case Study 13.2 (continued)

the operating costs of the unit, which is around €100,000 per annum and per 1000 ha treated.

Conclusion

Prescribed burning has reached a crossroads in the Pyrénées-Orientales. Over 30 years of development supported by scientific research have resulted in an effective technical and organisation model. It has achieved the dual objectives of controlling wildfires due to poor pastoral burning practices and meeting farmers' needs in terms of maintaining and renewing the pastoral resources. But is it really efficient? The per-hectare financial and human resources required for operations are high. However, the strictly agronomic and forest fire prevention points of view are only a partial vision of the benefits of integrated fire management in this area. Maintaining wildlife habitats, strengthening fire fighters' skills through prescribed burning practice, maintaining mountain landscapes and supporting the remaining farmers in these rural communities are positive outcomes that should be better evaluated from an environmental, social and economic point of view in order to give a full picture of the efficiency of prescribed burning in the Pyrénées-Orientales region. While biotechnological research is still required in some areas, notably into combustion management to ensure better smoke control, the social science and humanities research is needed to continue improving integrated fire management this Mediterranean mountain region. Ultimately, political science must inform public decision-making in terms of the inevitable trade-offs that exist between risk management and the multiple uses of mountainous areas and nature conservation.

Case Study 13.3 Integrated Fire Management in Kruger National Park

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African savannas are driven by fluctuations in rainfall, herbivory, nutrients and fires (Sankaran et al. 2005). In Africa and the Kruger National Park (KNP), fires are ignited by people, whether on purpose or accidentally, and by lightning (Archibald et al. 2009). Lightning fires are less common and usually do not burn large expanses of natural veld (van Wilgen 2009). The fauna and flora in these fire-prone ecosystems have co-evolved with fire, resulting in a resilient fire-adapted system with many fire-adapted plant species (Bond and Keeley 2005). In southern Africa, people have been using and controlling fires to manipulate their environment for thousands of years.

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