Learning and Training on the Use of Prescribed Burning Techniques

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undesirable understory, especially in pine forests" to prevent wildfires. Similar examples were found in France, in the second half of the 19th century, and the long history of the different cycles on the use of prescribed burning in forestry, including the recent cooperation between Europe and the USA was described in the documentary "Fire in the Balance" (Manso et al. 2008) produced by Fire Paradox and shown at the 20th anniversary of the Yellowstone Fires.

In the most recent decades the use of prescribed burning for the reduction of wildfire hazard in Portugal, Spain and France has importantly increased, with some valuable efforts focused on operational training for prescribed burning.

The first attempts to promote training in prescribed burning for fire prevention in European forests date from the 1980s in Portugal (Rego et al. 1989: Silva 1990). In Spain, the first prescribed burning training course was conducted in 1995 at the University of Lleida, which included a detailed prescribed burning plan and its prescription window using Behave 'RxWindow' software (Andrews and Bradshaw 1990). These prescribed burnings (ca. 2 ha total) were accomplished in plots established in the Tortosa Mountains (Catalonia, northeast Spain). In 1998, the Spanish Ministry of the Environment developed and disseminated a training and demonstration video on prescribed burning with the scientific and didactic support of the University of Lleida. Since 2000, GRAF (the fire fighting organization of Catalonia) has trained on prescribed burning on a regular basis in Catalonia (Spain). At the beginning of the 1990s fire professionals in France created a Prescribed Burning Network and the first "Charter of prescribed burning", signed by 74 technicians in 1997. Materials with contents for the use of fire to support their training program have been permanently updated since then (CIFSC 2004; Binggeli and Bento 2009). Many of these early efforts followed similar programmes in the USA, Canada and Australia where the use of prescribed fire was more widely spread than in Europe and systematic approaches to provide training on the use of prescribed burning techniques were more developed.

In other parts of the world, prescribed burning courses followed similar patterns. For example, in Argentina courses started in 1996 promoted by INTA in Santiago del Estero (Kunst and Moscovich 1996). Before that, several isolated attempts to carry out prescribed burning based on scientific knowledge were made only by the National Park Administration and other organizations. In South Africa, prescribed burning courses have existed since 2001, mainly attended by foresters and nature conservationists.

In all cases, many of the technicians who applied the technique of prescribed burning were forest and range managers, but they could also be fire fighters, among many other professions. We will use the term fire professional for all of those trained in fire. In our point of view, agreeing with Kobziar et al. (2009), fire professionals should have not only specific training on prescribed burning (professional/continuous training) and practical experience in the field, but also a good fire education (university courses).

Following this premise, the objectives of this chapter are to:

- Describe and assess the current context on prescribed burning training in Europe (Spain, Portugal and France);
- Propose ways to continue the efforts to harmonise qualifications in Europe and to permanently exchange experiences on prescribed training;

- Describe and assess the current situation with regard to forest education, university level in Europe (Spain and Portugal) and compare it to the US forest education;
- Propose new ways for the example of an International Graduate Program in Fire Science and Management.

4.3.2 Training on prescribed burning in Europe

When addressing the term vocational training, the focus is on "providing the skills, knowledge and competences needed in the labour market" (Tissot 2004). In this section we will describe the vocational training on prescribed burning in Portugal, Spain and France since these are the countries in Europe with the most experience on this subject. Details on the training systems are provided in Molina et al. (2009).

In Portugal there are several institutions and professionals that work in a direct or indirect way with fires. To acquire competences on the use and management of fire (prescribed burning included), these professionals look for specific training that can be provided by universities, institutions like the National Forest Authority (at the base of Lousã) or by some Portuguese Forest Associations (in particular Forestis) in partnership with the universities.

