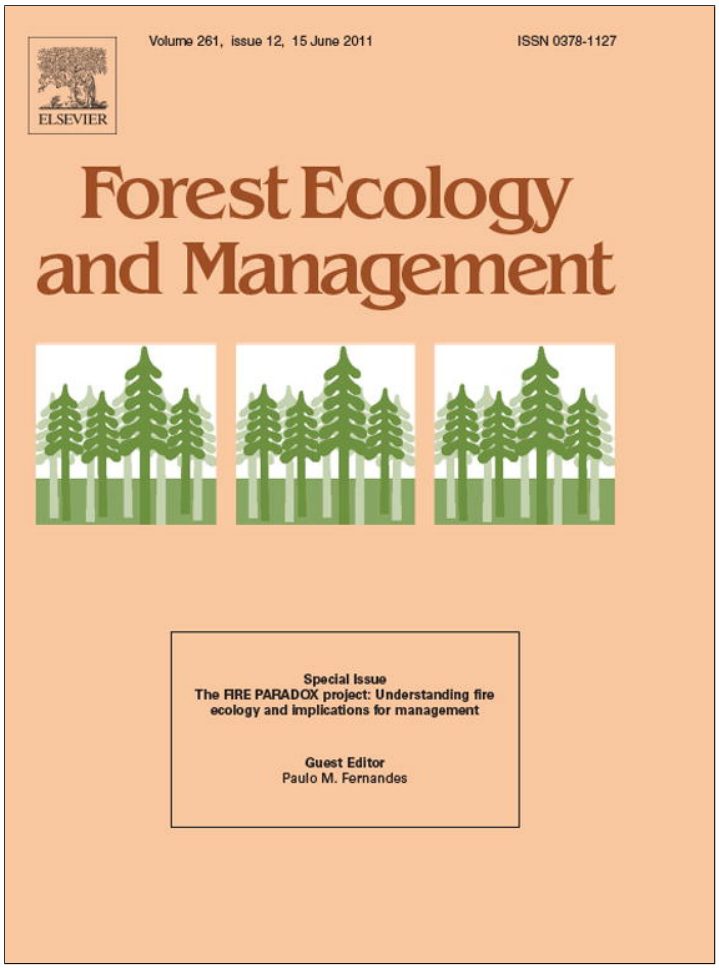

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The FIRE PARADOX project: Towards science-based fire management in Europe

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The fundamental and primordial relevance of wildland fire to ecosystem processes and human activities is undisputed (Bowman et al., 2009). Not only is fire the most pervasive natural disturbance on Earth (Lavorel et al., 2007) but also its global incidence is expected to increase with future climate change (Pechony and Shindell, 2010). Learning to live with fire is an imperative, as fire cannot and should not be excluded from fire-prone environments, where it is often needed for land management and/or ecosystem maintenance (Burrows, 2008; Pausas and Keeley, 2009).

Traditionally, and especially in forests intensively managed for a few key resources, fire management usually only involves preventing and suppressing fire (Lotan, 1979). Considering the variety of land uses and assets involved, fire management should instead be approached as a 'multi-stakeholder, multi-variable, multi-scale problem', hence implying the integration of multiple partial solutions (Gill, 2005). Integrated Fire Management (IFM) *sensu* Myers (2006) has been proposed as a comprehensive approach that assesses and balances the threats posed by fire with its benefits by considering the environmental, socio-economic, cultural and political contexts. IFM integrates science, society and fire management technologies at multiple levels and is in line with the need, expressed by Bowman et al. (2009), to develop a holistic approach to wildland fire research.

Wildfire incidence has increased in the Mediterranean Basin in the last decades. Changes in the type and intensity of land use are thought to be the main driver, by facilitating abnormally large fires under extreme weather conditions (Pausas and Keeley, 2009). Ecosystem resilience to fire is widespread (although forest types that are modified from natural conditions tend to be fire-sensitive), but fire is generally perceived as a catastrophe (Pausas et al., 2008). This perception reinforces the overwhelming role of fire suppression in the current policy, which paradoxically can exacerbate the problem through fuel accumulation (e.g., Fernandes, 2008).

