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Toward a more ecologically informed view of severe forest fires

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Abstract. We use the historical presence of high-severity fire patches in mixed-conifer forests of the western United States to make several points that we hope will encourage development of a more ecologically informed view of severe wildland fire effects. First, many plant and animal species use, and have sometimes evolved to depend on, severely burned forest conditions for their persistence. Second, evidence from fire history studies also suggests that a complex mosaic of severely burned conifer patches was common historically in the West. Third, to maintain ecological integrity in forests born of mixed-severity fire, land managers will have to accept some severe fire and maintain the integrity of its aftermath. Lastly, public education messages surrounding fire could be modified so that people better understand and support management designed to maintain ecologically appropriate sizes and distributions of severe fire and the complex early-seral forest conditions it creates.

Key words: early succession; ecological integrity; ecological system; fire management; fire regime; forest resilience; forest restoration; severe fire; wildfire.

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Introduction

The spatiotemporal expression of fire events over time in any landscape produces a "fire regime" that influences ecosystem dynamics in that area (Heinselman 1981, Kilgore 1981). Even though the various characteristics of a fire regime (Table 1) are continuous in nature, the traditional approach in representing this variation has been to create a small number of discontinuous categories. Fire regimes in western North America, for example, are often classified into as few as three categories: (1) low-severity, (2) mixed-severity, and (3) high-severity or stand-replacement (Agee 1998, Brown 2000). Our attempt to categorize fire regimes is ". . . an oversimplification…for the convenience of humans" (Sugihara et al. 2006; p. 62), and has had the unfortunate consequence of minimizing rather than emphasizing variation in fire behavior and fire outcomes among vegetation types and across spatial scales (Morgan et al. 2014). In reality, relatively few forest types fit entirely within either of the two extremes—the low-severity (e.g., some interior ponderosa pine) or the stand-replacement (e.g., Rocky Mountain lodgepole pine) categories. Instead, as a simple analysis

Table 1. Characteristics or descriptors often used to describe disturbance regimes (from Keane 2013).

Disturbance Characteristic	Description	Example
Agent	Factor causing the disturbance	Fire is an agent that can kill trees
Source, Cause	Origin of the agent	Lightning is a source for wildland fire
Frequency	How often the disturbance occurs or its return time	Years since last fire (scale dependent)
Intensity	A description of the magnitude of the disturbance agent	Wildland fire heat output
Severity	The level of impact of the disturbance on the environment	Fuel consumption in wildland fires; change in biomass
Size	Spatial extent of the disturbance	Tree kill can occur in small patches or across entire landscapes
Pattern	Patch size distribution of disturbance effects; spatial heterogeneity of disturbance effects	Fire can burn large regions but weather and fuels can influence fire intensity and therefore the patchwork of tree mortality
Seasonality	Time of year of that disturbance occurs	Spring burn vs. fall burn
Duration	Length of time of that disturbances occur	Fires can burn for a day or for an entire summer
Interactions	Disturbance types may interact with each other, or with climate, vegetation and other landscape characteristics	Mountain pine beetles may create fuel complexes that facilitate or exclude wildland fire
Variability	The spatial and temporal variability of the above factors	Each of the above characteristics has variation associated with it

using LANDFIRE data (Rollins 2009, <http://www.landfire.gov>) reveals, roughly 85% of all forested lands within the western US fit within the mixed-severity category, which includes proportions of low-, moderate-, and high-severity (lethal to more than 70% of all trees) fire that vary widely across vegetation types and biophysical settings.

