Air Quality

Key Points

- All action alternatives and the Proposed RMP would produce more particulate emissions than the No Action alternative and current conditions. However, adherence to the requirements of the Oregon Smoke Management Plan would continue to limit impacts to human health and visibility from prescribed fires.
- Based on the amount of area where active management would occur, Alternative C has the most potential to reduce adverse effects to human health and visibility from wildfires over the long-term, while the No Action alternative would present the highest risk.

Summary of Notable Changes from the Draft RMP/EIS

- Changed **Figure 3-10** and **Figure 3-11** to display the emissions from prescribed fire only; wildfire emissions discussed separately to provide context for prescribed fire emissions and generalized more to reflect uncertainty over when wildfires would actually occur.
- Added an uncertainty analysis to the discussion on hazardous fuels prescribed fire emissions.
- Added a cumulative effects discussion.
- Removed the discussion concerning the potential of each alternative and the Proposed RMP to reduce wildfire emissions through active management, as it is not supported adequately by science.

Issue 1

How would the proposed management actions affect $PM_{2.5}$, PM_{10}, and expected visibility?

Summary of Analytical Methods

The effects analysis includes emissions from both the hazardous fuels and activity fuels prescribed fire programs. The expected emissions from prescribed fire to reduce hazardous fuels do not vary, because there is no reasonable basis for the BLM to forecast a difference in the acreage of treatments among the alternatives and the Proposed RMP. Therefore, the main variable in estimated particulate emissions from prescribed fire is the amount of activity fuels prescribed burning.

The Woodstock model produced estimates of the acres of activity fuels treatments by treatment type (e.g., hand pile burning, machine pile burning, and broadcast burning) for each alternative and the Proposed RMP. Based on input from district fuels specialists using professional expertise and experience, the RMP interdisciplinary team fuels specialist provided pile dimensions, estimates of the number of piles per acre, and the amount of fuel typically consumed in broadcast burns. The fuels specialist provided similar details for the hazardous, or natural, fuels program along with the expected acres of each treatment type for each district. The BLM input these details into Consume 3.0 to estimate particulate emissions. The Planning Criteria provides detailed information on analytical assumptions, methods and techniques, and geographic and temporal scales, which is incorporated here by reference (USDI BLM 2014, pp. 33–35). Data sources include annual smoke reports from the Oregon Department of Forestry and visibility information from the Interagency Monitoring of Protected Visual Environments (IMPROVE) program for the existing condition. **Appendix E** contains a more detailed description of the analytical methods used to estimate particulate emissions from prescribed burning and wildfires.

This analysis does not quantify emissions from treating sudden oak death. At present, the number of acres treated through prescribed burning to control sudden oak death remains small, averaging 55 acres per year, but with considerable interannual variability (see Invasive Species, Issue 3 in this chapter for more detail). This small acreage of burning contributes a negligible amount to emissions, compared to other prescribed fire activities. Although it is reasonably foreseeable that the acreage treated for sudden oak death will increase over time, it is not possible to forecast that increase quantitatively, and emissions from sudden oak death treatments are likely to remain a negligible contribution to emissions compared to other prescribed fire activities.

The BLM analyzed the expected emissions from wildfires to provide additional context. Estimated wildfire emissions vary over time, but not among alternatives or the Proposed RMP. The BLM altered the analysis process used to estimate particulate matter emissions from wildfires to reflect uncertainties over when those emissions might occur. Instead of estimating the emissions per decade, the BLM totaled the number of acres burned in wildfires over the 50-year analysis period and estimated the average emissions per year. The BLM estimated emissions from wildfires to provide context for the emissions from prescribed fire.

Background

Western Oregon has a history of air quality problems due to the combination of weather patterns and topography. Poor air quality develops when a major polluting activity or event combines with temperature inversions and strong high-pressure systems that create stagnant air. The topography of the planning area contains several bowls that trap and concentrate pollutants in valley bottoms, exacerbating the effects of stagnant air. The worst air quality in winter typically occurs due to the combination of a strong and persistent inversion, high vehicle use, and biomass consumption associated with heat or power generation (particulates) (ODEQ 2012). The worst air quality in summer typically occurs due to the combination of strong persistent high pressure and high vehicle use (ozone) or widespread and large wildfires (particulates, ozone). Sources of pollutants may be chronic, such as from a factory or homes heating with wood during the winter, or transient, such as from prescribed burning or wildfires. Pollutants from BLM land management activities or wildfires can exacerbate existing air quality problems.

Smoke from prescribed fire and wildfire produces carbon monoxide, nitrogen oxide compounds, and particulates, along with certain air toxics such as acrolein, benzene, and formaldehyde. The main criteria pollutant of concern for BLM management activities is particulate matter (PM_{10} and $PM_{2.5}$) (ODEQ 2003, 2009, 2012, 2013a); in addition to posing a human health risk (see **Table 3-11**) due to their small size, particulate matter from wildland fuels are excellent at scattering light, thereby reducing visibility. Carbon monoxide, on the other hand, while a substantial human health risk, dilutes rapidly, making it a hazard to firefighters only. The concentration of air toxics found in smoke are typically very low, with regulations focused on industrial and commercial sources, vehicle emissions, and indoor air. Prescribed fire and wildfire do not produce ozone directly, but do produce two additional pollutants, nitrogen oxides (NO_x) and volatile organic compounds, which are precursors for ground-level ozone under certain conditions.

The Oregon Department of Environmental Quality (ODEQ) Air Quality Division implements the U.S. Environmental Protection Agency's (EPA's) air quality regulations and this division has delegated smoke management responsibilities to the Oregon Department of Forestry (ODF). All forest managers including the BLM conduct prescribed burning in western Oregon under requirements in the Oregon Smoke Management Plan (OAR 629-048-0001–0500). This plan requires dispersion, dilution, and avoidance techniques to minimize smoke impacts on mandatory Class 1 areas, designated air quality non-attainment and maintenance areas, and smoke sensitive receptor areas. Mandatory Class 1 areas are areas, such as designated Wilderness Areas, identified under the Clean Air Act as requiring the highest level of

protection.[36] Non-attainment and maintenance areas are areas that are either not attaining, or have a history of not attaining, the National Ambient Air Quality Standards (NAAQS). [37] A Smoke Sensitive Receptor Area is an area that has the highest level of protection under the Oregon Smoke Management Plan due to a history of smoke incidents, its' population density, or from a legal protection related to visibility.

Visibility is protected in mandatory Class I areas as required by the Clean Air Act. The goal of the Regional Haze Rule (a part of the Clean Air Act) is to reduce haze in mandatory Class I areas to naturally occurring levels by 2064. Because visibility varies day by day, the rule requires that visibility on the 20 percent worst-case days be reduced to natural background conditions, while ensuring no degradation of the 20 percent best-case days. States are to take reasonable measures to make progress towards this goal.

Crater Lake National Park and the Kalmiopsis, Mt. Hood, Three Sisters, Mt. Jefferson, Mt. Washington, Diamond Peak, Gearhart Mountain, and Mountain Lakes Wilderness Areas are mandatory Class 1 areas within the air quality analysis area. Of these areas, visibility monitoring occurs at Crater Lake National Park and the Kalmiopsis, Three Sisters, and Mount Hood Wilderness Areas. Visibility is measured in deciviews with the lower the number, the better the visibility. The Interagency Monitoring of Protected Visual Environments (IMPROVE) program monitors air quality and visibility at selected mandatory Class 1 areas and has established natural condition deciviews at each monitored site for the clearest and haziest days. The program has estimated annual values and trends for the clearest days and haziest days since 2003 (data summaries available at http://views.cira.colostate.edu/fed/AqSummary/VisSummary.aspx?siidse=1).

The EPA regulates air quality under the Clean Air Act to protect human health and welfare, with visibility in mandatory Class 1 areas serving as the indicator for human welfare with respect to smoke. The EPA has established NAAQS for seven criteria pollutants (**Table 3-10**). The primary standard addresses human health and the secondary standard human welfare. On October 1, 2015, the EPA formally lowered the 8-hour ozone standard to 0.070 ppm.

[36] Mandatory Class 1 areas include 156 national parks, Wilderness Areas, international parks, and other areas identified by Congress in the 1977 amendment to the Clean Air Act. The areas designated include all national parks greater than 6000 acres in size and all designated Wilderness Areas and national memorial parks greater than 5,000 acres in size in existence as of August 1977. The amendment also set a visibility goal for these areas to protect them from future human-caused haze, to eliminate existing human-caused haze, and require reasonable progress toward that goal.

