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Restoration relevance of recent National Fire Plan treatments in forests of the western United States

Tania Schoennagel^{1*} and Cara R Nelson²

The US National Fire Plan (NFP) is among the largest forest-restoration initiatives worldwide, removing wildland fuels on about 11 million hectares and costing over \$6 billion. We evaluated the extent to which areas treated under the NFP – from 2004 to 2008, in forest ecosystems outside the wildland–urban interface in 11 western states (“West”) – were predicted to need restoration, due to disruption of fire regimes and expected fuels buildup. Fuel-reduction treatments were implemented on about 1% of the West’s forested areas. Forty-three percent of the treated area was predicted to have high-restoration need – almost twice as much as expected, given the distribution of these forests. However, an equal amount was in mixed- or uncertain-need forests, and 14% occurred in low-need forests, suggesting that managers need additional information on fire-regime disruptions in some forest ecosystems to help prioritize restoration activities. Only one-quarter of the West’s forested area shows strong evidence of uncharacteristic fuels buildup, which is often emphasized as the primary cause of current wildfire problems, potentially directing attention away from other important drivers such as climate change and an expanding wildland–urban interface.

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Restoration of forests that historically have experienced frequent, low-severity fires but are currently at risk of high-severity fires is a high management priority (NFP 2000), especially given recent increases in the occurrence and severity of large fires in some forest types (Westerling *et al.* 2006; Miller *et al.* 2009). In 2000, the US Government initiated the National Fire Plan (NFP), a long-term fuels-reduction program for restoring the historical structure, diversity, and dynamics of forest and rangeland ecosystems, and reducing fire risk to communities along the wildland–urban interface (WUI; WGA 2002). Under the direction of the NFP and associated Healthy Forests Initiative (HFI) and Healthy Forests Restoration Act (HFRA), five US land-management agencies implemented activities to reduce wildland fuels on over 11 million ha between 2001 and 2008 (US GAO 2009), yet there has been no comprehensive evaluation of the extent to which treatments target forests degraded by past management and fire suppression and are, therefore, in need of restoration.

Ecological restoration is the “process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed” (SER 2004), in order to promote recovery from environmental stress and disturbance. The NFP and associated policies use a narrower definition of ecosystem restoration, which is to remove accumulated fuels such as trees, shrubs, grasses, and litter in ecosystems where historically frequent, low-severity fire regimes have been altered by fire suppression or grazing (WFLC

2006). Consistent with the NFP, here we define restoration as the re-establishment of historical forest fuel structure through the use of prescribed fire or mechanical treatments such as thinning.

The NFP also emphasizes mitigation of fire risk to people and property in the WUI, regardless of restoration need (ie degree of fire-regime alteration). Because the WUI area in the western US has expanded by over 50% during recent decades (Theobald and Romme 2007) and wildfire suppression costs have exceeded \$1 billion per year, due in large part to protection of private property (OIG 2006), natural resource management policies emphasize fire mitigation where human lives and property are at risk, regardless of restoration need. However, in areas far from the WUI, ecosystem restoration may be a more important management goal than fire mitigation. Although restoration and fire mitigation are separate goals of the NFP, in some locations, fuel-reduction treatments may accomplish both fire mitigation and restoration, depending on ecosystem type and landscape context.

Several factors have contributed to restoration need in some western forests. For example, in many dry, ponderosa pine (*Pinus ponderosa*)-dominated forests, past grazing and fire suppression have increased understory tree density and surface-fuel loads (Agee 1993; Covington and Moore 1994), increasing the risk of uncharacteristic high-severity fires. Departure from historical fire regimes is considerable in these types of forests, as well as in others that historically experienced frequent, low-severity fires. In these forests, therefore, removal of fuels may contribute to the restoration of historical fuel structures and fire regimes (Stephens *et al.* 2009).

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In contrast, grazing and fire suppression have had little effect on fire regimes and fuel structures in ecosystems that typically experienced long fire-return intervals and/or high-severity fires (Keane *et al.* 2008). In these forest types (eg high-elevation or highly productive forests) and possibly in arid, low-productivity woodlands (Romme *et al.* 2009), there has been little alteration of historical fire regimes, and fuel-reduction treatments may create stand structures that are unprecedented historically. Furthermore, in these forest types, large, catastrophic fires – which are the norm – are primarily driven by extreme drought and high winds, rather than by uncharacteristic accumulations of fuels; thus, fuel restoration may be unwarranted (Schoennagel *et al.* 2004) and incompatible with the NFP's restoration goals.

