The Latest Science

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Forests and Woodlands

Beaty, R. Matthew; Taylor, Alan H. 2008. Fire history and the structure and dynamics of a mixed conifer forest landscape in the northern Sierra Nevada, Lake Tahoe Basin, California, USA. Forest Ecology and Management 255 (3-4): 707-719.

Abstract. The goal of this study was to understand how fire regimes promote fine- and coarse-grain vegetation patterns in an old-growth mixed conifer forest dominated landscape in the General Creek watershed on the west shore of Lake Tahoe, California. We quantified the structure (e.g., composition, age, and size) of old-growth mixed conifer stands located across a range of environmental settings. Fire histories were reconstructed using fire-scar dendrochronology, and the influence of regional climatic variability on fire occurrence was assessed by relating the fire record to regional climate reconstructions. Fire regimes parameters varied across topographic gradients at landscape scales promoting fine grain forest structural patterns. The timing and extent of fires was related to inter-annual and inter-decadal variation in drought which was linked to the El Niño-Southern Oscillation and the Pacific Decadal Oscillation. Coarse scale vegetation patterns where related to upper slope positions and relatively infrequent high severity fires. Fire regimes and forest structure have changed since EuroAmerican settlement with virtually no fires and structural shifts towards higher stand densities and a greater representation of fire intolerant species. At the landscape scale, fire regimes and forests patterns in mixed conifer forests are influenced by a variety of process operating at multiple spatial and temporal scales. Coarse scale heterogeneity related to topography and moderate to high severity fire is superimposed on fine scale variability related to topographic gradients and local variability in fuel and forest structural characteristics. Fire suppression has resulted in a more homogenous landscape particularly with regard to the loss of coarse scale heterogeneity.

Brassard, Brian W.; Chen, Han Y.H.; Wang, Jian R.; Duinker, Peter N. 2008. Effects of time since stand-replacing fire and overstory composition on live-tree structural diversity in the boreal forest of central Canada. Canadian Journal of Forest Research 38(1): 52-62.

Abstract. Stand structure diversity is hypothesized (*i*) to increase with stand development and (*ii*) to be greater in mixedwood stands than in conifer and broadleaf stands. We examined the effects of time since stand-replacing fire (TSF) and overstory type on stand volume, stand density, and tree-size variability, which is measured using Shannon's diversity index (*H*′) and coefficient of variation, in fire-origin boreal forest stands. We sampled 36 stands representing conifer, mixedwood, and broadleaf overstory types, ranging in ages from 72 to 201 years TSF on upland mesic sites in northwestern Ontario, Canada. Stand volume decreased in older mixedwood and broadleaf stands, but followed a U-shaped pattern in conifer stands with TSF. Diameter-at-breast-height-based *H*′ followed an inverse U-shaped pattern with TSF for all overstory types. Height-based *H*′ decreased with TSF in conifer and mixedwood stands but peaked at the intermediate age class in broadleaf stands. Diameter-at-breast-height- and height-based coefficient of variation indices followed an inverse U-shaped distribution with TSF. Our results partially supported the two hypotheses, as (*i*) the 124- to 139-year-old stands were most diverse and (*ii*) mixedwood stands were more than or as equally diverse as conifer and broadleaf stands, depending on stand development stage and the diversity indices used.

Campbell, D. Bruce; Bulmer, Chuck E.; Jones, Melanie D.; Philip, Leanne J.; Zwiazek, Janusz J. 2008. Incorporation of topsoil and burn-pile debris substantially increases early growth of lodgepole pine on landings. Canadian Journal of Forest Research 38(2): 257-267.

Abstract. Rehabilitation of skid trails, temporary roads, and log landings is required for many harvested sites in British Columbia; however, more information is needed regarding practical methods to return these access areas to productive forest. Lodgepole pine (*Pinus contorta* Dougl. ex Loud. var. *latifolia* Engelm.) seedlings (1 + 0) were planted into (*i*) fully rehabilitated landings (burn-pile debris and topsoil incorporated), (*ii*) tilled landings, and (*iii*) unprepared portions of the adjacent cutblock. After two seasons of growth in the field, seedlings planted on fully rehabilitated landings were 38% larger, more robust, and exhibited 44% greater absolute growth and 22% greater relative growth rates, than seedlings planted in the adjacent cutblock. Seedlings planted on tilled landings were 33% smaller, and exhibited absolute growth rates 38% less, and relative growth rates 18% less, than seedlings planted in the adjacent cutblock. Seedlings planted in the cutblock exhibited higher ectomycorrhizal colonization rates. Our results indicate that tillage alone was not sufficient to fully rehabilitate these landings, but that incorporation of recovered topsoil and burn-pile debris produced an excellent growth substrate. This method, using materials found on site, can prevent a significant loss of land regenerating to productive second-growth forest.

Capitanio, Raimondo; Carcaillet, Christopher. 2008. Post-fire Mediterranean vegetation dynamics and diversity: A discussion of succession models. Forest Ecology and Management 255: 431-439.

Abstract. Post-fire vegetation dynamics is examined over an extended timescale, to investigate the long-term effects of fire on plant diversity and to verify if a succession model, such as Clements' "relay floristic" or Egler's "initial floristic" models, applies to post-fire dynamics in Mediterranean communities. In the Alpilles massif, Provence, southern France, 20 plots were sampled at each of six sites; five that had been burned by wildfires within the last 30 years (1977, 1983, 1989, 1999 and 2003), and a control site not burned for at least 80 years. Temporal variations in relative species density are modelled by regression curves. The structure of diversity is analysed based on mean species richness (a), beta diversity (β_w), Shannon diversity index (H) and relative equitability index (E_h), knowing that the Egler's model leads to the prediction that richness should be highest immediately following disturbance. No significant differences in species richness were detected between sites, and species diversity is not related to time since the last fire except 2 years after fire that shows the highest β_w-diversity resulting from an elevated list of species per site (γ-diversity) immediately after fire. Instead, an effect of site location on species diversity is detected. The observed post-fire dynamics show a progressive transition between three stages, from initial, through transitional to mature. Each stage is characterized by different relative species density. Furthermore, several plant species can be considered as early, intermediate or late successional species with regards to their density at different times after burning. In conclusion, initial floristic composition model (Egler's model) applies to this ecosystem, with all species present at the early post-fire dynamics, and the diversity shows the highest γ-diversity 2 years after fire. In the long term (>50 years), a successional pathway can be discerned. The growth rates and longevity of main species influence the post-fire dynamics.

Chuvieco, Emilio; Opazo, Sergio; Sione, Walter; del Valle, Héctor; Anaya, Jesús; Bella, Carlos Di; Cruz, Isabel; Manzo, Lilia; López, Gerardo; Mari, Nicolas;

González-Alonso, Federico; Morelli, Fabiano; Setzer, Alberto; Csiszar, Ivan; Kanpandegi, Jon Ander; Bastarrika, Aitor; Libonati, Renata. 2008. Global burned-land estimation in Latin America using MODIS composite data. Ecological Applications 18(1): 64-79.

Abstract. This paper presents results of the AQL2004 project, which has been developed within the GOFC-GOLD Latin American network of remote sensing and forest fires (RedLatif). The project intended to obtain monthly burned-land maps of the entire region, from Mexico to Patagonia, using MODIS (moderate-resolution imaging spectroradiometer) reflectance data. The project has been organized in three different phases: acquisition and preprocessing of satellite data; discrimination of burned pixels; and validation of results. In the first phase, input data consisting of 32-day composites of MODIS 500-m reflectance data generated by the Global Land Cover Facility (GLCF) of the University of Maryland (College Park, Maryland, USA) were collected and processed. The discrimination of burned areas was addressed in two steps: searching for "burned core" pixels using postfire spectral indices and multitemporal change detection and mapping of burned scars using contextual techniques. The validation phase was based on visual analysis of Landsat and CBERS (China–Brazil Earth Resources Satellite) images. Validation of the burned-land category showed an agreement ranging from 30% to 60%, depending on the ecosystem and vegetation species present. The total burned area for the entire year was estimated to be 153 215 km^2. The most affected countries in relation to their territory were Cuba, Colombia, Bolivia, and Venezuela. Burned areas were found in most land covers; herbaceous vegetation (savannas and grasslands) presented the highest proportions of burned area, while perennial forest had the lowest proportions. The importance of croplands in the total burned area should be taken with reserve, since this cover presented the highest commission errors. The importance of generating systematic products of burned land areas for different ecological processes is emphasized.

Coleman, T.W.; Meeker, James R.; Clarke, Stephen R.; Rieske, L.K. 2008. The suppression of *Dendroctonus frontalis* and subsequent wildfire have an impact on forest stand dynamics. Applied Vegetation Science 11(2): 231-242.

Question: Interacting disturbance effects from *Dendroctonus frontalis* outbreaks and wildfire are thought to maintain *Pinus* spp. composition in the southeastern U.S. Our objective was to assess forest composition, structure, and succession following the interaction of two frequently occurring disturbance events in southern *Pinus* spp. forests: cut-and-leave suppression, a commonly used means for managing *D. frontalis* outbreaks, and wildfire.

Location: Western Gulf Coastal Plain, Louisiana, USA.

Method: *Pinus taeda* stands with cut-and-leave suppression and subsequent wildfire were compared to stands undisturbed by *D. frontalis* but with the same wildfire events twenty years after *Pinus* spp. mortality. The woody plant community was assessed in three different size classes and used to predict future forest types with the Forest Vegetation Simulator (50 years).

Results: *P. taeda* is the most abundant (> 50%) species of saw- and poletimber-sizes following cut-and-leave suppression with wildfire and in stands only with fire. Using canonical correspondence analysis, vegetation assemblages were primarily explained by slope position and elevation (7.6% variation explained). Fire intensity and stand age also accounted for variance in the ordination (4.4% and 3.1%, respectively). Dominant and co-dominant *P. taeda* forest types were predicted by the model to be the most abundant forest

types in each disturbance regime. In addition, new regeneration represents high hazard for future mortality from *D. frontalis*.

Conclusion: Our study demonstrates that cut-and-leave suppression with additional wildfire disturbance maintains *P. taeda* composition, and does not alter forest composition differently from stands receiving only wildfire. As a result, predicted *Pinus* spp. basal area under both disturbances is great enough to facilitate future bark beetle disturbance.

Duncan, R. Scot; Anderson, Corinna B.; Sellers, Heather N.; Robbins, Erin E. 2008. The effect of fire reintroduction on endemic and rare plants of a southeastern glade ecosystem. Restoration Ecology 16(1): 39–49.

Abstract. Open habitats dominated by herbaceous plants on thin, rocky soils occur within the forests of eastern North America. Although these habitats vary in origin, structure, geology, and species composition, all contribute greatly to regional biodiversity by harboring endemic and/or rare plants. Little is known about how disturbances affect plant populations in these ecosystems. Fire once was a frequent natural disturbance in the Ketona dolomite glades of Alabama, an ecosystem harboring eight endemic taxa and numerous other species of conservation concern. We designed an experiment to determine how the reintroduction of fire into the glades and surrounding longleaf pine forests affects populations of rare glade plant species. Experimental and control plots were established within the glades. Experimental plots were burned in April 2004, and all plots were surveyed during two subsequent growing seasons (2004 and 2005). Populations of three of 14 species of conservation concern declined significantly after the initial fire but recovered the next year. Among other herbaceous species, only five and two differed in population size in 2004 and 2005, respectively. In 2004, more species were more abundant in control than burned plots, but this difference was not detected in 2005. Multivariate community-level analyses of species presence–absence suggested that the effects of fire were negligible by the 2005 survey. Populations of young trees that had invaded the glades declined dramatically as a result of treatment fires. These results suggest that the reintroduction of fire will not harm glade species and may help prevent encroachment of the surrounding forest.

Fernández, Cristina; Vega, José A.; Fonturbel, Teresa; Jiménez, Enrique; Pérez-Gorostiaga, Pedro. 2008. Effects of wildfire, salvage logging and slash manipulation on *Pinus pinaster* Ait. recruitment in Orense (NW Spain). Forest Ecology and Management 255: 1294-1304.

Abstract. The effect of wildfire and the subsequent harvesting on *P. pinaster* recruitment was evaluated in a burned stand of this species in Orense (Galicia, NW Spain). Most of the seedling emergence (88%) that occurred during the first year after wildfire, took place between the end of the winter and the beginning of the spring, although meteorological conditions during the first autumn after fire were not adverse. The mild environmental conditions during the first summer after wildfire resulted in very low seedling mortality. The degree of crown damage caused by wildfire significantly and negatively affected pine seedling stocking, which was, as average, 3.5 seedlings m^{-2} at the end of the first year after wildfire.

