Fire and Fuels Science Quarterly: Fall 2012

Climate Change and Carbon Management

Mackey, Brendan, Sandra Berry, Sonia Hugh, Simon Ferrier, Thomas D. Harwood, and Kristen J. Williams, 2012

Ecosystem greenspots: identifying potential drought, fire, and climate-change micro-refuges. Ecological Applications, 22(6): 1852–1864 http://www.esajournals.org/doi/abs/10.1890/11-1479.1

Abstract. In response to climate change and other threatening processes there is renewed interest in the role of refugia and refuges. In bioregions that experience drought and fire, micro-refuges can play a vital role in ensuring the persistence of species. We develop and apply an approach to identifying potential micro-refuges based on a time series of remotely sensed vegetation greenness (fraction of photosynthetically active radiation intercepted by the sunlit canopy; fPAR). The primary data for this analysis were NASA MODIS 16-day L3 Global 250 m (MOD13Q1) satellite imagery. This method draws upon relevant ecological theory (source–sink habitats, habitat templet) to calculate a micro-refuge index, which is analyzed for each of the major vegetation ecosystems in the case-study region (the Great Eastern Ranges of New South Wales, Australia). Potential ecosystem greenspots were identified, at a range of thresholds, based on an index derived from: the mean and coefficient of variance (COV) of fPAR over the 10-year time series; the minimum mean annual fPAR; and the COV of the 12 values of mean monthly fPAR. These greenspots were mapped and compared with (1) an index of vascular plant species composition, (2) environmental variables, and (3) protected areas. Potential micro-refuges were found within all vegetation ecosystem types. The total area of ecosystem greenspots within the upper 25% threshold was 48 406 ha; around 0.2% of the total area of native vegetation (23.9×10^6 ha) in the study region. The total area affected by fire was 3.4×10^6 ha. The results of the environmental diagnostic analysis suggest deterministic controls on the geographical distribution of potential micro-refuges that may continue to function under climate change. The approach is relevant to other regions of the world where the role of micro-refuges in the persistence of species is recognized, including across the world's arid zones and, in particular, for the Australian, southern African, and South American continents. Micro-refuge networks may play an important role in maintaining beta-diversity at the bio-region scale and contribute to the stability, resilience, and adaptive capacity of ecosystems in the face of ever-growing pressures from human-forced climate change, land use, and other threatening processes.

Fulé, Peter Z., Larissa L. Yocom, Citlali Cortés Montaño, Donald A. Falk, Julián Cerano and José Villanueva-Díaz. 2012.

Testing a pyroclimatic hypothesis on the Mexico–United States border. Ecology, 93(8):1830–1840.

Abstract. The "pyroclimatic hypothesis" proposed by F. Biondi and colleagues provides a basis for testable expectations about climatic and other controls of fire regimes. This hypothesis asserts an a priori relationship between the occurrence of widespread fire and values of a relevant climatic index. Such a hypothesis provides the basis for predicting spatial and temporal patterns of fire occurrence based on climatic control. Forests near the Mexico–United States border offer a place to test the relative influence of climatic and other controls in mountain ranges that are

ecologically similar and subject to broadly similar top-down climatic influence, but with differing cultural influences. We tested the pyroclimatic hypothesis by comparing fire history information from the Mesa de las Guacamayas, a mountain range in northwestern Chihuahua, with previously published fire data from the Chiricahua Mountains, in southeastern Arizona, approximately 150 km away. We developed a priori hypothetical models of fire occurrence and compared their performance to empirical climate-based models. Fires were frequent at all Mesa de las Guacamayas study sites through the mid-20th century and continued uninterrupted to the present at one site, in contrast to nearly complete fire exclusion after 1892 at sites in the Chiricahua Mountains. The empirical regression models explained a higher proportion of the variability in fire regime associated with climate than did the a priori models. Actual climate–fire relationships diverged in each country after 1892. The a priori models predicted continuing fires at the same rate per century as prior to 1892; fires did in fact continue in Mexico, albeit with some alteration of fire regimes, but ceased in the United States, most likely due to changes in land use. The cross-border comparison confirms that a frequent-fire regime could cease without a climatic cause, supporting previous arguments that bottom-up factors such as livestock grazing can rapidly and drastically alter surface fire regimes. Understanding the historical patterns of climate controls on fire could inform the use of historical data as ecological reference conditions and for future sustainability.