In other vegetation types, such as mixed-conifer or upper-montane forests at intermediate elevations, historical fire frequency and severity are more variable (Fulé *et al.* 2003; Sherriff and Veblen 2006) and generally less well quantified, as compared with the fire regimes mentioned above. In these vegetation types, it is often difficult to know what proportion of stands or landscapes historically experienced frequent, low-severity fires (where effective fire suppression has increased fuels) versus less-frequent, mixed- or high-severity fires (where fire suppression has had minimal effects). This is due in part to the methodological challenges associated with reconstructing mixed-severity fires and to the lack of research on this topic. In these areas of highly complex, hybrid fire regimes, the degree of fuel alteration and the need for treatments to restore historical fuel structures either are variable across space or time, or are uncertain because of a lack of data. Restoration is warranted in some portions of these forests; however, spatially explicit characterizations of fuels buildup are needed to assist managers in developing specific restoration guidelines.

This study is the first to analyze recent NFP fuel-reduction activities to determine the degree to which treatment locations reflect current understanding of forest-restoration needs across the western US. Specifically, we assessed: (1) the overall proportion of forests treated in areas of high, mixed/uncertain, and low restoration need, based on expected change from historical fire

regimes; and (2) variation in these proportions by geography (forest type and state), management objective, and treatment type.

Methods

We assessed the location of NFP fuels treatments implemented by five federal agencies (National Park Service, Forest Service, Bureau of Land Management, Fish and Wildlife Service, and the Bureau of Indian Affairs) across 11 western states (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming) from 2004 to 2008, using National Fire Plan Operations and Reporting System (NFPORS) data (<http://wildfire.cr.usgs.gov/nfpmaps/viewer.htm>). We restricted our analyses to 25 432 treatments implemented in forests (including woodland, savanna, parkland, and wooded draws), located >2.5 km from the WUI (Schoennagel *et al.* 2009), where fire-mitigation goals of protecting communities are assumed to be secondary to restoration goals. Hereafter, “West” and “area treated” refer to forests >2.5 km from the WUI across the 11 western states listed above, to which analyses were restricted. NFPORS data contain information systematically entered by federal land managers, including treatment year, geometric center, area, type (fire, mechanical, other), and management objectives. We created a circular buffer zone around each treatment center, sized according to the maximum area treated at that location (see Schoennagel *et al.* [2009] for details). The circular buffer zone is a necessary simplification of the irregular shapes of treated area, given that the NFPORS database did not include actual treatment perimeters. This buffer zone contributes to some spatial errors in the analysis and a potential bias in areas of complex terrain (by potentially [a] over-reporting the area treated in low- or mixed-need forests, where in fact high-restoration-need forests were targeted, or [b] over-reporting the area treated in high-restoration-need forests, where low- or mixed-restoration-need forests were targeted). We overlaid maps of the area treated with maps of historical Fire Regime Groups (FRG) and forest type (Existing Vegetation Type [EVT]), created by LANDFIRE – a federal project that produces national maps for use in regional prioritization of fuel-reduction and ecosystem-restoration treatments under the NFP and HFRA (Rollins and Frame 2006).

LANDFIRE's FRG map classifies historical (ie prior to the putative effects of fire exclusion and grazing) frequency and severity of fires, based on a gradient of fire frequency and severity (Table 1). Classifications were derived from existing regional studies and expert opinion, and were peer reviewed (www.landfire.gov; WebTable 1; Figure 1). Based on expected deviation from historical fire regime, we defined

Table 1. Historical fire frequency and severity associated with LANDFIRE's Fire Regime Groups (FRGs)

Fire Regime Group	Historical fire frequency (yrs)	Historical fire severity
1	0–35	low to mixed
2	0–35	high
3	35–200	low to mixed
4	35–200	high
5	200+	any

Notes: Orange represents high-restoration-need forests, gray shows mixed/uncertain-restoration-need forests, and green represents low-restoration-need forests.

three classes of “potential restoration need” (hereafter “restoration need”):

