Recent Papers in Fire Ecology and Fuels Management: Winter 2011

Compiled by Louisa Evers, Regional Fire Ecologist, Portland, OR
(Abridged for the Great Basin and related topics, links added where available)

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Carbon Management

Hurteau; Matthew D.; Brooks, Matthew L. 2011. Short- and Long-Term Effects of Fire on Carbon in US Dry Temperate Forest Systems. BioScience 61(2): 139–146. http://oak.ucc.nau.edu/mdh22/Publications/Hurteau%20and%20Brooks%202011.pdf

Abstract. Forests sequester carbon from the atmosphere, and in so doing can mitigate the effects of climate change. Fire is a natural disturbance process in many forest systems that releases carbon back to the atmosphere. In dry temperate forests, fires historically burned with greater frequency and lower severity than they do today. Frequent fires consumed fuels on the forest floor and maintained open stand structures. Fire suppression has resulted in increased understory fuel loads and tree density; a change in structure that has caused a shift from low- to high-severity fires. More severe fires, resulting in greater tree mortality, have caused a decrease in forest carbon stability. Fire management actions can mitigate the risk of high-severity fires, but these actions often require a trade-off between maximizing carbon stocks and and carbon stability. We discuss the effects of fire on forest carbon stocks and recommend that managing forests on the basis of their specific ecologies should be the foremost goal, with carbon sequestration being an ancillary benefit.

Sorensen, C.D.; Finkral, A.J.; Kolb, T.E.; Huang, C.H. 2011. Short- and long-term effects of thinning and prescribed fire on carbon stocks in ponderosa pine stands in northern Arizona. Forest Ecology and Management 261(3): 460-472.

Abstract. Euro–American logging practices, intensive grazing, and fire suppression have increased the amount of carbon that is stored in ponderosa pine (*Pinus ponderosa* Dougl. Ex Laws) forests in the southwestern United States. Current stand conditions leave these forests prone to high-intensity wildfire, which releases a pulse

of carbon emissions and shifts carbon storage from live trees to standing dead trees and woody debris. Thinning and prescribed burning are commonly used to reduce the risk of intense wildfire, but also reduce on-site carbon stocks and release carbon to the atmosphere. This study quantified the impact of thinning on the carbon budgets of five ponderosa pine stands in northern Arizona, including the fossil fuels consumed during logging operations. We used the pre- and post-treatment data on carbon stocks and the Fire and Fuels Extension to the Forest Vegetation Simulator (FEE–FVS) to simulate the long-term effects of intense wildfire, thinning, and repeated prescribed burning on stand carbon storage.

The mean total pre-treatment carbon stock, including above-ground live and dead trees, below-ground live and dead trees, and surface fuels across five sites was 74.58 Mg C ha^{-1} and the post-treatment mean was 50.65 Mg C ha^{-1} in the first post-treatment year. The mean total carbon release from slash burning, fossil fuels, and logs removed was 21.92 Mg C ha^{-1}. FEE–FVS simulations showed that thinning increased the mean canopy base height, decreased the mean crown bulk density, and increased the mean crowning index, and thus reduced the risk of high-intensity wildfire at all sites. Untreated stands that incurred wildfire once within the next 100 years or once within the next 50 years had greater mean net carbon storage after 100 years compared to treated stands that experienced prescribed fire every 10 years or every 20 years. Treated stands released greater amounts of carbon overall due to repeated prescribed fires, slash burning, and 100% of harvested logs being counted as carbon emissions because they were used for short-lived products. However, after 100 years treated stands stored more carbon in live trees and less carbon in dead trees and surface fuels than untreated stands burned by intense wildfire. The long-term net carbon storage of treated stands was similar or greater than untreated wildfire-burned stands only when a distinction was made between carbon stored in live and dead trees, carbon in logs was stored in long-lived products, and energy in logging slash substituted for fossil fuels.

