Prescribed Fire Policy Barriers and Opportunities

A Diversity of Challenges and Strategies Across the West

COURTNEY SCHULTZ, HEIDI HUBER-STEARNS, SARAH MCCAFFREY, DOUGLAS QUIRKE, GWEN RICCO, AND CASSANDRA MOSELEY

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PLPG Public Lands Policy Group

ENR Environmental and Natural Resources Law Center

About the authors

Courtney Schultz is the Director of the CSU Public Lands Policy Group and Associate Professor in the Department of Forest and Rangeland Stewardship, Colorado State University.

Heidi Huber-Stearns is Associate Director of the Ecosystem Workforce Program, Institute for a Sustainable Environment, University of Oregon.

Sarah McCaffrey is a Research Social Scientist with the U.S. Forest Service Rocky Mountain Research Station.

Douglas Quirke is a Research Associate at the University of Oregon School of Law's Environmental & Natural Resources Law Center.

Gwen Ricco is a Research Associate with the Public Lands Policy Group, Colorado State University.

Cassandra Moseley is Director of the Ecosystem Workforce Program, Institute for a Sustainable Environment, and Associate Vice President for Research, University of Oregon.

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Ecosystem Workforce Program
Institute for a Sustainable Environment
5247 University of Oregon
Eugene, OR 97403-5247-1472
ewp@uoregon.edu
ewp.uoregon.edu

Public Lands Policy Group
Department of Forest and Rangeland Stewardship
Colorado State University
Fort Collins, CO 80523-1472
courtney.schultz@colostate.edu
sites.warnercnr.colostate.edu/courtneyschultz/

UNIVERSITY OF OREGON

Executive summary

We are conducting a project investigating policies that limit managers' ability to conduct prescribed fire on US Forest Service and Bureau of Land Management (BLM) lands in the 11 Western states. The goals for this phase of our work were to understand the extent to which various policies are limiting prescribed fire programs, strategies to maintain and increase prescribed fire activities, and opportunities for improving policies or policy implementation. To understand the diversity of challenges faced and strategies in use across the West, we conducted a legal analysis of the laws and policies that affect prescribed fire programs on Forest Service and BLM lands (available online at http://ewp.uoregon.edu/publications/working) and approximately 60 interviews with land managers, air regulators, state agency partners, and several NGO partners.

Key findings

Interviewees in most states said air quality was not the primary variable limiting their application of prescribed fire. The exceptions were in Oregon and Washington, where interviewees said that state-level smoke management programs restrict their ability to burn. Respondents in California also said air quality can be a major consideration; however, they emphasized that there are many other factors that are currently limiting their programs that need to be addressed, and they did not suggest a need for changes to state regulatory approaches at this time. No respondent suggested the need for changes to the Clean Air Act. Some additional details include the following:

- In the Intermountain West, people said air quality is a consideration and constraint for all burners, but that available funding and capacity, other land management considerations, and internal agency dynamics were the primary factors limiting their use of prescribed fire.
- Air quality is a more significant consideration in areas near large population centers where there are many sources of pollution in the airshed, areas with poor air quality (e.g. the Wasatch and San Joaquin Valleys), and sensitive populations.
- In Oregon and Washington, there are relatively stricter state standards for regulating air quality, and burners said air quality regulation is one of the major barriers to burning. Both states are in the process of revising their smoke management programs, and revised programs likely will continue to limit smoke from prescribed fire to standards stricter than those of the federal Clean Air Act.
- Challenges on the horizon include managing air quality for large, multi-day burns and during natural ignitions that are managed for resource benefit.

Lack of capacity and funding, and challenges sharing resources across agencies were the most significant barriers to accomplishing more prescribed fire that we uncovered in our interviews. Additional details include the following:

- Capacity to burn is limited when burn windows coincide with wildfire season.
- Capacity to burn can be limited outside of wildfire season due to loss of seasonal staff, trainings, and other demands on staff time.
- People cite significant problems sharing resources across units and agencies, due to a lack of flexibility associated with budgetary requirements and challenges using agreement mechanisms efficiently and effectively.

Interviewees said there are limited incentives to burn, making leadership and personal investment in burning central to success.

- Committed leaders, according to our interviewees, often find creative strategies to overcome the multiple challenges associated with burning. Successful programs depend on a personal investment from line officers and fire management officers in conducting prescribed fire.
- The current structure of performance measures within the Forest Service could provide stronger incentives to conduct prescribed fire.
- Interviewees across all states also believed risk aversion was an important factor in willingness to burn. At the local level this tended to reflect concerns about personal liability in case of an escaped fire. At the higher level it tended to reflect political considerations.

Interviewees also cited other challenges, including short burn windows, planning limitations, and other landscape conditions and conservation priorities (e.g. sage grouse conservation, the presence of cheat grass, steep topography) that significantly limit burning in many places. With regard to planning, some suggested streamlined planning requirements and better coordination across agencies, while others noted the need for fire personnel to be present on planning teams to ensure project design supports prescribed fire. In some locations burn windows are short and infrequent; when coupled with capacity limitations, people said it is often difficult to accomplish burning during their available windows.

Opportunities and successful strategies

There is no "silver bullet" to increasing prescribed fire, and finding opportunities requires: collaborative, place-specific problem solving; active coordination across air regulators and land managers; and coordination among burners to share resources, communicate effectively with the public, and manage competition in airsheds. Examples of collaborative bodies and strategies that interviewees pointed to include:

- California's Fire MOU Partnership, which is a voluntary group that involves regulators, CALFIRE, federal land managers, and NGO partners. The group is focused on improving understanding of barriers to prescribed fire and opportunities. Working groups within this partnership are examining why burning does not occur on available burn days, and whether this is due to weather, lack of capacity, poor planning, or other variables.
- The Montana-Idaho Airshed Group, which is run by and for major burners (federal and state land managers, and large private landowners) to coordinate burning activities and streamline communication with the state air quality regulatory bodies. The group tracks all planned burns and communicates on behalf of the burners to regulators.
- Dedicated air quality liaisons and smoke coordinators, who are federal agency employees that work directly and often daily with state air quality regulators. The first such position was in Arizona and was jointly funded by the Arizona DEQ and the Forest Service; the Forest Service has these positions in place in many states. The Department of Interior also has similar positions in some states, but there are opportunities to expand this practice for both agencies.

- People on the ground have some strategies to share resources through agreements and use of the Good Neighbor and "Wyden" Authorities; however, people said that finding easier ways to share resources and charge to common funding codes are high priorities for change.

