Annotated Bibliography for "Dimensions of Resilience" Workshop Participants

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Forest resilience, general

Biggs, R., et al. 2012. Toward principles for enhancing the resilience of ecosystem services. Annual Review of Environment and Resources 37: 421-448 *(These authors synthesize seven general principles of how resilience can be fostered in ecosystem management. The paper is not focused on forest management per se, but gives a good introduction into resilience thinking in the context of ecosystem services provisioning)*.

Ghazoul J., Z. Burivalova, J. Garcia-Ulloa, and L. A. King. 2015. Conceptualizing forest degradation. Trends in Ecology and Evolution 30: 622–32. *(These authors develop a definition for forest resilience that gives weight to both how much a given change—climate, management or otherwise—impacts ecosystem functions and how easily unwanted changes in function are reversed. This framework could be especially useful for guiding management when tradeoffs are common).*

Hughes, T. P., C. Linares, V. Dakos, I. A. van de Leemput, and E. H. van Nes. 2013. Living dangerously on borrowed time during slow, unrecognized regime shifts. Trends in Ecology and Evolution 28: 149-155. (*Although this is not a "forest" paper, it emphasizes slow changes that can prove difficult to revers and how such changes can be hard to detect. This idea applies to forests because trees are long-lived and it takes a lot of time for changes in forest extent and composition to become obvious. Changes may be inevitable before we actually can detect them.*)

Johnstone, J. F. et al. 2016. Changing disturbance regimes, climate warming and forest resilience. Frontiers in Ecology and the Environment 14: 369-378. (*This study describes responses of forests to changing environmental conditions that are already being observed and describes key mechanisms currently being explored in temperate forests. The focus here is on changing disturbance regimes, how different disturbances may interact, and how disturbance and climate can interact to change forests qualitatively*.)

Newton, A. C., and E. Cantarello. 2015. Restoration of forest resilience: an achievable goal? New Forests 46: 645-668. *(These authors give a thorough review of certain perspectives on forest resilience, with a particular emphasis on achieving resistance to disturbance, or in the event that such resistance is not possible, fast recovery after disturbance. Note that this paper puts more emphasis on resistance than many other frameworks would recommend, as resistance can sometimes come at the cost of resilience.)*

Reyer, C., et al. 2015. Forest resilience and tipping points at different spatio-temporal scales: approaches and challenges. Journal of Ecology 103: 5-15. (*Excellent overview of the concepts of ecological resilience as they apply in forests. Highly recommended as background reading.*)

Seidl, R. 2014. The shape of ecosystem management to come: Anticipating risks and fostering resilience. BioScience 64: 1159-1169. *(This paper discusses the differences between (more traditional concepts of) risk management and resilience thinking. It maintains that both concepts are important for ecosystem management, but that under high uncertainty a focus on resilience is warranted.)*

Seidl, R., et al. 2016. Searching for resilience: addressing the impacts of changing disturbance regimes on forest ecosystem services. Journal of Applied Ecology 53: 120-129. *(A work focusing specifically on resilience of forests (and the services they provide) to changing disturbance regimes. Puts some of the ideas of resilience thinking into the context of more established concepts of forest ecology such as the historical and future ranges of variability. Closes with recommendations and approaches of how to foster resilience of forest ecosystem services provisioning in the face of changing disturbance regimes.)*

Climate and fire relationships

<u>Trends</u>

Abatzoglou, J. T. and A. P. Williams. 2016. Impact of anthropogenic climate change on wildfire across western US forests. PNAS 113: 11770-11775. *(This study looked at changes in climate and fire across in forests across the western US and estimates how much of the recent increase in fire extent is attributable to human greenhouse gas emissions. By their estimate, human-caused climate change might account for 50% of the forest fire area from 1979 to 2015.)*

Rocca, M. E., P. M. Brown, L. H. MacDonald, and C. M. Carrico. 2014. Climate change impacts on fire regimes and key ecosystem services in Rocky Mountain forests. Forest Ecology and Management 327: 290-305. *(This paper presents a conceptual framework for how changing climate drivers is likely to alter fire regimes and how a combination of climate, fire, and management actions may impact future fire risk, carbon storage, water resources, air quality, and biodiversity in four forest types (piñon-juniper, lower montane, upper montane, and subalpine) in the US Rocky Mountains.)*