Fire Behavior and Fuels

Casey C. Teske, Carl A. Seielstad, and LLoyd P. Queen. 2012.
Characterizing Fire-on-Fire Interactions in Three Large Wilderness Areas. Fire Ecology 8(2): 82-106.

Abstract. The interaction of fires, where one fire burns into another recently burned area, is receiving increased attention from scientists and land managers wishing to describe the role of fire scars in affecting landscape pattern and future fire spread. Here, we quantify fire-on-fire interactions in terms of frequency, size, and time-since-previous fire (TSPF) in three large wilderness areas in Montana and Idaho, USA, from 1984 to present, using spatially consistent large fire perimeter data from the Monitoring Trends in Burn Severity (MTBS) dataset. The analysis is supplemented with less consistent fire perimeter data from a regional fire atlas in order to examine the potential role played by smaller fires in fire-on-fire interactions. We compare current rates of burning to existing estimates using the natural fire rotation (NFR) to determine whether recent fire activity falls within established historical ranges. We also compare actual fires to randomly located fires to establish whether the frequency and size of re-burns differ by chance. Finally, we systematically classify shared fire edges as fire-stopping or breached to quantify the effect of previous fires on subsequent fire spread. In total, more than half of the Frank Church, one-quarter of the Bob Marshall, and fifteen percent of the Selway-Bitterroot wilderness areas have burned since 1984. Area burned within each of the study areas yielded NFRs that are consistent with results derived from fire atlas and tree-ring research studies. The data show that re-burning occurs less frequently than chance in the Frank Church Wilderness Area, perhaps less frequently in the Bob Marshall Wilderness Area, and the same as chance in the Selway-Bitterroot Wilderness Area. In each of the study areas, the total amount of edge at which a fire met another fire was less than three percent of the total available perimeter. However, ~80 % of the total edge encountered was breached, resulting in fire spreading onto previously burned landscapes and re-burning at least 40 ha. Year-to-

year variability in re-burn occurrence was high, and the size of re-burns was typically small, implying a general resistance to re-burning, but the preponderance of small patches resulting from fire interactions has perhaps significant ecological implications. There was a systematic decrease in the frequency of small to medium sized re-burns (40 ha to 405 ha) as time between fires increased in all three wilderness areas. The frequency of large re-burns increased with time in the Frank Church wilderness area, but this trend was not apparent in the other two wilderness areas. Overall, fire-on-fire interactions show a high degree of complexity, making direct comparisons between the three wilderness areas difficult, but the evidence suggests that large wildfires generally inhibit the spread of subsequent fires, while small fires appear to have little impact on the spread of other fires. The limiting effect of large fires on small fires is potentially significant based on the number of cases observed (n = 101).

Scott L. Goodrick, Gary L. Achtemeier, Narasimhan K. Larkin, Yongqiang Liu and Tara M. Strand. 2012.

Modelling smoke transport from wildland fires: a review. International Journal of Wildland Fire. http://dx.doi.org/10.1071/WF11116

Abstract. Among the key issues in smoke management is predicting the magnitude and location of smoke effects. These vary in severity from hazardous (acute health conditions and drastic visibility impairment to transportation) to nuisance (regional haze), and occur across a range of scales (local to continental). Over the years a variety of tools have been developed to aid in predicting smoke effects. This review follows the development of these tools, from various indices and simple screening models to complex air quality modelling systems, with a focus on how each tool represents key processes involved in smoke transport.

Keane, Robert E. 2012.

Describing wildland surface fuel loading for fire management: a review of approaches, methods and systems. International Journal of Wildland Fire - http://dx.doi.org/10.1071/WF11139

Abstract. Wildland fuelbeds are exceptionally complex, consisting of diverse particles of many sizes, types and shapes with abundances and properties that are highly variable in time and space. This complexity makes it difficult to accurately describe, classify, sample and map fuels for wildland fire research and management. As a result, many fire behaviour and effects software prediction systems use a generalised description of fuels to simplify data collection and entry into various computer programs. There are several major fuel description systems currently used in the United States, Canada and Australia, and this is a source of confusion for many in fire management. This paper (1) summarises the challenges of describing fuels, (2) contrasts approaches (association, classification and abstraction) for developing fuel description systems and (3) discusses possible future directions in wildland fuel description and science to transition to a universal fuel description system. Most discussion centres on surface fuel loadings as the primary descriptive characteristic. This synthesis paper is intended to provide background for understanding surface fuel classification and description systems and their use in simulating fire behaviour and effects, quantifying carbon inventories and evaluating site productivity.

