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SESSION 5 – FIRE IN ECOSYSTEM DYNAMICS AND RESTORATION

Chairs: Orsolya Valkó, Béla Tóthmérész

Fire is a major driver of ecosystem dynamics in many parts of the World. Fires in the form of natural wildfires and controlled burning actions alter the abiotic environment, resource availability and population dynamics, which all lead to changes in community composition. There are numerous examples on the use of prescribed burning in the management of fire-prone ecosystems, such as boreal forests, prairies, heathlands and Mediterranean shrublands. In less fire-prone ecosystems, there are debates on the application of prescribed burning in biodiversity conservation and restoration. Some conservationists highly welcome prescribed fire, while others are strongly against it. These contrasting attitudes are likely due to the lack of proper scientific knowledge on both short- and long-term effects of fires in these ecosystems. The overall aim of the special session is to present best practices and future perspectives of fire management and to highlight the potential of prescribed burning in ecosystem restoration. We welcome presentations from theory and practice on the effects of fire on ecosystems, on historical and current fire regimes and on conservation and restoration projects that applied prescribed burning. The session is associated with the Eurasian Fire in Nature Conservation Network (http://www.fire.uni-freiburg.de/programmes/natcon/EFNCN.html).

USE OF PRESCRIBED FIRE IN NATURE CONSERVATION, LANDSCAPE MANAGEMENT AND FORESTRY – EXPERIENCES AND PERSPECTIVES FOR GERMANY

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With the exception of few regions, extended areas of Europe are faced by the abandonment of agriculture and pastoralism. This trend of land-use change is threatening the sustainability and survival of open cultural landscapes with their habitats for open-space dependent species. Abandoned lands are undergoing rapid succession. Substitution measures, which are practiced in some places to encounter succession and to maintain the open space habitats, include subsidized mechanical treatment or targeted grazing but are limited by the sheer magnitude of land area to be managed and by the rapidly increasing costs. Since the 1990s the use of prescribed fire is increasingly tested and applied to maintain open-landscape habitats. The application of prescribed fire on active and abandoned military areas, which often have a high conservation value and are classified as Natura2000 sites, are limited due to the contamination by unexploded ordnance. Technical solutions have been developed to encounter these threats. The paper is summarizing the experiences, progress and perspectives of the use of prescribed fire for the maintenance of biodiversity of the open cultural landscapes of Germany. Furthermore, the state-of-the art in using prescribed fire in landscape management and in forestry are discussed.

TO BURN OR NOT – A PERSPECTIVE ON BRITISH MOORLANDS

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British moorlands hold an almost unique place in burning research. Prescribed burning has been carried out for centuries, originally for sheep grazing but more recently it is implemented mainly for grouse shooting. Much of the moorland vegetation grows on deep peat and recently there has been much debate about whether it should be continued. The essence of the debate is that UK peatland contains a very large carbon store and also acts a means of retaining water and assisting with flood relief. Prescribed burning will release carbon to the atmosphere and there is some evidence that it can also discolour water, adding to purification costs when used for human consumption. However, the ecosystems are fire-adapted and where no prescribed burning takes place there is a build-up of biomass, an ever increasing fuel load. Here, I will discuss some of the pros and cons of prescribed burning using data from a long-term manipulative experiments. I will consider effects on vegetation, regeneration potential as well as impacts on peat and illustrate part of the dilemma using data from a predictive model which assess the relative impacts of prescribed burning at different rotations on carbon balance, including the effects of periodic wildfire.