Westerling, A. L., H. G. Hidalgo, D. R. Cayan, and T. W. Swetnam. 2006. Warming and earlier spring increase western US forest wildfire activity. Science 313: 940-943. (*This benchmark paper was the first to demonstrate a strong statistical relationship between warming climate and increased fire activity in the West. Climate variables associated with large fires included timing of spring snowmelt, spring-summer temperature, and lengthening of the fire season.*)

Westerling, A. L. 2016. Increasing western US forest wildfire activity: sensitivity to changes in the timing of spring. Philosophical Transactions of the Royal Society B 371: 20150178. *(This study finds that compared to the mid/late 1900s (1973 to 1982), current fire regimes in the Northern Rockies have changed considerably. For instance, the fire season length has gone from 49 to 134 days. The study also explores the relationship between snowmelt date and wildfire prevalence.)*

<u>Projections</u>

Romme, W. H. and M. G. Turner. 2015. Ecological implications of climate change in Yellowstone: Moving into uncharted territory? Yellowstone Science 23: 6-13. *(This piece is not primary literature, but rather provides an "on the horizon" view of some potential changes in forest composition and wildfires for the 21st century.)*

Westerling, A. L., et al. 2011. Continued warming could transform Greater Yellowstone fire regimes by mid-21st century. Proceedings of the National Academy of Sciences USA 108: 13165–13170. *(This study estimates how fire regimes might change by the mid-century and beyond. If the current relationship between weather and fires holds, climate conditions that can support large, severe fires (similar to the 1988 Yellowstone fires) could occur every 10 to 60 years from 2050 onwards.)*

Potential mechanisms underpinning forest resilience

<u>Background levels of tree mortality:</u>

Anderegg, W. L., et al. 2015. Tree mortality from drought, insects, and their interactions in a changing climate. New Phytologist 208: 674–683. *(This study provides a review of recent advances on measuring tree mortality rates due to drought, insects, and drought-insect interactions. Fig 1 is a useful quantitative overview of species-specific causes of mortality and mortality patterns over space and time this century, and for much of the Northern Rockies).*

Van Mantgem, P. J., et al. 2009. Widespread increase of tree mortality rates in the Western United States. Science 323: 521-524. (*It is difficult to detect the "background" mortality of trees that is not associated with disturbance events, but his paper does so. Results reveal that background levels of tree mortality have been increasing throughout the West.*)

McDowell, N. G., et al. 2011. The interdependence of mechanisms underlying climate-driven vegetation mortality. Trends in Ecology and Evolution 26: 523-533. *(This paper provides an evaluation of the mechanisms through which drought can cause tree mortality including carbon starvation and cavitation. Note that McDowell and colleagues are on the cutting edge of trying to figure out the exact mechanisms of drought mortality and have many more papers on this topic.)*

Shortening fire return Intervals

Harvey, B. J., D. C. Donato, and M. G. Turner. 2016. Burn me twice, shame on who? Interactions between successive forest fires across a temperate mountain region. Ecology 97: 2272-2282. *(This study looked at patches in the Greater Yellowstone area that have burned twice in the last 25 years. They specifically assessed how severity of the first fire and time since the first fire impact fire severity in the second fire. These results are critical for determining whether severe fires promote more severe fires in the future, or have a dampening effect on future fire severity that would buffer forest losses.)*

Harvey, B. J., D. C. Donato, and M. G. Turner. 2016. Drivers and trends in landscape patterns of stand-replacing fire in forests of the US Northern Rocky Mountains (1984–2010). Landscape Ecology 31: 2367-2383. *(This study quantifies how the fire regime of the Greater Yellowstone ecosystem varied over time from 1982 to 2010. A key finding is that severe fires are making up an increasing proportion of area burned.)*

Holsing, L., S. A. Parks, and C. Miller. 2016. Weather, fuels, and topography impede wildland fire spread in western US landscapes. Forest Ecology and Management 380: 59-69. *(A key question for both long-term management and immediate responses to unfolding wildfires, is what features in space and time are most likely to act as a barrier to fire spread? This study considers three landscapes emblematic of the central and eastern Northern Rockies, and quantified whether different daily weather conditions, fuel properties (current NDVI, years since last burn, etc.), and topographic feature were most commonly associated fire termination. In general, they found that weather and fuels played approximately equal roles, whereas topographic effects were weak.)*