Jain, Theresa B.; Battaglia, Mike A.; Han, Han-Sup; Graham, Russell T.; Keyes, Christopher R.; Fried, Jeremy S.; Sandquist, Jonathan E. 2012.

A Comprehensive Guide to Fuel Management Practices for Dry Mixed Conifer Forests in the Northwestern United States. Rocky Mountain Research Station, General Technical Report RMRS-GTR-292, 344pp.

Abstract. This guide describes the benefits, opportunities, and trade-offs concerning fuel treatments in the dry mixed conifer forests of northern California and the Klamath Mountains, Pacific Northwest Interior, northern and central Rocky Mountains, and Utah. Multiple interacting disturbances and diverse physical settings have created a forest mosaic with historically low- to mixed-severity fire regimes. Analysis of forest inventory data found nearly 80 percent of these forests rate hazardous by at least one measure and 20 to 30 percent rate hazardous by multiple measures. Modeled mechanical treatments designed to mimic what is typically implemented, such as thinning, are effective on less than 20 percent of the forest in single entry, but can be self-funding more often than not. We provide: (1) exhaustive summaries and links to supporting guides and literature on the mechanics of fuel treatments, including mechanical manipulation, prescribed fire, targeted grazing and chemical use; (2) a decision tree to help managers select the best mechanical method for any situation in these regions; (3) discussion on how to apply prescribed fire to achieve diverse and specific objectives; (4) key principles for developing an effective monitoring plan; (5) economic analysis of mechanical fuel treatments in each region; and (6) discussion on fuel treatment longevity. In the electronic version of the document, we have provided links to electronic copies of cited literature available in the TreeSearch online document library (http://www.treesearch.fs.fed.us/).

Forests

Edburg, Steven L.; Hicke, Jeffrey A.; Brooks, Paul D.; Pendall, Elise G.; Ewers, Brent E.; Norton, Urszula; Gochis, David; Gutmann, Ethan D.; and Meddens, Arjan JH. 2012.

Cascading impacts of bark beetle-caused tree mortality on coupled biogeophysical and biogeochemical processes. Frontiers in Ecology and the Environment, 10(8): 416-424.

Abstract. large-scale outbreaks of bark beetle infestations have affected millions of hectares of forest in western North America, covering an area similar in size to that impacted by fire. Bark beetles kill host trees in affected areas, thereby altering water supply, carbon storage, and nutrient cycling in forests; for example, the timing and amount of snow melt may be substantially modified following bark beetle infestation, which impacts water resources for many western US states. The quality of water from infested forests may also be diminished as a result of increased nutrient export. Understanding the impacts of bark beetle outbreaks on forest ecosystems is therefore important for resource management. Here, we develop a conceptual framework of the impacts on coupled biogeophysical and biogeochemical processes following a mountain pine beetle (*Dendroctonus ponderosae*) outbreak in lodgepole pine (*Pinus contorta* Douglas var *latifolia*) forests in the weeks to decades after an infestation, and highlight future research needs and management implications of this widespread disturbance event.

Miller, Carol and Ager, Alan A. 2012.

A review of recent advances in risk analysis for wildfire management. International Journal of Wildland Fire - http://dx.doi.org/10.1071/WF11114

Abstract. Risk analysis evolved out of the need to make decisions concerning highly stochastic events, and is well suited to analyse the timing, location and potential effects of wildfires. Over the past 10 years, the application of risk analysis to wildland fire management has seen steady growth with new risk-based analytical tools that support a wide range of fire and fuels management planning scales from individual incidents to national, strategic interagency programs. After a brief review of the three components of fire risk – likelihood, intensity and effects – this paper reviews recent advances in quantifying and integrating these individual components of fire risk. We also review recent advances in addressing temporal dynamics of fire risk and spatial optimisation of fuels management activities. Risk analysis approaches have become increasingly quantitative and sophisticated but remain quite disparate. We suggest several necessary and fruitful directions for future research and development in wildfire risk analysis.

Prichard, Susan J. and Kennedy, Maureen C. 2012.