Conclusions and recommendations

Our interviews did not yield clear indications that policy change is needed at the federal level at this time, as most interviewees said there were opportunities to increase the use of prescribed fire that would not require changes to federal law. Realizing these opportunities will require creative problem-solving, and a commensurate input of staff time, funding and capacity, and leadership initiative. Two areas where policy change may be warranted are 1) in smoke management programs in Oregon and Washington, where such revisions are underway, and 2) potentially to facilitate easier approaches to interagency resource sharing. In addition, changes to incentive structures within the Forest Service may be warranted, and it is worth exploring possible internal practices that could alleviate current capacity limitations. Some suggestions drawn from our interviews include:

- Ensuring air quality liaisons are in place for all states and exploring whether additional state-level groups, modeled after practices in California and Montana/Idaho, are needed to coordinate among burners and with air quality regulators.
- Improving internal incentives to burn through redesign of some performance measures or the creation of special initiatives with funding that units and collaborative partners could compete for.
- Identifying more efficient and effective avenues for resource sharing. Suggestions include: centralizing contracts and agreements staff, or finding other ways to ensure they are knowledgeable about all options and give consistent advice; creating other agreement mechanisms that are less cumbersome than current options; and finding ways to charge more easily to single budget lines when using resources from multiple agencies. As our work continues, we will explore whether any of these recommendations may require policy changes.
- Ensuring capacity is available through improved strategic planning, use of dedicated prescribed fire crews, greater flexibility to use fire personnel across units, and more effective use of partner capacity.
- Improving measurement of smoke generation and dispersion in order to identify additional opportunities to burn and promote transparency in decision making. Investments could be directed to necessary equipment and meteorologist positions.

This report contains additional, specific details on the strategies in place and suggestions from participants in this phase of our research. Our future work will build on this analysis with case studies in locations that are currently finding ways to build their prescribed fire programs and will include ongoing dialogue with practitioners, partners, agency leadership, and policymakers.

We are conducting a project investigating policies that limit managers' ability to conduct prescribed fire on US Forest Service and Bureau of Land Management lands in the 11 Western states. Our primary objectives are to: 1) Identify current perceived policy barriers to implementing prescribed fire and how these vary across the West, and 2) Characterize actionable opportunities and mechanisms for overcoming barriers. Ultimately, our aim is to identify which policies present the greatest priorities and opportunities for change, and what the mechanisms are for realizing those opportunities. This report details our findings from our initial phases of research on this project, including a legal analysis and approximately 60 interviews with key informants (e.g. land managers, air regulators, and state agency partners).

Prescribed fire[1] is an essential management tool for restoring and maintaining the resilience of fire-dependent ecosystems; however, land managers are unable to apply prescribed fire at the necessary levels to achieve land management objectives (North et al. 2012, Ryan et al. 2013, USDA and USDI 2014). In past surveys, managers have indicated that air quality regulation is the most significant barrier to undertaking prescribed fire (Cleaves et al. 2000). Other policies that reportedly act as barriers include the Endangered Species Act (ESA) and environmental planning laws, such as the National Environmental Policy Act (NEPA) and National Forest Management Act (NFMA) (Cleaves et al. 2000; Quinn-Davidson & Varner 2012). Recent papers on the challenges in US fire management generally have emphasized the need for policy change to support prescribed fire, and some have suggested there may be a need to reduce regulatory restrictions on smoke to allow for more application of prescribed fire to promote fire-adapted ecosystems and communities (North et al. 2015; Schoennagel et al. 2017). As a result, there is a widely accepted understanding that the current policy environment significantly constrains decision-making around prescribed fire (USDA & USDI 2014).

The term "policy" encompasses a variety of actions taken (or not taken) by government, and changing policy is a complex process. To identify both where policy change may be necessary and also possible, it is critical to distinguish between policy barriers that are: 1) fixed in congressional laws, 2) a result of state or federal agency policy interpretations (e.g. regulations and agency guidance), 3) a result of agency culture or habit, and 4) a result of individual decision-making at the field level, where decisions are influenced by factors such as the social environment in which decision-makers act and their individual degree of risk-aversion (Moseley and Charnley 2014). Each type of policy-related challenge presents different opportunities, risks, and pathways for change. Amending federal environmental law through the US Congress is difficult to achieve; issues for congressional action must be on the political agenda and often require substantial lobbying of members of Congress to champion legislative changes. Regulatory changes can be undertaken by the executive branch, but they also take many years to achieve through rule-making processes under the Administrative Procedures Act and can be amended by subsequent administrations. Substantial changes to agency policy generally are relatively less difficult to achieve, although altering agency norms and behaviors requires sustained changes to communication, leadership, and incentive structures (Fernandez & Rainey 2006). It is also important to note that policy changes may have limited efficacy and unexpected effects. These considerations should inform discussions of policy change as an avenue for increasing the application of prescribed fire on federal lands.

Approach

This project was funded by the Joint Fire Science Program in 2016 with the objectives of identifying the origin and range of interpretation of perceived policy barriers, characterizing the opportunities and mechanisms that are available to overcome barriers at various scales, and educating stakeholders about the most ready opportunities for change. The project involves four primary tasks: 1) a legal analysis of laws that affect the use of prescribed fire (available online at http://ewp.uoregon.edu/publications/working); 2) interviews across the 11 western states to identify the diversity of approaches and challenges associated with accomplishing prescribed fire; 3) a spatial analysis of prescribed fire accomplishments and their correlation with air quality; and 4) case studies of locations that are actively finding ways to accomplish more prescribed fire. This report details our findings from tasks 1 and 2.

We began with an analysis of the major policies that constrain prescribed fire, including a detailed investigation of state-level air quality regulation under the federal Clean Air Act. For the state-level investigation, we initially identified references to prescribed fire, smoke management, and visibility or regional haze in state implementation plans (SIPs), which are required by the Clean Air Act. We reviewed state laws pertaining to prescribed fire and additional state laws, policies, or plans relevant for prescribed fire on federal lands. Subsequent interviews with practitioners generally revealed more specific details regarding the implementation of laws and policies on the ground, and brought to light additional laws and policies having an effect on implementation of prescribed fire. We reviewed these as necessary to complete our legal analysis.