In Portugal, by law, only an accredited technician can conduct a prescribed burn. Due to that obligation, the National Forest Authority (AFN) certifies the technicians and their training by law (Portaria nº 1061/2004 of 21st of August). Also, to perform a prescribed burn, the 'Burning plan' must be evaluated by the municipalities and forest services, with the technicians of those entities also receiving specific training to acquire the knowledge to evaluate the burning plans. Finally, there is a specific training provided by AFN for the forest workers and fire prevention brigades that support the use of prescribed fire.

The contents of the three types of training are common in addressing issues as guidelines for use of fire, fire behaviour and its impacts, and prescribed burning planning and operational implementation. These issues are addressed at different depths and the practical modules with field experience are not required for the group of the evaluators. The duration of the courses vary accordingly:

1. Prescribed burning training for technicians accreditation
   Theoretical modules (duration: 21 hours)
   Theoretical-practical modules (duration: 35 hours)
   Practical modules (duration: 49 hours)
2. Training for technicians able to evaluate the prescribed burning plan
   Theoretical modules (duration: 9 hours)
   Theoretical-practical modules (duration: 19 hours)
3. Forest workers and fire prevention brigades
   Theoretical modules (duration: 4 hours)
   Simulated practice modules (duration: 31 hours)

In Spain, although several vocational courses are offered to professionals by the Ministry of the Environment, or by fire fighter academies, none of them work

specifically on prescribed burning except for the region of Catalonia. There, the Institute for Public Safety (ISPC) has been providing training in the use of fire since 2001. There are five training levels for different job positions (all end-users in the fire fighting institute) and two specific modules for: (i) specialists that will execute both prescribed burning and backfiring), and (ii) managers who plan and supervised them. Today a total of 120 fire fighters and managers have taken these courses. Since 2009, 55 of them have a certificate that ensures the required competence for a wise use of fire.

Recently (since 2008), the Department of the Environment of Gran Canaria (Canary Island local government) is developing a prescribed burning course in collaboration with the University of Lleida. They have accomplished three editions with more than 50 people. Trainees receive a diploma if they pass the course. Additionally, the Department of the Environment will latter certify their competence (for their workers) after successful work on 20 prescribed burning days (equivalent to 160 hours).

In France, fire is taught through a professional training system that is only available in some regions. Since the risk of wildfire is only important in part of the country, only 32 departments (mostly in the south) among the 95 departments are subject to the wildfire risk legislation. Only fire fighters and fuel managers of this part of France are to be trained in prescribed burning techniques. Therefore, there are two schools for fire professionals in France dealing with prescribed burning – an established one in the southeast, and a more recent one in the southwest). The schools are managed by the civil protection services but are open to foresters.

French trainees on prescribed burning get a training certification if they follow and complete a specific course and are endorsed by the trainers. The certificate is valid for five years and they can become prescribed burning bosses if asked by their employers. The assessment of practices in the field is only performed by the employers. Better assessment of the quality of the practices in the field could strengthen the development of this technique.

Training in prescribed burning is the same for fire fighters and for vegetation and fuel managers. They are learning in the same classrooms and practicing together in the field. A general certification for conventional fire fighting activities, with five levels, includes assessment of trainees. However, prescribed burning is a training option that French fire fighters or foresters are not required to take.

4.3.3 Cooperation, exchanges and the search for harmonization of European qualifications on prescribed burning

One of the objectives of Fire Paradox was the creation and sharing of knowledge between fire professionals of Europe and elsewhere and the promotion of their mobility between countries. However, with the diversity of educational qualifications in different European countries, the mobility of workers in Europe is very difficult. To solve this question, the European Commission created The European Qualifications Framework (EQF) that acts as a translation device to make national qualifications more readily understood and compared across Europe,

Table 1. EuroFire competency standard units and training modules for self learning.