Nelson, K. N., M. G. Turner, W. H. Romme, and D. B. Tinker. 2016. Landscape variation in tree regeneration and snag fall drive fuel loads in 24-yr old post-fire lodgepole pine forests. Ecological Applications 26: 2424-2438. *(There has been tremendous interest in understanding how fuels develop following fire, and whether and when young forests can burn again. This paper reports fuels for the young forests and finds that most stands can support crown fire. These fuels data were used in real-time during summer 2016 when fires re-burned post-88 forests.*)

Parks, S. A. et al. 2016. Wildland fire limits subsequent fire occurrence. International Journal of Wildland Fire 25: 182-190. *(There is still plenty of uncertainty of if, and for how long, recently burned areas have a lower probability of ignition or blocking the transmission of fire across the landscape. The authors looked at fires in the greater Missoula area from 1972 to 2012 and found that recently burned areas often acted as a fire-break for at least 10 to 20 years, depending on the forest location).*

Controls on post-fire regeneration

Harvey, B. J., D. C. Donato, and M. G. Turner. 2016. High and dry: post-fire tree seedling establishment in subalpine forests decreases with post-fire drought and large stand-replacing burn patches. Global Ecology and Biogeography 25: 655-669. *(This study focused on how post-fire weather conditions affect seedling establishment rates. In general, the study suggests that there will be shifts in species composition if years with extensive high severity fire are followed by hot conditions or if the average size of fire increases substantially. Montane species expected to move upslope appeared to be unaffected by both drought and distance to unburned forest.)*

Kemp, K. B., P. E. Higuera, and P. Morgan. 2016. Fire legacies impact conifer regeneration across environmental gradients in the U.S. northern Rockies. Landscape Ecology 31: 619–636. *(This study took place in the central and southwestern portion of the Northern Rockies. They quantified the effects of fire characteristics and forest legacies on post-fire seedling establishment rates of Douglas-fir, grand fir, ponderosa pine, and lodgepole. Douglas-fir and ponderosa pine showed very limited establishment in patches more than 95 m from an unburned forest patch, but composition shifts were rare because 75% of burned patches were within 95 m of a mature forest patch).*

McKenzie, D. A. and D. B. Tinker. 2012. Fire-induced shifts in overstory tree species composition and associated understory plant composition in Glacier National Park, Montana. Plant Ecology 213: 207-224. *(This study compared tree composition before and after stand replacing fires in montane portions of Glacier National Park. Most notably, there was a large increase in the density of lodgepole pine and quaking aspen (>1000% increase), often at the expense of other species typical of montane forests.)*

Turner, M. G., D. M. Turner, W. H. Romme, and D. B. Tinker. 2007. Cone production in young post-fire *Pinus contorta* stands in Greater Yellowstone (USA). Forest Ecology and Management 242: 119-126. *(This study sampled stands 15 years after the 1988 Yellowstone fires, and found very high variability in cone production. Serotinous cones were present in 30% of stands and 10 to 15% of trees. These results have implications for how well lodgepole stands could reseed if fire intervals shrink.)*

Urza, A. K. and J. S. Sibold. 2017. Climate and seed availability initiate alternate post-fire trajectories in a lower subalpine forest. Journal of Vegetation Science 28: 43-56. *(This study looked at stands in Glacier Park that burned between 1988 and 2003, with the goal of teasing apart what factors impact species specific regeneration rates. They looked at the relative impacts of distance to seed sources, relic trees, pre-fire stand characteristics, fire severity, topography, and weather anomalies during the first 5 years after fire.)*

Modeling forest resilience, with a focus on iLand

Gustafson, E. J. 2013. When relationships estimated in the past cannot be used to predict the future: using mechanistic models to predict landscape ecological dynamics in a changing world. Landscape Ecology 28: 1429-1437. *(This study illustrates some of the particular strengths of process based models, and how they can generate potentially more accurate forecasts. In contrast, statistical models might be more likely to fail, because they typically do not account for new 'emergent behaviors', including qualitative changes in fire behavior).*

Halpin, C. R., Lorimer, C. G. 2016. Trajectories and resilience of stand structure in response to variable disturbance severities in northern hardwoods. Forest Ecology and Management 365: 69-82. *(Once process-based models have been validated, they still need to be analyzed in ways that capture forest resilience. This paper provides one example of how to analyze a process based models to estimate resilience).*

Seidl, R., et al. 2011. Modelling natural disturbances in forest ecosystems: a review. Ecological Modelling 222: 903-924. *(This study synthesizes different approaches to model forest disturbances, and suggests a way forward for disturbance modeling. It's more of a methods-oriented paper for those interested in the nuts and bolts of implementing disturbance processes in simulation models.)*