Salvage logging was carried out 13 months after the fire. Three post-fire alternatives were compared: no harvesting (standing burned trees), harvesting + windrowing slash and harvesting + slash chopping. Slash chopping favoured a new seedling cohort. Harvesting and slash windrowing caused an immediate seedling mortality of 22%. Harvesting and slash chopping operations caused a mean mortality of 18 and 31%, respectively. Averaged over both slash treatments, 27% of the seedlings were damaged, which increased deferred

mortality during the subsequent months. Pine seedling survival was significantly related to seedling height, especially in harvested plots and was significantly reduced by harvesting and logging slash operations, with this reduction significantly higher in the harvest + slash chopping treatment. Harvesting and slash manipulation significantly reduced seedling height and growth, especially after slash chopping. The percentage of bare soil resulting from clearcutting was significantly and negatively related to *P. pinaster* density, survival and height.

Because of the contribution of the new cohort, at the end of the study there were no differences in seedling density related to treatment; the densities ranged from 3.4 seedlings m^{-2} in the non-harvested treatment to 2.5 seedlings m^{-2} in harvest + slash windrowing treatment, whereas in the harvest + slash chopping treatment these were 3.2 seedlings m^{-2}. The delay in harvesting may have lessened the impact of these forestry operations on *P. pinaster* recruitment. Reduction in seedling density caused by harvest and slash manipulation operations might reduce the need for subsequent thinning operations.

Fukushima, Maki; Kanzaki, Mamoru; Hara, Masatoshi; Ohkubo, Tatsuhiro; Preechapanya, Pornchai; Choocharoen, Chalathon. 2008. Secondary forest succession after the cessation of swidden cultivation in the montane forest area in Northern Thailand. Forest Ecology and Management 255: 1994-2006.

Abstract. As controls over swidden cultivation have tightened since the 1980s, the number of abandoned fallow fields has increased in mountainous areas of Northern Thailand. The objective of this study was to investigate the recovery of species composition, diversity (Shannon's *H'*), and aboveground biomass in secondary forests that were abandoned after swidden cultivation for more than 20 years. A census of trees in secondary forest abandoned after upland rice cultivation or poppy cultivation and in uncultivated forest stands was conducted in a Karen village in Doi Inthanon National Park. *Castanopsis acuminatissima* and other Fagaceae species were the dominant species in uncultivated forest stands, while *Schima wallichii* was the most dominant species in secondary forest stands. The dominance of *S. wallichii*, *Machilus bombycia*, and *Eurya acuminate* var. *wallichiana* was higher in stands that had experienced poppy cultivation, resulting in the lower species diversity. Aboveground biomass in stands abandoned after upland cultivation with no history of poppy cultivation was higher than in stands that had a history of poppy cultivation. This is probably because tree stumps, which act as reservoirs for rapid recovery, were left after abandonment of upland rice cultivation. Cluster analysis revealed three different stand groups, based on presence/absence data of each species. Stands used only for upland rice cultivation were found in the stand group characterized by Fagaceae species, while stands abandoned after poppy cultivation and stands abandoned after upland rice cultivation that were located in the area where poppy had been cultivated in the past tended to be included in the stand group characterized by *E. acuminate* var. *wallichiana*. The species presence/absence composition results in stands with a history of poppy cultivation show that these areas take more time to reach climax species composition.

Fulé, Peter Z.; Ribas, Montserrat; Gutiérrez, Emilia; Vallejo, Ramón; Kaye, Margot W. 2008. Forest structure and fire history in an old *Pinus nigra* forest, eastern Spain. Forest Ecology and Management 255: 1234-1242.

Abstract. Wildfires have decimated forests of *Pinus nigra* in the Mediterranean Basin in recent decades, but little is known about the fire ecology of this native species. We sampled three small relict forest sites on Sierra Turmell, Castellón, Valencia, northeastern Spain, to determine forest structure and past fire events. The forest was characterized by relatively

large and old trees (mean 158 year, max 362 year). Fire history was affected by obliteration of some fire scars, but we determined 11 fire dates in the past 172 years. The minimum fire-free interval was 2 years, maximum 57 years. Fire dates were not linked with dry climatic conditions, possibly due to occupational burning by pastoralists. Compared to inventory data averages for *P. nigra* in northeastern Spain (Catalunya), the old forest at Sierra Turmell supported over twice the basal area and over 2.5 times the biomass, with a comparable advantage in terms of carbon storage. Carbon sequestration, on the other hand, was over six times higher in the younger forests. The relict forest at Sierra Turmell provides evidence of multi-aged forest structure persisting through numerous surface fires over several centuries. This example may be useful for guiding management of younger forests and for ecological restoration of degraded areas.

Hart, Stephen A.; Chen, Han Y. H. 2008. Fire, logging and overstory affect understory abundance, diversity and composition in boreal forest. Ecological Monographs 78(1): 123-140.

Abstract. Understory vegetation plays a critical role in boreal ecosystems. Despite this, quantitative evaluation of the factors controlling understory vegetation abundance, diversity, and composition in the most diverse boreal forest region in North America is lacking. This study examined the dynamics of understory vegetation of stands of fire origin and tested effects of overstory composition and logging vs. fire on the understory vegetation dynamics in Ontario, Canada. Understory vegetation communities were sampled in 68 stands of conifer, mixed-wood, and deciduous overstory type ranging from 7 to 201 years postfire for stands of fire origin, and from 7 to 31 years for stands of logging origin. For stands of fire origin, total cover and species richness followed similar trends for the three overstory types and were highest in the intermediate-aged stands (72–90 years). Trends in cover and richness, however, differed significantly for vascular and nonvascular plant groups. Vascular cover and species richness were generally higher under deciduous stands, and lower on older stands, while nonvascular species richness was highest under conifer stands and increased with time since fire. Neither species richness nor compositional turnover was higher under mixed-wood stands; mixed-wood stands were compositionally intermediate to conifer and deciduous stands. Multivariate analysis using multiple-response permutation procedures indicated that understory communities were compositionally distinct for all overstory types and showed no convergence with increasing time since fire. Compared with postfire stands of similar ages, post-logged stands had similar total understory cover and richness. Vascular cover and richness, however, were higher on post-logged stands, and nonvascular cover and richness were lower. Stands of logging and fire origin were compositionally distinct for all overstory types and ages. Compositional differences appeared to be driven by higher preestablished rhizomatous species and few pyrophilic species on post-logged sites. Understory vegetation communities in the central boreal shield appear to support the intermediate disturbance hypothesis. Understory richness, however, was not negatively associated with high cover values as predicted by the intermediate disturbance hypothesis. Moreover, richness appears to be highest on sites with high light availability, suggesting that boreal understory communities are influenced more by plant tolerances for low resources, rather than by competition.

Holzmueller, Eric J.; Jose, Shibu; Jenkins, Michael A. 2008. The relationship between fire history and an exotic fungal disease in a deciduous forest. Oecologia 155: 347–356.

Abstract. Exotic diseases have fundamentally altered the structure and function of forest ecosystems. Controlling exotic diseases across large expanses of forest has proven difficult,

but fire may reduce the levels of diseases that are sensitive to environmental conditions. We examined *Cornus florida* populations in burned and unburned *Quercus–Carya* stands to determine if burning prior to anthracnose infection has reduced the impacts of an exotic fungal disease, dogwood anthracnose, caused by *Discula destructiva*. We hypothesized that fire has altered stand structure and created open conditions less conducive to dogwood anthracnose. We compared *C. florida* density, *C. florida* health, and species composition and density among four sampling categories: unburned stands, and stands that had burned once, twice, and 3 times over a 20-year period (late 1960s to late 1980s). Double burn stands contained the greatest density of *C. florida* stems (770 stems ha^{-1}) followed by triple burn stands (233 stems ha^{-1}), single burn stands (225 stems ha^{-1}) and unburned stands (70 stems ha^{-1}; $P < 0.01$). We observed less crown dieback in small *C. florida* trees (<5 cm diameter at breast height) in burned stands than in unburned stands ($P < 0.05$). Indicator species analysis showed that burning favored species historically associated with *Quercus–Carya* forests and excluded species associated with secondary succession following nearly a century of fire suppression. Our results suggest that fire may mitigate the decline of *C. florida* populations under attack by an exotic pathogen by altering forest structure and composition. Further, our results suggest that the burns we sampled have had an overall restorative effect on forest communities and were within the fire return interval of the historic fire regime. Consequently, prescribed fire may offer a management tool to reduce the impacts of fungal disease in forest ecosystems that developed under historic burning regimes.

Junninen, Kaisa; Kouki, Jari; Renvall, Pertti. 2008. Restoration of natural legacies of fire in European boreal forests: an experimental approach to the effects on wood-decaying fungi. Canadian Journal of Forest Research 38(2): 202-215.

Abstract. Effective fire suspension in Fennoscandian boreal forests has caused a number of species to become threatened. To compensate for the negative ecological impacts of fire elimination, prescribed burning of forests as a restoration method has been introduced recently. We studied the effects of controlled burning on assemblages of wood-decaying polypores (Basidiomycota), including red-listed species, in a large-scale field experiment in Finland. A total of 24 forest sites were included in the factorial study design with two factors: logging and burning. The presence of polypore fruiting bodies was documented 1 year before the treatments, and 1 and 4 years after the treatments. Over 11 000 observations of 104 species of polypores were made. Change in the fungal species composition due to logging and burning was clear after 4 years. At the species level, the responses to logging and fire varied depending on the species. Treatments increased fruiting of pioneer decayers; however, most red-listed species seemed to suffer. Thus, prescribed burning does not offer immediate benefits for most red-listed species. In unlogged forests, the restorative effects of fire are likely to be seen later as the death and decay processes of trees continue and provide more resources for polypores.

Kuenzi, Amanda M.; Fulé, Peter Z.; Sieg, Carolyn Hull. 2008. Effects of fire severity and pre-fire stand treatment on plant community recovery after a large wildfire. Forest Ecology and Management 255: 855-865.

Abstract. The Rodeo–Chediski fire burned approximately 189,650 ha in east–central Arizona from June 18 to July 7, 2002, 113,700 ha of it on White Mountain Apache tribal land. In 2004 and 2005, we measured plant canopy cover and richness in areas of high and low burn severity in each of two treatments: (1) cutting and prescribed burning, or (2) untreated, in the 11 years prior to the wildfire. Total understory plant canopy cover was significantly higher in areas of high severity ($p = .0002$ in 2004 and $p = .0001$ in 2005).

Overall, there was high richness of exotic species but cover was surprisingly low at <3% across all years, severities, and treatments. There were no significant differences in exotic species cover between high and low severity or between treated and untreated areas. Areas of high severity burn were seeded after the fire with several native grasses, native forbs, and common wheat (*Triticum aestivum* L.). Wheat had a strong presence in the plant community in 2004, but was uncommon by 2005. Indicator Species Analysis showed the indicators of high severity were seeded or early successional species. In contrast, indicators of low severity included several perennial bunchgrasses. While our results show that wheat declined quickly and exotic plants were uncommon, any longer-term impacts of the fire on the plant community can only be addressed by continued monitoring of these sites.

Kurulok, Stephanie E.; Macdonald, S. Ellen. 2007. Impacts of postfire salvage logging on understory plant communities of the boreal mixedwood forest 2 and 34 years after disturbance. Canadian Journal of Forest Research 37(12): 2637-2651.

Abstract. We compared understory vegetation composition and richness in aspen-dominated boreal mixedwood forest stands in Alberta, Canada, that had been burned by wildfire with those that burned and were subsequently salvage logged. Stands were examined at early and midsuccessional (2 and 34 years after disturbance(s), respectively) developmental stages. In comparison with wildfire stands, understory communities of early successional salvage-logged stands were characterized by greater species richness, weedy species presence, higher shrub abundance, and lower abundances of fire-specialist seed bank species. In constrained ordination, the understory community of early successional wildfire stands was related to greater canopy cover, sapling density, and moss depth, whereas that of salvage-logged stands was related to greater light, volume of downed deadwood, and litter and organic matter. Longer term effects of salvage logging on the understory community were minimal and, instead, reflected the influence of forest canopy redevelopment. In midsuccessional stands, understory composition was related to conifer density, litter cover, soil moisture, organic layer depth, tall shrub density, and bryophyte-covered microsite cover. Postfire salvage logging can have substantial short-term effects on the postfire understory plant community; in the longer term, effects will depend to a large extent on the influence of harvesting and subsequent management on canopy redevelopment.

Laughlin, Daniel C.; Fulé, Peter Z. 2008. Wildland fire effects on understory plant communities in two fire-prone forests. Canadian Journal of Forest Research 38(1): 133-142.

Abstract. Our understanding of wildland fire effects on understory plant communities is limited because of a lack of repeated measurements before and after lightning-ignited fires. We examined vegetation responses to a surface fire in a ponderosa pine forest and a mixed-severity fire in a spruce–fir–aspen forest using before–after, control–impact (BACI) study designs. We hypothesized that the surface fire would stimulate plant species richness and minimally alter community composition, but that the mixed-severity fire would decrease richness and significantly alter composition. In ponderosa pine forests, total species richness and plant cover increased slightly because of annual and biennial forb and grass establishment in soils where duff layers were reduced by the surface fire. In spruce–fir–aspen forests, total species richness and plant cover were similar in burned and unburned forests after 2 years, although annual and biennial forbs and graminoids increased significantly in the burned area. Plant community composition was altered by both fires. Wildfires may indirectly influence the understory plant community through the mediating effects of overstory basal area and litter depth. Fire effects on plant species richness and

cover were weaker than effects due to environmental factors. Managers should anticipate increases in both native and non-native ruderal species following landscape-scale fires.