- (1) *High restoration need*: where past fire suppression and grazing are known to have decreased historical fire frequencies, resulting in increased fuels and risk of high-severity fires (FRG 1). This class is dominated by Southern Rocky Mountain ponderosa pine woodland (12% of FRG 1 area of the West), Mediterranean California mesic mixed conifer forest and woodland (9%), and Mediterranean California dry-mesic mixed conifer forest and woodland (7%).
- (2) *Low restoration need*: where fire suppression and grazing are known to have had minimal effects on historical high-severity and/or low-frequency fires, and fuels therefore have not changed greatly (FRGs 2, 4, and 5). This class is dominated by Rocky Mountain sub-alpine dry/wet-mesic spruce-fir forest and woodland (22%), Great Basin/Colorado Plateau pinyon-juniper woodland (17%), North Pacific Maritime Douglas-fir (*Pseudotsuga menziesii*)-western hemlock (*Tsuga heterophylla*) forest (12%), and Rocky Mountain lodgepole pine (*Pinus contorta*) forest (7%).
- (3) *Mixed/uncertain restoration need*: where historical fire regimes were of intermediate frequency (35–200 yr) and low-to-mixed severity, and the impacts of fire suppression and grazing are either variable or unknown (FRG 3). This class is dominated by Colorado Plateau and Great Basin pinyon-juniper woodlands (22%), Inter-Mountain and Northern Rocky Mountain mixed conifer forest (16%), and Douglas-fir forest alliance (12%). Given limited information and the broad range of fire frequencies in this class, some portion may be more appropriately classified as high restoration need.

Assessments of treatment location with respect to restoration-need class were conducted for the West overall and for each state. We also assessed proportion of area treated within each restoration-need class by management objective: “ecosystem restoration” and fire mitigation (which included the terms “defensible space”, the removal of fuels around homes or communities to slow the spread of wildfire; “wildland–urban interface”; and “municipal water supply [or watershed] protection”).

■ Results

Areal extent of treatments in forests across the West (2004–2008) was about 1.1 million ha, or 1% of the West’s total forested area. About 460 000 ha (2%) of high-

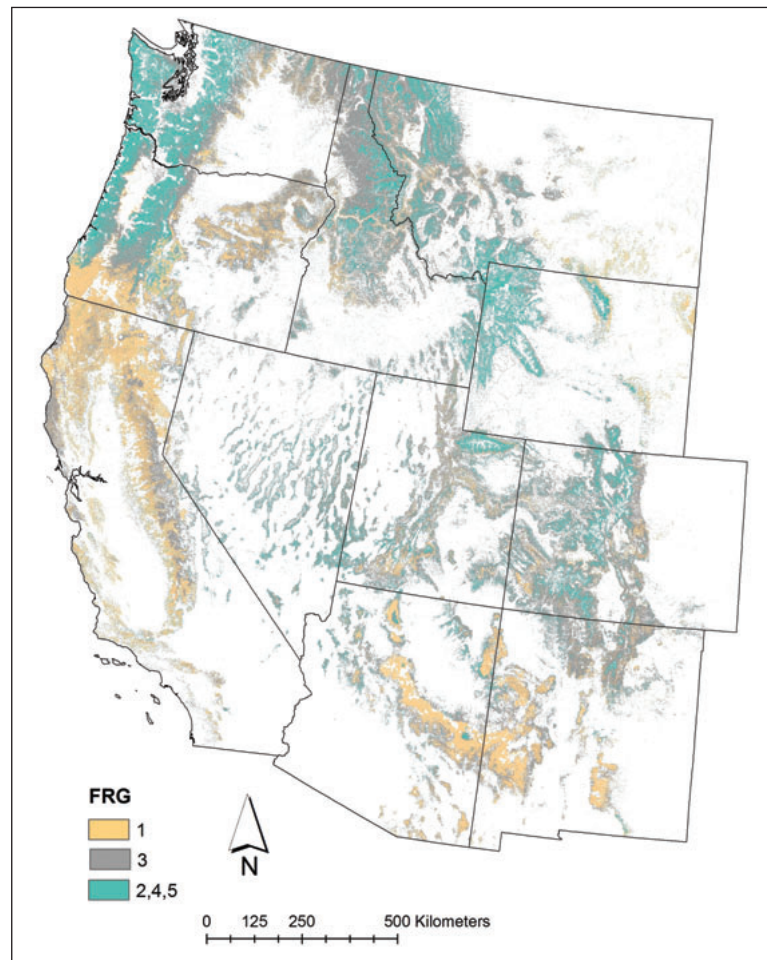


Figure 1. Distribution of LANDFIRE’s Fire Regime Groups (FRGs) in forests (Existing Vegetation Type [EVT]) across 11 western states. Orange color represents high-restoration-need forests, gray shows mixed/uncertain-restoration-need forests, and green represents low-restoration-need forests. See Methods section for definitions of FRG and restoration-need classes.

restoration-need forests across the West and a similar extent (1%) of mixed/uncertain-restoration-need forests across the West were treated. Only 160 000 ha (1%) of low-restoration-need forests across the West were treated.