Fuel treatment effects on tree mortality following wildfire in dry mixed conifer forests, Washington State, USA. International Journal of Wildland Fire. http://dx.doi.org/10.1071/WF11121

Abstract. Fuel reduction treatments are increasingly used to mitigate future wildfire severity in dry forests, but few opportunities exist to assess their effectiveness. We evaluated the influence of fuel treatment, tree size and species on tree mortality following a large wildfire event in recent thin-only, thin and prescribed burn (thin-Rx) units. Of the trees that died within the first 3 years, most died in the first year regardless of treatment. First-year mortality was much higher in control and thin-only units (65 and 52%) than in thin-Rx units (37%). Cumulative third-year mortality followed a similar trend (78 and 64% in control and thin-only units) v. 43% in thin-Rx units. Percentage crown scorch is a strong predictor of mortality and is highly dependent on fuel treatment. Across all treatments, Pinus ponderosa had a lower probability of post-fire mortality than did Pseudotsuga menziesii. Finally, the probability of beetle attack on surviving trees was highest in large-diameter trees within thin-only treatments and lowest within thin-Rx treatments. This study contributes further evidence supporting the effectiveness of thinning and prescribed burning on mitigating post-fire tree mortality. We also present evidence that a combination of thinning and prescribed burning is associated with lower incidence of post-fire bark beetle attack.

Postfire Recovery

Peppin, Donna, Peter Z. Fulé, Carolyn Hull Sieg, Jan L. Beyers, Molly E. Hunter, 2010

Post-wildfire seeding in forests of the western United States: An evidence-based review. Forest Ecology and Management, 260(5):573–586.

Abstract. Broadcast seeding is one of the most widely used post-wildfire emergency response treatments intended to reduce soil erosion, increase vegetative ground cover, and minimize establishment and spread of non-native plant species. We conducted an evidence-based review to examine the effectiveness and effects of

post-wildfire seeding treatments on soil stabilization, non-native species invasion, and plant community recovery in the western U.S. We reviewed 94 scientific papers and agency monitoring reports identified using a systematic search protocol. As sampling designs have become more rigorous in recent years, evidence that seeding is effective in reducing erosion has decreased. Of highest and high quality studies evaluating soil erosion, 92% (11 of 12) were published since 2000, none of which showed an effective result. Before 2000, the majority of the studies (71%) fell into the lowest quality categories, of which 72% showed seeding to be effective. The majority of studies (20 of 27, 74%) evaluating soil erosion in seeded versus unseeded controls showed that seeding did not reduce erosion relative to unseeded controls. Even when seeding significantly increased vegetative cover, seeded sites rarely supported plant cover levels considered sufficient to stabilize soils within the first and second year post-wildfire. Of the 11 studies evaluating seeding effectiveness for curtailing invasions of non-native plant species, an almost equal percentage found seeding treatments to be either effective (54%, 6 studies) or ineffective (45%, 5 studies). However, the majority of effective and ineffective treatments (83% and 80%, respectively) used non-native species. Sixteen of 26 studies (62%) evaluating seeding effects on plant communities reported that seeding suppressed recovery of native plants, although data on long-term impacts of this reduction are limited. The literature suggests that post-wildfire seeding does little to protect soil in the short-term, has equivocal effect on invasion of non-native species, and can have negative effects on native vegetation recovery, although long-term studies are needed to assess lasting impacts of seeded species.

Restoration

Gifford Pinchot, with an Introduction by James K. Agee, 2011
The Relation of Forests and Forest Fires. Fire Ecology 7(3): 2-11.

Abstract. An article by the first Chief of the Forest Service, Gifford Pinchot, entitled, *The Relation of Forests and Forest Fires*, was published in National Geographic in 1899. Pinchot, at the time of article publication, was a forester without a portfolio. He was the Chief of the Bureau of Forestry in the Department of Agriculture, while the forest reserves (later to be renamed national forests) were managed by the Office of Public Lands within the Department of the Interior. In the article, Pinchot shows a remarkable understanding of fire ecology, ranging from the grass stage of the frequently burned longleaf pine, to the even-aged forests of the coastal Pacific Northwest, with their *infrequent but stand-replacing fires. In between, he mentions the fire adaptations of* western larch, giant sequoia, and pitch pine, and the ability of lodgepole pine to regenerate after stand-replacing fires. Pinchot would seem to have been the perfect leader to emplace an intelligent fire management policy onto the national forests of America. However, in spite of the evidence he provided, he could not bring himself to admit that fire had a beneficial role, and ended his article with, "I hasten to add that these facts do not imply any desirability in the fires which are now devastating the West."