North, Malcolm P.; Hurteau, Matthew D. 2011. High-severity wildfire effects on carbon stocks and emissions in fuels treated and untreated forest. Forest Ecology and Management 261(6): 1115-1120. http://oak.ucc.nau.edu/mdh22/Publications/North%20and%20Hurteau%202011%20FEM.pdf

Abstract. Forests contain the world's largest terrestrial carbon stocks, but in seasonally dry environments stock stability can be compromised if burned by wildfire, emitting carbon back to the atmosphere. Treatments to reduce wildfire severity can reduce emissions, but with an immediate cost of reducing carbon stocks. In this study we examine the tradeoffs in carbon stock reduction and wildfire emissions in 19 fuels-treated and -untreated forests burned in twelve wildfires. The fuels treatment, a commonly used thinning 'from below' and removal of activity fuels, removed an average of 50.3 Mg C ha−1 or 34% of live tree carbon stocks. Wildfire emissions averaged 29.7 and 67.8 Mg C ha−1 in fuels treated and untreated forests, respectively. The total carbon (fuels treatment plus wildfire emission) removed from treated sites was 119% of the carbon emitted from the untreated/burned sites. However, with only 3% tree survival following wildfire, untreated forests averaged only 7.8 Mg C ha−1 in live trees with an average quadratic mean tree diameter of 21

cm. In contrast, treated forest averaged 100.5 Mg C ha−1 with a live tree quadratic mean diameter of 44 cm. In untreated forests 70% of the remaining total ecosystem carbon shifted to decomposing stocks after the wildfire, compared to 19% in the fuels-treated forest. In wildfire burned forest, fuels treatments have a higher immediate carbon 'cost', but in the long-term may benefit from lower decomposition emissions and higher carbon storage.

Fire Behavior

Andrews, Patricia L.; Heinsch, Faith Ann; Schelvan, Luke. 2011. How to generate and interpret fire characteristics charts for surface and crown fire behavior. Gen. Tech. Rep. RMRS-GTR-253. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 40 p. http://www.fs.fed.us/rm/pubs/rmrs_gtr253.pdf

Abstract. A fire characteristics chart is a graph that presents primary related fire behavior characteristics-rate of spread, flame length, fireline intensity, and heat per unit area. It helps communicate and interpret modeled or observed fire behavior. The Fire Characteristics Chart computer program plots either observed fire behavior or values that have been calculated by another computer program such as the BehavePlus fire modeling system. Program operation is described in this report, and its flexibility in format, color, and labeling is demonstrated for use in a variety of reports. A chart produced by the program is suitable for inclusion in briefings, reports, and presentations. Example applications are given for fire model understanding, observed crown fire behavior, ignition pattern effect on fire behavior, prescribed fire planning, briefings, and case studies. The mathematical foundation for the charts is also described. Separate charts are available for surface fire and crown fire because of differences in the flame length model used for each.

Forests

Acuna, Mauricio A.; Palma, Cristian D.; Cui, Wenbin; Martell, David L.; Weintraub, Andres. 2010. Integrated spatial fire and forest management planning. Canadian Journal of Forest Research 40(12): 2370-2383.

Abstract. Forest management planners usually treat potential fire loss estimates as exogenous parameters in their timber production planning processes. When they do so, they do not account for the fact that forest access road construction, timber harvesting, and silvicultural activities can alter a landscape‟s vegetation or fuel composition, and they ignore the possibility that such activities may influence future fire losses. We develop an integrated fire and forest management planning methodology that accounts for and exploits such interactions. Our methodology is based on fire occurrence, suppression, and spread models, a fire protection value model that identifies crucial stands, the harvesting of which can have a significant influence on the spread of fires across the landscape, and a spatially explicit timber harvest scheduling model. We illustrate its use by applying it to a forest management unit in the boreal forest region of the province of Alberta in western

Canada. We found that for our study area, integrated fire – forest management planning based on our methodology could result in an 8.1% increase in net present value when compared with traditional planning in which fire loss is treated as an exogenous factor.