The overall goal of the cooperative FIRE PARADOX project (2006–2010) was to develop the scientific and technological foundation for European practices and policies consistent with the IFM concept. FIRE PARADOX was an integrated project, in that research, development and outreach activities had similar weight. The project was structured around four complementary integration pillars, including (1) the use of prescribed burning to mitigate potential wildfire impacts, the assessment of wildfire risk in relation to (2) its ignition and (3) spread, and (4) the use of fire in wildfire suppression. The research component of the project addressed physical, biological and socio-economical fire-related processes and mechanisms in order to advance the broad understanding of trade-offs associated with alternative fire regimes. The FIRE PARADOX partnership and structure can be accessed at the project website (http://www.fireparadox.org). The European Forest Institute has published two research reports (Montiel and Kraus, 2010; Silva et al., 2010) and one policy brief (Rego et al., 2010) on

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the project, and hosts its metadata, deliverables and products at http://fireintuition.efi.int/. An upcoming special issue of Forest Policy and Economics will address the socio-economic realm of FIRE PARADOX.

Forest Ecology and Management had previously published four FIRE PARADOX papers. Koetz et al. (2008) presented and tested a method to classify and map land cover and fuel types from high-resolution remote sensing data. Ganteaume et al. (2009) related fire recurrence with the structural features of fuel layers in pine stands, oak-pine mixed stands and shrublands of southeastern France. Fernandes et al. (2008) reviewed the post fire survival of European pine species and classified their relative resistance to fire from data and a process-based model. Narayan et al. (2007) did an exploratory analysis of the potential of prescribed burning to contribute to decreased CO_2 emissions in Europe as required by the Kyoto protocol. This special issue comprises seven additional papers pertaining to the ecology and management of fire in forests and woodlands.

Forest disturbance by fire is currently a relatively minor concern in Central Europe but is expected to increase as a result of climate change. In the canton of Ticino, Switzerland, Conedera et al. (2011) examine the relative likelihood of fire starting as a function of vegetation type, physiography and proximity to the wildland–urban interface (WUI) using Monte-Carlo simulations. Zumbrunnen et al. (2011) expand the study area to consider also the canton of Valais and assess the relative influences of weather and anthropogenic drivers on the probability of fire occurrence over the period of 1904–2008.

The recent and on-going sprawl of the WUI is one of the land use changes that is affecting the Mediterranean fire regime. In order to add to the knowledge of how the WUI relates with fire risk, Lampin-Maillet et al. (2011) classify an area within Provence, southeastern France, according to an existent WUI typology. Then, land cover features and fire incidence metrics are described and analyzed for each WUI type.

The influence of fuel properties on fire behaviour and the fire regime is a critical research theme in relation to the ecology and management of fire-prone vegetation types. The complementary studies of Curt et al. and Ganteaume et al. (2011) contribute to the topic in southeastern France forest, woodland and shrubland types, namely in *Quercus suber*, mixed oak, pine-oak and *Pinus halepensis* stands. The fire-carrying ability of undisturbed litter is addressed experimentally in the laboratory to compare flammability, both between vegetation types and classes of past fire frequency.

Assessing the likelihood of fire-induced tree mortality should be a key component of the decision-making process either when fire is planned or unintended, but its scientific basis remains underdeveloped in Europe. A significant advance is put forward by Vega et al. (2011), by presenting models for the delayed (3-year) probability of tree death after wildfire for four ecotypes of *Pinus pinaster* in Spain.

This special issue ends with a contribution from a non-European partner of the FIRE PARADOX consortium. Prescribed burning has been suggested to have a positive impact on carbon storage, depending on how it affects the overall fire regime. Defossé et al. (2011) use simulation modeling to quantify the carbon balance benefits of a proposed prescribed fire program in pine plantations in the Andean region of Patagonia, Argentina.

Transferring European research on fire ecology and management to the society has been a difficult process in the past. As a consequence, management policies and practices have been very often decoupled from the state-of-the-art. FIRE PARADOX was structured to optimize interchange among modules and work packages and to facilitate communication between scientists, technology developers and end-users. The whole range of R&D project outcomes reflects the pursued integration approach, which has already resulted in enhanced knowledge transfer throughout the project existence.

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