Seidl, R., W. Rammer, R. M. Scheller, and T. A. Spies. 2012. An individual-based process model to simulate landscape-scale forest ecosystem dynamics. Ecological Modelling 231: 87-100. *(This study lays down the main components of iLand, including tree growth and competition).*

Seidl, R., et al. 2013. Scaling issues in forest ecosystem management and how to address them with models. European Journal of Forest Research 132: 653-666. *(This study describes why scaling information from trees to regions is not trivial in forest ecosystems. It furthermore outlines how simulating modeling can help to attain information about forests at larger scales.).*

Seidl, R., W. Rammer, and T. A. Spies. 2014. Disturbance legacies increase the resilience of forest ecosystem structure, composition, and functioning. Ecological Applications 24: 2063–2077. *(This study describes the incorporation of fire processes into the iLand model and tests how well the addition of disturbances matches actual forest fire and regeneration in forests of the Pacific Northwest. It then goes on to study how live tree legacies contribute to the resilience of forests after large fire events, focusing on the recovery of C stocks, late-seral species communities, and canopy complexity).*

Thom, D., et al. 2017. The impacts of climate change and disturbance on spatio-temporal trajectories of biodiversity in a temperate forest landscape. Journal of Applied Ecology 54: 28-38. *(Using simulations with iLand the authors investigated how climate change and changing disturbance regimes could affect biodiversity in a National Park in the Austrian Alps. The results show that climate has both positive and negative effects on biodiversity, depending on species group.)*

Thom, D., W. Rammer, and R. Seidl. 2017. Disturbances catalyze the adaptation of forest ecosystems to changing climate conditions. Global Change Biology 23: 269-282. *(Using simulations with iLand the authors asked how changing climate and disturbance regimes could alter tree species composition and forest types in a National Park in the Austrian Alps. The results show that tree vegetation responds to climatic changes only with considerable time lags, but that disturbances accelerate tree species change.)*

Seidl, R. and W. Rammer. 2017. Climate change amplifies the interactions between wind and bark beetle disturbances in forest landscapes. Landscape Ecology *In Press*. doi: 10.1007/s10980-016-0396-4. *(This study analyzes how climate change affects the interactions between disturbances, using iLand simulations and remote sensing data. It focuses on the disturbance regime in the Alps in Europe, where windthrow and bark beetle outbreaks are the dominant disturbance agents).*

Learning to live with fire

Alexandre, P. M., et al. 2016. The relative impacts of vegetation, topography and spatial arrangement on building loss to wildfires in case studies of California and Colorado. Landscape Ecology 31: 415-430. (*This study found that the ability of vegetation, topography, and spatial arrangement variables to explain patterns in building loss different among case study communities. In Boulder, percentage of highly flammable land and elevation were most important in explaining building loss due to fire, but there was a high amount of unexplained building loss. Overall, this is a good example of human development can be incorporated into process-based forest models.)*

Martinuzzi, S., S. I. Stewart, D. P. Helmers, M. H. Mockrin, R. B. Hammer, and V. C. Radeloff. 2015. The 2010 wildland-urban interface of the conterminous United States. USDA Forest Service, Northern Research Station Research Map NRS-8, Newtown Square, PA. (*This publication presents state-level maps of the wildland urban interface, housing density, land ownership, land cover, and wildland vegetation cover as of 2010. The authors also summarize current trends and challenges in the WUI. The data are available at* http://www.nrs.fs.fed.us/data/WUI/*)*

Moritz, M. A., et al. 2014. Learning to coexist with wildfire. Nature 515: 58-66. *(In the ecological literature on resilience there is a growing emphasis on "social ecological systems" with some calls to consider humans as an integrated part of an ecosystem, rather than thinking of humans being external or detached from ecosystems. This paper provides a very nice review of how the social-ecological systems can be applied to forest resilience, potentially informing more resilient management and human development.)*

Smith, A. M. S., et al. 2016. The science of firescapes: Achieving fire-resilient communities. BioScience 66: 130-146. *(Playing directly of the Moritz paper above, his review/synthesis starts with the argument that humans and 'firescapes' are integrated systems in many locations, and therefore, should be managed as such. The unique contribution here is bridging multiple disciplines interested in fire (biology, physics and sociology). This is also a useful resource of basic methods for identifying practical ways to management human development near fire-prone forests.)*