In Fall of 2017, we began interviews across the 11 western states.[2] Our goal was to obtain a broad understanding of policy barriers to prescribed fire across the West, and to identify differences across the states and opportunities for improving practice. We were not conducting comprehensive case studies of every state in this analysis. Our approach was to interview a lead person for the BLM and Forest Service in each state. At the state or regional level for these agencies, we identified people who were fuels program leads or directors/assistant directors of fire and aviation management. We also spoke to air quality or smoke management liaisons within these agencies when our primary point of contact recommended we do so. In states where the Forest Service has no regional office, we spoke to a fire management staff person at the national forest level. We also reached out to state forestry agencies to identify a contact for each state and to state departments of environmental quality to hear the perspective of air quality regulators. In the states where they exist, we also spoke to chairs of prescribed fire councils. In the end, we targeted at a minimum one Forest Service, one BLM, one state forestry, one air quality regulatory, and one prescribed fire council individual for all 11 states. Our total number of interviews was 56, with some state-to-state variation, due either to unwillingness to participate or recommendations for additional, key people to interview. Interview questions focused on: 1) goal-setting processes and progress towards goals for the land management agencies; 2) regulatory processes for regulatory agencies; 3) barriers to improving prescribed fire accomplishments, 4) strategies and suggestions for increasing use of prescribed fire, and 5) the role of partners and communication in supporting the use of prescribed fire.

I. Air quality regulation and prescribed fire

Because the literature had identified air quality regulation as a major barrier to prescribed fire and an arena for potential policy change, we investigated this topic in detail in both our legal analysis and interviews. In this section, we provide an overview of interviewees' perspective on air quality regulation as it interacts with prescribed fire programs (the legal analysis of laws that affect the use of prescribed fire is available online at http://ewp.uoregon.edu/publications/working). Policy in this area is complex, necessitating some background, provided in the next section, on how regulation works under the Clean Air Act in order to interpret our findings. Subsequent sections report on findings from both our legal and interview analyses.

An overview of relevant legal provisions in the Federal Clean Air Act

Federal Clean Air Act regulation of prescribed fire emissions primarily addresses two categories of potential consequences of such emissions:

- The potential for prescribed fires emissions to violate National Ambient Air Quality Standards (NAAQs); and
- The potential for prescribed fires emissions to negatively affect visibility and regional haze.

States have smoke management programs to maintain compliance with requirements related to both regional haze and NAAQs. The eleven states encompassed by this project generally regulate emissions from prescribed fires for both of these potential effects, with specific details of programs varying from state to state. Smoke management programs are typically incorporated into state regulatory law, and the elements of a state's smoke management program that are legally binding under the Clean Air Act also are referenced in the State Implementation Plan (SIP).

NAAQs: The federal Clean Air Act requires the federal Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS), and "states have the primary responsibility for achieving and maintaining" these standards.[3] EPA has established standards for carbon monoxide, lead, nitrogen dioxide, ozone, particle pollution, and sulfur dioxide. States then must outline their strategies for achieving and maintaining the standards for each of these pollutants in their SIPs. Areas within states are designated as in "attainment," "nonattainment," or an "unclassifiable" status based on available information. The major pollutants of concern from fires are particulate matter—both coarse (PM_{10}) and fine ($PM_{2.5}$)—and ozone precursors (NWCG, 2001, as cited in Engel, 2013).

SIPs: State implementation plans (SIPs) are required under the Clean Air Act, are legally binding, and incorporate a range of tools to address air pollution, including statutes, regulations, directives, manuals, and county and municipal ordinances. The Clean Air Act and its implementing regulations (promulgated by the federal EPA) establish minimum standards for SIPs, with differing "requirements and procedures . . . triggered depending on the degree of attainment or nonattainment of the NAAQS."

Visibility & Regional Haze:[4] The Clean Air Act's visibility protection requirements date to 1977 amendments to the Act aimed at remedying existing and preventing future "impairment of visibility" in "Class I Areas," which are primarily designated wilderness areas over 5,000 acres in size and national parks over 6,000 acres in size. There are 108 Class I areas in the eleven-state region encompassed by this project, which amounts to 69% of all Class I areas nationwide. Congress amended the Clean Air Act in 1990 to address impairment of visibility in Class I areas by "regional haze", or "visibility impairment that is produced by a multitude of sources and activities that are located across a broad geographic area . . . ."[5] Current regional haze regulations require comprehensive SIP revisions to strengthen existing regional haze SIPs by July 31, 2021. Revised regional haze SIPs must focus on "attain[ing] natural visibility conditions by the year 2064,"[6] and must include "a long-term strategy that addresses regional haze visibility impairment for each mandatory Class I Federal area within the State and for each mandatory Class I Federal area located outside the State that may be affected by emissions from the State."[7]

Exceptional Events Rule: When exceptional events, such as a wildland fire, occur, a state can petition EPA to exclude the monitored emissions of that event from assessments of state compliance with SIPs. In recent years, EPA has signaled increased support for prescribed fires in its revised regulations regarding exceptional events. EPA has stated that it "do[es] not expect the total acreage subject to prescribed fires on wildlands to decrease in the future because prescribed fire is needed for ecosystem health and to reduce the risk of catastrophic wildfires."[8] Although managers are not allowed to plan a prescribed fire that will violate a state's SIP (e.g. cause an exceedance of NAAQs), the rule allows emissions from qualifying prescribed fires to be excluded from compliance determinations when smoke from prescribed fires leads to unanticipated exceedances, as long as smoke management is employed and the fire is part of a qualifying prescribed fire program included in a land or resource management plan.[9]

Prescribed fire air quality permitting processes

Every state is unique in its regulatory structure and interagency partnerships for overseeing air quality impacts from prescribed burning (see Table 1, page 14 for an overview of legal requirements by state). Most states have a Department of Environmental Quality (DEQ) or equivalent office that handles air quality permitting for prescribed burning. Exceptions include: California, where the California Air Resources Board oversees 30+ air pollution districts or control boards that handle permitting for specific areas; Nevada, where two county offices handle permits for their county, while the NV Department of Environmental Protection handles permits for the rest of the state; Oregon, where the Oregon Department of Forestry handles permitting as a conduit between the Oregon DEQ and burners; and Washington, where the Department of Natural Resources handles permitting for federal public lands.