Agee (1993) captured the essence of this important idea in a graph depicting the proportion of low-, moderate-, and high-severity fire across the range of fire regimes (Fig. 1). Note that change from one fire regime to the next (movement along the x-axis) is accompanied not by the sudden appearance of a different fire severity, but by continuous changes in the proportions of each fire severity category. Thus, fire regimes blend imperceptibly into one another. More importantly, except for the two end points on the graph where the proportion of high-severity fire would be either 0% or 100%, most fire regimes consist of a mix of fire severities so, technically speaking, they fit best within a mixed-severity regime (Fig. 2). It is not the presence of a particular fire severity, but the proportion (and, presumably, the distribution and patch sizes) of each severity component that distinguishes regimes. Indeed, empirical data drawn from recent fires across the western United States between 1984 and 2008 (Fig. 3) reveal this continuous variation in proportions of different fire severities among fires. Thus, a more continuous view of fire regimes might be a better way to appreciate the infinite variability in fire behavior among forest types and geographic locations, and it might also promote a greater appreciation of severe fire as an integral

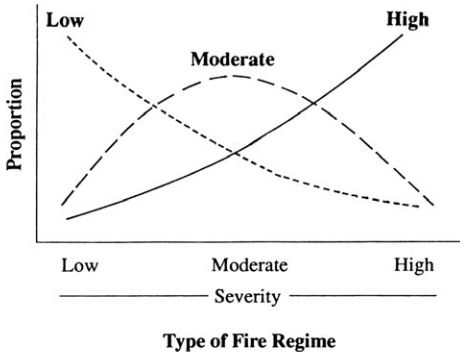

Fig. 1. This graph (from Agee 1993) illustrates that fire regimes are not characterized by the presence of only one kind of fire. Rather, it is the relative frequency of low-, moderate-, and high-severity fire in an average burn that varies among fire regimes.

Fig. 2. Mixed-severity fires (fires that leave recognizable patches of low-severity, medium-severity, and high-severity effects) typify the majority of mixed-conifer forest systems in the western United States. The brown-needled and blackened areas harbor unique sets of plant and animal species found in no other forest conditions. This photograph of the North Fork of the Blackfoot River was taken 10 months after the 1988 Canyon Creek fire in Montana. Many fire-dependent plant and animal species were present in the more severely burned areas until they were helicopter logged, suggesting that unburned forests might be a better alternative for timber harvest.

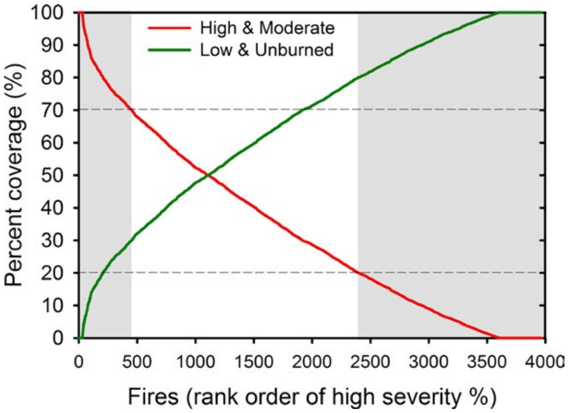

Fig. 3. The percent area within a fire perimeter that burned at low (green line) and at moderate to high (red line) severity is shown for a series of 3696 fires that burned in the western United States between 1984 and 2008 (after Belote 2015). The figure shows that the proportions of each severity category are continuously variable and that high-severity fire is a natural part of most forest fires in the West.

part of mixed- and high-severity conifer forest fire regimes.