Angela T. Moles, Habacuc Flores-Moreno, Stephen P. Bonser, David I. Warton, Aveliina Helm, Laura Warman, David J. Eldridge, Enrique Jurado, Frank A. Hemmings, Peter B. Reich, Jeannine Cavender-Bares, Eric W. Seabloom, Margaret M. Mayfield, Douglas Sheil, Jonathan C. Djietror, Pablo L. Peri, Lucas Enrico, Marcelo R. Cabido, Samantha A. Setterfield, Caroline E. R. Lehmann and Fiona J. Thomson, 2012.

Invasions: the trail behind, the path ahead, and a test of a disturbing idea. Journal of Ecology, 100(1): 116-127

Abstract. 1. We provide a brief overview of progress in our understanding of introduced plant species. 2. Three main conclusions emerge from our review: (i) Many lines of research, including the search for traits that make species good invaders, or that make ecosystems susceptible to invasion, are yielding idiosyncratic results. To move forward, we advocate a more synthetic approach that incorporates a range of different types of information about the introduced species and the communities and habitats they are invading, (ii) Given the growing evidence for the adaptive capacity of both introduced species and recipient communities, we need to consider the implications of the long-term presence of introduced species in our ecosystems, (iii) Several foundational ideas in invasion biology have become widely accepted without appropriate testing, or despite equivocal evidence from empirical tests. One such idea is the suggestion that disturbance facilitates invasion. 3. We use data from 200 sites around the world to provide a broad test of the hypothesis that invasions are better predicted by a change in disturbance regime than by disturbance Per se. Neither disturbance nor change in disturbance regime explained more than 7% of the variation in the % of cover or species richness contributed by introduced species. However, change in disturbance regime was a significantly better predictor than was disturbance per se, explaining approximately twice as much variation as did disturbance. 4. Synthesis. Disturbance is a weak predictor of invasion. To increase predictive power, we need to consider multiple variables (both intrinsic and extrinsic to the site) simultaneously. Variables that describe the changes sites have undergone may be particularly informative.

Riparian Areas

Smith, D. Max, Deborah M. Finch, David L. Hawksworth, 2012.

Nesting Characteristics Of Mourning Doves in Central New Mexico: Response to Riparian Forest Change. The Journal of Wildlife Management 76(2):382–390.

Abstract. Riparian forests of the American Southwest are especially prone to changes in composition and structure due to natural and anthropogenic factors. To determine how breeding mourning doves (Zenaida macroura) respond to these changes, we examined nest site use and nest survival in control plots, fuel reduction plots before and after mechanical thinning, and post-wildfire sites. The greatest numbers of nests (50%), were located in post-wildfire sites where resprouted vegetation and woody debris provided numerous nest sites in the understory. We found fewer nests in post-treatment fuel reduction plots (17%), where most were constructed in cottonwoods, and an intermediate number of nests in control and pretreatment plots (33%), where most were constructed in exotic plants. The best-supported logistic-exposure nest survival model indicated that survival varied among years and with date. Models containing effects of forest type, study block, and nest site selection received little support, suggesting that survival was constant among plot locations, disturbance types, and nest sites. Our nest survival estimates were low relative to those from other studies, but productivity could offset mortality if

adults make numerous nest attempts each year. Our results highlight the utility of woody vegetation and debris as understory nest sites for mourning doves and other riparian birds. Managers should devise methods to preserve or reestablish these nest sites when conducting fuel reduction, exotic vegetation removal, or post-fire restoration activities.

Watersheds and Hydrology

Robichaud, Peter R and Louise E. Ashmun. 2012.
Tools to aid post-wildfire assessment and erosion-mitigation treatment decisions. International Journal of Wildland Fire - http://dx.doi.org/10.1071/WF11162.

Abstract. A considerable investment in post-fire research over the past decade has improved our understanding of wildfire effects on soil, hydrology, erosion and erosion-mitigation treatment effectiveness. Using this new knowledge, we have developed several tools to assist land managers with post-wildfire assessment and treatment decisions, such as prediction models, research syntheses, equipment and methods for field measurements, reference catalogues and databases of past-practice, and spreadsheets for calculating resource valuation and cost–benefit analysis. These tools provide relevant science to post-fire assessment teams and land managers in formats that often can be directly entered into assessment and treatment decision-making protocols. Providing public access to these tools through the internet not only has increased their dissemination, but also has allowed them to be updated and improved as new knowledge and technology become available. The use of these science-based tools has facilitated a broader application of current knowledge to post-fire management in the United States and in other fire-prone areas around the world.