The forest type with the most area treated was the Southern Rocky Mountain ponderosa pine woodland; 13% of total area treated was of this type, which comprises only 4% of the West’s forested area. Nine percent of forest area treated was Northern Rocky Mountain ponderosa pine woodland and savanna, whereas Colorado Plateau pinyon-juniper woodland and Northern Rocky Mountain dry-mesic montane mixed conifer forest were 8% each; these vegetation types comprise 3%, 9%, and 5%, respectively, of the entire forested area of the western US (WebTable 2).

Of the total forest area treated, 43% was characterized as high restoration need (Figure 2). This restoration class occupies about one-quarter of the West’s forested area. The treated area in mixed- or uncertain-restoration-need forests was roughly equivalent to their prevalence across the West (43% versus 46%, respectively). Only 14% of

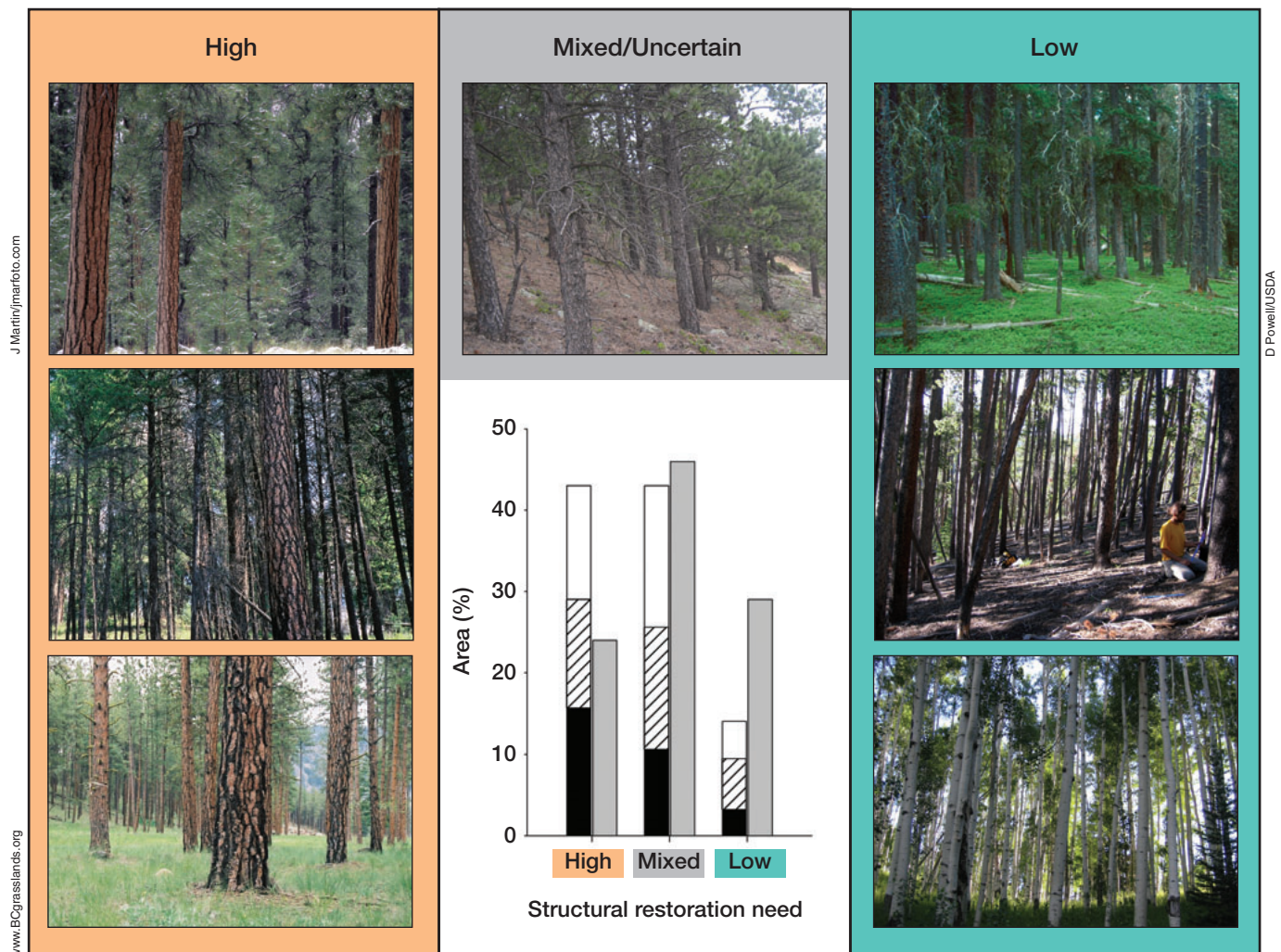


Figure 2. For each restoration-need class, total percent area treated (left bars) by treatment objective (fire mitigation only [black]; ecological restoration only [white]; both fire mitigation and ecological restoration [hashed]) compared with percent of the West (right bars, gray). Only treatments under the National Fire Plan between 2004 and 2008 and forests > 2.5 km from the wildland–urban interface are included. Photographs show example forests in each restoration-need class: high (orange panel); mixed/uncertain (gray panel); and low (green panel). See Methods section for description of restoration-need classes.

the treated area occurred in low-restoration-need forests, which occupy 29% of western US forests.

The amount of area treated varied considerably among states (Figure 3). Oregon, Arizona, California, and New Mexico each had over 10% of their total forested area treated. On average, across all states, 32% of area treated in each state was high restoration need. Arizona, California, and New Mexico had > 50% of their treated area in this class; conversely, Colorado, Idaho, Montana, Nevada, and Utah had < 20% of their treated area in this class. On average, 20% of treated forested area within each state was low need; Nevada, Utah, and Wyoming treated over 30% of forest in this class.

States also varied in the ratio of forest area treated to total forest area. Arizona, Oregon, and New Mexico – three of the four states with the highest treated area – implemented activities on substantially more area than expected (based on the ratio of forest area treated in the state to total forest area in the state, which was > 1.25).