Accordingly, we highlight the need for better information on the historical patterns and abundances of high-severity patches in different forest types. This is an important discussion because, even though our National Cohesive Wildland Fire Management Strategy (Wildland Fire Executive Council 2014) acknowledges that many fire regimes exist and that management needs to accommodate that variation and the variety of habitat such variation produces, contemporary fire management is focused heavily on the exclusion (prevention and suppression, collectively) or mitigation of severe fire. When either of those fails, management efforts seem to shift toward speeding the "recovery" of the forest after severe fire. With respect to the latter, there are repeated attempts to introduce legislation designed to expedite logging after fire (salvage logging). Although the removal of dead trees is justified near roads and structures for safety reasons, and although postfire logging can capture economic value of wood that would otherwise be lost, such logging has been shown to carry significant ecological costs (Hutto 2006, Lindenmayer and Noss 2006, Swanson et al. 2011, Lindenmayer and Cunningham 2013, DellaSala et al. 2015). The ecological benefits and necessity of severe fire (and its aftermath) has widespread implications for the flora and fauna that depend on the presence of burned forest conditions. Ecologically sound fire management includes land management designed to ensure the maintenance of ecologically appropriate mixes of fire severities within the forested landscapes of western North America while protecting homes and lives at the same time (Perry et al. 2011). An ecologically informed view of severe fire requires recognition that it is a natural component of many western conifer forests (Heinselman 1981, Arno 2000). Moreover, the severe-fire component must have been large enough and frequent enough to have favored the evolution of specialization by various plant and animal species to conditions that occur in the aftermath of severe fire. We offer the following points in an effort to better recognize and include severe fire as an integral part of fire management in mixed-conifer forest systems:

SEVERELY BURNED FORESTS CREATE BIOLOGICALLY UNIQUE CONDITIONS THAT CANNOT BE CREATED BY OTHER KINDS OF DISTURBANCES OR THROUGH ARTIFICIAL MEANS

Patterns in the habitat associations of plant and animal species can provide definitive evidence that severe fire plays an essential role in the ecology of mixed-conifer forests (Hutto et al. 2008). Specifically, if a plant or animal species occurs only in burned forest conditions created by severe fire events, then it cannot be using burned forest conditions merely opportunistically. Instead, the species must have evolved to depend on such conditions because it occurs rarely, if ever, in unburned habitat (Swanson et al. 2011, DellaSala et al. 2014). For example, some moss and lichen species are relatively restricted to severely burned forest conditions (Ahlgren and Ahlgren 1960), as are the fire morel mushroom (*Morchella elata*) and Bicknell's geranium (*Geranium bicknellii*) in forests throughout the West (Heinselman 1981, Pilz et al. 2004). The black-backed woodpecker (*Picoides arcticus*) is emblematic of a species that is relatively restricted to early successional conditions created by high-severity fire (Hutto 1995, Dixon and Saab 2000, Hoyt and Hannon 2002). Black-backed woodpeckers are attracted to postwildfire conditions because of the abundance of larvae of a number of wood-boring beetle species that are attracted to the fire-killed trees (Murphy and Lehnhausen 1998, Rota et al. 2015). Several of these beetle species are themselves relatively restricted to recently burned forests (Saint-Germain et al. 2004*a,b*, Boucher et al. 2012). Importantly, black-backed woodpeckers are significantly more likely to occur in the more severely burned portions of a mixed-severity fire (Hutto 2008, Latif et al. 2013). Although black-backed woodpeckers are known to occur outside severely burned forests on rare occasions, detailed study of survival and reproductive success shows that they exhibit growing populations only in forests recently burned by summer wildfires (Rota et al. 2014). The adaptations of thick bark, branch shedding, and serotiny in *Pinus* are thought to have evolved in response to a period of more intense crown fires in the mid-Cretaceous (He et al. 2012), and those adaptations also reflect the severe-fire backdrop against which pine, Douglas-fir, and larch are thought to thrive.

Many additional animal species, while not as narrowly restricted to burned forest conditions, clearly benefit from the burned forest conditions created by severe fires in mixed-conifer forests throughout the West (Hutto et al. 2015). For example, nest survival of white-headed woodpeckers is significantly higher in burned (wildfire) compared to unburned forest (Hollenbeck et al. 2011, Lorenz et al. 2015). In aquatic systems, severe fire events can rejuvenate stream habitats by causing large amounts of gravel, cobble, woody debris, and nutrients to be imported, resulting in increased production and aquatic insect emergence rates (Benda et al. 2003, Burton 2005, Malison and Baxter 2010, Ryan et al. 2011, Jackson et al. 2015). These changes can, in turn, affect food web dynamics in a way that results in higher growth rates in young trout, including young coastal cutthroat trout (*Oncorhynchus clarkii clarkii*) (Heck 2007) and rainbow trout (*Oncorhynchus mykiss*) (Rosenberger et al. 2011). Indeed, nonnative fish populations declined and native trout densities increased 3 yr after a severe fire in the Bitterroot River watershed, Montana, indicating that severe fire may help ensure ecological integrity of some western streams (Sestrich et al. 2011). In addition, native amphibians such as boreal toads (*Bufo boreas*) thrive in areas that burn severely (Dunham et al. 2007, Hossack and Corn 2007) and use severely burned areas more than expected due to chance (Hossack and Corn 2007, Guscio et al. 2008), as do some bat species (Buchalski et al. 2013).