Miller, Darren A.; Chamberlain, Michael J. 2008. Plant community response to burning and herbicide site preparation in eastern Louisiana, USA. Forest Ecology and Management 255: 774-780.

Abstract. High yield commercial forests are an important source of fiber for global forest product needs and the southeastern United States is a key region for global wood supply needs with intensively managed pine stands (*Pinus* spp.) an important component of forested landscapes in this region. Concern has arisen over possible effects of stand establishment practices on vegetation communities within commercial forests, particularly relative to use of herbicides and burning. Therefore, we examined response of plant communities to site preparation within intensively managed pine stands in eastern Louisiana, USA that were either prescribe burned (PF; $n = 5$) or treated with a combination of herbicides (imazapyr and triclopyr) and prescribe burned (PFH; $n = 5$) during 2002. We used 5 m line intercepts ($n = 10$ per stand) to quantify species richness, diversity, and relative abundance of plant species for 3 years post-treatment (2003–2005) with a repeated measures analysis of variance. We documented 80 genera or species of plants and neither species richness nor diversity differed between treatments. Site preparation with PFH appeared to promote development of an herbaceous plant community and reduced relative abundance of woody plants, whereas PF-treated sites were dominated by woody vegetation. Our results demonstrate that different plant communities result from PF and PFH site preparation and may place stands on different successional trajectories. We suggest PFH site preparation may increase availability of early successional vegetation associations on managed forest landscapes and may extend the time stands stay in this successional stage. However, increased crop tree growth from site preparation may shorten open canopy conditions.

Nowacki, Gregory J.; Abrams, Marc D. 2008. The demise of fire and "mesophication" of forests in the eastern United States. BioScience 58(2): 123-138.

Abstract. A diverse array of fire-adapted plant communities once covered the eastern United States. European settlement greatly altered fire regimes, often increasing fire occurrence (e.g., in northern hardwoods) or substantially decreasing it (e.g., in tallgrass prairies). Notwithstanding these changes, fire suppression policies, beginning around the 1920s, greatly reduced fire throughout the East, with profound ecological consequences. Fire-maintained open lands converted to closed-canopy forests. As a result of shading, shade-tolerant, fire-sensitive plants began to replace heliophytic (sun-loving), fire-tolerant plants. A positive feedback cycle—which we term "mesophication"—ensued, whereby microenvironmental conditions (cool, damp, and shaded conditions; less flammable fuel beds) continually improve for shade-tolerant mesophytic species and deteriorate for shade-intolerant, fire-adapted species. Plant communities are undergoing rapid compositional and structural changes, some with no ecological antecedent. Stand-level species richness is declining, and will decline further, as numerous fire-adapted plants are replaced by a limited set of shade-tolerant, fire-sensitive species. As this process continues, the effort and cost required to restore fire-adapted ecosystems escalate rapidly.

Penman, Trent D.; Binns, Doug L.; Kavanagh, Rodney P. 2008. Quantifying successional changes in response to forest disturbances. Applied Vegetation Science 11(2): 261-268.

Question: Can dissimilarity measures of individual plots be used to forecast the driving factors among various anthropogenic disturbances influencing understorey successional changes?

Location: Yambulla State Forest, south-eastern Australia (37°14′ S, 149°38′ E).

Methods: Assessments of understorey vegetation communities were taken prior to anthropogenic disturbances and at three subsequent time periods representing a period of 15 years post-disturbance. Dissimilarities were calculated from the original assessment and modelled in a Bayesian framework to examine the influence of logging, number of prescribed burns and time.

Results: All sites underwent significant changes over time independently of the imposed management regimes. Logging resulted in an immediate change in vegetation assemblage which decreased in the subsequent assessments. The number of prescribed fires brought greater change in the shrub vegetation assemblages, but less change in the ground species vegetation assemblages.

Conclusions: The anthropogenic disturbances did have some role in the changes of vegetation assemblages but these were minimal. The ongoing changes appear to be a natural response to the last wildfire, which passed through the study area in 1973 (13 years prior to the study). Forest management practices should consider the influence of wildfire succession when planning for the conservation of biodiversity.

Pitkänen, Aki; Kouki, Jari; Viiri, Heli; Martikainen, Petri. 2008. Effects of controlled forest burning and intensity of timber harvesting on the occurrence of pine weevils, *Hylobius* spp., in regeneration areas. Forest Ecology and Management 255: 522-529.

Abstract. Recently introduced modifications to timber harvesting, such as leaving retention trees and applying prescribed burning, are likely to have an influence on the occurrence of pests affecting regeneration, such as pine weevils (*Hylobius* spp.). We analyze here the occurrence of pine weevils in regeneration areas representing different harvesting methods. Pine weevils were monitored during three summers using flight intercept and pitfall traps placed on clear-cut sites, sites with 10 or 50 m^3 timber ha^{-1} and uncut forest sites, totalling 24 in all. A half of the sites were treated with prescribed burning. Burning and the use of retention trees increased the catches of *Hylobius abietis* but not of *H. pinastri*. Pitfall trap catches suggested 10–24 times higher population density of *H. abietis* on logged clear-cut sites than in undisturbed forests. Catches on burned and clear-cut forest sites were 35–55 times higher than in undisturbed forests. Flight intercept trap catches suggested that the migration of flying weevils to freshly treated sites (logging or prescribed burning or both) continued after the early summer swarming period, which differs from previous results. The groups of retention trees attracted both flying and walking *H. abietis* individuals. These results indicate that retention trees may provide an alternative food source for weevils and may consequently reduce the harmful impacts that weevils have on pine seedlings.

Scheller, Robert M.; Van Tuyl, Steve; Clark, Kenneth; Hayden, Nicholas G.; Hom, John; Mladenoff, David J. 2008. Simulation of forest change in the New Jersey Pine Barrens under current and pre-colonial conditions. Forest Ecology and Management 255: 1489-1500.

Abstract. Changes in land use patterns in and around forests, including rural development and road building, have occurred throughout the United States and are accelerating in many areas. As a result, there have been significant departures from 'natural' or pre-settlement

disturbance regimes. Altered disturbance regimes can shift composition and dominance in tree species communities, potentially affecting ecosystem functioning. We examined the potential consequences of various forest management practices and forest fragmentation on tree community composition. Both forest management and fragmentation are changing as land use changes within the New Jersey Pine Barrens (NJPB). The NJPB has and is continuing to experience rapid rural development and urbanization that are altering the types, frequency, and intensity of forest management, and are increasing forest fragmentation. In the NJPB, the size and frequency of wildfires have declined and the use of prescribed fires is limited to a small portion of the landscape. In addition, the expansion of roads and decline in total forested area – two common measures of fragmentation – may impede the ability of tree species to colonize available habitat. To assess the consequences of fire management and fragmentation on fire regimes and forest communities, we simulated forest landscape change using LANDIS-II, a stochastic, spatially dynamic forest succession model that simulates the growth of tree species cohorts (defined by species and age), dispersal and colonization, and mortality. Simulated fires are sensitive to fuel loads and fuel load continuity. We constructed scenarios to mimic the pre-colonial contiguous landscape with an estimated pre-colonial fire regime; scenarios of the current day landscape with current and potential fire management; and scenarios designed to highlight the effects of fragmentation. Our simulations indicate that relative to the pre-colonial landscape and fire regime, the landscape is changing from a pine-dominated to an oak-dominated state. However, within areas where prescribed burning remains a viable management option, a doubling of the mean annual area that is managed with prescribed burns may substantially push the system back towards pre-colonial conditions, although oaks will continue to retain a higher than pre-colonial dominance. Our results also indicate that aside from a reduction in the potential fire sizes, fragmentation does not appear to substantially alter forest successional dynamics. In summary, our simulations estimate the departure from pre-colonial conditions and indicate the potential for a limited restoration of these conditions.

Smirnova, Evgeniya; Bergeron, Yves; Brais, Suzanne; Granström, Anders. 2008. Postfire root distribution of Scots pine in relation to fire behaviour. Canadian Journal of Forest Research 38(2): 353-362.

Abstract. Fire can potentially have a large direct impact on tree roots and, thus, contribute to reduced vitality. Tree canopy status after fire should have an impact on the postfire production of fine roots, further affecting root function. We analyzed the standing crop of live and dead roots in *Pinus sylvestris* L. with varying degrees of crown scorch, 1 year after fire in northern Sweden. On the burned sites, total *Pinus* live fine-root biomass was 74% of that at the control sites, and it was only 19% of the control for roots <2 mm, indicating an 80% reduction due to fire. Root mortality was highest for high-scorch trees, but this was probably due to greater depth of burn in the organic soil for these trees and not to higher fire intensity per se. Fine-root production was also assessed by an ingrowth experiment. This showed relatively similar fine-root production in both control trees and fire-damaged trees, indicating a high allocation to root growth for the damaged trees, to make up for lost root function. Root dynamics after fire are related to a number of factors, and direct effects are determined by the depth of burn in the organic soil layer. Indirect, long-lasting effects could be due mainly to girdling of coarse roots close to tree stems and canopy loss.

Grasslands and Shrublands

Aleper,Daniel; Lye, Kåre A.; Moe, Stein R. 2008. Response of *Acacia sieberiana* to repeated experimental burning. Rangeland Ecology and Management 61(2): 182-187.

Abstract. We conducted a study on how *Acacia sieberiana* respond to repeated burning in the Kidepo National Park in northeastern Uganda. The study was conducted to understand effects of common burning regimes (early dry season, late dry season, and no burn [control]) in the area on *Acacia sieberiana.* The three treatments were applied for three consecutive years to 14 replicate blocks in a randomized block design. All *A. sieberiana* trees were number tagged and monitored for height and girth (diameter at breast height) growth. All fires were set as head-fires and attained intensity ranging between 422 and 5693 kW · m^{-1}. Both early and late dry season burning increased the number of small (< 49 cm) *A. sieberiana* trees after 2 yr. Burning did not affect the growth rates. Although the number of trees < 49 cm increased after 2 yr, the mortality in this height class was also increased by the late dry season burning, and after 3 yr of consecutive burning there were no statistical treatment differences in the height class < 49 cm. Late dry season burning also led to high mortality among trees > 250 cm in the third year. Mortality attributed to elephant browsing was important in all treatments but a substantial portion of mortality could not be attributed to any particular cause. In the late burn, fire was the most important mortality factor. Thus, 2 yr of burning may be used as a tool to stimulate recruitment of *A. sieberiana*, but additional years of late dry season burning will increase the mortality of older trees.

Baeza, M.J.; Vallejo, V.R. 2008. Vegetation recovery after fuel management in Mediterranean shrublands. Applied Vegetation Science 11(2): 151-158.

Question: What is the effect of fuel management practices in the recovery capacity of seeder-dominated shrublands?

Location: *Ulex parviflorus* shrubland localities in Mediterranean regions of eastern Spain.

Methods: We applied prescribed burning and brush-chipping as fuel management techniques in three young and three mature shrublands, and evaluated the effects in the following four years.

Results: Canopy opening by the treatments allowed increasing species richness through the four years of secondary succession. The treatments produced a change in community structure and dominant species, from the woody seeder *Ulex parviflorus* to the resprouter grass *Brachypodium retusum*. Vegetation response was conditioned by both shrubland developmental stage and treatment applied. Burning resulted in more severe modification of the ecosystem, increasing bare soil cover. Four years after fuel management in different aged Mediterranean gorse shrublands, vegetation response followed a similar pattern with the exception of the young, brush-chipped shrublands. The treatments applied for controlling *Ulex parviflorus* were seen to be very effective, with the exception of brush-chipping in young shrublands.

Conclusions: Selective brush-chipping in middle-aged or mature gorse shrublands would combine a drastic reduction in fire hazard with ecosystem conservation and regeneration.

Cardoso, Manoel F.; Nobre, Carlos A.; Lapola, David M.; Oyama, Marcos D.; Sampaio Gilvan. 2008. Long-term potential for fires in estimates of the

occurrence of savannas in the tropics. Global Ecology and Biogeography 17(2): 222–235.

Aim This study aims to improve the formulation and results of the Brazilian Center for Weather Forecasting and Climate Studies Potential Vegetation Model (CPTEC-PVM) by developing a new parameterization for the long-term occurrence of fire in regions of potential savannas in the tropics. Compared with the relatively slow processes of carbon uptake and growth in vegetation, fast mortality and biomass consumption by fires may favour grasses and reduce tree coverage.

Location The tropics.

Methods For finding large-scale relationships between fires and other environmental factors, we made two main simplifying assumptions. First, lightning is the most important source of ignition for natural fires. Second, over continental areas in the tropics, lightning is mainly related to the zonal flux of moisture transport.