[37] National Ambient Air Quality Standards are specific target threshold concentrations and exposure durations of six pollutants based on criteria gauged to protect human health and the welfare of the environment.

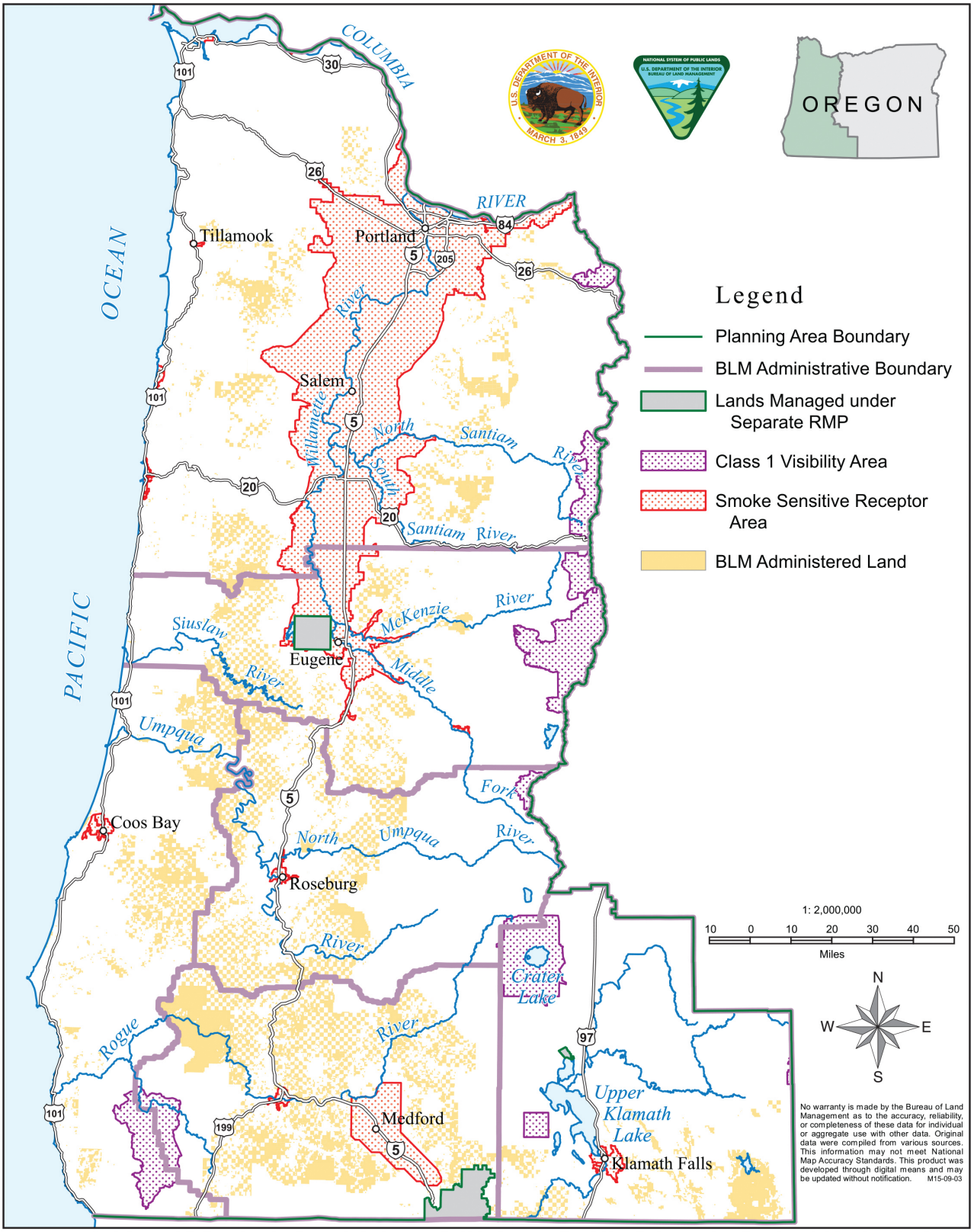
Table 3-10. Criteria pollutants regulated under the Clean Air Act and the current NAAQS for each

Pollutant	Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)	Primary	8-hour	9 ppm	Not to be exceeded more than once per year
		1-hour	35 ppm	
Lead	Primary and Secondary	Rolling 3 month average	0.15 µg/m^3	Not to be exceeded
Nitrogen Dioxide (NO_2)	Primary	1-hour	100 ppb	98th percentile, averaged over 3 years
	Primary and Secondary	Annual	53 ppb	Annual mean
Ozone (O_3)	Primary and Secondary	8-hour	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
$PM_{2.5}$	Primary	Annual	12 µg/m^3	Annual mean, averaged over 3 years
	Secondary	Annual	15 µg/m^3	Annual mean, averaged over 3 years
	Primary and Secondary	24-hour	35 µg/m^3	98th percentile, averaged over 3 years
PM_{10}	Primary and Secondary	24-hour	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)	Primary	1-hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

ppm = parts per million, ppb = parts per billion, µg = micron

Air quality non-attainment areas within the planning area include Eugene-Springfield and Oakridge for PM_{10}, and Oakridge and Klamath Falls for $PM_{2.5}$. Portland-Vancouver and Salem are air quality maintenance areas for ozone. However, the BLM does not know whether Portland-Vancouver and Salem would fall back into non-attainment under the new standard. The Oregon Smoke Management Plan identifies the following Smoke Sensitive Receptor Areas (SSRAs) within the planning area (**Map 3-1**):

- The cities of Carlton, Corvallis, Cottage Grove, Eugene, McMinnville, Portland, Sheridan, Silverton, Springfield, St. Helens, Stayton, Sublimity, Veneta, Willamina, and Yamhill;
- The acknowledged urban growth boundaries of the following cities: Astoria, Coos Bay, Grants Pass, Klamath Falls, Lakeview, Lincoln City, Newport, North Bend, Oakridge, Roseburg, and Tillamook;
- The area within the Bear Creek and Rogue River Valleys described in OAR 629-048-0160, including the cities of Ashland, Central Point, Eagle Point, Jacksonville, Medford, Phoenix, and Talent; and
- The area within the Columbia River Gorge Scenic Area, as described in 16 U.S.C. Section 554b (2003).



Map 3-1: Smoke Sensitive Receptor Areas as Described in the Oregon Smoke Management Plan

The BLM must register all prescribed burns on BLM-administered forestlands within the planning area with ODF in compliance with Oregon's administration of the Clean Air Act. The registration includes the location, the planned date and time of ignition, and the estimated fuel load and consumption. The day before each planned burn, ODF meteorologists evaluate this information along with the forecasted weather for the next day to determine whether smoke from a given burn is likely to enter a SSRA. Meteorologists must not knowingly allow a burn to occur which will cause an intrusion of smoke into an SSRA. Thus, each day these meteorologists create burn instructions for different parts of the forest region to prevent smoke from entering SSRAs. The BLM must follow these instructions in compliance with Oregon's administration of the Clean Air Act.

The Air Quality Index is widely used to report relative daily air quality in a common framework related to potential impacts to human health (**Table 3-11**). Index values range from zero to 300 and are typically displayed in a color-coded table or graph. The higher the value, the greater the level of air pollution and the greater the human health concerns. The Air Quality Index is based on the combined 24-hour concentrations of $PM_{2.5}$ and O_3. As pollution standards are changed, the formula used to calculate the air quality index is also adjusted in order to maintain the relationship to human health concerns.

Table 3-11. Air Quality Index with health advisories

Air Quality	Air Quality Index	Health Advisory
Good	0–50	No health impacts expected.
Moderate	51–100	Unusually sensitive people should consider reducing prolonged or heavy outdoor exertion.
Unhealthy for Sensitive Groups	101–150	People with heart disease, respiratory disease (such as asthma), older adults, and children should reduce prolonged or heavy exertion. Active healthy adults should also limit prolonged outdoor exertion.
Unhealthy	151–200	People with heart disease, respiratory disease (such as asthma), older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy outdoor exertion.
Very Unhealthy (Alert)	201–300	People with heart disease, respiratory disease (such as asthma), older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.