These strong associations between organisms and severely burned forest patches suggests that many plant and animal species have evolved to rely on recurring severe wildfire events, and further indicates that severe fire events are a natural and important part of the fire regimes associated with many western mixed-conifer forest types. In other words, if one or more species occupy severely burned forests to the exclusion of other forest types (and if they do not tend to occupy forests disturbed through artificial means), then a severely burned forest would have to be considered natural, and would necessarily lie within the historical range of variation (Hutto et al. 2008). Moreover, a more intimate understanding of the biology of those plants and animals (e.g., knowledge of dispersal processes and patterns, foraging ecology, home-range sizes) can provide insight into the historical spatial scales at which severe fire operated across the broader landscape.

FIRE HISTORY STUDIES SUGGEST THAT SEVERE FIRE IS AN INTEGRAL COMPONENT OF MOST FIRE REGIMES

In addition to the definitive evidence provided above, a growing body of fire history information points to the same conclusion—severe fire was historically, and is currently, an important component of many western conifer forest systems. At one end of the fire regime spectrum, conifer forests in the warmer, drier geographic areas in western North America are commonly characterized by frequent, low-severity fires that killed primarily juvenile trees historically, resulting in the maintenance of open pine forests with low densities of mature trees (Covington and Moore 1994*a,b*). Nevertheless, mixed and stand-replacement fires were possible even in these forest types after long inter-fire intervals, such as after an especially cold, wet period similar to what occurred during the Little Ice Age (Brown et al. 1999, Sherriff and Veblen 2007, Williams and Baker 2012, Odion et al. 2014, Hanson et al. 2015). At the other end of the fire regime spectrum, cooler, moister forest types, such as lodgepole pine forests, support fire regimes dominated by severe fire events (Brown and Smith 2000), although mixed- and low-severity fires are known to occur in these types as well (Barrett et al. 1991).

Between these two extremes lie the vast majority of mixed-conifer forest types in western North America. These include everything from the xeric, low-elevation, mixed ponderosa pine and Douglas-fir forest types to mesic, high-elevation, spruce-fir forest types. Unlike the forest types that are dominated by either the absence or presence of severe fire, mixed-conifer forests are best characterized by fire regimes of variable, or mixed severity (see Baker 2009: fig. 7.1), which means that the presence of sizable proportions of the three classes of fire severity characterize the fires that burn in those forest systems (Sherriff and Veblen 2006, 2007, Baker et al. 2007, Hessburg et al. 2007, Klenner et al. 2008, Perry et al. 2011, Schoennagel et al. 2011). Importantly, extreme weather (e.g., high temperature, low humidity, high wind speed) rather than quantity of woody fuels often exerts the greatest influence on fire severity and extent across that broad range of mixed-conifer forest types (Johnson et al. 2003, Schoennagel et al. 2004, Lydersen et al. 2014, Williams et al. 2015). This means that, in contrast with the situation in low-elevation or xeric-type ponderosa pine forests in some areas of the southwestern United States (Keane et al. 2008), the amount of high-severity fire in other mixed-conifer forest types is less likely to have departed significantly from historical ranges of variability, even though those forests may have experienced measurable twentieth century changes in fuels due to fire exclusion, timber harvest, and cattle grazing (e.g., Baker et al. 2007, Dillon et al. 2011, Marlon et al. 2012, Miller et al. 2012, Odion et al. 2014, Sherriff et al. 2014). We recognize the lack of relevant historical information on landscape-level distributions and spatial scales of different classes of fire severity for many forest types and regions, but severely burned forest patches have probably always occurred naturally, even in pure ponderosa pine forests of the Southwest, as Cooper (1961) and Weaver (1943) described long ago. We also know that, at least throughout the northern half of the western United States, the extent of severe-fire patches must have been both substantial enough in area and frequent enough to support those plant (e.g., lodgepole pine) and animal (e.g., wood-boring beetle and woodpecker) species that evolved to depend on severe fire itself or on the resulting severely burned forest conditions.