Stephens, S. L., J. K. Agee, P. Z. Fulé, M. P. North, W. H. Romme, T. W. Swetnam, and M. G. Turner. 2013. Managing forests and fire in changing climates. Science 342: 41-42. (*This article in the Policy Forum section of Science addresses the need for forward thinking to manage forests in the face of warming climate and increased fire activity in many places. This brings perspectives from scientists who work on different forest types in varied geographic locations.*)

Stein, S. M., et al. 2013. Wildfire, wildlands, and people: understanding and preparing for wildfire in the wildland-urban interface—a Forests on the Edge report. USDA Forest Service, Rocky Mountain Research Station Gen. Tech. Rep. RMRS-GTR-299. Fort Collins, CO. (*This report outlines trends in fire regimes and other disturbances, the impacts these disturbances may have on WUI communities, and strategies that planners, developers, communities and managers can pursue to create "fire-adapted" communities.)*

Forest/fuels management

Ager, A. A., et al. 2014. Wildfire exposure and fuel management on western US national forests. Journal of Environmental Management 145: 54-70. *(This study combines multiple types of inference to try to identify areas where large wildfires are most likely, with a specific goal of identifying areas where wildfire has a high potential of carrying into urban areas).*

DeRose, R. J., and J. N. Long. 2014. Resistance and resilience: A conceptual framework for silviculture. Forest Science 60: 1205-1212. *(Resistance and resilience are usually considered to be two separate, but related concepts—resistance is the ability to not undergo much change for a given amount of pressure, whereas resilience is the capacity to return to a general state. This study thinks about how these two terms relate to fuel and stand management, in the context of responding to wildfire conditions and possible budworm outbreaks.)*

Haire, S. L., K. McGarigal, and C. Miller. 2013. Wilderness shapes contemporary fire size distributions across landscapes of the western United States. Ecosphere 4: Article 15. *(This study looked at how wilderness and non-wilderness areas differ in their fire regimes, including the correlation between large fires and weather. Larger fires were more common in wilderness areas of the Northern Rockies. But still, large fire occurrence was most strongly correlated with winter and summer precipitation, with topography not showing up as a consistent predictor of large fires.)*

Hood, S. M., S. Baker, and A. Sala. 2016. Fortifying the forest: thinning and burning increase resistance to a bark beetle outbreak and promote forest resilience. Ecological Applications 26: 1986-2000. *(This study quantifies how thinning interacts with burning and mountain pine beetle outbreak severity in western Montana. Burning without thinning favors increased Douglas-fir, whereas thinning (with or without burning) favored ponderosa pine. Thinning (not surprisingly) decreased beetle outbreak severity, which was attributed to observed increases in resin duct productivity in thinned stands.)*

Larson, A. J., et al. 2013. Latent resilience in ponderosa pine forest: effects of resumed frequent fire. Ecological Applications. Ecological Applications 23: 1243-1249. *(This study looked at how a Ponderosa pine dominated forest responds to a fire in 2003, and then another in 2011. Fires were suppressed up until 2003, and therefore, the authors thought there would be a stand-replacing fire followed by a switch to mid-montane species. Results suggests that if fires are reintroduced (prescribed or otherwise) they need to be frequent, whereas intermediate fires could expedite a transition to lodgepole dominance.)*

Policy

Bone, C., C. Moseley, K. Vinyeta, and R. P. Bixler. 2016. Employing resilience in the United States Forest Service. Land Use Policy 52: 430-438. *(As Bone and colleagues show, resilience is not just a popular term in academia, it's also very en vogue in federal management and research. This paper provides a quantitative overview of how and where the term 'resilience' is being used is the forest service and how this usage relates to various definitions of resilience.)*

Davidson, J. L., et al. 2016. Interrogating resilience: toward a typology to improve its operationalization. Ecology and Society 21: 27*. (This paper explores how the definition of resilience has evolved and broadened as it has been transferred from ecological to social contexts. The authors create a useful typology for considering different definitions of resilience with the aim of aiding operationalization of the term and communication across disciplines)*

Fisichelli, N. A., G. W. Schuurman, and C. H. Hoffman. 2016. Is 'resilience' maladaptive? Towards an accurate lexicon for climate change adaptation. Environmental Management 57: 753-758. *(This paper argues that climate change "resilience" terminology is ambiguous, often misunderstood, and difficult to apply consistently. They show how resilience can encompass divergent strategies (persistence, directed change) and conclude the term is confusing rather than helpful for climate change adaptation and management interventions. The authors are National Park Service employees from Fort Collins, CO and they have conducted adaptation planning for many federal lands.)*