All states have unique permitting processes that depend on their smoke management plans, regulatory structure, and local considerations. Some states, like New Mexico and Wyoming, have a permit-by-rule system, whereby burners must register burns and notify DEQs about burning activities, but do not receive a permit. In Colorado and Washington, air quality agencies write permits for each burn plan, usually with daily acreage limits that vary depending on ventilation conditions. In other states, such as Montana and Idaho, the DEQ writes a single permit for the entire year for each "major burner," a category that includes each land management agency. During much of the burn season, daily coordination calls are held between DEQ and with major burners to minimize conflicts and potential smoke impacts. In Arizona, burners register their burns and smoke management prescriptions with the DEQ annually and then must seek a daily permit, based on daily conditions and considerations. Permitting in California proceeds similarly, with annual registration of planned burns in the Prescribed Fire Information Reporting System and then a daily coordination call to communicate whether burning is allowable on a particular day and for coordinating and approving planned burns within 24 hours of ignition. States generally require 24-hour-prior notification of plans to burn and post-burn reporting

Air quality as a barrier to prescribed fire

Although air quality is a consideration and constraint for all burners, many interviewees, particularly in the Intermountain West, said air quality is not the primary barrier they face to increasing their prescribed fire accomplishments. As we discuss in more detail in Section II of this paper, in most of the states in the Intermountain West, people said that available capacity (resources and personnel), other land management considerations, or internal agency dynamics were the primary factors limiting their use of prescribed fire. People acknowledged that while there are times when air quality is a limiting factor, there are often many other days they can burn. Some staff indicated that if they were burning as much as they should be to mimic natural ecological processes, then air quality would become a major consideration; however, people said their programs were nowhere near this ambitious, because of other reasons like risk tolerance, funding, capacity, and competing priorities. When we asked why air quality gets highlighted as a barrier, interviewees indicated that an air quality permit is an easy variable for managers to focus on, because it is a structured process and often the last piece of the puzzle to put into place in planning a burn. To illustrate, we include here a sample of comments from different land managers:

- "We have worked really hard to communicate and build relationships with our air quality folks in Arizona and New Mexico. I think there are a lot of other things that come into play before air quality does, to keep us from implementing prescribed burns."
- "There's a misconception out there a lot of times that I hear, that the air quality regulator is the barrier that's restricting us from being able to accomplish our burns that we are required to do. I find that is an easy go-to, but the data that we have does not reflect that."
- "The law doesn't necessarily impede prescribed burning so much as some of the more practical realities on the ground. You don't have enough money, you don't have enough people, there's too much fire danger."
- "I think the biggest thing is burn window availability. The smoke side of it . . . it does have an effect, but I think it's minor."
- "Air quality is something we have to consider, but it's also just a matter of, 'Do we have the people to burn where we want to burn? Do we have the burn windows? Is there political tolerance?' I've heard from a number of people that they feel like air quality gets almost scapegoated as an easy excuse sometimes. I'll say . . . it does get scapegoated, because it has a structure that you have to follow."
- "Air quality plays a role in all these things, but in my experience people like to complain about it. But, I haven't seen it deemed a major barrier. Once people have all their ducks in a row and are ready to go, air quality is generally not the issue."

- "I think a lot of people kind of hang their hat on [air quality permitting] being our major implementation barrier, but when you start to look at the numbers, I don't think it's the major one. It's definitely a component that restricts...kind of narrows our windows when we can use prescribed fire . . . extra hoops that we have to jump through. And it's not universal [i.e., it's different from state to state]."

Air quality is a more significant consideration in areas with large populations centers, poor air quality, and sensitive populations. Being close to Class I airsheds or population centers, where there are many sources of emissions that compromise air quality, presents both land management agencies with more air-quality related considerations. For example, one person explained that air quality was a challenge on Colorado's Front Range, given population centers and the presence of a Class I airshed (Rocky Mountain National Park). As another person noted, "When you go to a national park...the one time in your life you might visit an individual park, you can have a very poor experience because of fire . . . . It's really hard to convince somebody this is a wonderful, natural experience." Inversions in places like Missoula or the Wasatch Valley of Utah were cited as a limiting factor, as was air quality in highly populated and polluted areas of California, such as the San Joaquin Valley. In Oregon and Washington, in addition to relatively higher levels of regulation, which we discuss below, some said towns with high levels of tourism and smoke-sensitive populations can be less tolerant, leading land managers and air quality regulators to be more careful about smoke intrusions[10] than the NAAQS would require. Another person pointed to communities throughout Arizona with people who have moved their specifically because they are sensitive to smoke and air pollution. However, outside of the West Coast states, people did not indicate these considerations were primary variables limiting their burning programs.

In Oregon and Washington, there are relatively stricter state standards for regulating air quality; in these states, burners said air quality regulation is one of the major barriers to burning. Both states limit smoke intrusions into communities, even in cases where these would not cause an exceedance of a NAAQS. For example, a prescribed fire might result in a temporarily unhealthy level of smoke that the state regulator deems intolerable even when it might not trigger an exceedance if the NAAQS is based on a 24-hour standard. One person explained, "Washington really has been strict. They don't want any intrusion of any smoke into any communities at any time." Prescribed burns are generally prohibited on weekends (Friday-Sunday) between June 15 and October 1 in Washington (though there are provisions allowing for exceptions to this prohibition). Another person explained that smoke management plans and permitting in Washington also create barriers to burning, saying "when it comes to air quality regulation, the biggest barrier is the way the smoke management plans and the permitting [are] implemented [which] is really [about] protection against short term intrusions of smoke or nuisance smoke." They went on to explain that even if federal standards are not violated, it can lead to complaints from the public, discussions of fines from the state, and increased local regulation. An interviewee said in Oregon they would like to see ongoing consideration of sub-24-hour intrusions but less formal regulation to a standard that exceeds that of EPA. A number of people said that inversions and intrusions tend to happen at night, even during times of good daytime dispersion, limiting the ability to burn. People indicated that the tolerance of individual regulators in Oregon for writing intrusion reports and dealing with public backlash leads to variability in what is allowed across the state. When discussing tradeoffs between human health and then need for fire, it was in these two states that burners consistently said there was a need to improve smoke management plans, noting that some of these changes were in the works. Both Oregon and Washington are revising their smoke management plans, which will require demonstration to EPA that changes to regulation will not lead to a greater chance of an exceedance of a NAAQS.