MAINTAINING ECOLOGICAL INTEGRITY MEANS ACCOMMODATING A BROAD SPECTRUM OF FIRE SEVERITIES, INCLUDING SEVERE FIRE AND ITS AFTERMATH, IN MOST MIXED-CONIFER FORESTS

We have now established two important facts: severe fire (moderate-to-high burn severity) is a natural agent of disturbance in many mixed-conifer forest types, and such fire is thought to be ecologically necessary for the presence or success of many plant and animal species. These two facts make it clear that management to maintain the ecological integrity of any ecosystem that harbors species that depend on severe fire as a disturbance agent will have to integrate severe fire and its effects into management goals. Moreover, if we better considered distribution patterns, home range sizes, movement patterns, and other animal adaptations that reflect the environment within which they evolved (e.g., Hutto et al. 2008), we could gain considerable insight into historical spatial scales under which severe fire operated as well. We are not questioning or attempting to discredit the evidence that some forest systems were historically dominated by low-severity fire; rather, we are encouraging land managers to also pay close attention to maintaining amounts and distributions of higher severity fire consistent with ecological integrity in our western mixed-conifer forests. The current science, management, and policy challenge for ecosystem managers is to estimate and incorporate amounts of low-, moderate-, and high-severity fire in a manner that maintains ecological integrity (Hessburg et al. 2007, Perry et al. 2011, Baker 2015).

While many fire ecologists understand the importance of more severe fire in forest ecosystems, politicians and the public at large have yet to reach the same understanding. Recent increases in the amount of forested area burned by wildfire over the past three decades in western North American forests (Westerling et al. 2006, Dennison et al. 2014) signaling what many believe to be the emergence of a new age of megafires (Attiwill and Binkley 2013), has created increased movement toward pre and postfire land management activities designed to reduce fire severity, mimic fire effects without the use of fire, or speed the recovery of a forest after fire. These activities may provide some societal benefits, but they can have real costs in terms of the way they negatively affect the ecological integrity of mixed-conifer forests born of mixed-severity fire. Removed from locations that pose a clear and immediate threat to human lives and property, the ecological costs associated with forest thinning may outweigh stated benefits by large margins. We highlight two types of land management (beyond fire suppression itself) that can have significant negative effects on fire-dependent species and, therefore, can interfere with our ability to maintain the ecological integrity of fire-dependent conifer forests: prefire fuel treatments and postfire salvage logging.

Prefire harvest treatments

We know a great deal about the effects of fuel treatments and restoration harvests on forest structure and vegetation recovery, but we know little about the ecological effects of such treatments on the prefire responses of most plant and animal species, and virtually nothing about postfire responses of the most fire-dependent plant and animal species after a treatment subsequently burns in a wildfire. This is because such treatments are rarely accompanied by "ecological effects monitoring," which, in contrast with implementation monitoring (evaluating whether a management activity was implemented) and effectiveness monitoring (evaluating whether the management activity achieved the stated goal), is specifically designed to address whether there are unforeseen negative ecological consequences of a management treatment (Hutto and Belote 2013).