Rist, L., and J. Moen. 2013. Sustainability in forest management and a new role for resilience thinking. Forest Ecology and Management 310: e416-427. (*Excellent review and discussion that compares and contrasts "resilience thinking" with other forest management paradigms and emphasizes its use for anticipating large and uncertain changes. The paper also treats barriers to incorporating resilience thinking in forest management and the need to operationalize the ideas.*)

Steelman, T. 2016. US wildfire governance as social-ecological problem. Ecology and Society 21: 3. *(This paper reviews the spatial and temporal disconnects between wildlife policies and changing biophysical conditions in the U.S. It suggests the need for anticipatory wildfire governance focused on social and ecological resilience that would 1) not take historical patterns as givens, 2) identify thresholds of concern, 3) embrace diversity in ecological and social responses, and 4) foster learning among scales of actors.)*

Steelman, T. A., and C. Burke. 2007. Is wildfire policy in the United States sustainable? Journal of Forestry 33: 67-72. *(This article provides a great overview of the shift in wildfire policy away from a near-exclusive focus on suppression between 2000 and 2006. It notes an emphasis in practice on suppression and hazardous fuels reduction over ecosystem restoration and community economic assistance, which they argue are an incomplete solution that risks perpetuating wildfire challenges.)*

Historical and future range of variability

Coops N. C., and R. H. Waring. 2011. Estimating the vulnerability of fifteen tree species under changing climate in Northwest North America. Climatic Change 105: 313– 328. *(This study built a statistical model that could describe the climate envelope (climate conditions that a species is usually found in) for 15 common species. They used this model to identify what geographic locations will likely be favorable for establishment of each species under expected climate change scenarios).*

Higuera, P., C. Whitlock, and J. A. Gage. 2011. Linking tree-ring and sediment-charcoal records to reconstruct fire occurrence and area burned in subalpine forests of Yellowstone National Park, USA. Holocene 21: 327-341. *(This study provides an updated assessment of how fire regimes (size and return interval) varied from approximately 1200 through the late 1990s, in the Greater Yellowstone area. They estimate that years with widespread fire (>10,000) had a return interval of 150 to 300 years).*

Iglesias, V., T. R. Krause, and C. Whitlock. 2015. Complex Response of White Pines to Past Environmental Variability Increases Understanding of Future Vulnerability. PLoS One 10: e0124439. *(This study used data from a large number of sediment cores taken in and around Yellowstone National Park. Over much of the last 15,000 years, whitebark pine has persisted at the upper treeline, even when fire extent and summer temperatures were at their highest. However, the study cannot offer much guidance on how even warmer winters will impact the species.)*

Power, M. J., C. Whitlock, and P. J. Bartlein. 2011. Postglacial fire, vegetation, and climate history across an elevational gradient in the Northern Rocky Mountains, USA and Canada. Quaternary Science Reviews 30: 2520-2533. *(This study presents estimates of how forest composition and fire have changed over the last 15,000 years, in Glacier National Park, Foy Lake, and the surrounding areas. The results are available for different elevations and are useful for judging whether emerging trends in fire extent fall within the range of variability these forests have experience in the recent past).*

Lessons from the 1988 Yellowstone fires

Synthesis papers

Romme, W. H., M. S. Boyce, R. E. Gresswell, E. H. Merrill, G. W. Minshall, C. Whitlock and M. G. Turner. 2011. Twenty years after the 1988 Yellowstone fires: lessons about disturbance and ecosystems. Ecosystems 14: 1196-1215. (*Synthesis paper led by Bill Romme and Monica Turner, emerged from a symposium at the 2008 AFE meeting in Jackson Hole, Wyoming. Coauthors on this paper were all involved in studies initiated right after the fires and have tracked responses since then. The paper touches on terrestrial, aquatic and wildlife effects. Discussion consider long-term context and implications for future.)*

Schoennagel, T., E. A. H. Smithwick and M. G. Turner. 2008. Landscape heterogeneity following large fires: insights from Yellowstone National Park, USA. International Journal of Wildland Fire 17: 742-753. *(The first synthesis paper of our post-fire research that also includes ecosystem processes.)*