Ozone Maintenance Areas

Prescribed burning produces precursor emissions (e.g., NO_x and volatile organic compounds) that under higher temperatures and sunny days produce ground-level ozone. However, BLM prescribed burning activities are projected to be a long distance from the two ozone maintenance areas within the planning area. As a result, effects would be very low for the precursors of ozone. Local vehicular traffic in Portland, Vancouver, and Salem represents a primary source of air emissions that may lead to the development of ozone. Furthermore, the highest levels of ozone in the maintenance areas occur during summer, while most prescribed burning activity is during spring and fall. Therefore, it is very unlikely that any of the alternatives or the Proposed RMP would have a notable effect on ozone levels in ozone maintenance areas in the planning area; therefore, the BLM did not analyze for this pollutant.

Conformity

The General Conformity Rule (a part of the Clean Air Act) applies to Federal actions occurring in non-attainment or maintenance areas when the net change in total direct and indirect emissions of non-

attainment pollutants (or their precursors) exceeds specific thresholds (known as *di minimis* levels). The intent of the General Conformity Rule is to prevent the air quality impacts of Federal actions from causing or contributing to a violation of the NAAQS (EPA 2013) or interfering with the purpose of the State Implementation Plan. This means that under the Clean Air Act, Section 176 and 40 CFR, Part 93, Subpart W, Conformity Rules, Federal agencies must make a determination that proposed actions in Federal non-attainment areas conform to the applicable EPA-approved State Implementation Plan before taking an action.

All prescribed burns within western Oregon must comply with the Oregon Smoke Management Plan, which prohibits smoke intrusions into SSRAs. As a result, the Conformity Rule is not applicable for BLM prescribed burning actions within non-attainment areas, since the burning would not—

- Be likely to cause or contribute to new violations of Federal air quality standards;
- Increase the severity of existing violations for Federal and State air quality standards; or
- Delay the timely attainment of Federal air quality standards.

Affected Environment

Particulate Matter Emissions

Most broadcast-type prescribed burning (broadcast burning, under-burning, jackpot burning) occurs in spring and early fall, when frequent cold fronts and short-wave troughs create atmospheric instability during the day. This instability promotes air mixing and transport of pollutants away from SSRAs and air quality non-attainment and maintenance areas. Most pile burning (hand piles, machine piles, landing piles) occurs in late fall and winter, when the atmosphere is typically more stable, with a higher potential to affect air quality adversely for relatively short periods.

Large wildfires contribute to air quality issues over large areas and for prolonged periods. During 2002, wildfires resulted in 14 daily $PM_{2.5}$ exceedences in Klamath Falls and one in Medford (ODEQ 2003); at that time, the daily $PM_{2.5}$ standard was 65 $\mu g/m^3$ (the standard has since been lowered). Elevated particulate levels were reported between late July and the end of August at Bend, Brookings, Cave Junction, Grants Pass, Klamath Falls, and Medford (ODEQ 2003). Similar issues developed in 2008 from extensive wildfires burning in northern California; smoke from those fires reached as far north as Portland (ODEQ 2009).

ODF began estimating $PM_{2.5}$ emissions from wildfires as part of their annual smoke management reports beginning in 2002, although only a statewide accounting is available. Estimated wildfire $PM_{2.5}$ emissions commonly exceed 1,000 tons per year and exceeded 6,000 tons per year in 2006, 2007, 2012, and 2014. The 2012 fire season resulted in the highest estimated $PM_{2.5}$ emissions from wildfire at nearly 12,000 tons. The 2014 fire season the second highest, at about 9,000 tons. Most of the 2012 emissions were from the large rangeland wildfires in southeastern Oregon. Several large wildfires in southwestern Oregon in 2013 contributed a significant amount of particulate pollution, and potentially created problematic surface ozone concentrations as well.

Large wildfires that started on BLM-administered lands within the planning area produced an estimated 1,217 tons per year of PM_{10} emissions and 731 tons per year of $PM_{2.5}$ emissions on average, based on acres burned from 1981 through 2013. However, there is considerable interannual variability in emissions. Notable years where wildfire emissions were particularly high include 1987, 2002, and 2014, principally from wildfires originating on the Medford and Roseburg Districts.

Based on ODF annual reports of tons consumed by prescribed burning in the Other Federal category from 1995 through 2012, actual emissions have averaged 840 tons (range 376 – 1,538 tons) of PM_{10} and 753 tons (range 337 – 1,378 tons) of $PM_{2.5}$ per year, primarily from hazardous fuels reduction treatments in southwest Oregon and slash disposal following forest management operations (**Figure 3-3**). These estimated emissions account for approximately 7.5 percent of total PM_{10} and $PM_{2.5}$ emissions from prescribed burning in western Oregon. The Other Federal category consists mostly of burning by the BLM, with only minor contributions from the National Park Service and U.S. Fish and Wildlife Service.

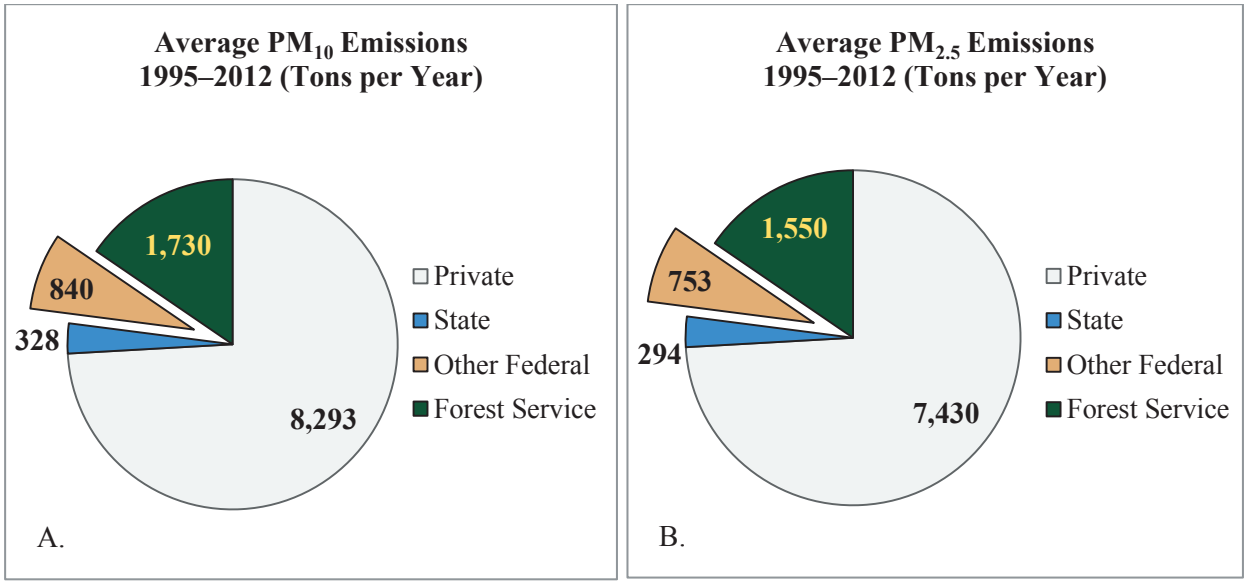


Figure 3-3. Estimated emissions from prescribed burning in western Oregon for (a) particulate matter 10 microns in size and smaller, and (b) particulate matter 2.5 microns in size and smaller

The Oregon Department of Environmental Quality (ODEQ) (2013a) reports that trends have been downward for most pollutants in most areas, except for daily $PM_{2.5}$ in Klamath Falls and Oakridge. Both Klamath Falls and Oakridge have exceeded the daily $PM_{2.5}$ standard of 35 $\mu g/m^3$ nearly every year since 2006, when the standard was lowered to that level. Residential home heating in winter is associated with most exceedences of the $PM_{2.5}$ standard, with summer wildfires a secondary factor. The EPA (2013) lowered the primary annual $PM_{2.5}$ standard to 12 $\mu g/m^3$, effective March 18, 2013. Whether this change will result in any areas designated as non-attainment for the annual $PM_{2.5}$ standard will not be known until late 2015 at the earliest. The daily $PM_{2.5}$ standard remains unchanged.