Ganey, Joseph L.; Vojta, Scott C. 2011. Tree mortality in drought-stressed mixed-conifer and ponderosa pine forests, Arizona, USA. Forest Ecology and Management 261(1): 162-168. http://ddr.nal.usda.gov/dspace/bitstream/10113/46563/1/IND44452901.pdf

Abstract. We monitored tree mortality in northern Arizona (USA) mixed-conifer and ponderosa pine (*Pinus ponderosa* Dougl. *ex* Laws) forests from 1997 to 2007, a period of severe drought in this area. Mortality was pervasive, occurring on 100 and 98% of 53 mixed-conifer and 60 ponderosa pine plots (1-ha each), respectively. Most mortality was attributable to a suite of forest insects, mediated by drought stress. The number of trees dying from 2002 to 2007 was more than 200% greater than the number dying from 1997 to 2002 in mixed-conifer forest and 74% greater in ponderosa pine forest. Extent of mortality was spatially variable in both forest types. Median cumulative mortality (the ratio of dead to live trees) increased by approximately 53 and 65% in mixed-conifer and ponderosa pine forests, respectively, from 2002 to 2007. Median mortality rates from 2002 to 2007 were approximately 2.0% year−1 in mixed-conifer forest (range = 0–28.5%) and 0.4% year−1 in ponderosa pine forest (range = 0–13.6%). Mortality rates generally were not strongly related to either elevation or stand density. Mortality was nonrandom with respect to tree size classes and species. Proportions of trees dying were greatest in the largest size classes, particularly in mixed-conifer forest, where mortality in the largest size class exceeded 22% from 2002 to 2007. Mortality in mixed-conifer forest was particularly pronounced for quaking aspen (85%) and white fir (28%), the least drought tolerant species present. These results provide an early glimpse of how these forest types are likely to respond to predicted climate changes in the southwestern USA. They suggest that these forests are not resilient to climate change, and that treatments to increase resilience to climate change may be appropriate. Research on causes of spatial heterogeneity in extent of mortality might suggest valuable approaches to aid in increasing resilience.

Haugo, Ryan D.; Hall, Sonia A.; Gray, Elizabeth M.; Gonzalez, Patrick; Bakker, Jonathan D. 2010. Influences of climate, fire, grazing, and logging on woody species composition along an elevation gradient in the eastern Cascades, Washington. Forest Ecology and Management 260(12): 2204-2213.

Abstract. Across western North America, current ecosystem structure has been determined by historical interactions between climate, fire, livestock grazing, and logging. Climate change could substantially alter species abundance and composition, but the relative weight of the legacy of historical factors and projected future conditions in informing management objectives remains unresolved. We integrated land use histories with broad scale climatic factors to better understand

how inland Pacific Northwest ecosystems may develop under projected climates. We measured vegetation structure and age distributions in five vegetation types (shrub steppe to subalpine forest) along an elevation gradient in the eastern Cascades of Washington. We quantitatively assessed compositional changes, and qualitatively summarized the environmental history (climate, fire and fire suppression, grazing, and logging) of each site. Little change was evident in woody species composition at the shrub steppe site. At the shrub steppe/forest ecotone, densities of drought-tolerant *Artemisia tripartita* and *Pinus ponderosa* increased. In the dry conifer, montane, and subalpine forest sites, increases in *Pseudotsuga menziesii*, *Abies grandis*, and *Abies lasiocarpa*, respectively, and decreases in *Pinus ponderosa*, *Larix occidentalis*, and *Pinus contorta*, respectively, have shifted species composition from fire and drought-tolerant species to shade-tolerant species. Fire suppression, grazing, and logging explain changes in species composition more clearly than climate variation does, although the relative influence of these factors varies with elevation. Furthermore, some of the observed changes in composition are opposite what we expect would be most suited to projected future climates. Natural resource managers need to recognize that the current state of an ecosystem reflects historical land uses, and that contemporary management actions can have long-term effects on ecosystem structure. Understanding the processes that generated an ecosystem's current structure will lead to more informed management decisions to effectively respond to projected climate changes.