Results The parameterization of fire occurrence was built based on a simple empirical relationship, combining information on mean and intra-annual variance of the zonal wind.

Main conclusions The implementation of this new relationship improved the formulation and the results of the CPTEC-PVM. As a result of this new parameter, the accuracy of the model in allocating the correct vegetation (seasonal forests) instead of savannas for large regions in India and Southeast Asia is now substantially higher than in previous studies.

Cleary, M.B.; Pendall, E.; Ewers, B.E. 2008. Testing sagebrush allometric relationships across three fire chronosequences in Wyoming, USA. Journal of Arid Environments 72(4): 285-301.

Abstract. Aboveground and coarse root allometric relationships were tested across three mountain big sagebrush (*Artemisia tridentata* var. *vaseyana* (Rydb.) chronosequences at three stages of recovery from fire (establishment, expansion, and mature) in Wyoming, USA. Big sagebrush shrubs dominate North American rangelands and are critical components of habitat for threatened species such as sage grouse. There were no differences in regression relationships estimating biomass over space and time, which reduces the need to destructively sample sagebrush for local studies and supports regional carbon modeling and biomass estimates. Crown volume (CV) explained the most variability (R^2>0.75) in aboveground biomass, and crown area (CA) explained the most variability for coarse roots (R^2>0.87). Analyses supported both the $\frac{1}{4}$and $\frac{2}{3}$power universal scaling rules between leaf and stem biomass, but did not support global models of seed plant reproductive part biomass. This study provides compelling evidence that simple field measurements may be used to estimate biomass over large regions and that universal scaling rules are valid for semiarid shrubs.

Davies, Kirk W.; Bates, Jonathan D. 2008. The response of Thurber's needlegrass to fall prescribed burning. Rangeland Ecology and Management 61(2): 188-193.

Abstract. Thurber's needlegrass (*Achnatherum thurberianum* [Piper] Barkworth) is an important component of many sagebrush communities in the Intermountain West. Prescribed fall burning is often implemented in sagebrush plant communities to mimic historic wildfires, improve wildlife habitat, and increase livestock forage production. Burning is used because it shifts dominance from sagebrush to herbaceous vegetation. The effects of prescribed fall burning on Thurber's needlegrass are largely unexplored. The purpose of this study was to determine the response of Thurber's needlegrass to prescribed fall

burning. A randomized block design was used, and each block consisted of a fall burned and unburned (control) Wyoming big sagebrush (*Artemisia tridentata* subsp. *wyomingensis* [Beetle & A. Young] S. L. Welsh)–bunchgrass communities. Response variables measured in the first and second years after burns were Thurber's needlegrass community foliar cover and density, vegetative and reproductive biomass, photosynthetic rates, tissue carbon (C) and nitrogen (N) content, and N (^{15}N:^{14}N) and C (^{13}C:^{12}C) isotope ratios. Density of Thurber's needlegrass in both postburn years and cover in the second postburn year were not different between treatments ($P > 0.05$), but cover was less in the burned than control treatment in the first postburn year ($P = 0.008$). Carbon isotope ratios in Thurber's needlegrass differed between the burn (−25.9 ± 0.1 SE) and control (−26.3 ± 0.1 SE) treatments in the first postburn year ($P = 0.019$). Nitrogen isotope ratios indicated nitrogen was more available in the burned than control treatment in both years ($P < 0.05$). Photosynthetic rates of Thurber's needlegrass were also generally greater in the burned than control treatment ($P = 0.045$). Our results suggest burning altered the availability of resources to Thurber's needlegrass plants. Our results also suggest that prescribed fall burning is not detrimental to Thurber's needlegrass and, thus, can be used as a method to shift dominance from sagebrush to herbaceous vegetation.

de A. Mamede, M.; de Araújo, F.S. 2008. Effects of slash and burn practices on a soil seed bank of caatinga vegetation in Northeastern Brazil. Journal of Arid Environments 72(4): 458-470.

Abstract. The semiarid tropical zone covers 20% of Brazil and is dominated by caatinga, a thorny deciduous savanna well adapted to seasonal water shortage and periodic drought years. This study was focused on effects of slash and burn agriculture on the soil seed bank in a Caatinga area, in Sobral, CE, Brazil. Caatinga is rich in species, called therophytes, which remain as seeds in the soil during unfavorable seasons and rely on regeneration from the soil seed bank for persistence in the environment. Although slash and burn agriculture has been intensified in the region for the past three centuries, its effects on the soil seed bank are not well known. A seedling emergence greenhouse experiment was conducted to evaluate differences in seed bank density and diversity among soil samples collected before and after an experimental burning. Soil samples were previously submitted to sequential sieving to assess fire effects on different-sized seeds. Fire significantly reduced overall seed bank density, with smaller sieving fractions being most strongly affected. Shanon's diversity index was also lowered by fire. Combined, these results show that agricultural practices represent a serious threat to plant biodiversity conservation in the Caatinga biome.

Getz, Hilary L.; Baker, William L. 2008. Initial invasion of cheatgrass (*Bromus tectorum*) into burned piñon-juniper woodlands in western Colorado. The American Midland Naturalist 159(2): 489-497.

Abstract. We studied initial invasion of cheatgrass (*Bromus tectorum*) into burned piñon-juniper woodlands to determine: (1) if particular features enhance invasion and (2) if particular grasses promote or retard invasion. We compared cheatgrass cover among roads, burn edges, seeded interiors, unseeded interiors and unburned woodlands and quantified grasses present or absent near cheatgrass. Invasion was favored by burn edges, roads and seeded interiors, but not unseeded interiors. Odds of finding cheatgrass were seven times higher near prairie junegrass (*Koeleria macrantha*), but six times lower near James' galleta (*Hilaria jamesii*) and two times lower near intermediate wheatgrass (*Agropyron intermedium*). Invasion may be favored: (1) in burn edges because of higher seed-bank survival, (2) along roads because of moisture, disturbance and dispersal and (3)

in seeded interiors because of seed-mix contamination or seeded species that enhance invasion.

Gómez-González, S.; Sierra-Almeida, A.; Cavieres, L.A. 2008. Does plant-derived smoke affect seed germination in dominant woody species of the Mediterranean matorral of central Chile? Forest Ecology and Management 255: 1510-1515.

Abstract. Studies performed in the fire-prone Mediterranean-type climate shrublands of Australia, California, and South Africa have shown that plant-derived smoke enhances seed germination in many species. Unlike other areas with similar climate, central Chile stands out for the absence of natural fires, suggesting that smoke may not be expected to promote germination. However, anthropogenic fires have been frequent since several millennia, and the role of fire on shaping fire functional traits is not clear at this point. The aim of this study was to evaluate the effects of plant-derived smoke on seed germination of some predominant native woody species from the Mediterranean matorral of central Chile. We exposed seeds of 18 woody species to plant-derived smoke for 30 min and assessed their germination. Five species failed to germinate under either the experimental and control conditions. Smoke significantly stimulated germination in three species, while decreasing it in eight. Species showing smoke-inhibited germination tend to be major dominants in the Chilean matorral vegetation. The three smoke-stimulated species are known colonizers. This suggests that current human-caused fires could drastically change the structure of Chilean matorral. Although our results suggest fire have not played a major role in shaping adaptations for seed germination of woody species in the Chilean matorral, more investigation about ephemeral species is needed. This study provides the first results about smoke-related germination in the Mediterranean-type zone of central Chile, generating the opportunity to investigate the evolutionary context and distribution of smoke-stimulated germination in all the Mediterranean-type ecosystems.

Miller, Richard F.; Tausch, Robin J.; McArthur, E. Durant; Johnson, Dustin D.; Sanderson, Stewart C. 2008. Age structure and expansion of piñon-juniper woodlands: a regional perspective in the Intermountain West. Res. Pap. RMRS-RP-69. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 15 p. Available at http://www.fs.fed.us/rm/pubs/rmrs_rp069.pdf

Numerous studies have documented the expansion of woodlands in the Intermountain West; however, few have compared the chronology of expansion for woodlands across different geographic regions or determined the mix and extent of presettlement stands. We evaluated tree age structure and establishment for six woodlands in four ecological provinces in the central and northern Great Basin. Since 1860, the area occupied by piñon and or juniper has increased 125 to 625 percent. The increase of trees was a result of infill into shrub-steppe communities with relatively open low density stands of trees and expansion of piñon and juniper into sagebrush-steppe communities that previously did not support trees. Woodland expansion in Oregon, Utah, and Nevada were similar, but began two to three decades earlier in Idaho. The majority of woodlands are still in the early to mid phases of stand closure, which means they often support an understory of shrubs and herbaceous vegetation. This has implications for future changes that will occur within these woodlands in the next 30 to 50 years. In the absence of disturbance or management, the majority of these landscapes will become closed woodlands resulting in the loss of understory plant species and greater costs for restoration.

Parmenter Robert R. 2008. Long-term effects of a summer fire on desert grassland plant demographics in New Mexico. Rangeland Ecology and Management 61(2): 156-168.

Abstract. Plant demographic responses to an experimental summer fire were monitored for 12 yr on the Sevilleta National Wildlife Refuge, New Mexico, to determine recovery rates of burned plants and evaluate fire effectiveness in preventing shrub invasion of desert grasslands. Fourteen common species of grasses, shrubs, yucca, and cacti were measured for mortality, resprouting, regrowth, herbivory, and reproduction. After the first postfire growing season, black grama (*Bouteloua eriopoda* [Torr.] Torr.) declined 80% in size, whereas blue grama (*Bouteloua gracilis* [Willd. ex Kunth] Lag. ex Griffiths) exhibited no decline. Linear regression indicated that *B. eriopoda* needed 11 yr to recover. Spike dropseed (*Sporobolus contractus* A.S. Hitchc.) and purple three-awn (*Aristida purpurea* Nutt.) showed postfire declines in plant sizes, requiring 4- and > 5-yr recovery times, respectively. Sand muhly (*Muhlenbergia arenicola* Buckl.) exhibited no fire impact. Snakeweed (*Gutierrezia sarothrae* [Pursh] Britt. & Rusby) sustained 61% fire mortality and reduction in regrowth canopy size. Creosotebush (*Larrea tridentata* [Sesse & Moc. ex DC.] Coville) had 12% mortality, but survivors recovered over 12 yr. Fourwing saltbush (*Atriplex canescens* [Pursh] Nutt.) sustained 62% mortality, but recovered plant size in 5–6 yr. Winterfat (*Krascheninnikovia lanata* [Pursh] A. D. J. Meeuse & Smit) suffered 7% mortality, but required 9+ yr to recover. Pale desert-thorn (*Lycium pallidum* Miers) survived fire, recovering prefire canopy size in 3 yr. Torrey joint-fir (*Ephedra torreyana* Watson) exhibited < 1% mortality, and recovered in 2–3 yr. Soapweed yucca (*Yucca glauca* Nutt.) had < 2% mortality, recovered plant sizes in 2 yr, and increased numbers of rosettes 17%. Chollas (*Opuntia imbricata* [Haw.] DC. and *Opuntia clavata* Engelm.) suffered high mortality rates and required > 12 yr recovery times. Results demonstrated that summer fire may counter some shrub and cacti invasion in central New Mexico, but once shrubs mature, fire is less effective in removing woody plants to restore southwestern grasslands.

Rau, Benjamin M.; Chambers, Jeanne C.; Blank, Robert R.; Johnson, Dale W. 2008. Prescribed fire, soil, and plants: burn effects and interactions in the central Great Basin. Rangeland Ecology and Management 61(2): 169-181.

Abstract. Pinyon and juniper expansion into sagebrush ecosystems results in decreased cover and biomass of perennial grasses and forbs. We examine the effectiveness of spring prescribed fire on restoration of sagebrush ecosystems by documenting burn effects on soil nutrients, herbaceous aboveground biomass, and tissue nutrient concentrations. This study was conducted in a central Nevada woodland and included control and burn treatment plots sampled before and after a prescribed fire. Six native understory plant species (*Crepis acuminata*, *Eriogonum umbellatum*, *Eriogonum elatum*, *Poa secunda secunda*, *Festuca idahoensis*, and *Lupinus argenteus*) important for native sagebrush obligate foragers were chosen to represent the understory plant community. *L. argenteus* is also important for system nutrient cycling and nitrogen fixation. Plants were collected from three microsites (under tree canopy, under shrub canopy, and interspace) common in transitional woodlands during peak growth the summer before a spring prescribed burn and each of two summers following the burn. Soils were collected from corresponding locations at two depth intervals (0–8 and 8–52 cm) to determine the relationships between soil and plant nutrients following fire. Microsite affected soil nutrients but did not influence plant tissue concentrations with the exception of *F. idahoensis.* Burning resulted in increases in soil surface NH+4, NO_3^-, inorganic N, Ca^{2+}, Mn^{2+}, and Zn^{2+}. Increases in NO_3^-, inorganic N, and Zn^{2+} were also observed in deeper horizons. Burning did not affect aboveground plant biomass or nutrient concentrations in the first year with the exception of *F. idahoensis*, which had increased tissue P. By the second year, all species had statistically significant responses to burning.