Conversely, Montana, Washington, Wyoming, and Nevada each treated substantially less forest than expected (< 0.75). All states treated more high-restoration-need forests than expected, given each state's area in this class: the average proportion was 1.7. States with average proportions higher than this value were Washington (3.5), Idaho (1.9), Colorado (1.9), and Arizona (1.8). Only Nevada and Utah treated more forests in the low-need class than expected (1.2 and 1.1, respectively); Washington treated the least (0.1 of expected). On average, states treated areas of mixed/uncertain need in proportion to the availability of that class in the state.

Of the total area treated, 36% had exclusively ecosystem-restoration objectives, 29% had fire-mitigation (but not restoration) objectives, and 35% had both objectives. Municipal watershed or water-supply protection accounted for less than one-quarter of the area treated for fire-mitigation purposes. Within each restoration-need

group, the percentage of area treated for each objective was similar (Figure 2).

Prescribed fire (predominantly broadcast burns – controlled ground fires over a defined area) and mechanical treatments (predominantly thinning) were implemented in roughly equal proportions, regardless of restoration-need class, but varied depending on management objective. Prescribed fire was implemented on 60% of the area treated for ecosystem-restoration objectives, but on only 41% of the area treated with fire-mitigation as the main objective. In contrast, mechanical treatments were carried out on 39% of the area in which ecosystem restoration was the objective, but on 57% of land where fire mitigation was the main objective.

■ Discussion

Between 2004 and 2008, the overall footprint of NFP treatments in the western US – excluding the WUI plus a 2.5 km buffer zone around it – is small (1%) relative to the vast extent of forests that occur in this part of the country. Prioritization of high-restoration-need landscapes, based on presumed increases in fuels and fire severity, is therefore critical. Of the forest treatments implemented away from the WUI, 43% were classed as high-restoration need – much higher than the proportion of the West in the high-need class. This trend of treating more area than expected in these forest types was consistent for all 11 states. Almost one-quarter of the total area treated was concentrated in ponderosa pine woodlands – the archetypal forest where restoration need, resulting from fire-suppression-induced increases in fuels, has been most clearly demonstrated (Agee 1993; Covington and Moore 1994; Schoennagel *et al.* 2004).

While federal agencies treated more area than expected in restoration-appropriate forests across the western states, 14% of the area treated occurred where restoration need was predicted to be low. Although low-restoration-need forests were treated less than expected as compared with the prevalence of such forests across the West, fuel-reduction activities were implemented on about 160 000 ha of low-need forest, and two states treated more area than expected based on the distribution in forests of this class.