Despite the best efforts of both ODF smoke forecasters and BLM personnel, intrusions into SSRAs can and do occur. The occurrence of intrusions is not related to the number of acres burned in any given year (**Figure 3-4**) but, according to an evaluation of six smoke intrusion reports for 2008 and 2012, is most commonly a result of an unexpected shift in wind direction from the forecasted direction. Many of these shifts likely resulted from localized meteorological patterns, which could not be resolved with coarse-scale weather forecast models. Nearly all intrusions shown in were in southwest Oregon.

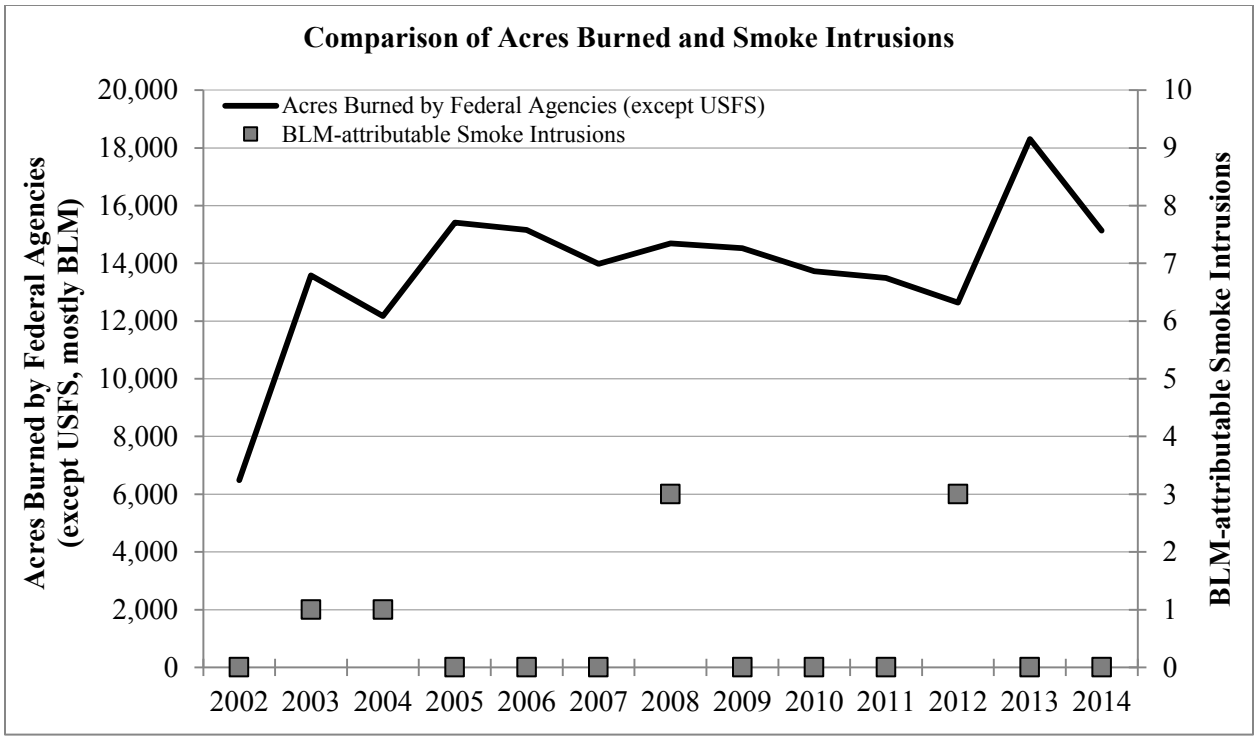


Figure 3-4. Number of smoke intrusions attributed to BLM prescribed fires into SSRAs compared to annual acres burned from 2002 through 2014 in western Oregon
Source: ODF annual smoke reports 2002–2014

Visibility and Air Quality

Of the four monitored mandatory Class 1 areas within or adjacent to the planning area, none meet the natural background conditions for haze for either the clearest or the haziest days, although Crater Lake National Park and Mount Hood Wilderness come the closest for the clearest days (**Table 3-12**). Visibility is generally improving at Crater Lake National Park and the Mount Hood and Kalmiopsis Wildernesses, although not all trends are statistically significant. Visibility at Three Sisters Wilderness is slowly degrading, although the trend is not statistically significant yet. The main contributors to the haziest days are organic carbon and ammonium sulfate.

Table 3-12. Visibility conditions and trends at four mandatory Class 1 areas within or adjacent to the planning area from 2003 through 2012 and the statistical trend

Parameter	Crater Lake National Park	Kalmiopsis Wilderness	Mount Hood Wilderness	Three Sisters Wilderness
Natural condition: clearest days	246 miles (0 deciviews)	~ 161 miles (~ 4 deciviews)	229 miles (1 deciview)	211 miles (2 deciviews)
Current condition: clearest days	> 211 miles (< 2 deciviews)	~ 143 miles (~ 6 deciviews)	211–229 miles (1–2 deciviews)	174–198 miles (2.5–3.5 deciviews)
Statistical trend in clearest days	Significant downward	Non-significant downward	Significant downward	Non-significant upward
Natural condition: haziest days	~ 112 miles (~ 8 deciviews)	~ 90 miles (~ 9.5 deciviews)	~ 112 miles (~ 8 deciviews)	92 miles (9 deciviews)
Current condition: haziest days	40–87 miles (10–18 deciviews)	37–68 miles (13–19 deciviews)	47–81 miles (11–17 deciviews)	37–62 miles (13–18 deciviews)
Statistical trend in haziest days	Non-significant downward	Significant downward	Non-significant downward	Non-significant upward

Source: IMPROVE website: http://vista.cira.colostate.edu/improve/. Accessed November 18, 2014

In 2013, ODEQ evaluated the contribution of prescribed fire to the 20 percent worst-case visibility days in Oregon's Class I areas, concluding that prescribed burning in close proximity to mandatory Class I areas was a statistically significant contributor to the 20 percent worse days (ODEQ 2013b). The Kalmiopsis Wilderness and Crater Lake National Park were particularly affected, especially in October and November (**Figure 3-5**). As a result, ODF revised the Oregon Smoke Management Plan to require that any personnel conducting a prescribed fire within 31 miles (50 km) upwind of these two mandatory Class I areas follow a checklist of procedures designed to keep the main plume out of Crater Lake National Park and the Kalmiopsis Wilderness.

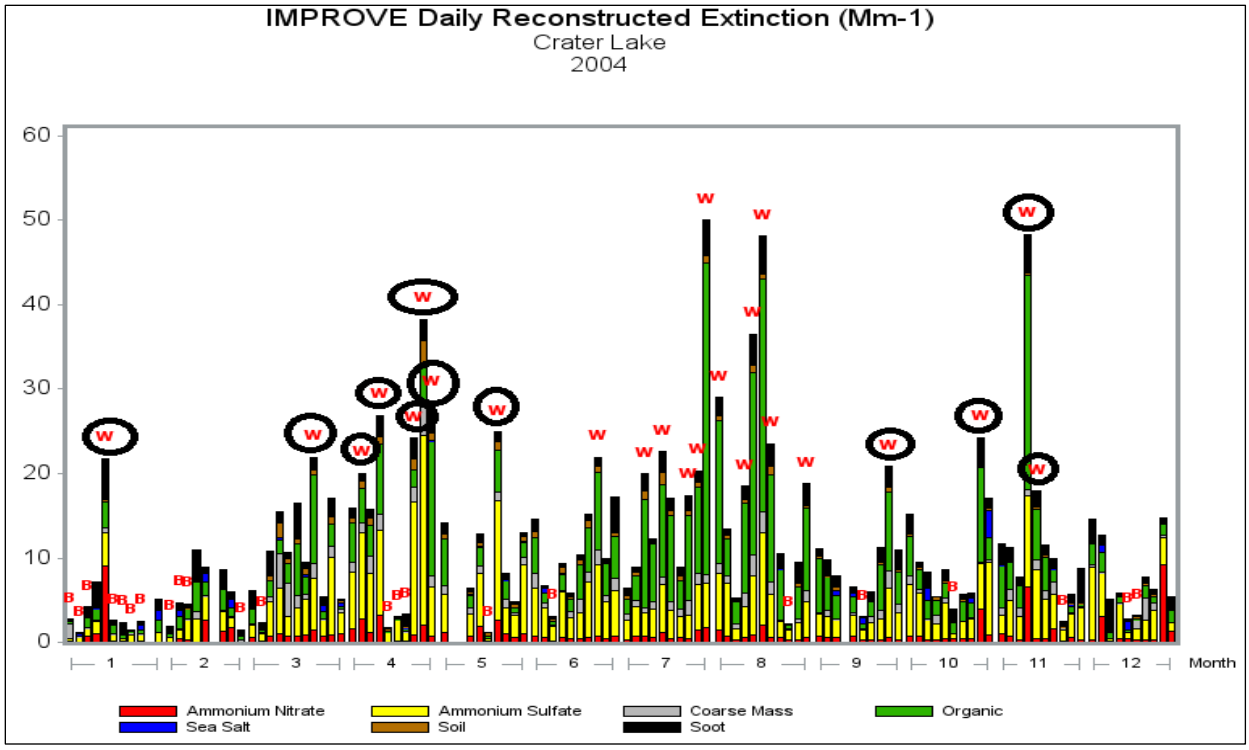


Figure 3-5. Example of identification of the 20 percent worse days in a given year and the proportional contribution of various factors to reduced visibility

Note: Black and green indicate vegetation burning as the source of the pollutant. W identifies a worse day and a circled W indicates prescribed fire as the probable cause.