RESTORING A GRASS-DOMINATED ECOSYSTEM FOR A SALAMANDER, A LILY, AND A WOODPECKER: A CASE STUDY OF FIRE IN THE APALACHICOLA NATIONAL FOREST

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The longleaf pine (*Pinus palustris*) ecosystem is dependent on frequent, low-intensity fires to maintain an open longleaf canopy and grass-dominated groundcover. Apalachicola National Forest (ANF, Florida, USA) has about 120,000 ha of upland pine forest that historically burned every 2-3 years. We discuss three rare species found in ANF that are acutely affected by fire management: red-cockaded woodpecker (*Picoides borealis*) requires extensive areas of pine-dominated habitat with significant components of older trees and grassy understory; frosted flatwoods salamander (*Ambystoma cingulatum*) needs open ephemeral wetlands for its breeding sites; and Harper's beauty (*Harperocallis flava*) occurs in ecotones between pine uplands and wet savannas or wetlands. ANF fire management program is one of the most active in the National Forest system, but the fire interval on most of the forest is closer to 4-5 years. Preliminary results of a recent study have shown that wetland shrubs are advancing into the uplands and filling up ephemeral wetlands presumably due to insufficient fire frequency and intensity. Highest productivity of red-cockaded woodpeckers occurs in pine woodland with grass-dominated understory maintained by frequent fires. More innovative practices need to be developed and implemented to stabilize population decline in the salamander and lily. Specifically, adaptive application of fire by season and mechanical or herbicides may provide management solutions.

SUPPORTING BIODIVERSITY BY PRESCRIBED BURNING IN DRY GRASSLANDS - A MULTI-TAXA APPROACH

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We studied the effects of prescribed burning in dry alkali grasslands of high conservation interest. Our aim was to test whether dormant-season prescribed burning can be a feasible conservation measure in these grasslands. We selected six sites in Hortobágy National Park (Hungary): in November 2011, a prescribed fire was applied in three sites, while three sites remained unburnt. We studied the effects of burning on soil characteristics, plant biomass, vegetation composition and arthropod assemblages (isopods, spiders, ground beetles and rove beetles). Soil pH, organic matter, potassium and phosphorous did not change, but soluble salt content increased significantly in the burnt sites. Burning had several positive effects from the nature conservation viewpoint. Plant diversity and the number of flowering shoots increased, and the cover of the dominant grass *Festuca pseudovina* decreased in the burnt sites. Graminoid biomass was lower, while total, green and forb biomass were higher in the burnt sites. The key finding of our study was that prescribed burning did not decrease the abundance and diversity of arthropod taxa. Out of the most abundant invertebrate species, ten were not affected, one was negatively and one was positively affected by burning. Our results suggest that prescribed burning leaving unburnt patches can be a viable management tool in open landscapes, because it supports plant diversity and does not threaten arthropods.

FOREST FIRES AND THE REGIONAL DISTRIBUTION OF BEETLES FAVOURED BY FIRE

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Modern forestry has dramatically reduced the amount and size of forest fires in northern Europe and several pyrophilic species are now threatened. Substantial efforts are put into control burns in forests Sweden, but the actual benefit of a an individual fire remains less clear, and there is room for optimizing both temporal and spatial occurrence of such conservation burns. We sampled insects attracted to smoke generated as an attractant at 21 sites in a forested region of SE Sweden. The catch was compared against recent (<15 yrs) forest fire statistics with the aim to relate the occurrence of species to temporal and spatial history of fires. Huge numbers of *Microsania* (Diptera) were attracted, but the catch was unrelated to fire history. Of eleven pyrophilic beetles, seven were positively correlated with recent forest fires, mostly at the smaller spatial scales (100–5000 m). The abundance of 17 beetles with unknown fire-dependency was also associated with recent forest fires. As the autecology of many of these species is not known, it is possible that they too might be favoured by substrates created by fires. Conclusion: Conservation burns that are strategically placed, both temporally and spatially, can help to increase the conservation benefit of forest fires to conserve both fire-dependent and fire-favoured insects.