The most common response was for increased aboveground plant weight and tissue N concentrations. Plant response to burning appeared to be related to the burn treatment and the soil variables surface K^+, $NO-_3$, and inorganic N.

Reemts, Charlotte M.; Hansen, Laura L. 2008. Slow recolonization of burned oak–juniper woodlands by Ashe juniper (*Juniperus ashei*): Ten years of succession after crown fire. Forest Ecology and Management 255: 1057-1066.

Abstract. Fire is an important control on the distribution of plant communities on the Edwards Plateau in central Texas. Although the effects of fire in grasslands have been well studied, little is known about the recovery of mature oak–Ashe juniper (*Quercus* spp.–*Juniperus ashei*) woodlands after crown fire. These woodlands are the only nesting habitat of the endangered golden-cheeked warbler (*Dendroica chrysoparia*). In February 1996, crown fires burned more than 4000 ha of woodland on Fort Hood Military Reservation. Permanent transects were installed in moderately to severely burned areas on three soils types in 1996 and data were collected annually from 1996 to 2002 and again in 2005. We also sampled 36 transects in unburned areas on the same soil types in 2001 and 2005. Overall stem density (all species combined) in the burned areas recovered rapidly, at least in the smaller size classes (<1.8 m tall), and, by 2005, sapling stem density (>1.8 m tall, <5 cm dbh) was higher in burned areas than in unburned areas for all soil types (ANOVA, $p < 0.02$). Tree density (>5 cm dbh) in burned areas remained low until 2005 (2001: 20 ± 36 stems/ha; 2005: 326 ± 260 stems/ha). The dominant oak species recovered rapidly due to vigorous resprouting. Ashe juniper, a fire-sensitive species, recovered much more slowly. Only six Ashe juniper saplings (and no trees) were found in burned transects in 2005, compared to 646–871 trees/ha in unburned areas. Although Ashe juniper was largely absent from the burned areas, post-fire species composition was otherwise similar to unburned communities and became more similar with time (Sorenson similarity index in 1996: 0.70–0.83; 2005: 0.86–0.88). NMS ordination separated burned communities on different soils more than unburned communities, because all unburned areas were dominated by Ashe juniper. Due to the slow recovery of Ashe juniper, it will likely be decades before the burned areas are again suitable as breeding habitat for golden-cheeked warblers.

Ribeiro, Natasha S.; Shugart, Herman H.; Washington-Allen, Robert. 2008. The effects of fire and elephants on species composition and structure of the Niassa Reserve, northern Mozambique. Forest Ecology and Management 255: 1626-1636.

Abstract. In the Miombo Woodlands Region of south-central Africa, the interaction between fires and elephants is one of the main drivers of vegetation, along with climate, soils and topography. Fire–elephant interaction is particularly important in conservation areas where elephant populations are confined and anthropogenic fires occur every year. The effects of this interaction on vegetation composition and structure have not been extensively studied in the region. The Miombo woodlands of the 42,000 km^2 Niassa Reserve in northern Mozambique are subject to annual anthropogenic fires and an increasing elephant population, but it is not understood whether, the elephant–fire interaction is manifest. We investigate the distribution of plant species composition and ecosystem structure, and their relationships with environmental and disturbance factors within the Niassa Reserve. Fifty sampling plots were established and measurements for vegetation composition and structure, fire and elephant damage to plants, environmental (edaphic and topographic) and disturbance data were collected. We used multivariate statistics analysis including detrended correspondence analysis (DCA), canonical correspondence analysis (CCA) and Principal Component Analysis (PCA) to explore the data. Three groups of species

were distinguished according to their abundances: the *Miombo* group, the eastern *Combretacea* group and the western *Uapaca* group. The miombo group was uniformly distributed in the area and independent of environmental and disturbances factors. The *Uapaca* group followed an elevation gradient from east to west, while the combretacea group was explained by edaphic and disturbance factors. The damage to the woody component was predominant in the east. The damage by fire and elephant to miombo species was concentrated on adults, while these species had low ingrowth.

Sankaran, Mahesh; Ratnam, Jayashree; Hanan, Niall. 2008. Woody cover in African savannas: the role of resources, fire and herbivory. Global Ecology and Biogeography 17(2): 236–245.

Aim To determine the functional relationships between, and the relative importance of, different driver variables (mean annual precipitation, soil properties, fire and herbivory) in regulating woody plant cover across broad environmental gradients in African savannas.

Location Savanna grasslands of East, West and Southern Africa.

Methods The dependence of woody cover on mean annual precipitation (MAP), soil properties (texture, nitrogen mineralization potential and total phosphorus), fire regimes, and herbivory (grazer, browser + mixed feeder, and elephant biomass) was determined for 161 savanna sites across Africa using stochastic gradient boosting, a refinement of the regression tree analysis technique.

Results All variables were significant predictors of woody cover, collectively explaining 71% of the variance in our data set. However, their relative importance as regulators of woody cover varied. MAP was the most important predictor, followed by fire return periods, soil characteristics and herbivory regimes. Woody cover showed a strong positive dependence on MAP between 200 and 700 mm, but no dependence on MAP above this threshold when the effects of other predictors were accounted for. Fires served to reduce woody cover below rainfall-determined levels. Woody cover showed a complex, non-linear relationship with total soil phosphorus, and was negatively correlated with clay content. There was a strong negative dependence of woody cover on soil nitrogen (N) availability, suggesting that increased N-deposition may cause shifts in savannas towards more grassy states. Elephants, mixed feeders and browsers had negative effects on woody cover. Grazers, on the other hand, depressed woody cover at low biomass, but favoured woody vegetation when their biomass exceeded a certain threshold.

Main conclusions Our results indicate complex and contrasting relationships between woody cover, rainfall, soil properties and disturbance regimes in savannas, and suggest that future environmental changes such as altered precipitation regimes, N-enrichment and elevated levels of CO_2 are likely to have opposing, and potentially interacting, influences on the tree–grass balance in savannas.

Wetlands, Riparian Areas and Hydrology

Hossack, Blake R.; Corn, Paul Stephen. 2008. Wildfire effects on water temperature and selection of breeding sites by the boreal toad (*Bufo boreas*) in seasonal wetlands. Herpetological Conservation and Biology 3(1):46-54.

Abstract. Disturbances can significantly affect the thermal regime and community structure of wetlands. We investigated the effect of a wildfire on water temperature of seasonal, montane wetlands after documenting the colonization of recently burned wetlands

by the Boreal Toad (*Bufo boreas boreas*). We compared the daily mean temperature, daily maximum temperature, and accumulated growing degree·days measured on the north shore of three classes of wetlands: unburned wetlands, burned wetlands that were colonized by breeding toads, and burned wetlands that were not colonized. We hypothesized that toads colonized burned wetlands because they were warmer than unburned wetlands and selected specific burned wetlands because they were warmer than neighboring burned sites. There was weak evidence that toads selected burned wetlands with higher temperature maxima; however, the differences were small (≤ 1°C) and were not supported when accounting for geography and wetland features. We also found no evidence that burning the forest around wetlands increased water temperatures two and three years after the fire. Unburned wetlands had higher daily mean and maximum temperatures and accrued more growing degree·days than either class of burned wetlands. Temperature differences among groups of wetlands seemed to be driven by subtle differences in geography. We suspect we did not find warmer temperatures in burned wetlands because all of the wetlands we monitored already had open canopies and the fire likely resulted in only small increases in incident radiation.

Terrestrial and Aquatic Wildlife

Bagne, Karen E.; Purcell, Kathryn L.; Rotenberry, John T. 2008. Prescribed fire, snag population dynamics, and avian nest site selection. Forest Ecology and Management 255(1): 99-105.

Abstract. Snags are an important resource for a wide variety of organisms, including cavity-nesting birds. We documented snag attributes in a mixed-conifer forest dominated by ponderosa pine in the Sierra Nevada, California where fire is being applied during spring. A total of 328 snags were monitored before and after fire on plots burned once, burned twice, or left unburned to assess the effects of prescribed fire on snag populations. The greatest loss of snags (7.1 snags ha^{-1} or 43%) followed the first introduction of fire after a long fire-free period. On plots burned a second time 21% of snags (3.6 snags ha^{-1}) were lost, whereas 8% (1.4 snags ha^{-1}) were lost on unburned control plots in the same time period. New snags replaced many of those lost reducing the net snag losses to 12% (2.0 ha^{-1}) for plots burned once, and 3% (0.5 ha^{-1}) for plots burned twice and unburned plots. We also examined snags used by cavity-nesting birds. Snags preferred for nesting were generally ponderosa pine (*Pinus ponderosa*), larger diameter, and moderately decayed as compared to available snags. For monitored snags that met the preferred criteria, there was a net loss (1.7 snag ha^{-1} or 34%) after the first burn, while the loss of useable snags was less than 1 snag ha^{-1} following the second burn (15%) or on unburned controls (8%). We recommend protection of preferred snags, in particular large ponderosa pines, especially during primary fire applications on fire-suppressed landscapes.

Driscoll, Don A; Henderson, Meredith K. 2008. How many common reptile species are fire specialists? A replicated natural experiment highlights the predictive weakness of a fire succession model. Biological Conservation 141(2): 460-471.

Abstract. Species with strong preferences for early or late successional stages after fire may be extinction prone under current fire regimes. However, the extent of specialisation to time since fire is poorly understood, and, for reptiles, succession models for predicting responses are in the development phase. In this study we tested predictions of a reptile succession model, and identified species that may be fire specialists. Reptiles were sampled in five burnt and unburnt mallee *Eucalyptus* woodlands, Australia. Two, 400 m transects

within each burn treatment were sampled using 11 pairs of pitfall-traps that were opened for five weeks over two summers. A habitat accommodation model of succession that was previously developed for mallee reptiles correctly predicted the observed responses of three of 16 common reptile species. A further four species showed non-significant trends in the predicted direction. However, eight other species showed unexpected responses. One species showed a strong interaction between burn age and location, requiring a two-dimensional successional model in contrast with the usual linear models explaining reptile responses to fire. One third of common species were not affected by fire and so may not have increased risks of extinction due to the fire suppression/incineration cycle. However, approximately half to two-thirds of common reptiles did have a fire response, so the risk of deterministic extinction in small fragments may be substantial. Further model development is needed to better predict fire responses and to assist the design of fire mosaics that can accommodate early and late successional fire specialists.

Guscoi, C. Gregory; Hossack, Blake R.; Eby, Lisa A.; Corn, Paul Stephen. 2008. Post-breeding habitat use by adult boreal toads (*Bufo boreas*) after wildfire in Glacier National Park, USA. Herpetological Conservation and Biology 3(1):55-62.

Abstract. Effects of wildfire on amphibians are complex, and some species may benefit from the severe disturbance of stand-replacing fire. Boreal Toads (*Bufo boreas boreas*) in Glacier National Park, Montana, USA increased in occurrence after fires in 2001 and 2003. We used radio telemetry to track adult *B*. *boreas* in a mosaic of terrestrial habitats with different burn severities to better understand factors related to the post-fire pulse in breeding activity. Toads used severely burned habitats more than expected and partially burned habitats less than expected. No toads were relocated in unburned habitat, but little of the study area was unburned and the expected number of observations in unburned habitat was < 3. High vagility of *B*. boreas and preference for open habitats may predispose this species to exploit recently disturbed landscapes. The long-term consequences of fire suppression likely have had different effects in different parts of the range of *B*. *boreas*. More information is needed, particularly in the northern Rocky Mountains, where toads are more likely to occupy habitats that have diverged from historic fire return intervals.

Haney, Alan; Apfelbaum, Steven; Burris, John M. 2008. Thirty years of post-fire succession in a southern boreal forest bird community. The American Midland Naturalist 159(2): 421-433.