Source: ODEQ 2013b

Adverse impacts to air quality that are caused by prescribed burning, including effects to visibility and human health, generally tend to be of short duration (hours) and limited to the local area (less than five miles from the burn). Conversely, wildfire adverse impacts tend to be of longer duration (days to weeks), occur over a much broader area, and produce much unhealthier conditions. **Figure 3-6** displays the daily Air Quality Index for Medford in 2008. Large spikes in July and August are from wildfires, while moderate air quality in September through January is primarily from woodstoves with some smoke from pile burning possible. Three intrusions into mandatory Class 1 areas were attributed to BLM prescribed burning.

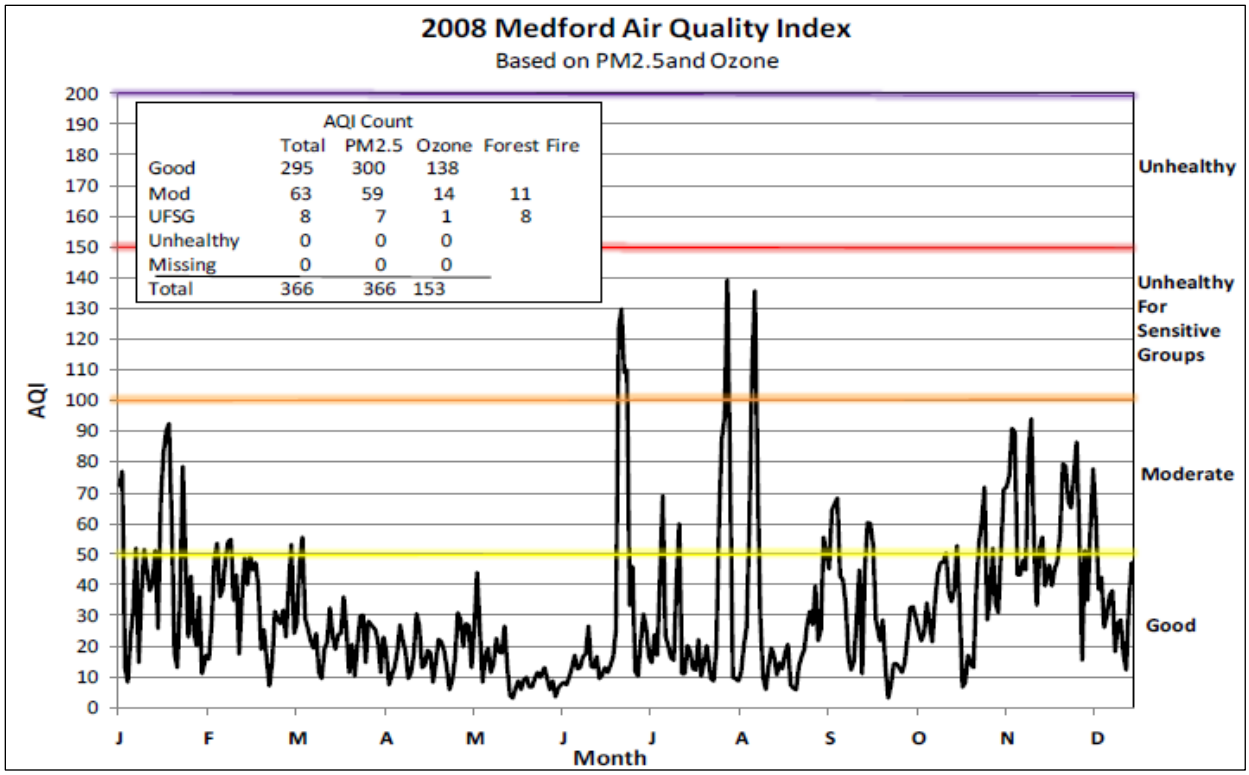


Figure 3-6. Daily air quality index for Medford in 2008
Source: ODEQ 2009

Air quality and visibility data from 2013 illustrate the impacts from wildfires. During that summer, wildfire impacts in southwest Oregon produced unhealthy or more severe levels for seven days in Medford (**Figure 3-7**) and for nine days in both Grants Pass and Cave Junction (**Figure 3-8**). The large spike in late July was due to a series of wildfires, of which the Douglas Complex was the largest. Additional air quality degradation occurred in Medford from November through February from sources other than prescribed fire. Wildfires also resulted in severe degradation of visibility in Crater Lake National Park (**Figure 3-9**) and the Kalmiopsis Wilderness (data not shown). Wildfires typically create five to ten times greater the impacts than other types of events and persist over several weeks.

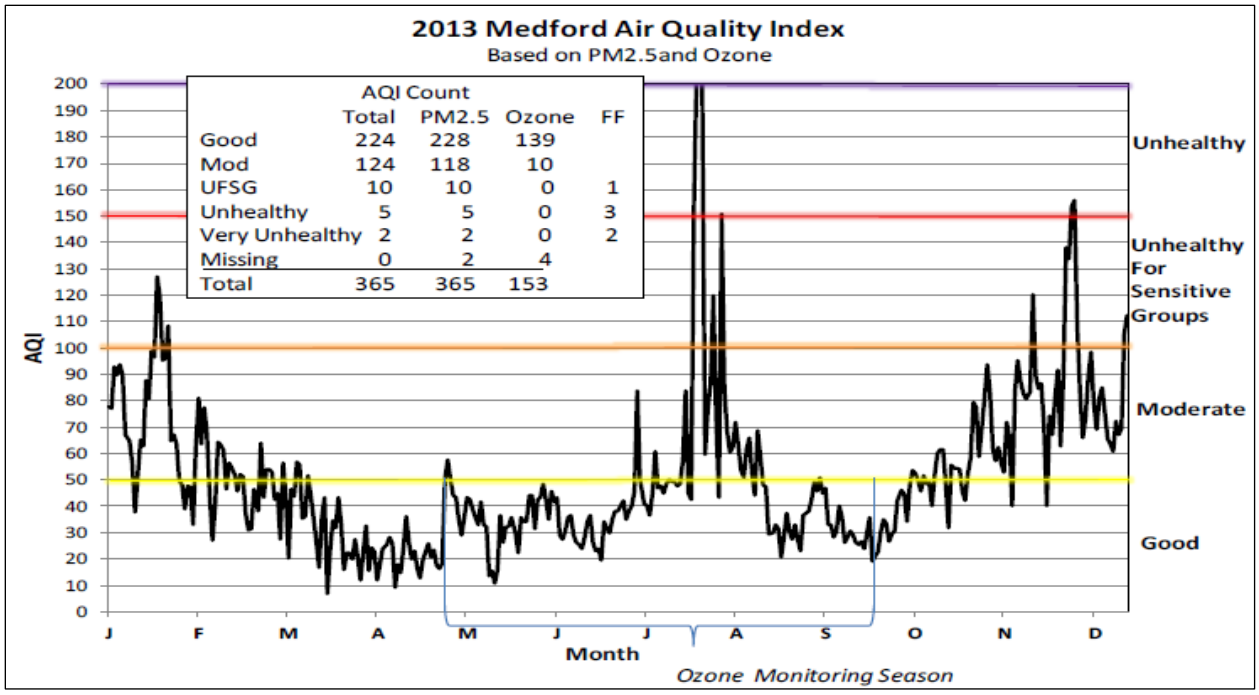


Figure 3-7. Air quality index for 2013 for Medford
Note: 'FF' refers to the days where air quality degradation was attributed to forest fires.
Source: ODEQ 2014