Leirfallom, Signe B.; Keane, Robert E. 2011. Six-year post-fire mortality and health of relict ponderosa pines in the Bob Marshall Wilderness Area, Montana. Res. Note RMRS-RN-42. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 5 p. http://www.fs.fed.us/rm/pubs/rmrs_rn042.pdf

Abstract. In 2003, lightning-caused fires burned through relict ponderosa pine (*Pinus ponderosa*) stands in the Bob Marshall Wilderness, Montana, after decades of fire exclusion. Since many trees in these stands had Native American bark-peeling scars, concern arose about the adverse fire effects on this cultural and ecological resource. In 2004, Keane and others (2006) began a post-fire monitoring study of the relict pine stands. In 2009, we completed a six year re-measurement of those stands. We found that many of the pines with major fire injury had recovered, and tree mortality was not as high as initially estimated. A low-intensity surface fire, prescribed or lightning-caused, within the next 10 years will help preserve the health of these stands in the future.

Scudieri, Catherine A.; Sieg, Carolyn Hull; Haase, Sally M.; Thode, Andrea E.; Sackett, Stephen S. 2010. Understory vegetation response after 30 years of interval prescribed burning in two ponderosa pine sites in northern Arizona, USA. Forest Ecology and Management 260(12): 2134-2142. http://ddr.nal.usda.gov/dspace/bitstream/10113/46560/1/IND44445729.pdf

Abstract. Southwestern USA ponderosa pine (*Pinus ponderosa* C. Lawson var. *scopulorum* Engelm.) forests evolved with frequent surface fires and have changed

dramatically over the last century. Overstory tree density has sharply increased while abundance of understory vegetation has declined primarily due to the near cessation of fires. We examined effects of varying prescribed fire-return intervals (1, 2, 4, 6, 8, and 10 years, plus unburned) on the abundance and composition of understory vegetation in 2007 and 2008 after 30+ years of fall prescribed burning at two ponderosa pine sites. We found that after 30 years, overstory canopy cover remained high, while understory plant canopy cover was low, averaging <12% on all burn intervals. We attributed the weak understory response to a few factors – the most important of which was the high overstory cover at both sites. Graminoid cover and cover of the major grass species, *Elymus elymoides* (squirreltail), increased on shorter fire-return intervals compared to unburned plots, but only at one site. Community composition differed significantly between shorter fire-return intervals and unburned plots at one site, but not the other. For several response variables, precipitation levels appeared to have a stronger effect than treatments. Our findings suggest that low-severity burn treatments in southwestern ponderosa pine forests, especially those that do not decrease overstory cover, are minimally effective in increasing understory plant cover. Thinning of these dense forests along with prescribed burning is necessary to increase cover of understory vegetation.

Grasslands and Rangelands

Mangla, S.; Sheley, R.L.; James, J.J. 2011. Field growth comparisons of invasive alien annual and native perennial grasses in monocultures. Journal of Arid Environments 72(2): 206-210. http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/19066/ManglaSeema.FieldGrowthComparisonsofInvasiveAlien.2010.pdf?sequence=1

Abstract. Throughout the western United States, the invasive annual grass, medusahead (*Taeniatherum caput-medusae* L. Nevski), is rapidly invading grasslands once dominated by native perennial grasses, such as bluebunch wheatgrass (*Pseudoroegneria spicata* (Pursh) A). It is also invading grasslands dominated by less undesirable invasive annual grasses, especially cheatgrass (*Bromus tectorum* L.). Understanding medusahead growth dynamics relative to native perennial grasses and cheatgrass is central to predicting and managing medusahead invasion. We hypothesized that medusahead would have a higher relative growth rate (RGR), a longer period of growth, and as a consequence, more total biomass at the end of the growing season than the native perennial grass and cheatgrass. In 2008 (dry conditions), 250 seeds and in 2009 (wet conditions), 250 and 100 seeds of each species were sown in 1 m2 plots with 5 replicates. Shoots were harvested on 3–25 day intervals throughout the growing season. The native perennial grass had more biomass and higher RGR than medusahead in the dry year, but the relationship was reversed in the wet year. Precipitation in 2008 was well-below average and this level of drought is very infrequent based on historical weather data. Medusahead had a longer period of growth and more total biomass than cheatgrass for both years. We expect that medusahead will continue to invade both native perennial and less undesirable invasive annual grasslands because of its higher RGR and extended period of growth.

Romo, J. T.; Gross, D. V. 2011. Preburn history and seasonal burning effects on the soil seed bank in the Fescue Prairie. The American Midland Naturalist 165(1): 74–90.