In California, multiple sources of pollution and high population levels can lead to air quality conditions that restrict burning. One person explained, when discussing communication with

Air Pollution Control Districts, "Some of these air districts have taken...more restrictive policies than the law requires. Some of those air districts might loosen up those policies. But, in California, if you are burning in an area where your smoke is going to wind up in the Central Valley, it's always going to be difficult, because you're dealing with so much competition for your air. The farming industry, manufacturing, cars, diesel trucks . . . everybody wants to pollute . . . . We're the easiest tap to turn off." Another person said, "We do face challenges on air quality, but we've sort of . . . submitted to those challenges, if you will . . . . We're competing with folks who are burning wood smoke in their old wood fireplaces. A couple million people doing that every day." Despite this, people did not highlight a need for regulatory change, but rather the need for more communication and creativity to help identify opportunities within the current legal framework. One person said, "The air regulations are going to be an impediment . . . , but I feel like there's a little bit of change happening . . . . Particularly after a year of really large, catastrophic wildfires, and the [fact that the] science shows that prescribed fire under almost all conditions . . . produce[s] significantly less smoke per acreage . . . . I feel like the air regulators are really working with us, but we are going to continue to comply with the statutes, as they exist." One person suggested changes to air quality regulations may be needed in the future, but everyone said that, before focusing on changes to regulations designed to protect human health, there were other priorities to address to increase use of prescribed fire, including better monitoring and planning to find ways to burn without triggering the NAAQS, addressing capacity issues, and planning more strategically to capitalize on burn days when they are available (see the Section II for more information on these topics).

Additional themes around air quality

Land managers and air quality regulators both discussed the importance of air quality regulation for protecting human health. Many regulators emphasized their professional duty to protect sensitive populations from air quality risks; in states with smoke management liaisons, who work for the land management agencies and interface with the DEQs, those individuals often also expressed significant concerns about the public health impacts of prescribed fire. People said a fundamental challenge is determining what is an acceptable level of risk to public health from prescribed fire. One regulator said, "One hour of the wrong smoke level can trigger an asthma attack [and] put someone in the hospital . . . . That's my main concern . . . are those vulnerable populations who can't really afford to protect themselves." Land managers also often acknowledged that air quality can be a life or death matter for individuals, and that the NAAQS may not be protective enough for sensitive populations. Another person from a land management agency explained, "One of the first things that I always talk to, when I talk to [staff frustrated with air quality regulation]—the first thing I explain to them is if we waited for an exceedance on burns, there would be people that would probably die." Interviewees said allowing prescribed fire requires trust that land managers are doing their best to limit smoke impacts and that prescribed fire will prevent wildfires in the future. One person noted, "I think the law has tried to facilitate prescribed burning, but not really give a blank check." Several people emphasized the need for air quality regulation and said that land managers, with their professional training and incentives oriented towards land management objectives, could not be relied upon to manage for smoke without input from air quality regulators, who are focused on and trained to address human health considerations.

Larger-scale, landscape burning is particularly challenging to achieve and to permit from a regulatory perspective. Some people explained that it is difficult to find multiple days in a row with the right weather conditions, adequate capacity, and air quality/dispersion conditions to facilitate large burns. From an air quality permitting perspective, it can be both uncertain and risky to permit large burns that may go on for weeks. In some places near towns, where smoke settles into populated areas at night, some people suggested landscape burning is difficult to justify and achieve, given the risks. In California, in particular, this issue may require attention. One person explained, "So we've all been saying, in all of our venues where we come together with air regulators, we need longer windows, and we need more opportunity to burn on marginal days. We've got to expand the permission space. And we don't mean that to hurt anyone, to cause

them to go to a hospital, or because we don't care, or anything like that; it's just that there's an emissions trade off every time we don't burn that we need to call out as very much a real thing. It's not speculative anymore. California is so flammable these days that we're trying to push this conversation . . . are the [burn] windows long enough? No, they're not."

The argument that communities have to face smoke now (i.e. through prescribed fire) or later (i.e. through wildland fire) was not convincing to many on the ground. Regulators emphasized that this argument hinges on the assumption, which may not always be true, that prescribed fire now will limit wildland fire later. Others noted that people in general prefer to put off risks into the future, particularly when those risks may never come to pass. Some noted that a key difference between wildfire and prescribed fire is that prescribed fire is intentionally lit, and, therefore, the government has a responsibility to minimize harm in a way that fundamentally differs from a wildland fire event. Ultimately such dichotomies are too simplistic to accommodate the deliberative dialogue about prescribed fire so many emphasized as being critical among the public, land managers, and air quality regulators. However, several people emphasized that smoke from prescribed fire, which can be done under controlled conditions with good ventilation, is far preferable to smoke from wildland fire. The challenge is ensuring that all involved parties believe the risks of prescribed fire, which may need to be done every few years, are worth taking in order to lower the risks associated with future fire.

Some have suggested that prescribed fire be treated as an exceptional event like wildland fire and not be regulated; this is not a feasible recommendation, according to our interviewees. Although a few interviewees indicated that the new exceptional events rule creates more space to petition for a prescribed fire that causes exceedances of NAAQS to be considered an exceptional event, interviewees also noted that the significance of the rule change was limited because it does not allow prescribed fire to be exempted from regulation. It is not permissible under the Clean Air Act for federal land managers to intentionally plan and cause for exceedances. As one person said, "The problem with the exceptional events rule is you've gotta have an exceptional event. You can't plan to have an exceptional event." Changing this would require an amendment to the Clean Air Act. People who spoke to this question said this is not desirable, offering multiple reasons: 1) air quality regulation to stay below NAAQS exceedances is not the biggest barrier to prescribed fire, 2) it would introduce considerable risk to a major environmental law to open it up to amendment, 3) it is unreasonable to think that land managers acting alone will steward air resources with adequate care, finding the ideal balance of burning to reduce risk while protecting human health, and 4) it is politically not viable to look for legislation where a federal land management agency wants an exemption from environmental law in a way that would compromise human health. One person said, "I think politically that would be suicide...public opinion would hang us. [They'd think] the government is trying to kill us."

There is potential for conflict around how smoke from managed natural ignitions is handled; some of these issues may require attention going forward. One regulator noted, "So if they get a natural start…they are going to be putting fire on the ground to keep that fire going as long as they can to avoid having to comply with our requirements because we did not see this coming. They're using that as a way to avoid our requirements for smoke management." This person explained that avoiding direct communication will only force regulators to act to protect public health. As a separate issue, some discussed that managers can count wildland fire acres burned as accomplishments towards fuels targets; however, in one state, we were told that these acres can only be counted towards targets on days when air quality regulators also would permit burning. On this topic, one person said, "[Regulators] realize they can't force a suppression. Then you get this policy jockeying around . . . you know, [air quality is] not favorable today, so it's not considered a resource benefit . . . but tomorrow [it] might be. It doesn't change on the ground generally, so it is bizarre." Some of these details may require additional attention to find positive paths forward.