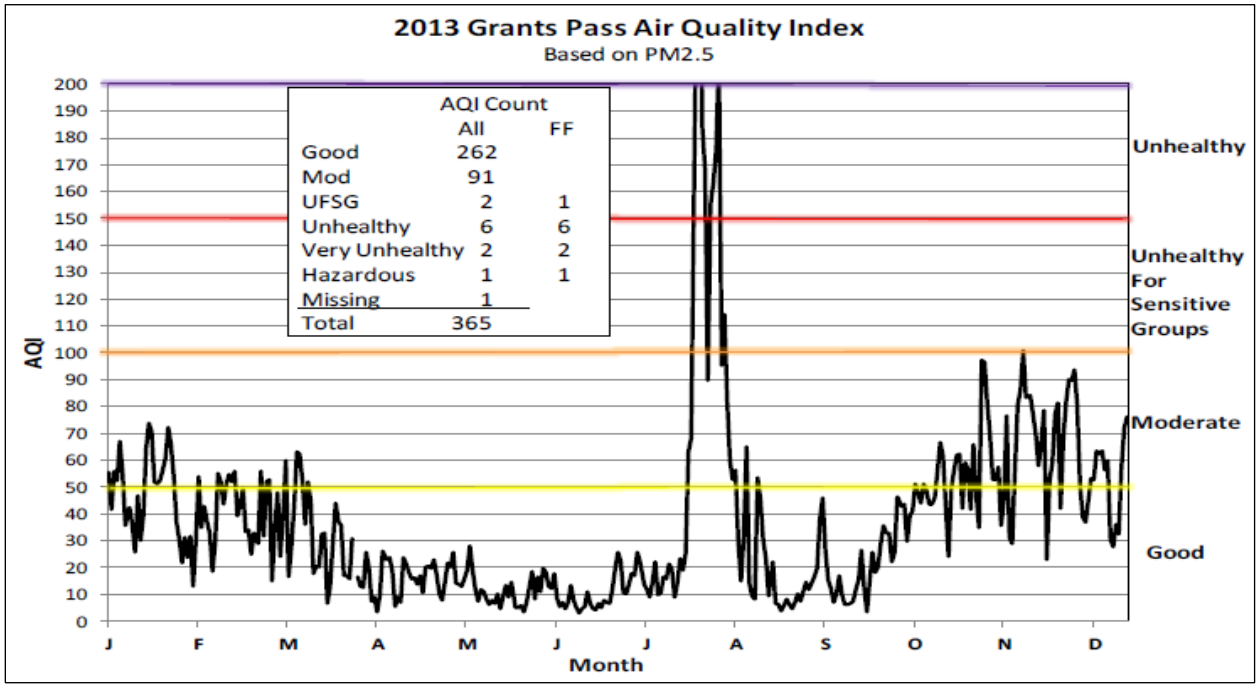


Figure 3-8. Air quality index for 2013 for Grants Pass
Note: 'FF' refers to the days where air quality degradation was attributed to forest fires.
Source: ODEQ 2014

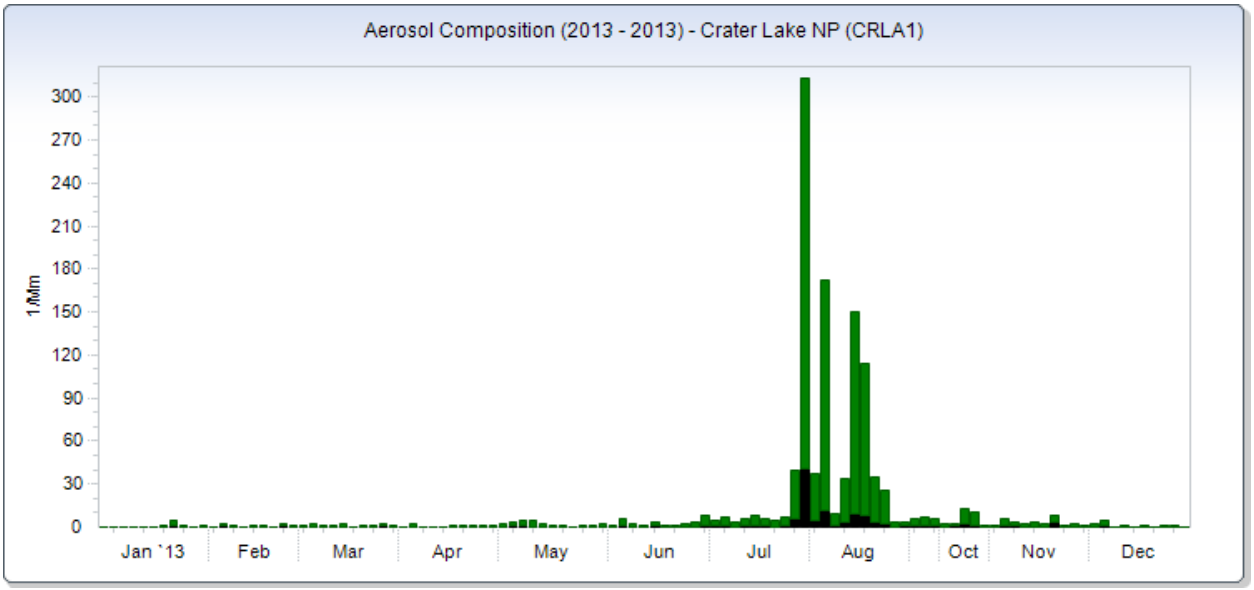


Figure 3-9. Degradation of visibility from burning vegetation in 2013 as measured through light scattering (inverse megameters) at Crater Lake National Park
Source: IMPROVE website, http://views.cira.colostate.edu/fed/DataWizard/Default.aspx, accessed November 25, 2014

Environmental Consequences

Particulate Matter Emissions

Emissions of both PM_{10} and $PM_{2.5}$ would increase relative to the 2013 baseline under all alternatives and the Proposed RMP because of the increase in activity fuels treatment levels (**Figure 3-10** and **Figure 3-11**). Although there are some decadal differences, prescribed burning emissions under the Proposed RMP would be very similar to those under Alternative B.

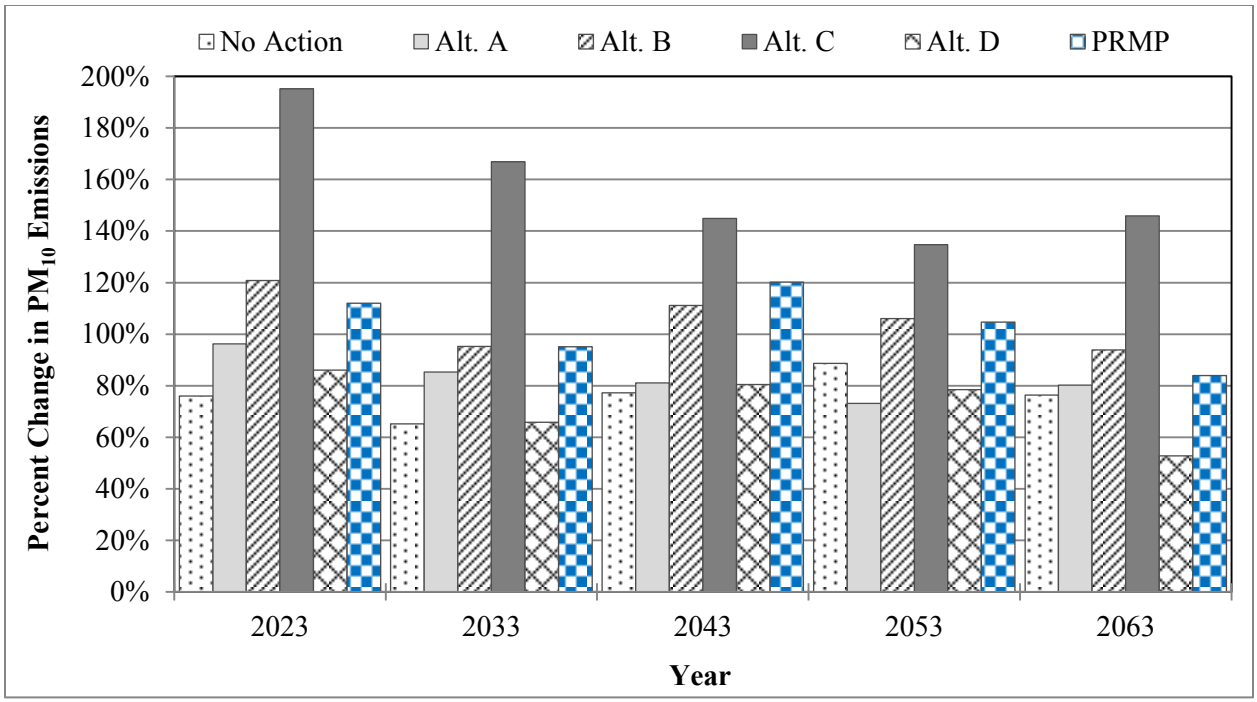


Figure 3-10. Expected increases in PM_{10} emissions from prescribed fire over time and relative to the estimate for current prescribed fires