Fuel treatments designed to restore fire-prone ecosystems should do so in the proper fire regime context; more specifically, they should produce appropriate postfire plant and animal responses when fire returns to the forest. Thus, treatments appropriate for dry forests that were historically maintained by a low-severity fire regime may be inappropriate for forests maintained by a mixed-severity fire regime. One serious negative consequence of canopy fuel reduction in forests that evolved with mixed-severity fire could be that fire-dependent species requiring high densities of large standing-dead trees created by the severe-fire component may not recruit after a subsequent fire. For example, the fire-dependent black-backed woodpecker was found to be even less abundant in mixed-conifer forests that were thinned before fire than in the same forest types logged after fire, even though the two pathways support similar standing dead tree densities. This is probably because birds rarely colonize thinned forests that burn, but they still make the best of a bad situation when trees are removed after they have already colonized a densely stocked, severely burned forest (Hutto 2008). Recent research on postfire soil conditions shows that soil C and N response following wildfire also depends on whether there have been fuel treatments, so the assessment of fuel treatment effects needs to include postfire response and not simply postharvest response (Homann et al. 2015). It has been suggested (e.g., Franklin and Johnson 2014) that variable-retention harvests could be designed to emulate early-seral conditions following natural disturbance events in forests born of mixed-severity fire, thereby avoiding the negative consequences associated with other tree harvesting methods. Unfortunately, that strategy is unlikely to satisfy the needs of those fire-dependent animal species that require high densities of fire-killed trees immediately following severe fire (Schieck and Song 2006, Hutto 2008, Reidy et al. 2014).

Postfire salvage logging

Salvage logging after fire is intended to recover economic value of timber that would otherwise be lost, to ensure human safety, and to reduce the risk of future fires. Unfortunately, salvage harvesting activities undermine the ecosystem benefits associated with fire (Lindenmayer et al. 2004, Lindenmayer and Noss 2006, Swanson et al. 2011). For example, postfire salvage logging removes dead, dying, or weakened trees, but those are precisely the resources that provide nest sites and an abundance of food in the form of beetle larvae and bark surface insects (Hutto and Gallo 2006, Koivula and Schmiegelow 2007, Saab et al. 2007, 2009, Cahall and Hayes 2009). No fire-dependent bird species has ever been shown to benefit from salvage logging (Hutto 2006, Hanson and North 2008). The ecological effects of salvage logging on aquatic ecosystems are also largely negative (Karr et al. 2004). In fact, the demonstrated negative ecological effects associated with postfire salvage logging are probably the most consistent and dramatic of any wildlife management effects ever documented for any kind of forest management activity (Hutto 2006). Therefore, because the National Forest Management Act and other legal mandates require public land managers to maintain the integrity of the larger ecological system, burned forests should perhaps be given special consideration compared with green-tree forests. Specifically, they could receive a low priority ranking when it comes to timber harvest decisions (with the obvious exception of small harvests associated with roads and other areas where safety or infrastructure are legitimate concerns). Timber can be harvested from many green-tree forests in a manner that imposes relatively little ecological cost in comparison with the costs associated with logging in burned forest (Lindenmayer and Cunningham 2013).

HOW DO WE MOVE TOWARD A MORE ECOLOGICALLY INFORMED VIEW OF FOREST FIRES?

The ecological costs associated with some of the more commonly employed pre and postfire management activities in the western United States probably increase substantially as one moves from the low-elevation or xeric ponderosa pine or woodland forest types, where trees were widely spaced and severe fire historically played a spatially restricted role, to the broad array of more densely stocked mixed-conifer forest types, where severe fire historically played a major role. Therefore, a thorough understanding of the historical fire regime associated with any particular vegetation type or land area (as determined from multiple lines of evidence concerning regionally specific fire history) is critically important for land managers who concern themselves with the issues of wildfire risk, ecological restoration, or maintenance of the diversity of native species (Schoennagel and Nelson 2011). More specifically, quantification of appropriate fire rotations and proportions of low-, moderate-, and high-severity fire for any given forest landscape is critical for enlightened land management. For example, in some xeric ponderosa pine forest types, ecosystem restoration activities designed to decrease the severity of wildfire may be ecologically appropriate. The same management activities are not likely to be ecologically appropriate in many mixed-conifer forests, however, because key indicator species evolved to depend on significant amounts of severe fire in those forest types (Schoennagel et al. 2004, Hutto 2008, Klenner et al. 2008, Baker 2012, 2015, Williams and Baker 2012, Odion et al. 2014).