Table 1 State-by-State Overview of Air Quality Regulatory Process and Interagency Relationships to Support Burning

	Regulatory overview: Responsible agencies and applicable law	Prescribed fire planning and approval[11]
Arizona	Arizona Department of Environmental Quality (ADEQ) Arizona Administrative Code	Land managers must make best efforts to register all planned burn projects before December 31 each year, but no later than January 31 ADEQ required to hold meeting after January 31 and before April 1 between ADEQ and land managers to evaluate program and cooperatively establish "annual emission goal" ("planned quantifiable value of emissions reduction from prescribed fires and fuels management activities") Land managers must submit burn plans to ADEQ at least 14 days before burn date Daily burn request must be submitted to ADEQ by 2 P.M. on business day preceding burn ADEQ approval of request required before ignition, with constructive approval where explicit approval is not received from ADEQ by 10 P.M. on the day request was submitted (burner must make effort to confirm that request was received by ADEQ)
California	California Air Resources Board and California's 35 air districts Smoke Management Guidelines for Agricultural and Prescribed Burning (codified in California Code of Regulations)	Smoke management programs for air districts with "prescribed burning in wildlands or urban interfaces" must include annual or seasonal registration of all planned burn projects; burns are registered online in Prescribed Fire Information Reporting System (PIFRS) Each of California's 35 air districts must have a smoke management program that includes a daily burn authorization system Air districts' burn authorization systems issue "48-hour forecasts, 72-hour outlooks, and 96-hour trends" for burns Air district burn authorization systems must include procedures "for authorizing . . . prescribed burns 24 hours prior to ignition" By 3 PM each day, California Air Resources Board must normally announce whether following day is a "permissive burn day" or a "no-burn day" for each of California's 15 air basins
Colorado	Colorado Air Quality Control Commission Colorado Department of Public Health and Environment or an authorized local agency Colorado Code of Regulations Colorado Smoke Management Program Manual	Significant users of prescribed fire must submit planning documents to Colorado Air Quality Control Commission for each area in which the user intends to use prescribed fire addressing the use and role of prescribed fire and resulting air quality impacts Air Pollution Control Division of Colorado's Department of Public Health and Environment must review planning documents and present comments and recommendations to the Commission Commission must hold a public hearing and complete review within 45 calendar days of receipt unless significant user of prescribed fire agrees to longer review period APCD may take up to 30 days to review permit application "Notification of Ignition" must be submitted 2 to 48 hours before ignition "Daily Actual Fire Activity" report due by 10:00 AM on business day following each proposed ignition day

	Regulatory overview: Responsible agencies and applicable law	**Prescribed fire planning and approval[11]**
Idaho/Montana	Montana/Idaho Airshed Group with Missoula-based "Smoke Management Unit" that coordinates/administers Idaho and Montana DEQs and local regulatory authorities also have roles Montana/Idaho Airshed Group MOU committing to agreed-upon smoke management program and operating guide Idaho and Montana DEQ regulations	Preseason burn lists entered into Airshed Management System between Dec 1 and Feb 28 for Spring Season burns (March 1 to May 31) and between June 1 and Aug 31 for Fall Season burns (Sep 1 to Nov 30) "Burns that will require more than one consecutive day of ignition to complete require additional coordination" "Special notification and direct approval from both DEQs" required for "Extended-duration Landscape-scale Prescribed Burns" ("ignited and managed over weeks of time to mimic the natural progression of fire on the landscape within parameters identified in the burn plan" and "monitored, additionally ignited, or partially extinguished until season-ending precipitation puts them out completely") Smoke dispersion forecasts posted to Airshed Group web page by approximately 10:00 am Mon through Fri Burns proposed via Airshed Management System by noon day before proposed burn (noon Fri for Sat/Sun/Mon burns) after reviewing dispersion forecast Idaho and Montana DEQs and local air agencies "may review the forecast and burn proposals by 2:30 pm . . . and relay any issues or concerns" Restrictions/burn recommendation posted by 4 pm "Local regulatory authorities . . . may impose additional burn restrictions after the . . . burn recommendations have been posted"
Nevada	Nevada Division of Environmental Protection (NDEP) for all of state except Clark County and Washoe County, which administer program in their jurisdictions Nevada Revised Statutes Nevada Smoke Management Program	Permit application must be submitted at least 30 days prior to planned ignition date for fires emitting more than 10 tons of PM10 Permit application must be submitted at least two weeks prior to planned ignition date for projects emitting between 1.0 and 10 tons of PM10 Land managers must notify the Division as soon as practicable, but no later than 2 pm of the business day preceding the burn Division must issue final decision on the burn (approval, approval with conditions, or disapproval) by 5 pm on the business day prior to ignition or burn is deemed approved Notification to relevant regulatory authorities is required prior to ignition for projects that emit more than 10 tons of PM10 and are within 15 miles of the state border, BIA trust lands managed under the jurisdiction of a tribal air quality agency, or the borders of Washoe or Clark counties
New Mexico	New Mexico Environment Department New Mexico Administrative Code	Different requirements for burn projects with < 1 ton PM-10 emissions per day (SMP-I) and burn projects with one or more ton PM-10 emissions per day (SMP-II) SMP-I: ▪ Notification of populations w/i one mile between 2 and 30 days prior to ignition ▪ Registration by 10 am one business day prior to planned ignition SMP-II: ▪ Registration by two weeks prior to planned ignition ▪ Public notification between 2 and 30 days prior to ignition for burns within 15 miles of a population or w/ wind blowing toward a population ▪ Notification to Dept. between 7 days prior to ignition and 10 am one business day prior to planned ignition Notification of local fire authority prior to ignition required for both