Competency standard units	Training modules for self learning
EF1:Ensure that your actions in the vegetation fire workplace reduce the risks to yourself and others.	EF1: Ensure that your actions in the vegetation fire workplace reduce the risks to yourself and others
EF2: Apply techniques and tactics to control vegetation fire	EF2: Apply techniques and tactics to control vegetation fire
EF3: Communicate within a team and with supervisors at vegetation fires	EF4: Apply hand tools to control vegetation fire
EF4: Apply hand tools to control vegetation fires	EF6: Apply vegetation ignition techniques
EF5: Control vegetation fires using	
EF6: Apply vegetation ignition techniques pumped water	

promoting the mobility of workers and learners mobility between countries and facilitating their lifelong learning (EC 2008). The EQF does this by setting qualifications into a series of reference levels (1–8), from basic to advanced. The eight reference levels are described in terms of learning outcomes, split into knowledge, skills and competence.

In collaboration with Fire Paradox, the EuroFire project (www.euro-fire.eu/), has developed fire training materials to support the development of similar fire management skills across the European Union. These materials have been developed to support fire training and assessment for a Level 2 work environment (members of a tanker crew, hand crew, or prescribed burning crew) whose personnel are instructed to do tasks under direct supervision. Six EuroFire competency standard units (Table 1) for fire crews and personnel involved in the suppression of wildfires (forest fires and rangeland fires) and in prescribed burning have been developed. Four training modules to support fire fighters self-learning are also available on the EuroFire website.

The diversity of fire professional qualifications in different European countries is also related to the complexity and diversity of cooperation mechanisms between departments dealing with fire management at the European and National Level (Correia et al. 2008). In spite of this complexity there are good examples such as that of the cooperation in the field of sharing knowledge, information and practical experiences between Spain and Portugal. Because of the lack of a global European framework for continuous cooperation between fire professionals the opportunities provided by the General Assemblies of Fire Paradox were used to promote exchanges between these professionals:

- Cagliari, Sardinia, Italy (2007) Seminar on the use of prescribed burning in Italy for the prevention and fight against forest fires. The objective of

this seminar was to initiate and stimulate the development of the theme of prescribed burning in Italy, through the exchange of ideas, knowledge and experiences between Italian professionals and professionals from other countries;

- Chania, Crete, Greece (2008) Enriching fire management in Greece with new tools: suppression fire and prescribed burning. This seminar had the purpose of initiating a plural debate on the use of fire in Greece, where it is still not allowed. Some professionals, forestry and fire fighters, and Greek researchers, gave their contribution, in order to show some initial experiences on prescribed burning, as well as, the need to legalise suppression fire, often used in fire fighting without consent. International experts explained the use of fire in their respective countries, as a way to influence a serious reflection on the introduction of the use of fire on prevention and fighting Greek wildfires.
- Puerto Madryn, Patagonia, Argentina (2009) 1st South American Symposium on Fire Ecology and Management. This symposium had the purpose of gathering South American professionals together to debate on fire ecology and management. Some professionals, forestry and fire fighters, and Argentine researchers, gave their contribution, describing the diversity of situations on the use of fire in South American countries (Argentina, Uruguay, Chile and Paraguay).

These types of meetings are also a very good opportunity to discuss and exchange views, experiences and actions and to address issues as job hazard abatement during the use of fire, allowing for the completion of an educational and training report on "Guidelines to mitigate personal risk in prescribed burning and suppression" (Pous et al. 2010).

The way forward for the continuation of the exchanges and cooperation between fire professionals can be based on the experience of these meetings and especially on the Euro-Mediterranean meeting for prescribed burning professionals held in Lousã, Portugal, 4–8 February 2009.

Similarly to the objectives of the annual meetings of the French National Prescribed Burning Network, this Euro-Mediterranean meeting had the main goal to expand exchanges to a much broader public, encouraging knowledge transfer and promoting interactions between European prescribed burning professionals. This was a very fruitful initiative, gathering almost one hundred Portuguese, Spanish, Italian, French, Moroccan and German prescribed burning professionals (Figure 1). For five days the participants had the opportunity to visit twelve sites where prescribed burning had been applied, as demonstration sites.

Future training initiatives at the European level should also make extensive use of the Network of Demonstration Sites for Prescribed Burning created by Fire Paradox (Molina et al., 2009b). Documentation of the most relevant sites can be found in the Fire Paradox information platform – Fire Intuition (fireintuition.efi.int/).