Soils

Cawson,J. G.; G. J. Sheridan, H. G. Smith and P. N. J. Lane. 2012.
Surface runoff and erosion after prescribed burning and the effect of different fire regimes in forests and shrublands: a review. International Journal of Wildland Fire - http://dx.doi.org/10.1071/WF11160

Abstract. This paper examines the state of knowledge about the effects of prescribed burning on surface runoff and erosion at point to catchment scales in forests and shrublands. Fires can increase surface runoff and erosion by removing vegetation, changing soil hydrologic properties and providing a readily erodible layer of sediment and ash. Catchment-scale studies in prescribed-burnt areas usually report minimal impacts from the burn. However, measurements at smaller spatial scales suggest that large changes to hydrologic properties and processes do occur, and a debris-flow example from Australia demonstrates that large catchment-scale impacts are possible. It appears that existing catchment-scale studies in prescribed burns do not capture these large events as the sample size (i.e. number of studies) is too small relative to the infrequency of such events. Furthermore, numerous knowledge gaps across all spatial scales limit understanding of the processes contributing to post-prescribed burn runoff and erosion. Understanding the influence of fire regime characteristics on post-fire runoff and erosion is particularly important in the context of prescribed burning, as fire regimes can be manipulated to reduce erosion and water-quality impacts. Therefore, two directions for future research are recommended: (1) process-based studies to understand the factors controlling

surface runoff and erosion, particularly in relation to aspects of the fire regime; and (2) landscape-scale surveys to quantify large erosion events.

Terrestrial Wildlife

LARRY L. IRWIN, DENNIS F. ROCK and SUZANNE C. ROCK, 2012.
Habitat Selection by Northern Spotted Owls in Mixed-Coniferous Forests. The Journal of Wildlife Management, 76(1):200-213.

Abstract. Conservation planning for the federally threatened northern spotted owl (Strix occidentalis caurina) requires an ability to predict their responses to existing and future habitat conditions. To inform such planning we modeled habitat selection by northern spotted owls based upon fine-scale (approx. 1.0 ha) characteristics within stands comprised primarily of mixed-aged, mixed coniferous forests of southwestern Oregon and north-central California. We sampled nocturnal (i.e., primarily foraging) habitat use by 71 radio-tagged spotted owls over 5 yr in 3 study areas and sampled vegetative and physical environmental conditions at inventory plots within 95% utilization distributions of each bird. We compared conditions at available forest patches, represented by the inventory plots, with those at patches used by owls using discretechoice regressions, the coefficients from which were used to construct exponential resource selection functions (RSFs) for each study area and for all 3 areas combined. Cross-validation testing indicated that the combined RSF was reasonably robust to local variation in habitat availability. The relative probability that a fine-scale patch was selected decreased nonlinearly with distances from nests and streams; varied unimodally with increasing average diameter of coniferous trees and also with increasing basal area of Douglas-fir (Psendotsuga menziesii) trees; increased linearly with increasing basal areas of sugar pine (Pinus lambertiand) and hardwood trees and with increasing density of understory shrubs. Large-diameter trees (> 66 cm) appeared important < 400 m from nest sites. The RSF can support comparative risk assessments of the short-versus long-term effects of silvicultural alternatives designed to integrate forest ecosystem restoration and habitat improvement for northern spotted owls. Results suggest fine-scale factors may influence population fitness among spotted owls.

Wildland-Urban Interface

Calkin, David E., Tyron Venn , Matthew Wibbenmeyer and Matthew P. Thompson. 2012.
Estimating US federal wildland fire managers' preferences toward competing strategic suppression objectives. International Journal of Wildland Fire - http://dx.doi.org/10.1071/WF11075

Abstract. Wildfire management involves significant complexity and uncertainty, requiring simultaneous consideration of multiple, non-commensurate objectives. This paper investigates the tradeoffs fire managers are willing to make among these objectives using a choice experiment methodology that provides three key advancements relative to previous stated-preference studies directed at understanding fire manager preferences: (1) a more immediate relationship between the instrument employed in measuring preferences and current management practices and operational decision-support systems; (2) an explicit exploration of how sociopolitical expectations may influence decision-making and (3) consideration of fire managers' relative prioritisation of cost-containment objectives. Results

indicate that in the current management environment, choices among potential suppression strategies are driven largely by consideration of risk to homes and high-value watersheds and potential fire duration, and are relatively insensitive to increases in cost and personnel exposure. Indeed, when asked to choose the strategy they would expect to choose under current social and political constraints, managers favoured higher-cost suppression strategies, ceteris paribus. However, managers indicated they would personally prefer to pursue strategies that were more cost-conscious and proportionate with values at risk. These results confirm earlier studies that highlight the challenges managerial incentives and sociopolitical pressures create in achieving cost-containment objectives.