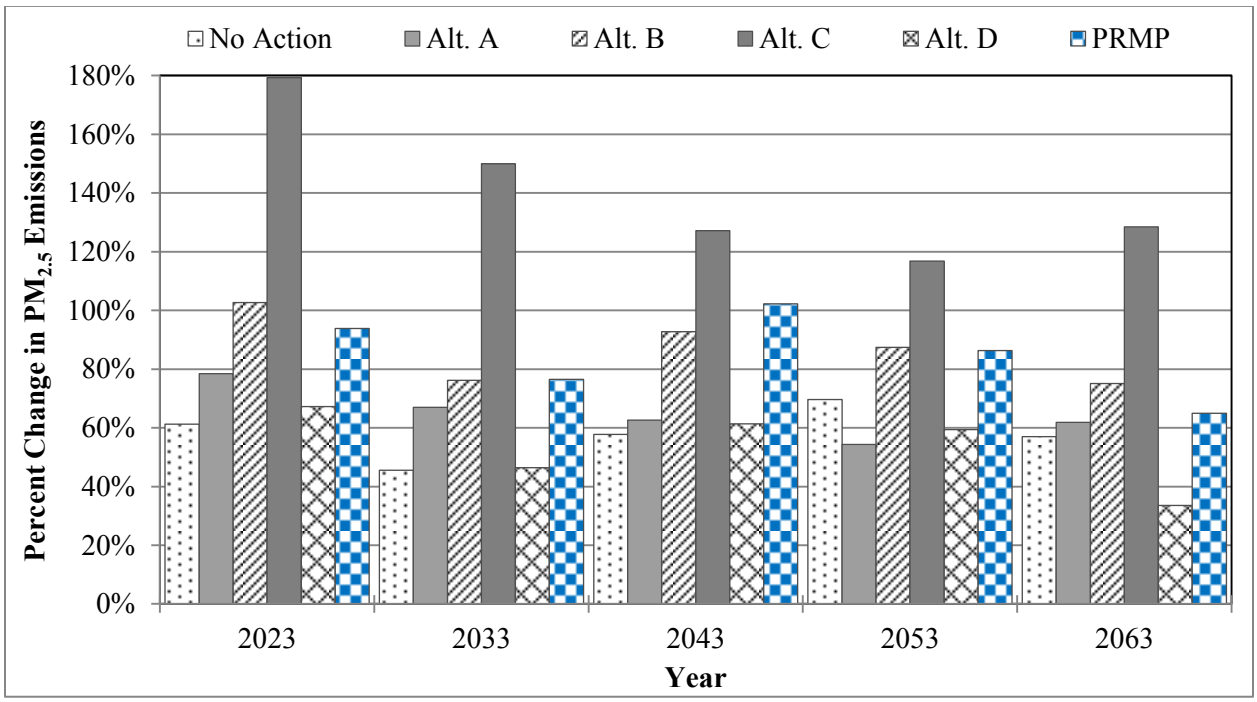


Figure 3-11. Expected increases in $PM_{2.5}$ emissions from prescribed fire over time and relative to the estimate for current prescribed fires

Some of the difference between the estimated current and projected emissions is likely due to the differing estimation methods used for each. Fuel treatment method (e.g., hand or machine pile burning and broadcast burning) affects the amount of particulates emitted by affecting the amount of fuel consumed and the relative proportions of flaming and smoldering combustion (Hardy *et al*. 2001). Smoldering combustion emits more than twice the particulates as flaming combustion (Hardy *et al*. 2001). The current condition is based on the tons of fuels consumed reported to ODF, with insufficient information to determine the proportions of actual treatment methods (Hardy *et al*. 2001, p. 100). Thus, the BLM assessed the current condition using a generic multiplier applied to the reported tons consumed. The BLM does not know whether this value represents an under-estimation or over-estimation of current conditions. The BLM estimated projected emissions on more detailed information using more sophisticated tools than a generic multiplier.

Although there is no reasonable basis for the BLM to forecast a difference in the acreage of hazardous fuels prescribed fire among the alternatives or the Proposed RMP, this program experiences considerable interannual variability in acres treated and treatment method (see the Fire and Fuels section of this chapter). As a result, the particulate matter emissions vary widely from year-to-year. Emissions for all prescribed burning can vary from the estimate due to actual verses assumed pile size, pile shape, and number of piles per acre and in fuel type, fuel loading, and fuel continuity in underburns and broadcast burns. Since fuels are more homogeneous in the activity fuels treatment program, the amount of variation is smaller than in the more heterogeneous fuelbeds of the hazardous fuels program. Accounting for these variations, the BLM estimated a potential range in average annual emissions of approximately 330 tons to 1,300 tons of PM_{10} and 230 to 1,030 tons of $PM_{2.5}$ with an expected annual average of 930 and 685 tons of PM_{10} and $PM_{2.5}$, respectively.

Similar to the current condition, the BLM projected that the Medford District would have the largest number of acres burned by wildfire, followed by the Roseburg District and then the Eugene and Salem Districts, with much smaller acres projected to burn over time on the Coos Bay District and the Klamath Falls Field Office. Since the projected hazardous fuels program is the same as the current program, the Medford District would continue to have the largest hazardous fuels program, followed by the Klamath Falls Field Office and then the Roseburg District. The Coos Bay District would have a small hazardous fuels program while the Eugene and Salem Districts essentially would have no hazardous fuels program. In contrast, which district has the largest activity fuels program would vary by alternative and the Proposed RMP.

Emissions from the BLM's prescribed fires under the alternatives and the Proposed RMP would typically exceed those projected from wildfires burning on BLM-administered lands for both PM_{10} and $PM_{2.5}$. The amount of the difference would vary by decade and by alternative or the Proposed RMP, with Alternative D having the smallest differences and Alternative C the largest differences. In more active wildfire periods, the particulate emissions from wildfire would nearly equal or exceed those from prescribed fire. If the predicted increases in wildfire activity arising from climate change occur, as discussed in the Climate Change section in this chapter, particulate emissions from wildfires burning on BLM-administered lands would exceed those from the BLM's prescribed fires more frequently later in the 50-year analysis period.

Under all alternatives, and the Proposed RMP, the Medford District would produce the most emissions from prescribed burning (**Figure 3-12**), with the highest emissions under Alternative B and the lowest under Alternative A. Emissions under the No Action alternative and Alternative D would be similar, with emissions under the Proposed RMP about midway in the range of estimated emissions. The Roseburg District would produce its highest emissions under Alternative C and lowest under Alternative A. Between these two districts, in combination with expected emissions from wildfire, the greatest potential impacts to air quality in the planning area would occur in the Rogue River and Umpqua River valleys and

their associated SSRAs, along with the Kalmiopsis Wilderness and Crater Lake National Park. Much of the activity for hazardous fuels burning consists of pile burning, which typically occurs in late fall and winter. In late fall, limited atmospheric instability in the afternoon and relatively frequent storms provide enough ventilation to limit smoke impacts during the day, but areas down-drainage from burn locations could experience smoke impacts at night due to increased atmospheric stability after sunset. Inversions in winter could result in prescribed fire smoke mingling with woodstove smoke to affect air quality adversely at all hours, although compliance with the Oregon Smoke Management Plan usually would limit degradation of air quality.