Forty-three percent of the total area treated occurred where the need for restoration was either spatially variable or unknown. These forests comprise the majority of western US forestlands, but are the least studied in terms of disturbance history, fuel dynamics, and responses to climate change. Limited scientific information and a lack of consensus among experts may have resulted in some classification error in this type. If a substantial portion of these forests is actually high-restoration need, we may have underestimated the restoration accomplishments of the NFP (eg area of high-restoration-need forests treated). Furthermore, even in forest types that have been correctly characterized as having mixed-severity fire regimes, some portion of the landscape may have experi-

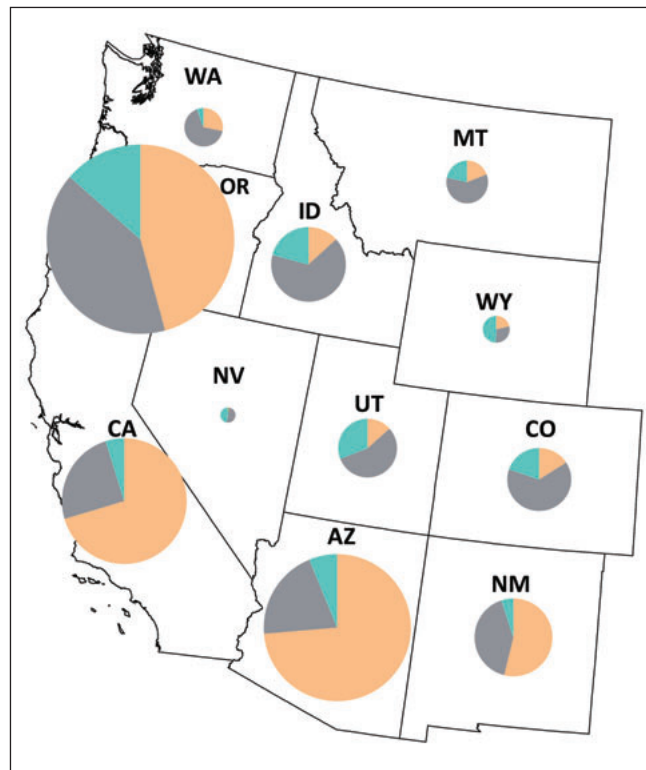


Figure 3. For each of the 11 western states, the percentage of forest area treated by restoration-need class: high (orange), mixed/uncertain (gray), low (green). See Methods section for description of restoration-need classes. Circles are sized according to percentage of total forested area treated within a given western state. Only treatments implemented in forests outside a 2.5-km buffer zone around the wildland–urban interface under the National Fire Plan between 2004 and 2008 are included.

enced predominantly high-frequency, low-severity fires, where restoration may in fact be appropriate. However, the spatial distribution and degree of uncharacteristic fuels buildup are unknown for most mixed-severity-fire landscapes. Land managers, therefore, often lack site-specific information on which to base restoration treatment plans in these forest types.

Contrary to expectations, there were no clear trends in restoration objectives between treated forests of high and low restoration need. However, prescribed burns were commonly used for restoration purposes; reintroduction of low-severity fires may facilitate the recovery of fire regimes by removing accumulated fuels that increase risk of high-severity wildfire. Mechanical treatments, such as thinning, were more commonly implemented where fire mitigation was the objective, and where reducing canopy fuels and severe-fire risk may have been the primary concern.

Although this study considered only the location of treatment areas in terms of targeting restoration-appropriate forest types, assessing the efficacy of treatments in meeting restoration goals remains critical. Most assessments focus largely on the effect of treatments on fire severity (eg Stephens *et al.* 2009) or carbon storage (eg

Hurteau and North 2009) – variables that are highly dependent on post-treatment wildfire occurrence – rather than looking more broadly at the extent to which overall composition, structure, and function have been restored. Given the low overall proportion of forest area treated and the likelihood that only a small proportion of treated stands will subsequently burn during treatment lifespan, it is imperative that treatments confer ecological benefits regardless of subsequent wildfires. This is vital, given the compelling evidence that treatments may have adverse ecological effects, including increased invasion by non-native plants (Nelson *et al.* 2008) and increased mortality or insect-susceptibility of older, ecologically important trees (Breece *et al.* 2008).