Aronson, Glen and Dominik Kulakowski. 2012.

Bark beetle outbreaks, wildfires and defensible space: how much area do we need to treat to protect homes and communities? International Journal of Wildland Fire - http://dx.doi.org/10.1071/WF11070

Abstract. Extensive beetle outbreaks across western North American forests have spurred debates about how to best protect communities from wildfire. Previous work has found that fuels in the wildland–urban interface and especially in the defensible space (40-m radius) around structures are the most important determinants of the flammability of structures during wildfire. We: (1) examined the extent of outbreaks in the western US and their intersection with the wildland-urban interface and its surrounding area and (2) calculated the combined area of defensible space around all wildland-urban interface housing units in the western US. This analysis indicates that: (1) >98% of areas affected by outbreaks are in remote areas rather than in the wildland-urban interface and (2) in the context of limited resources and the goal of protecting homes and communities from wildfire, the area required to create defensible space around all homes in the wildland-urban interface of the western US (which effectively reduces fire risk to structures) is substantially less than that needed to treat all beetle-affected forests (which does not reduce fire risk to structures as effectively). Thus, focusing fuel-reduction treatments in the immediate vicinity of homes and communities rather than in remote beetle-affected forests would be more effective at reducing fire risk to those structures and would incur lower financial and ecological costs.

Scott, Joe H.; Donald J. Helmbrecht, Sean A. Parks, and Carol Miller. 2012.

Quantifying the Threat of Unsuppressed Wildfires Reaching the Adjacent Wildland-Urban Interface on the Bridger-Teton National Forest, Wyoming, USA. Fire Ecology. 8(2):125-142.

Abstract. An important objective for many federal land management agencies is to restore fire to ecosystems that have experienced fire suppression or exclusion over the last century. Managing wildfires for resource objectives (i.e., allowing wildfires to burn in the absence of suppression) is an important tool for restoring such fire-adapted ecosystems. To support management decisions that allow wildfires to burn unsuppressed, land managers need a quantitative assessment of the potential for such wildfires to reach nearby fire-susceptible resources and assets. We established a study area on a portion of the Bridger-Teton National Forest near Jackson, Wyoming, USA, where land managers wish to restore fire by managing wildfires, but are concerned about the threat to residential buildings. We modeled the ignition and unsuppressed growth of wildfires starting in a remote portion of the study area using FSim, a fire occurrence, growth, and suppression simulation model. We then characterized annual area burned and the likelihood that wildfires would reach a

nearby wildland-urban interface (WUI) defense zone. Early-season fires burned longer and grew larger than late-season fires, and thus had a higher likelihood of reaching the WUI zone (3 % of May fires compared to 0.1 % of October fires). Because fire managers do not anticipate managing all fire starts for resource objectives, we applied a simple rule set termed "RO rules," indicating the fraction of starts by month to be managed for resource objectives. This reduced the expected number of fires reaching the WUI zone by 70 %, and the expected WUI zone area burned by 61 %. From 1990 to 2009, a mean of 207 ha yr-1 had been burned by wildfires starting in the remote portion of the study area. By contrast, we estimated that 14 431 ha yr-1 could burn if no fire starts were suppressed, and 4861 ha yr-1 after applying the RO rules. Our analysis approach can be extended to determine which parts of the landscape are most likely to produce fires that reach specific targets on the landscape

Woodlands and Rangelands

Kirk R. Sherrill and William H. Romme. 2012

Spatial Variation in Postfire Cheatgrass: Dinosaur National Monument, USA. Fire Ecology 8(2): 38-56.

Abstract. A major environmental problem in semi-arid landscapes of western North America is the invasion of native vegetation by cheatgrass (Bromus tectorum L.), an annual Eurasian grass that covers >40 million ha of range and woodland in the western US. Cheatgrass can be especially problematic after fire—either prescribed fire or wildfire. Although cheatgrass is known to generally thrive in regions of moderate temperatures, dry summers, and reliable winter precipitation, the spatial patterns of postfire cheatgrass invasion are not well characterized at finer spatial scales (e.g., within most individual landscapes).