A permanent framework for these exchanges of experiences at the European level, taking advantage of the networks of sites, people and materials gathered in projects such as Fire Paradox, and building on the experiences of national and international meetings is fundamental for the future.

Figure 1. Visit to a prescribed burning demonstration site during the "Euro-Mediterranean meeting for prescribed burning professionals".

4.3.4 Fire education in Europe (Portugal and Spain)

The European Universities and Institutes must enter by 2010 the European Higher Education Area (EHEA) where the university systems will be harmonized under the Bologna agreements, consisting of three different levels of studies:

- 1st cycle, with 3–4 academic years of study (depending on each country the denominations can be Bachelor of Sciences BSc, engineer, deputy forestry engineer, technical engineer, among others);
- 2nd cycle with 1, 1.5 or 2 more academic years (denominations like Master of Science MSc, graduate, and forestry engineer are common);
- 3rd cycle, consisting of more 3–5 academic years (the denomination of this level is Doctorate, Philosophy Doctor, PhD).

In Europe, specific university level courses on fire management are mostly available in Portugal and Spain, and these were reviewed by Colaço (2005) and by Molina et al. (2009a). Although France is a country with a tradition of forest science, and experience in the use of the prescribed burning technique, at present, this formal education system does not include courses on prescribed burning, even if they are topics in the PhD programs of some French university schools (Molina et al. 2009a).

In Portugal, fire management education is inserted both in the educational formal context as a forest engineering graduation major (university level) and in continuous learning and training programmes, that can also be offered by polytechnic institutes,

Table 2. Forestry Science higher studies in Portugal and corresponding fire courses.

	Courses (with the corresponding European Credit Transfer System – ECTS*)	
	First cycle	Second cycle
ESAB, ESAV	Forest Fires (6 ECTS)	
ESAC	Forest Defense Against Wildfires (6 ECTS)	Planning of Forest Defense Against Wildfires (6 ECTS)
UTAD, ISA/UTL	Forest Protection (7-7.5 ECTS)	Fire Ecology and Management (5-6 ECTS)

* 1 ECTS = from 25 to 30 hours (EC 2007)

especially with technological specialization programmes (CET). The CET training programmes in Portugal allow for integration into the working world after the secondary school or the continuation of studies at university level. The training held in CET is credited within the university where the student is admitted. In Portugal there are two approved CET programmes on Forest Defence Against Wildfires. Both are promoted by Polytechnic Institutes, (Coimbra and Bragança) with 43 European Credit Transfer System (ECTS) credits each and two semester duration (including 420 to 600 hours of training in a work context). Both schools have the course of prescribed burning with 3 ECTS.

In Portugal, there are five schools that offer graduate studies in Forestry science: two Universities (the University of Trás-os-Montes and Alto Douro - UTAD - in Vila Real, and the Technical University of Lisbon with the Institute of Agronomy - ISA/UTL), and three polytechnic institutes (the Agrarian Schools of Bragança ESAB, Viseu ESAV and Coimbra ESAC). All the schools have courses related to fires (Table 2).

The PhD degree is given by ISA/UTL and UTAD. On this cycle there are no specific courses on fire, however students can do their research in this subject area.

In Spain, there are twelve universities/colleges offering higher education for fire professionals. On the 1st cycle, corresponding to six semesters, 11 schools have a mandatory course on 'Natural Resources Protection' including Wildland Fire Issues with around 120 hours of instruction. On the 2nd cycle, seven schools have a mandatory course on 'Natural Systems Management & Protection' including Wildland Fire Issues with around 240 hours of instruction (Table 3).

Spanish universities also provide graduate courses or fire management that are nearly always short (less than 9 ECTS credits), and frequently are partly on-line courses. These courses are addressed to professionals who want to improve the knowledge that they have in specific subjects, to know the advances and the new contributions and also to be in touch with other specialists. The University of Lleida, University of Cordoba, and Polytechnic University of Madrid offer different courses on the subject 'Wildland Fire Management'.