Conceptions of ecological restoration have changed considerably over the past decade, owing to an increasing recognition of the dynamic nature of ecosystems and the impacts of climate change. There is now general agreement about the need to move beyond recreating historical conditions for which there may be no future analog (Williams and Jackson 2007), and instead to promote ecosystem resilience – the capacity of ecosystems to return to desired conditions after disturbance (Millar *et al.* 2007; Hobbs and Cramer 2008; Blate *et al.* 2009). In managing for ecological resilience in fire-adapted forests, information on past conditions – including historical fire regimes and the effects of past management – still plays a critical role. For example, historical information may help identify when and where ecological thresholds are likely to be exceeded as a result of climate-change-related disturbance. We recommend that forest managers combine information on historical fire regimes with information on predicted changes in climate, to prioritize treatments outside the WUI. For instance, treatments that restore fire-adapted structures and processes in forests predicted to have low resilience to severe wildfire may help forestall adverse impacts of climate change, such as hotter and drier conditions that exacerbate fire effects and/or inhibit regeneration. Conversely, forests resilient to high-severity or high-frequency fires may not be high priorities for restoration, even if their burn area is likely to increase with climate warming. In these forests, we recommend curtailing residential expansion, both to reduce wildfire risks to people and property, and to promote climate-change-resilient landscapes. Although restorative fuel reduction will be needed in many ecosystems, we recommend that future policies move beyond an almost exclusive focus on fuels and explicitly consider climate (Spracklen *et al.* 2009) and an expanding WUI (Theobald and Romme 2007) as important drivers of increasing wildfire risk in the western US.

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WebTable 1. The proportion of forest types comprising each restoration-need group derived from a spatial overlay of LANDFIRE’s historical Fire Regime Group (FRG) and forest type (Existing Vegetation Type [EVT]) across forested areas in the 11 western states

High restoration need (FRG1)	%
Southern Rocky Mountain ponderosa pine woodland	12
Mediterranean California mesic mixed conifer forest and woodland	9
Mediterranean California dry–mesic mixed conifer forest and woodland	7
Mediterranean California mixed evergreen forest	6
Northern Rocky Mountain ponderosa pine woodland and savanna	6
California Lower Montane blue oak–foothill pine woodland and savanna	6
Colorado Plateau pinyon–juniper woodland	5
Northern Rocky Mountain dry–mesic montane mixed conifer forest	5
Northwestern Great Plains–Black Hills ponderosa pine woodland and savanna	4
<i>Pseudotsuga menziesii</i> forest alliance	4
California Montane Jeffrey pine (ponderosa pine)–woodland	3
Southern Rocky Mountain dry–mesic montane mixed conifer forest and woodland	3
Madrean pinyon–juniper woodland	3
Central and Southern California mixed evergreen woodland	3
Mediterranean California mixed oak woodland	2
California Montane woodland and chaparral	2
Rocky Mountain aspen forest and woodland	2
Inter-Mountain Basins aspen–mixed conifer forest and woodland	2
Southern Rocky Mountain pinyon–juniper woodland	2
Mediterranean California Lower Montane black oak–conifer forest and woodland	1
Mediterranean California red fir forest	1
North Pacific Maritime dry–mesic Douglas–fir–western hemlock forest	1
Madrean Lower Montane pine–oak forest and woodland	1
Southern Rocky Mountain mesic montane mixed conifer forest and woodland	1
Mixed/uncertain restoration need (FRG3)	%
Colorado Plateau pinyon–juniper woodland	15
<i>Pseudotsuga menziesii</i> forest alliance	12
Northern Rocky Mountain dry–mesic montane mixed conifer forest	8
Great Basin pinyon–juniper woodland	7
Rocky Mountain aspen forest and woodland	5
Northern Rocky Mountain mesic montane mixed conifer forest	4
North Pacific Maritime dry–mesic Douglas–fir–western hemlock forest	4
Inter-Mountain Basins aspen–mixed conifer forest and woodland	4
Southern Rocky Mountain ponderosa pine woodland	3
Northern Rocky Mountain ponderosa pine woodland and savanna	3
Rocky Mountain subalpine dry–mesic spruce–fir forest and woodland	3
Rocky Mountain lodgepole pine forest	3
Madrean pinyon–juniper woodland	3
Northern Rocky Mountain subalpine woodland and parkland	2
Mediterranean California red fir forest	2
Mediterranean California mesic mixed conifer forest and woodland	2
Southern Rocky Mountain mesic montane mixed conifer forest and woodland	2
Southern Rocky Mountain pinyon–juniper woodland	2
Southern Rocky Mountain dry–mesic montane mixed conifer forest and woodland	2
California coastal redwood forest	1
East Cascades mesic montane mixed conifer forest and woodland	1
Inter-Mountain Basins mountain mahogany woodland and shrubland	1
Rocky Mountain subalpine wet–mesic spruce–fir forest and woodland	1
Mediterranean California dry–mesic mixed conifer forest and woodland	1