Abstract. Birds and vegetation were surveyed in a 9 ha plot in spring 1976 in a 73 y-old jack pine (*Pinus banksiana*) – black spruce (*Picea mariana*) forest in northeastern Minnesota. A 1368 ha wildfire burned across the area that autumn. The plot was resurveyed in 1977 and periodically through 2006. B efore the fire, birds with the highest importance values were Blackburnian Warbler (*Dendroica fusca*), Ovenbird (*Seiurus aurocapillus*), Red-eyed Vireo (*Vireo olivaceus*) and Bay-breasted Warbler (*D. castanea*). Within 7 y following the fire, canopy tree cover decreased to near zero as fire-damaged trees died. Afterwards, the canopy began increasing, reaching 53% cover by 30 y. Shrub cover, 8% before the fire, peaked at over 70% two decades after fire, primarily as a result of dense jack pine and black spruce regeneration, and then decreased to 58% 30 y after fire. The total number of bird species using the area doubled the first year following the fire while the number of bird species with discernable territories decreased 40%. Thereafter, territorial species began increasing and 30 y after the fire the number exceeded the pre-fire richness by 60%. Overall, density of bird territories decreased nearly three-fold the first 3 y after the fire, but by year 30, was over 56% greater than in the pre-burn mature pine

forest. Loss of canopy was related to a reduction in warbler and vireo diversity while increases in woody debris and near-ground vegetation were related to an increase in ground-brush foragers such as White-throated Sparrow (*Zonotrichia albicollis*) and Chipping Sparrow (*Spizella passerina*). Brown Creeper (*Certhia americana*) populations increased briefly as trees died, and for five years following fire there was an increase in woodpeckers and secondary cavity nesting species. At 7 to 10 y after fire, White-throated Sparrow, Magnolia Warbler (*Dendroica magnolia*), Chestnut-sided Warbler (*D. pensylvanica*), Nashville Warbler (*Vermivora ruficapilla*) and Mourning Warbler (*Oporornis philadelphia*) dominated. White-throated Sparrow continued to be the most important bird species through the first two decades, followed by Magnolia Warbler and Red-eyed Vireo. Thirty years after fire, the dominant birds were Nashville Warbler and Ovenbird, followed distantly by Veery (*Catharus fuscescens*) Swainson's Thrush (*Catharus ustulatus*), Least Flycatcher (*Empidonax minimus*) and Black-and-white Warbler (*Mniotilta varia*). Overall, bird species using the area after 30 y remained over 70% higher than in the mature forest before the fire.

Manning, Jeffrey A.; Edge, W. Daniel. 2008. Small mammal responses to fine woody debris and forest fuel reduction in southwest Oregon. Journal of Wildlife Management 72(3): 625-632.

Abstract. Despite its importance for wildlife, most forests in the Pacific Northwest contain low volumes of large downed wood compared to fine woody debris (FWD). We used a replicated experiment to compare short-term responses of deer mice (*Peromyscus maniculatus*) and western red-backed voles (*Clethrionomys californicus*) among 3 arrangements of FWD: piled, lopped and scattered, and pile burning, a commonly used method of fuel reduction in commercial Douglas fir (*Pseudotsuga menziesii*) forests in southwest Oregon, USA. We assessed habitat use, density, and survival of mice and voles during 2 consecutive summers (Jun–Aug 1999 and 2000). Both mice and voles used FWD cover disproportionately from its availability, and they differed in their responses to specific FWD arrangements. Mice used piled FWD (proportional use = 37.0%, 90% CI = 33.0–44.0) 43% more than expected (26.0). Number of mice captured ($\bar{x}$ = 1.9 mice, 90% CI = 1.5–2.5) and index of home range size ($\bar{x}$ = 4.8 m, 90% CI = 0.7–8.9) at individual FWD piles decreased up to 16% and increased up to 50%, respectively, for each 1-m increase in distance from piles. Voles used all FWD cover classes in proportion to availability, but number of voles captured increased slightly ($\bar{x}$ = 0.016 voles/m, 90% CI = 0.001–0.031) for each 1-m increase in distance from piles. Piled FWD had no discernable effect on population density and apparent survival of mice, but analyses had low power (0.25, 0.67). Our results suggest that piling FWD would benefit deer mice, whereas lopped and scattered FWD might benefit voles. Thus, a combination of methods to reduce fire risk should be considered to accommodate multiple small mammal species.

Sperry, Jinelle H.; George, T. Luke; Zack, Steve. 2008. Ecological factors affecting response of dark-eyed juncos to prescribed burning. The Wilson Journal of Ornithology 120(1): 131-138.

Abstract. We compared abundance, daily survival rate, nest site characteristics, food availability, nest activity, and nestling size of Dark-eyed Juncos (*Junco hymenalis*) between burned and unburned mechanically-thinned ponderosa pine (*Pinus ponderosa*) forest units. Dark-eyed Junco territory density, number of detections in point counts, and daily nest survival were similar between treatments. Average bare ground was 4.8 times higher and litter cover was 2.6 times lower at nest sites in burned units compared to unburned nest sites. However, there was 28% less burned area around nests compared to random points

in burned units, indicating that juncos placed nests in unburned portions of burned units. They also selected non-traditional nesting sites in burned units such as root holes and in trees. Arthropod abundance was higher in burned units 1-year post burn although numbers were similar in the second-year post burn. Nest attentiveness and feeding rates were three times higher in burned units, possibly in response to increased food availability. The potentially negative effect of prescribed burning through reduction of litter and increase in bare ground was offset by novel nesting strategies and increased food availability.

Zwolak, Rafał; Foresman, Kerry R. 2008. Deer mouse demography in burned and unburned forest: no evidence for source–sink dynamics. Canadian Journal of Zoology 86(2): 83-91.

Abstract. Deer mouse (*Peromyscus maniculatus* (Wagner, 1845)) populations increase dramatically after wildfires. These increases are puzzling because there are no obvious food sources or vegetation cover in severely burned areas. We conducted a capture–mark–recapture study of deer mice in a mosaic of burned and unburned montane forests in western Montana to determine if their postfire increase could be explained by source–sink dynamics, with burned areas acting as a sink. When overall mouse densities were very low, the vast majority of the population was found in burned areas. Mice appeared regularly in unburned forest only when the densities were high. This pattern is precisely opposite to the expected results if the sink hypothesis were correct. Moreover, mice in burned areas did not show decreased body mass, reproductive performance, or survival when compared with mice in unburned areas. Age structure and sex ratio did not differ between burned and unburned sites. We conclude that burned areas do not function as population sinks; rather, they represent high-quality habitat for deer mice.

Insects and Arthopods

Breece, C.R.; Kolb, T.E.; Dickson, B.G.; McMillin, J.D.; Clancy, K.M. 2008. Prescribed fire effects on bark beetle activity and tree mortality in southwestern ponderosa pine forests. Forest Ecology and Management 255(1): 119-128.

Abstract. Prescribed fire is an important tool in the management of ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) forests, yet effects on bark beetle (Coleoptera: Curculionidae, Scolytinae) activity and tree mortality are poorly understood in the southwestern U.S. We compared bark beetle attacks and tree mortality between paired prescribed-burned and unburned stands at each of four sites in Arizona and New Mexico for three growing seasons after burning (2004–2006). Prescribed burns increased bark beetle attacks on ponderosa pine over the first three post-fire years from 1.5 to 13% of all trees, increased successful, lethal attacks on ponderosa pine from 0.4 to 7.6%, increased mortality of ponderosa pine from all causes from 0.6 to 8.4%, and increased mortality of all tree species with diameter at breast height >13 cm from 0.6 to 9.6%. On a per year basis, prescribed burns increased ponderosa pine mortality from 0.2% per year in unburned stands to 2.8% per year in burned stands. Mortality of ponderosa pine 3 years after burning was best described by a logistic regression model with total crown damage (crown scorch + crown consumption) and bark beetle attack rating (no, partial, or mass attack by bark beetles) as independent variables. Attacks by *Dendroctonus* spp. did not differ significantly over bole heights, whereas attacks by *Ips* spp. were greater on the upper bole compared with the lower bole. Three previously published logistic regression models of tree mortality, developed from fires in 1995–1996 in northern Arizona, were moderately successful in predicting broad patterns of tree mortality in our data. The influence of bark beetle attack rating on tree mortality

was stronger for our data than for data from the 1995–1996 fires. Our results highlight canopy damage from fire as a strong and consistent predictor of post-fire mortality of ponderosa pine, and bark beetle attacks and bole char rating as less consistent predictors because of temporal variability in their relationship to mortality. The small increase in tree mortality and bark beetle attacks caused by prescribed burning should be acceptable to many forest managers and the public given the resulting reduction in surface fuel and risk of severe wildfire.

Larrivée, Maxim; Drapeau, Pierre; Fahrig, Lenore. 2008. Edge effects created by wildfire and clear-cutting on boreal forest ground-dwelling spiders. Forest Ecology and Management 255: 1434-1445.

Abstract. The response of ground-dwelling spider assemblages to edges created by wildfire was compared to their response to clear-cut edges in black spruce forests in eastern Canada. For each disturbance six edge transects 100 m long were established. Spiders were collected with pitfall traps 10 m apart from 50 m inside the disturbances to 50 m in the forest interior. Measurements of the forest floor structure and the habitat around the traps were also taken. Most habitat variables varied similarly across both wildfire and clear-cut edges but two variables, coarse woody debris and shrub cover changed more abruptly at edges of clear-cuts than at wildfire edges. Two separate CA analyses of the burned and clear-cut edge transects showed that changes in spider community species composition were more abrupt at clear-cut edges than at burn edges. A species indicator analysis (INDVAL) was used to identify species that were significantly associated with specific edge zones. Eight species were significantly associated with open (disturbed) habitats, one species was significantly associated with both burned and clear-cut edges, and four species were significantly associated with the forest interior. *T*-tests of slope coefficients from separate simple regressions of abundance and richness over distance showed that open habitat specialist's abundance and richness changed significantly more abruptly at clear-cut edges than at wildfire edges. Locally weighted smoothed regressions showed that the extent of edge influence on ground-dwelling spider guilds (open habitat and forest interior specialist) penetrated 20–30 m into the disturbances, 30 m into the forest interior at clear-cut edges, and at least 50 m into the forest interior for wildfire edge transects. Our results suggest that a minimum width of 100 m is necessary to maintain characteristics of forest interior spider assemblages in forest remnants, riparian or road buffers, and forest strips between cut-blocks.

Dead Wood and Fuels

Lezberg, Ann L.; Battaglia, Michael A.; Shepperd, Wayne D.; Schoettle, Anna W. 2008. Decades-old silvicultural treatments influence surface wildfire severity and post-fire nitrogen availability in a ponderosa pine forest. Forest Ecology and Management 255(1): 49-61.

Abstract. Wildfire severity and subsequent ecological effects may be influenced by prior land management, via modification of forest structure and lingering changes in fuels. In 2002, the Hayman wildfire burned as a low to moderate-severity surface fire through a 21-year pine regeneration experiment with two overstory harvest cuttings (shelterwood, seed-tree) and two site preparations (scarified, unscarified) that had been applied in a mature ponderosa pine forest in the montane zone of the Colorado Front Range in 1981. We used this event to examine how pre-fire fine fuels, surface-level burn severity and post-fire soil nitrogen-availability varied with pre-fire silvicultural treatments. Prior to the wildfire, litter

cover was higher under both shelterwood and unscarified treatments than seed-tree and scarified treatments. Immediately after the fire in 2002, we assessed burn severity under 346 mature trees, around 502 planted saplings, and in 448 4 m^2 microplots nested within the original experimental treatments. In one-fourth of the microplots, we measured resin-bound soil nitrate and ammonium accumulated over the second and third post-fire growing season. Microplots burned less severely than bases of trees and saplings with only 6.8% of microplot area burned down to mineral soil as compared to >28% of tree and sapling bases. Sapling burn severity was highest in unscarified treatments but did not differ by overstory harvest. Microplot burn severity was higher under the densest overstory (shelterwood) and in unscarified treatments and was positively related to pre-fire litter/duff cover and negatively associated with pre-fire total plant cover, grass cover and distance to tree. In both years, resin-bound nitrate and ammonium (NH_4^+-N) increased weakly with burn severity and NH_4^+-N availability was higher in unscarified than scarified plots. The lasting effects of soil scarification and overstory harvest regime on modern patterns of surface burn severity after two decades underscores the importance of historic landuse and silviculture on fire behavior and ecological response. Unraveling causes of these patterns in burn severity may lead to more sustainable fire and forest management in ponderosa pine ecosystems.

Soils

Massman, W. J.; Frank, J. M.; Reisch, N. B. 2008. Long-term impacts of prescribed burns on soil thermal conductivity and soil heating at a Colorado Rocky Mountain site: a data/model fusion study. International Journal of Wildland Fire 17(1): 131-146.

Abstract. Heating any soil during a sufficiently intense wild fire or prescribed burn can alter that soil irreversibly, resulting in many significant, and well studied, long-term biological, chemical, and hydrological effects. On the other hand, much less is known about how fire affects the thermal properties and the long-term thermal regime of soils. Such knowledge is important for understanding the nature of the soil's post-fire recovery because plant roots and soil microbes will have to adapt to any changes in the day-to-day thermal regime. This study, which was carried out at Manitou Experimental Forest (a semiarid site in the Rocky Mountains of central Colorado, USA), examines three aspects of how fire can affect the long-term (post-fire) thermal energy flow in soils. First, observational evidence is presented that prescribed burns can alter the thermal conductivity of soils to a depth of at least 0.2 m without altering its bulk density. Second, data are presented on the thermal properties of ash. (Such data are necessary for understanding and modeling the impact any remaining post-fire ash layer might have on the daily and seasonal flow of thermal energy through the soil.) Third, observational data are presented on the long-term effects that prescribed burns can have on soil surface temperatures. In an effort to quantify long-term changes in the soil temperatures and heat fluxes resulting from fire this study concludes by developing and using an analytical model of the daily and annual cycles of soil heating and cooling, which incorporates observed (linear variation of) vertical structure of the soil thermal properties and observed changes in the surface temperatures, to synthesise these fire-induced effects. Modeling results suggest that under the dry soil conditions, typical of the experimental forest, the amplitudes of the daily and seasonal cycles of soil heating/cooling in the fire-affected soils will greatly exceed those in the soils unaffected by fire for several months to years following the fire and that these effects propagate to depths exceeding one metre.