	Regulatory overview: Responsible agencies and applicable law	**Prescribed fire planning and approval[11]**
Oregon	Oregon Department of Forestry Oregon Department of Environmental Quality Oregon Administrative Rules Operational Guidance for the Oregon Smoke Management Program	Land managers must register burns with the State Forester at least seven days before the first day of ignition (requirement may be waived if federal policies met) Land managers may request special forecast and instructions at least two days in advance for multi-day burns and burns with > 2,000 tons of fuel loading Smoke Management Forecast Unit issues daily forecasts and instructions no later than 3:15 p.m. during periods of substantial prescribed burning (forecasts and instructions are for the day following issuance) Land managers must provide location, method of burning, and fuel loading tonnages to Smoke Management forecast unit by the day of the burn Land managers must obtain current smoke management forecast and instructions prior to ignition and must conduct burn in compliance with instructions Land managers must follow land management agency policies that provide for affirmative "go-no go decision" before ignition as documented and approved by line officer
Utah	Utah Department of Environmental Quality Division of Air Quality Utah Administrative Code	Director of Utah Department of Environmental Quality's Division of Air Quality must provide opportunity for an annual meeting with land managers to evaluate and adopt annual emission goal, which must be developed in cooperation with states, federal land management agencies and private entities to control prescribed fire emissions increases to the maximum feasible extent; goal is established prior to the beginning of fire season, either at the beginning of the calendar year or before the year begins Land managers must provide director with "long-term projections of future prescribed fire activity" and "list of areas treated using non-burning alternatives to fire during the previous calendar year" by March 15; land managers planning prescribed fire that will burn more than 50 acres annually must also submit a "burn schedule" at this time Land managers must submit pre-burn information to director for approval at least 2 weeks before beginning of the "burn window" Land managers must submit burn requests for large prescribed fires to the director by 10 AM at least two business days before planned ignition time
Washington	Washington Department of Natural Resources Washington Department of Ecology Smoke Management Plan codified in Washington Administrative Code	Multiple day burns require landowner to give burn plan information to DNR for review three months before the burn, with DNR notification of any additional requirements two months before the burn If DNR determines that the burn has potential to affect communities, landowner must notify public of the burn at least one week before they plan to burn Approval process for "large prescribed fires" (those with potential to create significant smoke impacts beyond the immediate fire area) Land managers responsible for gathering and entering pre-burn site data into smoke management reporting system Land managers screen, pre-authorize/pre-approve and prioritize burns daily, and submit prioritized pre-approvals to Smoke Management Section via Forest Service/DNR data exchange process Smoke Management Section approves or disapproves each burn Land managers give final approval to burns (taking into consideration a list of factors)
Wyoming	Wyoming Department of Environmental Quality's Air Quality Division Wyoming Smoke Management Standards and Regulations (codified as Chapter 10 of Wyoming Administrative Rules)	Burners/land managers "whose total planned burn projects in a year are projected to generate greater than 100 tons of PM10 emissions" must submit written reports to Administrator of Wyoming Department of Environmental Quality's Air Quality Division "by January 31 every third year"; reports must "include documentation of . . . long-term burn estimates for the next three years, including the location, burn area or pile volume, vegetation type, and type of burn for each planned burn project Burns projected to generate ≥ 2 tons/PM10 per day (classified as "SMP-II") must be registered with Air Quality Division at least 2 weeks prior to ignition Public notification required at least 2 days prior to ignition notification to Air Quality Division 1 hour prior to ignition for SMP-I burns and by 10 A.M. on business day prior to ignition for SMP-II burns Notification to relevant "jurisdictional fire authorities" prior to ignition

II. The most common barriers to prescribed fire: Incentives, capacity, and conditions on the ground

Interviewees across all states said internal agency variables, such as funding, incentives, and capacity, tended to pose larger barriers than air quality concerns. In this section we discuss the factors outside of air quality that prevent land management agencies from reaching their prescribed fire goals.

Capacity challenges: Personnel and funding

People often said inadequate funding and capacity to accomplish more prescribed fire were the key barriers to accomplishing more burning. Many people made statements like, "My biggest barrier right now is funding," or "We just didn't have the resources." In particular, people said they lacked the funding needed to hire qualified staff to prepare for, plan, and conduct the burns. As one person summarized, "It takes a lot of work to go from planning and doing the NEPA to implementation. We're pretty limited as far as the number of personnel we have." One person added that they often focus their limited budgets on mechanical thinning and explained, "Mechanical work is expensive. So, if we're spending our money on mechanical, then we don't have money to do the final treatments of doing burning on landscape. And, so, the constant push for new mechanical acres then causes a backlog in prescribed fires." Forest Service interviewees across regions felt that the size of the fire suppression budget as proportion of overall agency budgets restricts the amount of burning that can occur. BLM interviewees stated that to plan at landscape scales, units would require more stable funding. Burners with the BLM in states without sage grouse populations said their ability to burn had been limited particularly in recent years, because the agency at the national level had reallocated budgets to states with sage grouse. People said decreased state funding for DEQs also limits regulators' their ability to observe on burns or interact with land managers, which, as we note below, is important to finding opportunities to increasing burning.

Lack of sufficient qualified staff to conduct burns was a key capacity limitation.

- **Capacity to burn is limited when burn windows coincide with wildfire season.** Across agencies and states, individuals consistently said when wildfires are burning, their qualified personnel leave local units to work on wildland fires. Sometimes when the nation is at a preparedness level four or five, people said it is too difficult to request fire personnel to work on prescribed fire. One person explained, "One of our big strategic issues is of course when we need to burn in the summer, everybody's fighting wildfire... We just don't have people around to burn. I got certified as a helicopter manager because when I needed to burn in the summer, everybody was gone, doing suppression, and if...I could manage the helicopter, we could burn." One interviewee said that they sometimes can get burning done with severity resources (i.e. people relocated to an area in preparation for wildland firefighting), but this is challenging because those personnel might be called onto a fire at any moment. People said the fact that wildfire seasons are getting longer has exacerbated this problem.
- **Capacity to burn can be limited outside of wildfire season due to loss of seasonal staff, trainings, and other demands on staff time.** Often land managers want to burn in the off-season when they no longer have seasonal employees to implement burns. One person explained, "Just as burn season is gearing up, we lose most of our workforce. If that didn't happen, I think we would be in a very different position to do landscape-scale burning." In another state someone said, "One of the biggest restrictions is just funding in general. And then, because a lot of our firefighters are more of our operational staff, or more on a seasonal basis, a lot of times they'd be committed to other projects . . . committed to some seeding [elsewhere] or committed to doing some fencing. And so, then . . . when the burn window does open up, we don't have the capacity to complete the objectives, because we don't have the bodies." A few interviewees said that trainings and leave during the holiday season also limit the availability of personnel during key burn windows, especially in the Southwest.
- **Some pointed to the challenge of hiring and training qualified burners and "fire adapted" line officers.** People said the professionalization of fire personnel has limited the number of people who are available to staff burns. Some interviewees felt that there is a significant challenge in hiring personnel and having the right person in the right position in order to implement prescribed burn programs. One BLM interviewee said, "It's very challenging to hire fuel specialist(s) at the GS9 level . . . . [The] field offices are competing with the Forest Service and with [the state forestry agency] for the same personnel. [Those] agencies are often hiring at higher grades . . . . My first challenge is personnel-having the right person and the right position, in order to implement these prescribed fires." A Forest Service interviewee pointed out that there was a need, not just for people qualified to conduct a burn, but for line officers who understood fire, explaining a need for "actively finding and developing fire adapted line officers. And, that doesn't mean that they had a lot of fire experience, but that they have a lot of fire knowledge and have people that they can work with and trust to build that knowledge and continue to be able to do fire." One state forestry interviewee shared that their agency "does not hire foresters nor do we have a training program for foresters to be equipped to conduct prescribed burning on the landscape." In multiple states, we heard that if the state land board or forestry division does not support prescribed fire, this can limit federal burners' ability to burn, because it becomes more difficult to share resources, coordinate communication, or work across jurisdictions.