Land and fire managers are now facing future fires that many hypothesize will become larger and contain larger proportions of more severely burned patches under warming climate conditions (Rocca et al. 2014). Problems associated with climate change, however, must be solved through efforts directed toward the causes of climate change and not toward the symptoms of climate change. Any perceived problem with future changes in fire behavior cannot be solved by redoubling our effort to treat this particular climate change symptom by installing widespread fuel treatments that do nothing to stop the warming trend, and do little to reduce the extent or severity of weather-driven fires (Gedalof et al. 2005). Therefore, fuel management efforts to reduce undesirable effects of wildfires outside the xeric ponderosa pine forest types could be more strategically directed toward creating fire-safe communities (Calkin et al. 2014, Kennedy and Johnson 2014). A management emphasis directed toward altering conditions in and immediately adjacent to human communities is very different from an emphasis directed toward treating massive amounts of fuel on more remote public lands. Fuel treatment efforts more distant from human communities may carry the negative ecological consequences we outlined earlier and do little to stop or mitigate the effects of fires that are increasingly weather driven (Rhodes and Baker 2008, Franklin et al. 2014, Moritz et al. 2014, Odion et al. 2014).

Public land managers face significant challenges balancing the threats posed by severe fire with legal mandates to conserve wildlife habitat for plant and animal species that are positively associated with recently burned forests. Nevertheless, land managers who wish to maintain biodiversity must find a way to embrace a fire-use plan that allows for the presence of all fire severities in places where a historical mixed-severity fire regime creates conditions needed by native species while protecting homes and lives at the same time. This balancing act can be best performed by managing fire along a continuum that spans from aggressive prevention and suppression near designated human settlement areas to active "ecological fire management" (Ingalsbee 2015) in places farther removed from such areas. This could not only save considerable dollars in fire-fighting by restricting such activity to near settlements (Ingalsbee and Raja 2015), but it would serve to retain (in the absence of salvage logging, of course) the ecologically important disturbance process over most of our public land while at the same time reducing the potential for firefighter fatalities (Moritz et al. 2014). Severe fire is not ecologically appropriate everywhere, of course, but the potential ecological costs associated with prefire fuels reduction, fire suppression, and postfire harvest activity in forests born of mixed-severity fire need to considered much more seriously if we want to maintain those species and processes that occur only where dense, mature forests are periodically allowed to burn severely, as they have for millennia.

Another integral part of moving toward an ecologically informed perspective of forest fire involves getting the public, politicians, and policy-makers to better recognize and appreciate the critical role that severe fire plays in many forest systems. This has been difficult, and this difficulty has been exacerbated by public messages about severe fire that are uniformly negative. Progress toward allowing fires to burn is difficult unless the public begins to receive a message that differs markedly from the message that Smokey the Bear is sending them now. Fires in our wildlands are fundamentally natural and beneficial, so we must learn to live in a way that allows naturally occurring fires, including severe fires, to burn while minimizing risk to human property and lives (Calkin et al. 2014). That is a vastly different message from one that says severe fires are fundamentally bad and that we have to do everything in our power to prevent and suppress them, or from one that says severely burned forests are places where we should expedite efforts to capture residual economic value through "salvage" logging. We challenge ecologists and managers to pay greater attention to the degree of variation in fire regimes within mixed-conifer forests and to recognize that prefire thinning and postfire "restoration" activities may not always be compatible with maintenance of the ecological integrity of conifer forests that depend on complex mixed-severity fire disturbance.

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