Taking the University of Lleida as an example, we see that in this school, students can enrol in any of these courses individually and get credit and a diploma for it. However, a 'Wildland Fire Management Master' degree can be achieved if a final thesis or project is completed and a total of 45 ECTS credits is obtained.

Table 3. Forestry science higher studies in Spain with fire contents.

Universities	First cycle	Second cycle
Universidad de Córdoba	No	Yes
Universidad de Castilla-La Mancha, Universidad de Extremadura, Universidad de Huelva, Universidad de León, Universidad de Oviedo	Yes	No
Universidad Católica Santa Teresa de Jesús de Ávila, Universidad de Lleida, Universidad Politécnica de Madrid, Universidad de Santiago de Compostela, Universidad de Valladolid, Universidad Politécnica de Valencia	Yes	Yes

At the European level, the existing cooperation in forestry associates six European universities (Joensuu, as coordinator, Lleida, Freiburg, Vienna, Wageningen, and the Swedish Agricultural University) for a Master of Science in European Forestry. The Master of Science in European Forestry Erasmus Mundus (MSc EF) is a 2-year double-degree program including various topics. The idea of the MSc-program is to respond to the increasing number of issues in forest and nature management that are formulated, implemented, and co-ordinate above the classical nation-states, providing a whole range of new challenges and demands for policy and management at the European level. In this context, the participation of the University of Lleida includes a course on 'Principles of Wildland Fire Science and Management' and a 'Prescribed Burning Laboratory' with the cooperation of GRAF in Catalonia.

Cooperation between universities of different European countries exist in many research projects dealing with fire management but no specific common degree programmes under this topic have been developed.

4.3.5 Current initiatives in cooperation on fire education outside Europe

International cooperation developed under the Fire Paradox project outside Europe. Four international prescribed burning courses were taught between 2007 and 2009 in Patagonia and Santiago del Estero. The courses were organized by the two Argentinean teams (INTA and CIEFAP) with the assistance of the University of Lleida. More than 180 fire fighters, forestry students and professionals (most of them from different Argentinean provinces, but also from Spain, Uruguay and Paraguay), were trained in the use of prescribed burning techniques. The end result was the decision taken by the University of Patagonia during the 1st South American Fire Ecology and Management Symposium, to support the creation of a Masters Degree Program, which will continue with the task of broadening the knowledge and giving a more academic and professional scope to the dissemination of fire science, and in particular to training and learning about the use of prescribed burning techniques initiated during the development of the project.

Table 4. Universities in the USA offering both undergraduate and graduate fire specific courses (adapted from Kobziar et al. 2009).

US Universities	Number of fire specific courses	
	Undergraduate Level	Graduate Level
Humboldt State University	6	2
California Polytechnic & State University; University of Idaho	6	1
Colorado State University	4	2
Oklahoma State University; Oregon State University	3	2
Northern Arizona University	3	1
Texas Tech University; University of Florida	2	2
Clark University; Stephen F. Austin St University; University of California-Berkeley; University of Oregon; University of Montana; University of Washington	1	1

New initiatives to enhance international cooperation should be based in the knowledge of the status of fire education outside Europe. To compare the academic studies on fire outside Europe we decided to use the case of the USA since it is a country with strong experience in fire education and training, with a recent and excellent review on the challenges to educate their fire professionals (Kobziar et al. 2009).

As in Portugal and Spain, fire management and ecology education have been concentrated in forest and range management programs at universities and technical community colleges. According to a recent study, only 22 of the thousands of US universities (providing 2- or 4-year programs), "provide substantial educational opportunities in wildland fire management and ecology" (Kobziar et al. 2009).

From the 22 universities and colleges that provide at least one certificate or degree in fire science, 15 of them offer courses both for undergraduate and graduate studies (Table 4). Nine universities offer several fire specific courses at both levels. This allows for a certain specialization very useful for cooperation.