Robichaud, P. R.; Lewis, S. A.; Ashmun, L. E. 2008. New procedure for sampling infiltration to assess post-fire soil water repellency. Res. Note. RMRS-RN-33. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 14 p. Available at http://www.fs.fed.us/rm/pubs/rmrs_rn033.pdf

Abstract. The Mini-disk Infiltrometer has been adapted for use as a field test of post-fire infiltration and soil water repellency. Although the Water Drop Penetration Time (WDPT) test is the common field test for soil water repellency, the Mini-disk Infiltrometer (MDI) test takes less time, is less subjective, and provides a relative infiltration rate. For each test, the porous base plate of the MDI is placed on the soil surface and the amount of water that passes into the soil in one minute is measured.

Thousands of paired WDPT and MDI tests were applied at burned sites throughout the western United States, and the data were significantly correlated (r = 0.64). A classification tree analysis was used to group the MDI test results into "degree of soil water repellency" categories (strong, weak, and none) that correspond to similar categories established for the WDPT test. Fire-induced soil water repellency has high spatial variability and requires a valid sampling method if the data are to be credible. The MDI test protocol and sampling method described in this Research Note were developed for post-fire assessment, and provide a practical evaluation of burned soil infiltration characteristics in a limited time.

Climate, Carbon and Greenhouse Gases

Allen, Craig D.; Anderson, R. Scott; Jass, Renata B.; Toney, Jaime L.; Baisan, Christopher H. 2008. Paired charcoal and tree-ring records of high-frequency Holocene fire from two New Mexico bog sites. International Journal of Wildland Fire 17(1): 115–130

Abstract. Two primary methods for reconstructing paleofire occurrence include dendrochronological dating of fire scars and stand ages from live or dead trees (extending back centuries into the past) and sedimentary records of charcoal particles from lakes and bogs, providing perspectives on fire history that can extend back for many thousands of years. Studies using both proxies have become more common in regions where lakes are present and fire frequencies are low, but are rare where high-frequency surface fires dominate and sedimentary deposits are primarily bogs and wetlands. Here we investigate sedimentary and fire-scar records of fire in two small watersheds in northern New Mexico, in settings recently characterised by relatively high-frequency fire where bogs and wetlands (Chihuahueños Bog and Alamo Bog) are more common than lakes. Our research demonstrates that: (1) essential features of the sedimentary charcoal record can be reproduced between multiple cores within a bog deposit; (2) evidence from both fire-scarred trees and charcoal deposits documents an anomalous lack of fire since ~1900, compared with the remainder of the Holocene; (3) sedimentary charcoal records probably underestimate the recurrence of fire events at these high-frequency fire sites; and (4) the sedimentary records from these bogs are complicated by factors such as burning and oxidation of these organic deposits, diversity of vegetation patterns within watersheds, and potential bioturbation by ungulates. We consider a suite of particular challenges in developing and interpreting fire histories from bog and wetland settings in the Southwest. The identification of these issues and constraints with interpretation of sedimentary charcoal fire records does not diminish their essential utility in assessing millennial-scale patterns of fire activity in this dry part of North America.

Anderson, R. S.; Allen, C. D.; Toney, J. L.; Jass, R. B.; Bair, A. N. 2008. Holocene vegetation and fire regimes in subalpine and mixed conifer forests, southern Rocky Mountains, USA. International Journal of Wildland Fire 17(1): 96–114.

Abstract. Our understanding of the present forest structure of western North America hinges on our ability to determine antecedent forest conditions. Sedimentary records from lakes and bogs in the southern Rocky Mountains of Colorado and New Mexico provide information on the relationships between climate and vegetation change, and fire history since deglaciation. We present a new pollen record from Hunters Lake (Colorado) as an example of a high-elevation vegetation history from the southern Rockies. We then present a series of six sedimentary records from ~2600 to 3500-m elevation, including sites presently at the alpine–subalpine boundary, within the *Picea engelmannii–Abies lasiocarpa* forest and within the mixed conifer forest, to determine the history of fire in high-elevation forests there. High *Artemisia* and low but increasing percentages of *Picea* and *Pinus* suggest vegetation prior to 13 500 calendar years before present (cal yr BP) was tundra or steppe, with open spruce woodland to ~11 900 cal yr BP. Subalpine forest (*Picea engelmannii*, *Abies lasiocarpa*) existed around the lake for the remainder of the Holocene. At lower elevations, *Pinus ponderosa* and/or *contorta* expanded 11 900 to 10 200 cal yr BP; mixed conifer forest expanded ~8600 to 4700 cal yr BP; and *Pinus edulis* expanded after ~4700 cal yr BP. Sediments from lake sites near the alpine–subalpine transition contained five times less charcoal than those entirely within subalpine forests, and 40 times less than bog sites within mixed conifer forest. Higher fire episode frequencies occurred between ~12 000 and 9000 cal yr BP (associated with the initiation or expansion of south-west monsoon and abundant lightning, and significant biomass during vegetation turnover) and at ~2000–1000 cal yr BP (related to periodic droughts during the long-term trend towards wetter conditions and greater biomass). Fire episode frequencies for subalpine–alpine transition and subalpine sites were on average 5 to 10 fire events/1000 years over the Holocene, corresponding to one fire event every ~100 to 200 years. (5) Our Holocene-length sedimentary charcoal records provide additional evidence for the anomalous nature of the 20th-century fire regime, where fires were largely suppressed as a national policy.

Brown, Peter M.; Heyerdahl, Emily K.; Kitchen, Stanley G.; Weber, Marc H. 2008. Climate effects on historical fires (1630–1900) in Utah. International Journal of Wildland Fire 17(1): 28–39.

Abstract. We inferred climate effects on fire occurrence from 1630 to 1900 for a new set of crossdated fire-scar chronologies from 18 forested sites in Utah and one site in eastern Nevada. Years with regionally synchronous fires (31 years with fire at ≥20% of sites) occurred during drier than average summers and years with no fires at any site (100 years) were wetter than average. Antecedent wet summers were associated with regional-fire years in mixed-conifer and ponderosa pine forest types, possibly by affecting fine fuel amount and continuity. NINO3 (an index of the El Niño–Southern Oscillation, ENSO) was significantly low during regional-fire years (La Niñas) and significantly high during non-fire years (El Niños). NINO3 also was high during years before regional-fire years. Although regional fire years occurred nearly twice as often as expected when NINO3 and the Pacific Decadal Oscillation were both in their cool (negative) phases, this pattern was not statistically significant. Palmer Drought Severity Index was important for fire occurrence in ponderosa pine and mixed-conifer forests across the study area but ENSO forcing was seen only in south-eastern sites. Results support findings from previous fire and climate studies, including a possible geographic pivot point in Pacific basin teleconnections at ~40°N.

Chiang, Jyh-Min; McEwan, Ryan W.; Yaussy, Daniel A.; Brown, Kim J. 2008. The effects of prescribed fire and silvicultural thinning on the aboveground carbon stocks and net primary production of overstory trees in an oak-hickory ecosystem in southern Ohio. Forest Ecology and Management 255: 1584-1594.

Abstract. More than 70 years of fire suppression has influenced forest dynamics and led to the accumulation of fuels in many forests of the United States. To address these changes, forest managers increasingly seek to restore historical ecosystem structure and function through the reintroduction of fire and disturbance processes that mimic fire such as silvicultural thinning. In oak forests of eastern North America, prescribed fire and thinning are important tools used to facilitate oak (*Quercus* spp.) regeneration and recruitment. The global scientific community is increasingly raising concerns about the accumulation of atmospheric CO_2, and its potential to impact global climate; therefore, activities such as prescribed fire and thinning that can influence the carbon balance of terrestrial ecosystems should be evaluated. We used field measurements and modeling with the PnET-II carbon balance model in oak forests of southern Ohio, USA, to (1) assess the efficacy of prescribed fire and silvicultural thinning in facilitating oak recruitment and regeneration, and (2) quantify the impacts of these treatments on aboveground carbon stocks and net primary production. Silvicultural thinning increased recruitment of maples, but oak recruitment was minimal. Prescribed burning caused an increase in the mortality rate of oaks' major competitor (*Acer rubrum* L.) in the overstory (stems ≥10 cm DBH), but oak mortality also increased following the burn treatments. Our measurements of stem growth suggest that the timing of the prescribed fires coincided with the initiation of growth in oaks, which may have created vulnerability in these species that are generally considered fire-resistant. The pre-treatment aboveground biomass of overstory trees was approximately 233 Mg/ha (Mg = 1×10^6 g). Prescribed burning had significant impacts on the mortality of stems; however, it had no significant effects on the aboveground net primary production (ANPP). Thinning removed approximately 30% of the aboveground biomass and resulted in significant but transient (1 year) reduction of ANPP (386 and 560 g C m^{-2} $year^{-1}$ for thinned and non-thinned stands, respectively). In sum, thinning created recruitment opportunities in our study area, but these opportunities were captured by maples, and oak recruitment was minimal. Prescribed fire caused mortality in oaks and maples, and the oak mortality may have been related to the coincidence of the burn treatment and the initiation of oak stem growth. Finally, our data suggest that there is a transient impact of thinning on ANPP, but that there is no long-term effect of thinning and/or burning treatments on the aboveground carbon uptake in oak forests.

DeLuca, Thomas H; Aplet, Gregory H. 2008. Charcoal and carbon storage in forest soils of the Rocky Mountain West. Frontiers in Ecology and the Environment 6(1): 18-24.

Abstract. Charcoal represents a super-passive form of carbon (C) that is generated during fire events and is one of the few legacies of fire recorded in the soil profile; however, the importance of this material as a form of C storage has received only limited scientific attention. Here, we review the formation of charcoal in temperate and boreal forest ecosystems, discuss some of its desirable properties, and estimate the potential contribution charcoal to long-term C sequestration in forest ecosystems. Charcoal deposition over the course of several millennia probably accounts for a substantial proportion of the total soil C pool in fire-maintained forest ecosystems. Forest management processes that interfere with natural fire processes eliminate the formation of this passive form of C. We recommend that charcoal be considered in C storage budgets and modeling of forest ecosystems, especially in light of climate change and increasing occurrence of wildfire.

Heyerdahl, Emily K.; Morgan, Penelope; Riser, James P., II. 2008. Multi-season climate symchronized historical fires in dry forests (1650-1900), northern Rockies, USA. Ecology 89(3): 705-716.

Abstract. Our objective was to infer the climate drivers of regionally synchronous fire years in dry forests of the U.S. northern Rockies in Idaho and western Montana. During our analysis period (1650–1900), we reconstructed fires from 9245 fire scars on 576 trees (mostly ponderosa pine, *Pinus ponderosa* P. & C. Lawson) at 21 sites and compared them to existing tree-ring reconstructions of climate (temperature and the Palmer Drought Severity Index [PDSI]) and large-scale climate patterns that affect modern spring climate in this region (El Niño–Southern Oscillation [ENSO] and the Pacific Decadal Oscillation [PDO]). We identified 32 regional-fire years as those with five or more sites with fire. Fires were remarkably widespread during such years, including one year (1748) in which fires were recorded at 10 sites across what are today seven national forests plus one site on state land. During regional-fire years, spring–summers were significantly warm and summers were significantly warm-dry whereas the opposite conditions prevailed during the 99 years when no fires were recorded at any of our sites (no-fire years). Climate in prior years was not significantly associated with regional- or no-fire years. Years when fire was recorded at only a few of our sites occurred under a broad range of climate conditions, highlighting the fact that the regional climate drivers of fire are most evident when fires are synchronized across a large area. No-fire years tended to occur during La Niña years, which tend to have anomalously deep snowpacks in this region. However, ENSO was not a significant driver of regional-fire years, consistent with the greater influence of La Niña than El Niño conditions on the spring climate of this region. PDO was not a significant driver of past fire, despite being a strong driver of modern spring climate and modern regional-fire years in the northern Rockies.

Heyerdahl, Emily K.; McKenzie, Donald; Daniels, Lori D.; Hessl, Amy E.; Littell, Jeremy S.; Mantua, Nathan J. 2008. Climate drivers of regionally synchronous fires in the inland Northwest (1651–1900). International Journal of Wildland Fire 17(1): 40–49.

Abstract. We inferred climate drivers of regionally synchronous surface fires from 1651 to 1900 at 15 sites with existing annually accurate fire-scar chronologies from forests dominated by ponderosa pine or Douglas-fir in the inland Northwest (interior Oregon, Washington and southern British Columbia). Years with widespread fires (35 years with fire at 7 to 11 sites) had warm spring–summers and warm-dry summers, whereas years with no fires at any site (18 years) had the opposite conditions. Spring climate likely affected the length of the fire season via the effects of snowmelt on soil and fuel moisture, whereas summer climate influenced fuel moisture during the fire season. Climate in prior years was not a significant driver of regionally synchronous surface fires, likely because fuels were generally sufficient for the ignition and spread of such fires in these forests. Fires occurred significantly more often than expected by chance when the El Niño–Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) were both warm phase and less often when they were both cool phase. Interactions between large-scale climate patterns influenced fire synchrony in the inland Northwest because phases of ENSO and PDO were associated with changes in the frequency of warm-dry v. cool-wet spring–summer climate.