Laliberté, Etienne and Jason M. Tylianakis. 2012.

Cascading effects of long-term land-use changes on plant traits and ecosystem functioning. Ecology, 93(1): 145–155.

Abstract. There is much concern that the functioning of ecosystems will be affected by human-induced changes in biodiversity, of which land-use change is the most important driver. However, changes in biodiversity may be only one of many pathways through which land use alters ecosystem functioning, and its importance relative to other pathways remains unclear. In particular, although biodiversity–ecosystem function research has focused primarily on grasslands, the increases in agricultural inputs (e.g., fertilization, irrigation) and grazing pressure that drive change in grasslands worldwide have been largely ignored. Here we show that long-term (27-year) manipulations of soil resource availability and sheep grazing intensity caused marked, consistent shifts in grassland plant functional composition and diversity, with cascading (i.e., causal chains of) direct, indirect, and interactive effects on multiple ecosystem functions. Resource availability exerted dominant control over aboveground net primary production (ANPP), both directly and indirectly via shifts in plant functional composition. Importantly, the effects of plant functional diversity and grazing intensity on ANPP shifted from negative to positive as agricultural inputs increased, providing strong evidence that soil resource availability modulates the impacts of plant diversity and herbivory on primary production. These changes in turn altered litter decomposition and, ultimately, soil carbon sequestration, highlighting the relevance of ANPP as a key integrator of ecosystem functioning. Our study reveals how human alterations of bottom-up (resources) and

top-down (herbivory) forces together interact to control the functioning of grazing systems, the most extensive land use on Earth.

Davies, Kirk W. and Aleta M. Nafus. 2012.
Exotic annual grass invasion alters fuel amounts, continuity and moisture content. International Journal of Wildland Fire - http://dx.doi.org/10.1071/WF11161.

Abstract. Many exotic annual grasses are believed to increase wildfire frequency to the detriment of native vegetation by increasing fine fuels and thus, creating a grass-fire cycle. However, information on differences in fuel characteristics between invaded and non-invaded plant communities is lacking, or is based mainly on speculation and anecdotal evidence. We compared fuel biomass, cover, continuity and moisture content in plant communities invaded and not invaded by cheatgrass (Bromus tectorum L.), an exotic annual grass, in 2010 and 2011 in south-eastern Oregon, USA. Annual grass-invaded communities had higher fine fuel amounts, greater fuel continuity, smaller fuel gaps and lower fuel moisture content than did non-invaded plant communities. These conditions would increase the probability that ignition sources would contact combustible fuels and that fires would propagate. Fuel characteristics in the annual grass-invaded communities in our study may also support faster spreading fires. Fuel moisture content was low enough to burn readily more than a month earlier in annual grass-invaded communities than in non-invaded communities, thereby expanding the wildfire season. The cumulative effect of these differences in fuel characteristics between exotic annual grass-invaded and non-invaded plant communities is an increased potential for frequent, large-scale, fast-spreading wildfires. We suggest that research is needed to develop methods to mediate and reverse these changes in fuel characteristics associated with B. tectorum invasion.

RATAJCZAK, ZAKARY, JESSE B. NIPPERT AND SCOTT L. C. 2012.
Woody encroachment decreases diversity across North American grasslands and savannas. Ecology 93:697–703.

Abstract. Woody encroachment is a widespread and acute phenomenon affecting grasslands and savannas worldwide. We performed a meta-analysis of 29 studies from 13 different grassland/savanna communities in North America to determine the consequences of woody encroachment on plant species richness. In all 13 communities, species richness declined with woody plant encroachment (average decline ¼ 45%). Species richness declined more in communities with higher precipitation (r 2 ¼ 0.81) and where encroachment was associated with a greater change in annual net primary productivity (ANPP; r 2 ¼ 0.69). Based on the strong positive correlation between precipitation and ANPP following encroachment (r 2 ¼ 0.87), we hypothesize that these relationships occur because water-limited woody plants experience a greater physiological and demographic release as precipitation increases. The observed relationship between species richness and ANPP provides support for the theoretical expectation that a trade-off occurs between richness and productivity in herbaceous communities. We conclude that woody plant encroachment leads to significant declines in species richness in NorthAmerican grassland/savanna communities.