Abstract. Fescue Prairie is one of the most threatened ecosystems in Canada, and burning is essential for conserving remnants of this grassland. Burning is a key process in the natural disturbance regime, but its effect on the soil seed bank in Fescue Prairie is poorly understood. We tested the hypotheses that (1) preburn history influences the density and composition of seedlings emerging from the soil seed bank, and (2) burning in different seasons reduces densities and changes the composition of seedlings emerging from soil seed banks compared with non-burned controls in Fescue Prairie. Seedling emergence from seed banks was studied for 5 y in non-burned controls and following burning before, during or after the growing season on sites with different preburn histories (sites burned two times or sites burned >90 y before this study). Preburn history had no effect ($P \geq 0.14$) on the density of native graminoids, native forbs, non-native species, total species richness (R) and diversity (H′) of species emerging. Burning during or after the growing season reduced H′ of emergent seedlings by 13% compared with burning before the growing season ($P = 0.02$). Total seedling densities, densities of graminoids and forbs, R and H′ all varied significantly ($P \leq 0.01$) among years. Non-metric multidimensional scaling indicated species composition for seedlings emerging from seed banks correlated with preburn history, years after applying seasonal burning treatments, and soil water content in plant communities but not with season of burning. After burning remnant Fescue Prairies, inter-annual variation in the densities, R and H′ of seedlings emerging from seed banks usually overshadows preburn history and seasonal burning effects on emergent seedlings; however, species composition changes with preburn history, soil water content and years after burning.

Restoration

Gagnon, Paul R.; Passmore, Heather A.; Platt, William J.; Myers, Jonathan A.; Paine, C. E. Timothy; Harms, Kyle E. 2010. Does pyrogenicity protect burning plants? Ecology 91(12): 3481–3486. http://wx2mz2qh4l.scholar.serialssolutions.com/?sid=google&auinit=P&aulast=Gagnon&atitle=Does+pyrogenicity+protect+burning+plants%3F&id=doi:10.1890/10-0291.1 (Contact emb@cabnr.unr.edu for pdf.)

Abstract. Pyrogenic plants dominate many fire-prone ecosystems. Their prevalence suggests some advantage to their enhanced flammability, but researchers have had difficulty tying pyrogenicity to individual-level advantages. Based on our review, we propose that enhanced flammability in fire-prone ecosystems should protect the belowground organs and nearby propagules of certain individual plants during fires. We base this hypothesis on five points: (1) organs and propagules by which many fire-adapted plants survive fires are vulnerable to elevated soil temperatures during fires; (2) the degree to which burning plant fuels heat the soil

depends mainly on residence times of fires and on fuel location relative to the soil; (3) fires and fire effects are locally heterogeneous, meaning that individual plants can affect local soil heating via their fuels; (4) how a plant burns can thus affect its fitness; and (5) in many cases, natural selection in fire-prone habitats should therefore favor plants that burn rapidly and retain fuels off the ground. We predict an advantage of enhanced flammability for plants whose fuels influence local fire characteristics and whose regenerative tissues or propagules are affected by local variation in fires. Our "pyrogenicity as protection" hypothesis has the potential to apply to a range of life histories. We discuss implications for ecological and evolutionary theory and suggest considerations for testing the hypothesis.

Godefroid, Sandrine; Piazza, Carole; Rossi, Graziano; Buord, Stéphane; Stevens, Albert-Dieter; Aguraiuja, Ruth; Cowell, Carly; Weekley, Carl W.; Vogg, Gerd; Iriondo, José M.; Johnson, Isabel; Dixon, Bob; Gordon, Doria; Magnanon, Sylvie; Valentin, Bertille; Bjureke, Kristina; Koopman, Rupert; Vicens, Magdalena; Virevaire, Myriam; Vanderborght, Thierry. 2011. How successful are plant species reintroductions? Biological Conservation 144(2): 672-682. (Contact emb@cabnr.unr.edu for pdf.)