The need to target mid career professional, technicians or fire professional that are already employed, meant that both the US and Spanish universities prepared specific courses for them. This is the case of the University of Idaho which has an academic major and eight fire-specific continuing/distance/ short courses related to fire science.

4.3.6 New challenges and initiatives for the educational profile of a fire professional

To have a well educated fire professional, the professional needs to learn, and that is a "process where knowledge is presented to us, then shaped through understanding, discussion and reflection" (Freire 1998).

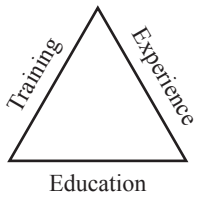

Figure 2. The fire professional development triangle (Kobziar et al. 2009)

In the last decades, there has been a substantial effort to understand, discuss and reflect about fire and new challenges have appeared for the educational background of a fire professional. According to Stephens and Ruth (2005), "fire management is in transition from an era dominated by fire suppression, to one where fire use and suppression are equally viable resource management options." Due to this changing paradigm, the education and training system must evolve to a more integrated way of looking into the use of fire in the ecosystem.

As referred to in Kobziar et al. (2009) the "new generation of fire professionals must continuously incorporate new knowledge on fire ecology, fire behaviour, and social sciences to tackle the multifaceted issues they will face". Kobziar et al. (2009) developed the 'Fire Professional Development Triangle', which depends on integrating training, education and experience (Figure 2). None of the sides of the triangle should be underestimated, but should be complementary.

In spite of these new needs, recognized internationally, there are still no internationally stable frameworks for cooperation between entities that would provide the new fire professionals with the knowledge, skills and competences for the future demands.

In addition, it is widely recognized that modern approaches to education in fire science should use the concepts of Integrated Fire Management. This implies that a complete fire professional could be trained to understand and/or use both prescribed burning and suppression fire. Simultaneously he/she should understand the social context including the traditional fire uses. This is a new perspective, solving the apparent paradox of having agents only prepared to use fire and others only prepared to extinguish it without an integrated perspective. At the moment there are no such international education programs.

Being aware of this gap at the international level, Fire Paradox launched the initiative to develop an International Graduate Program in Fire Science and Management for a Masters Degree (FireMaster). A partnership was established between the members of the Fire Paradox consortium with more experience in education in prescribed burning (University of Lleida and UTAD) and two of the more experienced US universities in this subject (Idaho and Florida) with the intent to extend the partnership in a second step to other universities (e.g. ISA and Patagonia). The objective of the partnership is to jointly develop a program to educate European and American graduate students in understanding, synthesizing and applying science to support Integrated Fire Management for forests and other natural resources.

Globally, the Graduate Program could involve three complementary parts, referring to science, applications and projects:

- Advanced Fire Science courses offered online and developed jointly for different topics (Fire Ecology, Fuels Inventory and Management, Fire Behaviour, Analysis of Real Case Studies, Fire and Landscape Dynamics, and an International Seminar), with a strong theoretical foundation and case studies from multiple ecosystems around the world.
- Field/laboratory/hands-on application courses (Prescribed Burning Laboratory, Restoration and Post-Fire Management, and Integrated Fire Management). These courses involve learning how the social, cultural and environmental context influence the fire challenges and their practical solutions.
- Professional project, including design, implementation and evaluation. These projects could benefit from the assistance of collaborators at partner institutions in the USA (e.g. US Forest Service Fire Science Labs), in Europe (e.g. Centre for Applied Ecology in Portugal), and agencies operating internationally, including the Global Fire Initiative of The Nature Conservancy, World Wildlife Fund for Nature, International Union for Conservation of Nature and the International Association of Wildland Fire.

This Fire Paradox initiative could be the international framework for the fire education of professionals of the future generation, taking advantage of all the materials and the network provided by the project. Such an initiative should use the global concept of Integrated Fire Management, and fully utilize the possibilities provided by the different nature of the partners, applying the positive spiral started in the triangle of Education, Training and Experience.

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