Jomura, Mayuko; Kominami, Yuji; Dannoura, Masako; Kanazawa, Yoichi. 2008. Spatial variation in respiration from coarse woody debris in a temperate secondary broad-leaved forest in Japan. Forest Ecology and Management 255(1): 149-155.

Abstract. We measured the rates of respiration from snags and logs ("coarse woody debris", CWD) of Japanese red pine (*Pinus densiflora* Sieb. et Zucc.) to examine the rate of decomposition and CO_2 efflux from these materials in a temperate secondary broad-leaved forest in Japan. At this site, a high quantity of CWD of *P. densiflora* had accumulated as a result of pine wilt disease during the 1970s. Respiration rates were measured using a dynamic closed chamber method combined with an infrared gas analyzer. We measured the respiration rate of 7 samples of snags and 10 samples of logs from August 2003 to January 2004. The responses of the respiration rates of snags (R_{snag}) and logs (R_{log}) to changing temperature were both exponential and the responses to water content were quadratic, and the same function could be used to estimate annual values of both R_{snag} and R_{log}. Intensive measurements of water contents of snags and logs showed a marked difference in water content. The mean water content of snags was 20% of log water content. This difference was likely responsible for the observed difference in annual R_{snag} and R_{log}. The decay rate constants estimated from the respiration rates measurement of snags and logs were 0.019 and 0.081 $year^{-1}$, respectively. Despite being lower than R_{log}, R_{snag} was a significant compartment of the CWD carbon budget at this site.

Morgan, Penelope; Heyerdahl, Emily K.; Gibson, Carly E. 2008. Multi-season climate synchronized forest fires throughout the 20th century, northern Rockies, USA. Ecology 89(3): 717-728.

Abstract. We inferred climate drivers of 20th-century years with regionally synchronous forest fires in the U.S. northern Rockies. We derived annual fire extent from an existing fire atlas that includes 5038 fire polygons recorded from 12 070 086 ha, or 71% of the forested land in Idaho and Montana west of the Continental Divide. The 11 regional-fire years, those exceeding the 90th percentile in annual fire extent from 1900 to 2003 (>102 314 ha or ~ 1% of the fire atlas recording area), were concentrated early and late in the century (six from 1900 to 1934 and five from 1988 to 2003). During both periods, regional-fire years were ones when warm springs were followed by warm, dry summers and also when the Pacific Decadal Oscillation (PDO) was positive. Spring snowpack was likely reduced during warm springs and when PDO was positive, resulting in longer fire seasons. Regional-fire years did not vary with El Niño–Southern Oscillation (ENSO) or with climate in antecedent years. The long mid-20th century period lacking regional-fire years (1935–1987) had generally cool springs, generally negative PDO, and a lack of extremely dry summers; also, this was a period of active fire suppression. The climate drivers of regionally synchronous fire that we inferred are congruent with those of previous centuries in this region, suggesting a strong influence of spring and summer climate on fire activity throughout the 20th century despite major land-use change and fire suppression efforts. The relatively cool, moist climate during the mid-century gap in regional-fire years likely contributed to the success of fire suppression during that period. In every regional-fire year, fires burned across a range of vegetation types. Given our results and the projections for warmer springs and continued warm, dry summers, forests of the U.S. northern Rockies are likely to experience synchronous, large fires in the future.

Pierce, Jennifer; Meyer, Grant. 2008. Long-term fire history from alluvial fan sediments: the role of drought and climate variability, and implications for management of Rocky Mountain forests. International Journal of Wildland Fire 17(1): 84–95.

Abstract. Alluvial fan deposits are widespread and preserve millennial-length records of fire. We used these records to examine changes in fire regimes over the last 2000 years in Yellowstone National Park mixed-conifer forests and drier central Idaho ponderosa pine forests. In Idaho, frequent, small, fire-related erosional events occurred within the Little Ice Age (~1450–1800 AD), when greater effective moisture probably promoted grass growth and low-severity fires. This regime is consistent with tree-ring records showing generally wetter conditions and frequent fires before European settlement. At higher elevations in Yellowstone, cool conditions limited overall fire activity. Conversely, both Idaho and Yellowstone experienced a peak in fire-related debris flows between ~950 and 1150 AD. During this generally warmer time, severe multidecadal droughts were interspersed with unusually wet intervals that probably increased forest densities, producing stand-replacing fires. Thus, severe fires are clearly within the natural range of variability in Idaho ponderosa pine forests over longer timescales. Historical records indicate that large burn areas in Idaho correspond with drought intervals within the past 100 years and that burn area has increased markedly since ~1985. Recent stand-replacing fires in ponderosa pine forests are likely related to both changes in management and increasing temperatures and drought severity during the 20th century.

Sherriff, Rosemary L.; Veblen, Thomas T. 2008. Variability in fire–climate relationships in ponderosa pine forests in the Colorado Front Range. International Journal of Wildland Fire 17(1): 50–59.

Abstract. Understanding the interactions of climate variability and wildfire has been a primary objective of recent fire history research. The present study examines the influence of El Niño–Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO) and Atlantic Multidecadal Oscillation (AMO) on fire occurrence using fire-scar evidence from 58 sites from the lower ecotone to the upper elevational limits of ponderosa pine (*Pinus ponderosa*) in northern Colorado. An important finding is that at low *v.* high elevations within the montane zone, climatic patterns conducive to years of widespread fire are different. Differences in fire–climate relationships are manifested primarily in antecedent year climate. Below ~2100 m, fires are dependent on antecedent moister conditions that favour fine fuel accumulation 2 years before dry fire years. In the upper montane zone, fires are dependent primarily on drought rather than an increase in fine fuels. Throughout the montane zone, fire is strongly linked to variations in moisture availability that in turn is linked to climate influences of ENSO, PDO and AMO. Fire occurrence is greater than expected during the phases of each index associated with drought. Regionally widespread fire years are associated with specific phase combinations of ENSO, PDO and AMO. In particular, the combination of La Niña, negative PDO and positive AMO is highly conducive to widespread fire.

Taylor, A. H.; Trouet, V.; Skinner, C. N. 2008. Climatic influences on fire regimes in montane forests of the southern Cascades, California, USA. International Journal of Wildland Fire 17(1): 60–71.

Abstract. The relationship between climate variability and fire extent was examined in montane and upper montane forests in the southern Cascades. Fire occurrence and extent were reconstructed for seven sites and related to measures of reconstructed climate for the period 1700 to 1900. The climate variables included the Palmer Drought Severity Index (PDSI), summer temperature (TEMP), NINO3, a measure of the El Niño–Southern Oscillation (ENSO), and the Pacific Decadal Oscillation (PDO). Fire extent at the site and regional scale was associated with dry and warm conditions in the year of the fire and regional fire extent was not associated with ENSO or PDO for the full period of analysis. The relationship

between regional fire extent and climate was not stable over time. The associations of fire extent with PDSI and TEMP were only significant from ~1775 onward and the associations were strongest between 1805 and 1855. PDO and fire extent were also associated during the 1805–1855 period, and ENSO was associated with fire extent before 1800, but not after. The interannual and interdecadal variability of the fire response to temperature and drought suggests that increased periods of regional fire activity may occur when high interannual PDSI variation coincides with warm decades.

Whitlock, Cathy; Marlon, Jennifer; Briles, Christy; Brunelle, Andrea; Long, Colin; Bartlein, Patrick. 2008. Long-term relations among fire, fuel, and climate in the north-western US based on lake-sediment studies. International Journal of Wildland Fire 17(1): 72–83.

Abstract. Pollen and high-resolution charcoal records from the north-western USA provide an opportunity to examine the linkages among fire, climate, and fuels on multiple temporal and spatial scales. The data suggest that general charcoal levels were low in the late-glacial period and increased steadily through the last 11 000 years with increasing fuel biomass. At local scales, fire occurrence is governed by the interaction of site controls, including vegetation, local climate and fire weather, and topography. At subregional scales, patterns in the long term fire-episode frequency data are apparent: The Coast Range had relatively few fires in the Holocene, whereas the Klamath–Siskiyou region experienced frequent fire episodes. Fire regimes in the northern Rocky Mountains have been strongly governed by millennial- and centennial-scale climate variability and regional differences in summer moisture. At regional scales, sites in present-day summer-dry areas show a period of protracted high fire activity within the early Holocene that is attributed to intensified summer drought in the summer-dry region. Sites in summer-wet areas show the opposite pattern, that fire was lower in frequency than present in the early Holocene as result of strengthened monsoonal circulation then. Higher fire-episode frequency at many sites in the last 2000 years is attributed to greater drought during the Medieval Climate Anomaly and possibly anthropogenic burning. The association between drought, increased fire occurrence, and available fuels evident on several time scales suggests that long-term fire history patterns should be considered in current assessments of historical fire regimes and fuel conditions.

Essays and Opinions

The following two papers are part of an on-going disagreement over appropriate interpretation of fire severity maps.

Safford, Hugh D.; Miller, Jay; Schmidt, David; Roath, Brent; Parsons, Annette. 2008. BAER soil burn severity maps do not measure fire effects to vegetation: a comment on Odion and Hanson (2006). Ecosystems 11(1): 1-11.

Abstract. We comment on a recent Ecosystem paper by Odion and Hanson (Ecosystems 9:1177–1189, 2006), in which the authors claim that high severity fire is rare in the Sierra Nevada under current conditions. Odion and Hanson's results are predicated on BAER soil burn severity maps, which are based primarily on fire effects to soil, not vegetation. Odion and Hanson, and we fear others as well, are misinformed as to the nature of the BAER severity mapping process, and proper applications of BAER soil burn severity maps. By comparing the BAER soil burn severity maps to a true vegetation burn severity measure (RdNBR) calibrated by field data, we show that the area in the high soil burn severity class for the three fires analyzed by Odion and Hanson is substantially less than the area of stand

replacing fire, and that BAER maps—especially hand-derived maps such as those from two of the three fires—also greatly underestimate the heterogeneity in vegetation burn severity on burned landscapes. We also show that, contrary to Odion and Hanson's claims, Fire Return Interval Departure (FRID) is strongly correlated with fire severity in conifer stands within the perimeter of the McNally Fire.

Odion, Dennis C.; Hanson, Chad T. 2008. Fire severity in the Sierra Nevada revisited: conclusions robust to further analysis. Ecosystems 11(1): 12-15.

Abstract. In our previous article (Odion and Hanson, *Ecosystems* 9:1177–89, 2006), we reported that fire severity in the conifer forests of the Sierra Nevada mountains of California, contrary to prevailing assumptions, did not burn with predominately stand-replacing, high severity fire. The reply by Safford and others (*Ecosystems*, this issue) using a new mapping approach also found this pattern. Their methods identify more high severity fire; however, as we illustrate here, this may be attributed to the different mapping approaches used. We previously also found that condition class based upon fire return interval departure (FRID) was not an effective predictor of fire severity. Safford and others (this issue) concluded that there was a strong correlation between FRID-based condition class and fire severity based upon data from the McNally fire of 2002. The difference between these findings about McNally fire reflects the fact that they combined FRID categories whereas we kept the categories separate. Here, using their fire severity data to evaluate all three fires, we found that severity was not predicted by FRID. Developing a consensus definition of fire severity within the scientific community might help alleviate future contradictions regarding fire effects.

Older Publications Newly Available on the Web

Arno, Stephen F.; Sneck, Kathy M. 1977. A method for determining fire history in coniferous forests in the Mountain West. Gen. Tech. Rep. INT-GTR-42. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 28 p. Available at http://www.fs.fed.us/rm/pubs_int/int_gtr042.pdf

Brown, James K.; Oberheu, Rick D.; Johnston, Cameron M. 1981. Handbook for inventorying surface fuels and biomass in the Interior West. Gen. Tech. Rep. INT-129. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experimental Station. 48 p. Available at http://www.fs.fed.us/rm/pubs_int/int_gtr129.pdf

Campbell, R. E.; Baker, Jr., M. B.; Ffolliott, P. F.; Larson, F. R.; Avery, C. C. 1977. Wildfire effects on a ponderosa pine ecosystem: An Arizona case study. USDA For. Serv. Res. Pap. RM-191. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experimental Station. 12 p. Available at http://www.fs.fed.us/rm/pubs_rm/rm_rp191.pdf

Fischer, William C.; Clayton, Bruce D. 1983. Fire ecology of Montana forest habitat types east of the Continental Divide. Gen. Tech. Rep. INT-GTR-141. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range

Experiment Station. 83 p. Available at
http://www.fs.fed.us/rm/pubs_int/int_gtr141.pdf