Abstract. Reintroduction of native species has become increasingly important in conservation worldwide for recovery of rare species and restoration purposes. However, few studies have reported the outcome of reintroduction efforts in plant species. Using data from the literature combined with a questionnaire survey, this paper analyses 249 plant species reintroductions worldwide by assessing the methods used and the results obtained from these reintroduction experiments. The objectives were: (1) to examine how successful plant species reintroductions have been so far in establishing or significantly augmenting viable, self-sustaining populations in nature; (2) to determine the conditions under which we might expect plant species reintroductions to be most successful; (3) to make the results of this survey available for future plant reintroduction trials. Results indicate that survival, flowering and fruiting rates of reintroduced plants are generally quite low (on average 52%, 19% and 16%, respectively). Furthermore, our results show a success rate decline in individual experiments with time. Survival rates reported in the literature are also much higher (78% on average) than those mentioned by survey participants (33% on average). We identified various parameters that positively influence plant reintroduction outcomes, e.g., working in protected sites, using seedlings, increasing the number of reintroduced individuals, mixing material from diverse populations, using transplants from stable source populations, site preparation or management effort and knowledge of the genetic variation of the target species. This study also revealed shortcomings of common experimental designs that greatly limit the interpretation of plant reintroduction studies: (1) insufficient monitoring following reintroduction (usually ceasing after 4 years); (2) inadequate documentation, which is especially acute for reintroductions that are regarded as failures; (3) lack of understanding of the underlying reasons for decline in existing plant populations; (4) overly optimistic evaluation of success based on short-term results; and (5) poorly defined success criteria for reintroduction projects. We therefore conclude that the value of plant reintroductions as a conservation tool could be improved by: (1) an increased focus on species biology; (2) using a higher number of transplants

(preferring seedlings rather than seeds); (3) taking better account of seed production and recruitment when assessing the success of reintroductions; (4) a consistent long-term monitoring after reintroduction.

Holmes, K. A., Veblen, K. E., Berry, A. M.; Young, T. P. 2011. Effects of prescribed fires on young valley oak trees at a research restoration site in the Central Valley of California. Restoration Ecology 19(1): 118–125.

Abstract. Woodland restoration sites planted with *Quercus lobata* (valley oak) often have serious invasions of nonnative annual grasses and thistles. Although prescribed fire can effectively control these exotics, restoration managers may be reluctant to use fire if it causes substantial mortality of recently planted saplings. We studied the effects of prescribed fires on the survival and subsequent growth of 5- and 6-year-old valley oak saplings at a research field near Davis, California. One set of blocks was burned in summer 2003 at a time that would control yellow star thistle, a second set of blocks was burned in spring 2004 at a time that would control annual grasses, and a third set was left unburned. Very few oaks died as a result of either fire (3–4%). Although a large proportion was top-killed (66–72%), virtually all these were coppiced and most saplings over 300 cm tall escaped top-kill. Tree height, fire temperature, and understory biomass were all predictive of the severity of sapling response to fire. Although the mean sapling height was initially reduced by the fires, the growth rates of burned saplings significantly exceeded the growth rates of unburned control trees for 2 years following the fires. By 2–3 years after the fires, the mean height of spring- and summer-burned saplings was similar to that of the unburned control saplings. The presence of valley oak saplings does not appear to preclude the use of a single prescribed burn to control understory invasives, particularly if saplings are over 300 cm tall.

Parson, Annette; Robichaud, Peter R.; Lewis, Sarah A.; Napper, Carolyn; Clark, Jess T. 2010. Field guide for mapping post-fire soil burn severity. Gen. Tech. Rep. RMRS-GTR-243. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 49 p. http://www.fs.fed.us/rm/pubs/rmrs_gtr243.pdf

Abstract. Following wildfires in the United States, the U.S. Department of Agriculture and U.S. Department of the Interior mobilize Burned Area Emergency Response (BAER) teams to assess immediate post-fire watershed conditions. BAER teams must determine threats from flooding, soil erosion, and instability. Developing a postfire soil burn severity map is an important first step in the rapid assessment process. It enables BAER teams to prioritize field reviews and locate burned areas that may pose a risk to critical values within or downstream of the burned area. By helping to identify indicators of soil conditions that differentiate soil burn severity classes, this field guide will help BAER teams to consistently interpret, field validate, and map soil burn severity.