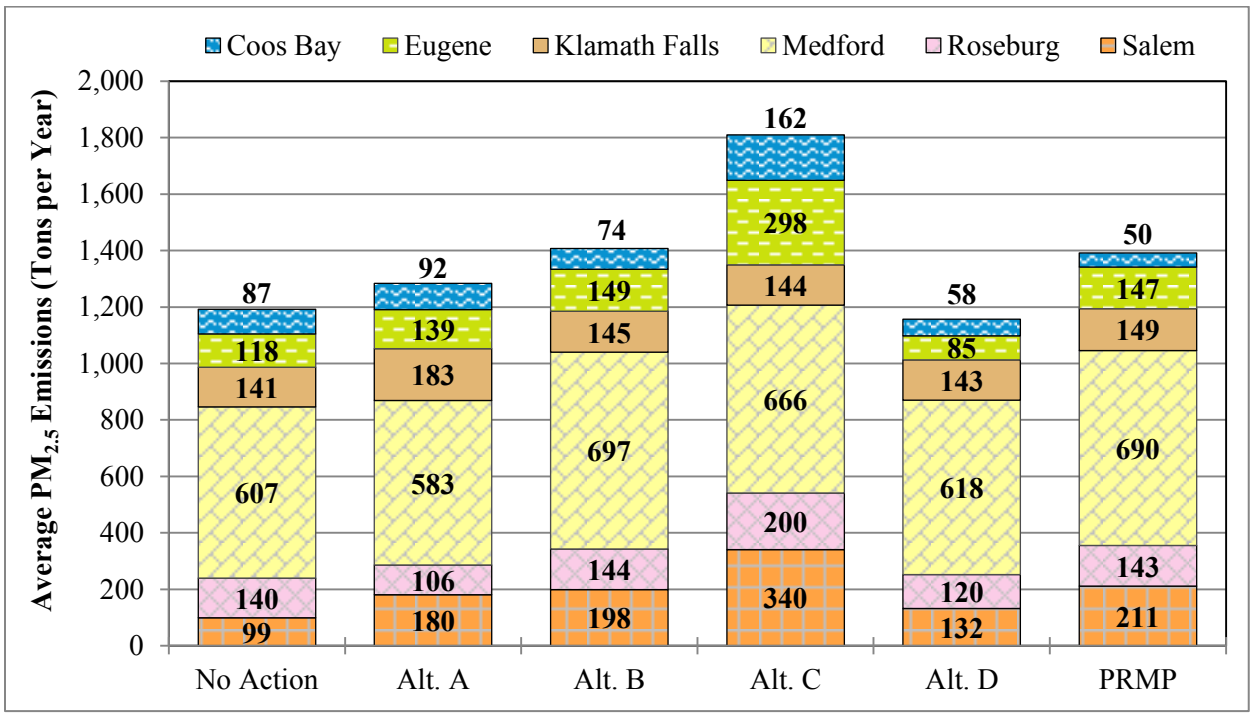


Figure 3-12. Average annual $PM_{2.5}$ emissions from prescribed burning over the 50-year analysis period

The Klamath Falls Field Office would produce its highest emissions under Alternative A with similar emissions among all other alternatives and the Proposed RMP (**Figure 3-12**). Due to compliance with the Oregon Smoke Management Plan, potential effects to the Klamath Falls non-attainment area likely would not differ from those currently experienced.

Expected emissions from the Coos Bay District vary little between the alternatives indicating little difference in the expected human health impacts given compliance with the Oregon Smoke Management Plan requirements. Alternative C would have the highest expected emissions and the Proposed RMP the lowest (**Figure 3-12**). Emissions would be similar for No Action and Alternatives A and B, while emissions from Alternative D would be slightly higher than under the Proposed RMP.

Due to expected increases in harvest levels and the associated prescribed burning, emissions from the Eugene and Salem Districts would increase under all alternatives and the Proposed RMP, except for Alternative D in the Eugene District, relative to the current condition, with the biggest increases under Alternative C (**Figure 3-12**). Emissions under the Proposed RMP would be slightly higher than under Alternative B for the Eugene District and slightly lower for the Salem District. As a result, the probability of adverse impacts to SSRAs in the Willamette Valley would increase, likely due to unexpected wind shifts, although the overall probability would remain low. Increased burning on the Eugene District may

result in additional adverse impacts to air quality in Oakridge, although the combined effects of the location of BLM-administered parcels relative to Oakridge (greater than 10 miles to the west), compliance with the Oregon Smoke Management Plan, terrain, and the timing of burns relative to the timing of the worst air quality in Oakridge would keep the probability of such effects very low.

Visibility and Air Quality

Continued adherence to the Oregon Smoke Management Plan would limit adverse effects to visibility and air quality across all alternatives and the Proposed RMP, although some issues would likely remain in southwest Oregon where the efficacy of the new requirements as of 2014 have not yet been established. The increased amount of prescribed burning, particularly under Alternative C, may increase the risk of additional smoke intrusions into mandatory Class I areas, although past intrusions have not been correlated with the number of acres burned. At present, there are no factors that provide a clear indication that the increased prescribed burning under the alternatives or the Proposed RMP would result in additional effects on visibility and air quality from smoke intrusions as compared to the observed past.

The relative proportion of the landscape under some degree of active management can influence subsequent wildfires and the potential to affect human health and visibility adversely in summer. Because the BLM has no way to know whether and where planned vegetation management would intersect with a future wildfire, the estimated wildfire emissions in this analysis do not include any impact from forest management on potential wildfire emissions under any of the alternatives or the Proposed RMP over the analysis period. Active management, particularly where a primary objective is to alter fire risks, can reduce the potential for adverse impacts to human health and visibility from wildfires by increasing landscape diversity in terms of the mix of stand sizes, age classes, structure, and species compositions. Landscape heterogeneity tends to create burn pattern heterogeneity and can reduce the potential for large, homogeneous stand-replacing patches and long-term smoldering within large wildfires, especially in landscapes with active fire regimes (e.g., Mitchell *et al*. 2009, Miller *et al*. 2012, Loudermilk *et al*. 2014, and Volkova *et al*. 2014). Less active management under the current conditions has tended to create landscapes that are more homogeneous, particularly with respect to stand structure, promoting larger patches of similar burn severity, longer-term smoldering, and resulting emissions.

Effect of Emissions from BLM Prescribed Burning in the Context of All Sources

Particulate emissions from prescribed burning by the BLM would increase relative to the current condition under all alternatives and the Proposed RMP, including the No Action alternative. This increase in emissions arises from the increase in harvest levels compared to the harvest levels currently being implemented, thereby increasing the amount of activity fuel to treat. Currently, BLM prescribed burns produce 7.5 percent of both PM_{10} and $PM_{2.5}$ total average annual emissions from all sources in the planning area. Under the No Action alternative, Alternative A, and Alternative D, the BLM's average annual prescribed fire emissions would increase to approximately 12 percent for PM_{10} and 11 percent for $PM_{2.5}$ of the total estimated emissions. Alternative C would produce the largest increase to an estimated 17 percent and 16 percent of PM_{10} and $PM_{2.5}$, respectively. The BLM's prescribed fire emissions would increase to 14 percent and 13 percent of total PM_{10} and $PM_{2.5}$, respectively, under Alternative B and the PRMP. Generally, the largest increase in BLM's portion of particulate emissions would occur in the first decade, with a reduction in expected emissions in subsequent decades. Adherence to the Oregon Smoke Management Plan requirements and daily instructions issued by the Oregon Department of Forestry are explicitly designed to limit potential impacts to smoke sensitive receptors by limiting the amount of fuel burned on any given burn day and by maintaining adequate separation between burn units. As such, the BLM expects that the potential increases in emissions would have no additional impacts on human health under any alternative or the Proposed RMP.

Climate Change

Over time, climate change may result in a reversal of the trend in visibility and a worsening of air quality in summer and fall, despite any actions taken or not taken by the BLM and with full compliance with the Oregon Smoke Management Plan. Many climate projections foresee longer fire seasons and more severe burning conditions, which would lead to more acres burned, increased fire severity (e.g., Mote *et al*. 2014 and references therein), and greater particulate production over the life of such wildfires. One result would be an increase in the number of unhealthy days and reduced visibility in mandatory Class 1 areas. In addition, as the atmosphere warms, it holds more moisture; an increasing trend in relative humidity has already been documented in the United States (Walsh *et al*. 2014 and references therein). Certain pollutants are very responsive to even small increases in relative humidity, potentially degrading visibility with no change in pollutant level (Hand *et al*. 2011).

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