Continued

WebTable 1. – Continued

Low restoration need (FRG2, FRG4, FRG5)	%
Rocky Mountain subalpine dry–mesic spruce–fir forest and woodland	12
Rocky Mountain subalpine wet–mesic spruce–fir forest and woodland	10
Great Basin pinyon–juniper woodland	9
Colorado Plateau pinyon–juniper woodland	8
Rocky Mountain lodgepole pine forest	7
North Pacific maritime dry–mesic Douglas–fir–western hemlock forest	7
North Pacific maritime mesic–wet Douglas–fir–western hemlock forest	5
Northern Rocky Mountain subalpine woodland and parkland	5
Rocky Mountain aspen forest and woodland	4
North Pacific mesic western hemlock–silver fir forest	3
Pseudotsuga menziesii forest alliance	3
North Pacific dry–mesic silver fir–western hemlock–Douglas–fir forest	3
Inter-Mountain Basins montane riparian systems	1
Northern Rocky Mountain ponderosa pine woodland and savanna	1
Inter-Mountain Basins aspen–mixed conifer forest and woodland	1

Notes: Only forest types comprising $\geq 1\%$ of each restoration-need group shown. See Methods in main text for definitions of FRG and restoration-need groups.

WebTable 2. The percent area and areal extent (ha) of treatments (TRT) across the West for forest types (Existing Vegetation Types [EVT]) comprising $\geq 2\%$, sorted by highest to lowest percent area treated

Forest type	TRT		WEST		FRG1	FRG2	FRG3	FRG4	FRG5
	%	(ha x 1000)	%	(ha x 1000)					
Southern Rocky Mountain ponderosa pine woodland	12.8	(137)	4.0	(3182)	83	0	17	0	0
Northern Rocky Mountain ponderosa pine woodland and savanna	8.7	(94)	2.8	(2195)	55	2	39	3	0
Colorado Plateau pinyon–juniper woodland	8.2	(88)	9.1	(7210)	23	1	56	16	4
Northern Rocky Mountain dry–mesic montane mixed conifer forest	8.1	(87)	4.8	(3749)	38	0	61	0	0
<i>Pseudotsuga menziesii</i> forest alliance	6.8	(73)	6.6	(5217)	21	0	74	3	1
Mediterranean California mesic mixed conifer forest and woodland	5.4	(58)	3.2	(2562)	77	0	22	0	0
Madrean pinyon–juniper woodland	3.2	(34)	1.8	(1390)	44	1	50	4	1
Rocky Mountain montane riparian systems	2.5	(27)	2.2	(1756)	14	0	79	2	6
Rocky Mountain aspen forest and woodland	2.4	(25)	3.2	(2536)	16	1	56	26	1
Inter-Mountain Basins aspen–mixed conifer forest and woodland	2.4	(25)	2.2	(1758)	24	1	63	10	1
Great Basin pinyon–juniper woodland	2.2	(23)	5.1	(4009)	1	0	46	43	9
Southern Rocky Mountain dry–mesic montane mixed conifer forest and woodland	2.2	(24)	1.4	(1102)	61	0	38	0	0
Mediterranean California dry–mesic mixed conifer forest and woodland	2.2	(23)	1.9	(1479)	82	0	18	0	0
Northern Rocky Mountain mesic montane mixed conifer forest	2.1	(22)	2.0	(1578)	2	0	93	2	4
Rocky Mountain lodgepole pine forest	1.9	(20)	3.1	(2482)	1	3	40	45	10
Rocky Mountain subalpine dry–mesic spruce–fir forest and woodland	1.7	(18)	4.7	(3708)	1	4	28	54	13
Rocky Mountain subalpine wet–mesic spruce–fir forest and woodland	1.6	(17)	3.2	(2549)	0	4	15	55	26
North Pacific maritime dry–mesic Douglas–fir–western hemlock forest	1.0	(10)	3.6	(2826)	6	0	47	7	39
Northern Rocky Mountain subalpine woodland and parkland	0.3	(3)	2.3	(1791)	1	0	59	7	33

Notes: For each forest type, the five columns to the right show the proportion treated in each historical Fire Regime Group (FRG), with the dominant FRG highlighted (colors reflect restoration-need groups: orange if high [FRG1], gray if mixed/uncertain [FRG3], and green if low [FRG2,4,5]). See Methods for restoration-need group definitions. Only treatments under the National Fire Plan during 2004–2008 and forests > 2.5 km from the wildland–urban interface are included.