Roccaforte, J. P., Fulé, P. Z.; Covington, W. W. 2010. Monitoring Landscape-Scale Ponderosa Pine Restoration Treatment Implementation and Effectiveness. Restoration Ecology 18(6): 820–833.

Abstract. We evaluated landscape-scale forest restoration treatment implementation and effectiveness in meeting objectives in a ponderosa pine forest at Mt. Trumbull, Arizona, U.S.A. The goal of the project was to alter forest structure by thinning and burning to more closely resemble forest conditions prior to Euro-American settlement in 1870. We measured 117 permanent plots before (1996/1997) and after (2003) treatments. The plots were evenly distributed across the landscape (approximately 1,200 ha), about half of which was an untreated control. We evaluated treatment implementation and effectiveness based on 1870 structure and/or goals outlined by managers. The success of treatment implementation varied: about 94% of the area originally planned for restoration was treated in some manner by 2003, but only 70% received the full planned treatment (thin and burn). Although density of ponderosa pines >2.5 cm was reduced significantly by 66% from approximately 429 pines/ha to approximately 146 pines/ha in the treated area, the targeted residual density was exceeded by 111–256% (all plots) or 10–85% (thinned and burned plots). Thirteen percent of the pre-settlement pines died in the treated area by 2003, but 9% percent also died in the control, indicating that pre-settlement pines in untreated areas were nearly as vulnerable as those exposed to restoration treatments. Large snags increased 45%, and 65% of logs >50 cm were retained, achieving implementation goals. Although restoration treatments were not implemented totally to specifications, they were effective in attaining the overall project goal of restoring more open forest structure while preserving more than 75% of the pre-settlement pines. Canopy fuel loads were substantially reduced, allowing for the reintroduction of surface fires.

Terrestrial Wildlife

Roberts, Susan L.; van Wagtendonk, Jan W.; Miles, A. Keith; Kelt, Douglas A. 2011. Effects of fire on spotted owl site occupancy in a late-successional forest. Biological Conservation 144(1): 610-619.

Abstract. The spotted owl (*Strix occidentalis*) is a late-successional forest dependent species that is sensitive to forest management practices throughout its range. An increase in the frequency and spatial extent of stand-replacing fires in western North America has prompted concern for the persistence of spotted owls and other sensitive late-successional forest associated species. However, there is sparse information on the effects of fire on spotted owls to guide conservation policies. In 2004–2005, we surveyed for California spotted owls during the breeding season at 32 random sites (16 burned, 16 unburned) throughout late-successional montane forest in Yosemite National Park, California. Our burned areas burned at all severities, but predominately involved low to moderate fire severity. Based on an information theoretic approach, spotted owl detection and occupancy rates were similar between burned and unburned sites. Nest and roost site occupancy was best explained by a model that combined total tree basal area (positive effect) with cover by coarse woody debris (negative effect). The density estimates of California spotted owl pairs were similar in burned and unburned forests, and the overall mean density estimate for Yosemite was higher than previously reported for montane forests. Our results indicate that low to moderate severity fires, historically common within montane forests of the Sierra Nevada, California, maintain habitat characteristics essential for spotted owl site occupancy. These results suggest that managed fires that emulate

the historic fire regime of these forests may maintain spotted owl habitat and protect this species from the effects of future catastrophic fires.

Wildland-Urban Interface

Massada, Avi Bar; Radeloff, Volker C.; Stewart, Susan I. 2011. Allocating fuel breaks to optimally protect structures in the wildland–urban interface. International Journal of Wildland Fire 20(1) 59-68. http://www.nrs.fs.fed.us/pubs/jrnl/2011/nrs_2011_bar-massada_001.pdf

Abstract. Wildland fire is a major concern in the wildland–urban interface (WUI), where human structures intermingle with wildland vegetation. Reducing wildfire risk in the WUI is more complicated than in wildland areas, owing to interactions between spatial patterns of housing and wildland fuels. Fuel treatments are commonly applied in wildlands surrounding WUI communities. Protecting the immediate surroundings of structures and building with fire-resistant materials might be more effective, but limited resources and uncooperative homeowners often make these impractical. Our question was how to allocate fuel treatments in the WUI under these constraints. We developed an approach to allocate fuel breaks around individual or groups of structures to minimise total treatment area. Treatment units were ranked according to their housing density and fire risk. We tested this method in a Wisconsin landscape containing 3768 structures, and found that our treatment approach required considerably less area than alternatives (588 *v.* 1050 ha required to protect every structure independently). Our method may serve as a baseline for planning fuel treatments in WUI areas where it is impractical to protect every single house, or when fire-proofing is unfeasible. This approach is especially suitable in regions where spotting is a minor cause of home ignitions.