SPOTLIGHT ON BEECH (*FAGUS SYLVATICA* L.) FIRE ECOLOGY

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Global warming will increase fire hazard in historically non fire-prone regions. The large fires affecting beech forests of the SW Alps in 2003 serve as an example. This raises questions on post-fire measures to re-establish ancestral ecosystem services. In order to base measures on ecological evidence, resistance and resilience processes were studied in 40 beech stands (300 plots à 200 m^2) burnt between 1970-2013 and surveyed between 2010–2014. Results of this retrospective (space for time substitution) approach show: (1) Beech mortality, if any, occurs within 20 yrs. since fire. Post-fire mortality depends on burn severity and impact such as damaged tissue across the stem and fungi infestation. (2) Seed production in mast years declines only where burn severity is high. Intermediate burn severity favours seed germination and seedling establishment by consuming the litter and increasing incident light. (3) Regenerating beeches dominate in the mid-term over other trees, and profit from partial canopy openings. Rapid beech mortality following high severity may favour stand-forming ferns, shrubs, grasses that outcompete beech regeneration for long.
To promote beech regeneration, surviving trees providing seeds and shelter should be left at place, even if highly damaged. To improve mechanical stand stability, beech should be felled timely (3–5 yrs) before wood decaying fungi establish and in coincidence with mast years. Deadwood provided by gradual beech mortality should not be removed.

ECOLOGICAL ROLE OF FIRE IN THE CENTRAL EUROPEAN *PINUS SYLVESTRIS* FORESTS

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In Europe, fire is considered to be an integral part of forest dynamics mainly in Mediterranean and Fenno-Scandinavian regions. In temperate forests of Central Europe, the ecological role of fire was traditionally neglected despite documented frequent fire occurrence. Firstly, we aimed to reveal the drivers of wildfire occurrence in the landscape of the Czech Republic. For this purpose, we performed spatial analyses based on officially reported data on wildfire statistics and GIS layers of human, biotic and abiotic environmental factors. According to our results, the markedly fire-prone habitat appeared to be the semi-natural *Pinus sylvestris* dominated forests of sandstone rocky areas of specific rugged relief. Afterwards, we focused on the effect of wildfire on long-term dynamics of such pine forests, using vegetation sampling method with a space-for-time substitution design. We observed the spontaneous post-fire development of the vegetation composition and diversity, the role of fire severity, the ability of tree species to resist the fire, and asked whether fire disturbance can contribute to preservation of the pine-dominated forests in the region. We found that forest vegetation is resilient to the fire similarly to boreal forests, as it spontaneously developed into pre-disturbance-like state in ca. 140 years. However, a continuous shift towards stands with higher proportional abundance of more shade-tolerant and fire-sensitive tree species than *P. sylvestris* was found in late post-fire successional phases. Periodic fire disturbance occurring ca. once in 200 years thus seems to be a factor maintaining *P. sylvestris* dominated forests in the Central European sandstone landscapes in the long run.

A MODELLING APPROACH TO REDUCE CARBON EMISSIONS IN *CALLUNA VULGARIS* MOORLANDS: WHEN PRESCRIBED BURNING AND WILDFIRES INTERACT

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A present challenge is to optimize management techniques so that ecological services are maximized and C emissions minimized. We model the effects of different prescribed-burning rotation intervals and wildfires on C emissions in British moorlands. Biomass-accumulation curves from four *Calluna*-dominated ecosystems along a north-south gradient were calculated and used within a matrix-model based on Markov Chains to calculate above-ground biomass-loads, and annual C losses under different prescribed-burning rotation intervals. We also assessed the interaction of these parameters with an increasing wildfire return interval. Litter accumulation patterns varied with differences between northern (colder and wetter) and southern sites (hotter and drier). The *Calluna*-biomass accumulation patterns were determined by site-specific conditions. The optimal prescribed-burning rotation interval for minimizing annual carbon losses differed between sites: for northern sites it was between 30 and 50 years, whereas for southern sites a hump-backed relationship was found with intervals either 8–10 years or 30–50 years. Increasing wildfire frequency interacted with prescribed-burning by both increasing C emissions and modifying the optimum burning interval for C minimum emission. This highlights the importance of studying site-specific biomass accumulation patterns with respect to environmental conditions for identifying suitable rotation intervals to minimize C losses.