Turner, M. G. 2010. Disturbance and landscape dynamics in a changing world. Ecology 91: 2833-2849. *(Yellowstone research summarized in this broader treatment of disturbance and why it is so important to understand as we anticipate the future condition of our ecosystems and landscapes.)*

Most recent papers (forest structure and function at 25 years postfire)

Donato, D. C., B. J. Harvey, and M. G. Turner. 2016. Regeneration of lower-montane forests a quarter-century after the 1988 Yellowstone Fires: a fire-catalyzed shift in lower treelines? Ecosphere 7: e01410. *(Douglas-fir regeneration is a slower process than lodgepole pine regeneration because seeds must disperse from nearby live trees. This paper reports the patterns of post-1988 fire Douglas-fir regeneration in the lower elevation forests after 25 years*).

Hansen, W. D., W. H. Romme, A. Ba, and M. G. Turner. 2016. Shifting ecological filters mediate postfire expansion of seedling aspen (*Populus tremuloides*) in Yellowstone. Forest Ecology and Management 362: 218-230. *(The seedling aspen that were ubiquitous throughout the burned conifer forests, at distances up to 15 km from the nearest mature aspens, were a surprise back in 1989. This paper reports the current status of the post-1988 aspen distribution and growth from re-sampling of permanent plots).*

Romme, W. H., T. G. Whitby, D. B. Tinker, and M. G. Turner. 2016. Deterministic and stochastic processes lead to divergence in plant communities during the first 25 years after the 1988 Yellowstone Fires. Ecological Monographs 86: 327-351. (*We have tracked plant species richness and community composition since about 1990. This paper reports the full data set on community composition and how it is changing with time since fire. Useful for thinking about plant community biodiversity.*)

Turner, M. G., T. G. Whitby, D. B. Tinker, and W. H. Romme. 2016. Twenty-four years after the Yellowstone Fires: Are postfire lodgepole pine stands converging in structure and function? Ecology 97: 1260-1273. *(The enormous variation in postfire lodgepole pine density was also a surprise, and we have been tracking stand dynamics over time. This paper reports stand structure and function after 25 years, including tree density, height, cone abundance, DBH, aboveground biomass, and stand-level aboveground net primary production based on resampling of permanent plots.)*

Bark beetles

Donato, D. C., B. J. Harvey, W. H. Romme, M. Simard, and M. G. Turner. 2013. Bark beetle effects on fuel profiles across a range of stand structures in Douglas-fir forests of Greater Yellowstone. Ecological Applications 23: 3-20. *(This study provides a very detailed, quantitative assessment of fuel loads in areas with differing beetle outbreak severities and years since beetle outbreak in the greater Yellowstone ecosystem.)*

Hicke, J. A., M. C. Johnson, J. L. Hayes, and H. K. Preisler. 2012. Effects of bark beetle-caused tree mortality on wildfire. Forest Ecology and Management 271: 81-90. *(This paper is one of the more up-to-date and comprehensive reviews of the current understanding of how bark beetles alter fire and fuel dynamics.)*

Hart, S. J., T. Schoennagel, T. T. Veblen, and T. B. Chapman. 2015. Area burned in the western United States is unaffected by recent mountain pine beetle outbreaks. Proceedings of the National Academy of Sciences USA 112: 4375-4380. *(This is a large scale study covering the Northern Rockies, quantifying whether recent mountain pine beetle outbreaks are associated with a higher probability of fire in following years. This study is also useful for comparing the extent and location of tree mortality due to fire versus beetle outbreaks.)*

Harvey, B. J., D. C. Donato, and M. G. Turner. 2014. Recent mountain pine beetle outbreaks, wildfire severity, and postfire tree regeneration in the US Northern Rockies. Proceedings of the National Academy of Sciences USA 111: 15120-15125. *(This study takes a very thorough look at how beetle outbreak severity, time since beetle outbreak, and fire conditions interact to affect fire severity and post-fire regeneration. In general, they observed that the presence/absence of by extreme burning conditions (low humidity and high windspeeds) and topography were the most reliable predictors of fire severity.)*

Raffa, K.F., et al. 2008. Cross-scale Drivers of Natural Disturbances Prone to Anthropogenic Amplification: The Dynamics of Bark Beetle Eruptions. BioScience 58: 501-517. *(While this paper is 9 years old, it is still one of the strongest reviews of beetle outbreaks and the factors that control them, including climate and stand characteristics at multiple scales.)*