Woodlands and Shrublands

Davies, Kirk W.; Bates, Jonathan D.; Svejcar, Tony J.; Boyd, Chad S. 2010. Effects of Long-Term Livestock Grazing on Fuel Characteristics in Rangelands: An Example From the Sagebrush Steppe. Rangeland Ecology & Management 63(6): 662-669. http://oregonstate.edu/dept/EOARC/sites/default/files/672.pdf

Abstract. Livestock grazing potentially has substantial influence on fuel characteristics in rangelands around the globe. However, information quantifying the impacts of grazing on rangeland fuel characteristics is limited, and the effects of grazing on fuels are important because fuel characteristics are one of the primary factors determining risk, severity, continuity, and size of wildfires. We investigated the effects of long-term (70+ yr) livestock grazing exclusion (nongrazed) and moderate levels of livestock grazing (grazed) on fuel accumulations, continuity, gaps, and heights in shrub-grassland rangelands. Livestock used the grazed treatment through 2008 and sampling occurred in mid- to late summer in 2009. Nongrazed rangelands had over twofold more herbaceous standing crop than grazed rangelands

($P < 0.01$). Fuel accumulations on perennial bunchgrasses were approximately threefold greater in nongrazed than grazed treatments. Continuity of fuels in nongrazed compared to grazed treatments was also greater ($P < 0.05$). The heights of perennial grass current year's and previous years' growth were 1.3-fold and 2.2-fold taller in nongrazed compared to grazed treatments ($P < 0.01$). The results of this study suggest that moderate livestock grazing decreases the risk of wildfires in sagebrush steppe plant communities and potentially other semi-arid and arid rangelands. These results also suggest wildfires in moderately grazed sagebrush rangelands have decreased severity, continuity, and size of the burn compared to long-term nongrazed sagebrush rangelands. Because of the impacts fuels have on fire characteristics, moderate levels of grazing probably increase the efficiency of fire suppression activities. Because of the large difference between fuel characteristics in grazed and nongrazed sagebrush rangelands, we suggest that additional management impacts on fuels and subsequently fires need to be investigated in nonforested rangelands to protect native plant communities and prioritize management needs.

Roth, Aaron D.; Bunting, Stephen C.; Strand, Eva K. 2011. Relationships between landscape patterns and fire occurrence within a successional gradient in sagebrush steppe–juniper woodland. International Journal of Wildland Fire 20(1) 69-77. (Contact emb@cabnr.unr.edu for pdf.)

Abstract. Expansion of western juniper (*Juniperus occidentalis* Hook. var. *occidentalis*) has altered vegetation composition, fire behaviour and fire potential throughout south-western Idaho and eastern Oregon. Utilising GIS-derived products and fire-simulation software, the influence of the spatial arrangement of different woodland developmental stages on simulated surface fire occurrence was evaluated. Custom fuel models and a recent vegetation map processed in FARSITE under moderate fire conditions were used to create a fire-occurrence grid in three sixth-order watersheds on the Owyhee Plateau of south-western Idaho. Landscape pattern metrics were selected to quantify the spatial arrangement of plant communities within a neighbourhood around points from each successional stage randomly placed within each watershed. Linear regression analysis of fire occurrence and each of the selected landscape metrics was compared for four successional stages of western juniper encroachment to assess the effect of landscape-scale vegetation arrangement on fire occurrence. The landscape structure had little influence on whether an early-successional area burns in a surface fire, whereas the surrounding landscape structure influenced whether a late-successional or mature woodland area burned. Landscape metrics that showed significance in late-successional and mature woodland stages include patch density, mean area and Simpson's diversity.