Capacity challenges: Resource sharing and logistics

People cited problems sharing resources across units due to lack of flexibility associated with budget requirements and limitations on travel. One person told us that in the past year they had observed that seasonal fire personnel on a particular forest were inactive, but were not being shared with other forests. When we asked why they said, "I don't know if it's a cultural thing, I don't know if there is actual legal barriers, or the budgets,

or whatever it is. There has to be some reason. I know when I talked with people in the past, it's ultimately they have people that they need to give paychecks to. There is a fear of if they start moving around like that, they will lose their budgets. They'll lose their people. They'll lose the ability to pay salaries." Another person indicated that when burn windows fall at the end of the fiscal year, this can be challenging because of the availability of accessing funding as the fiscal year ends and begins. Limitations on travel also have affected the ability to find capacity, according to several interviewees.

People said entering into agreements to share resources is a persistent challenge, and that there is a need for more knowledge of funding mechanisms, streamlined legal advice about their use, and more staff capacity to administer agreements. Many noted that they have to combine the resources of multiple units or agencies to conduct burns, and most people highlighted the challenges associated with sharing resources. One person explained this in detail saying, "We often reach out to our neighboring agencies for assistance with resources and staffing. And that's all facilitated through agreements that we have, both with our state and other federal partners, and that process of getting those agreements in place is often cumbersome. Some of the [authorities] I think are not clearly understood . . . . There [are] differences of opinion between individual grants and agreement specialists, or different lawyers, but there isn't even agreement from one region to another [about] how things are being interpreted. Or when the Washington office, when their staff puts together agreements, they may do something that our staff here says we can't do. And so, there's a lot of inconsistency or different interpretations of how law is applied to these agreements or the authorities that facilitate these agreements . . . . I see that as another big regulatory barrier that exists for us to be able to move forward and further utilize prescribed fire as a management tool." To share resources, often people have in place many agreements with partner agencies. For instance, a Forest Service Regional Office might have two agreements with a corresponding National Park Service unit—often one for outgoing and one for incoming funds, each only lasting five years and requiring tracking and reporting.

A consistent theme was the need to find ways to facilitate more nimble resource sharing, particularly among federal agencies. One person commented, "We try to partner, whether it's with the Forest Service, Fish and Wildlife, [National Park Service], [or Bureau of Indian Affairs], and we're trying to increase the size of the burn—do cross boundary type work. There's no good way to move money between the federal agencies for this. It would really help, because a lot of times, at least in [this state], the Forest Service is the ones with hot shot crews and the helicopters. We want to do larger landscape type burns, and want to use their helicopter. They're more than happy to work with us on that, but it is a nightmare to try and pay for that helicopter . . . . We have to be able to move money between the agencies, just like in a wildfire, we all charge to the same code. Why doesn't that happen on a prescribed fire? It's a huge hindrance." Staff frequently said things such as, "There has to be a way that we can exchange money between the agencies to get these larger landscape burns done." Another person said finding a way to use something akin to the funding system in place during wildland fire to order and pay for resources from other federal agencies would be "the single biggest breakthrough" she could imagine that would help the federal agencies get more fire on the ground.

Agency leadership and incentives

Interviewees said there are limited incentives to burn, making leadership a critical component of successful programs. Federal agency employees in particular said burn programs rely on the commitment of agency leadership and fire management officers (FMOs). As one person explained, "I really don't think there's a lot of incentive within the organization to do prescribed fire. I think the incentive comes from the agency administrator and burn boss passion for doing what's right on the landscape." Interviewees said when line officers and FMOs exhibit initiative and passion for burning, they often find creative ways to maintain and build their programs. One interviewee also reflected that local line officers or fire personnel can create a culture supportive of prescribed burning on their units. As they described their forest staff, this person explained, "They have a great deal of enthusiasm and understanding about why this work is important, and how they can use prescribed fires in the future to make good use of wildfire opportunities. There's a lot of focus on being strategic with the use of prescribed fire, and then also with the use of wildfire, and there's a huge amount of support from the regional leadership all the way down to get there. I think the leadership plays a huge role in that."

People said agency history, culture, and professional expertise can all influence prescribed fire programs. Besides the need for clear and active support of senior leadership for prescribed fire, people noted that having a culture or history of focusing on suppression can affect an agency's activities. One BLM employee explained that the agency has more experience, history, and personnel trained for suppression, creating some bias towards suppression and less expertise in prescribed fire. A Forest Service employee noted, "A key part is it's a cultural thing. I think [from] a lot of places [where] we get our fire folks, they come from the suppression background, so suppression is what they know . . . . They may not be completely comfortable with prescribed fire."

The structure of agency performance measures creates weak incentives to use prescribed fire. Setting fuels targets (i.e. acres on which fuel loads have been reduced by a certain amount) can create incentives for land management agencies to increase prescribed fire use. However, mechanical treatments (i.e. removal of fuel through mechanical thinning) can be a more predictable way to meet fuels targets with less associated risk, both to the public and to agency staff who need to implement projects and meet targets. As one person said, "[M]echanical treatments typically have wide open windows . . . [they] can happen 10 months, 11 months of the year, versus prescribed fire on a specific piece of ground. You may only have a few days here and there . . . to put that [prescribed fire] project on the ground." Others noted that the timber target (i.e. volume of board feet sold) is more challenging to meet than fuels targets, and that timber targets have gone up for the Forest Service in recent years. Mechanical thinning can help managers achieve both targets, while prescribed fire only contributes to the fuels target. Several Forest Service personnel noted that it is not difficult to meet fuels targets, particularly because they can count wildland fire acres that burn for resource benefit towards their targets, leading to relatively more emphasis on meeting timber targets (however, this has changed as of FY 18; regions and forests now only count prescribed fire and non-fire treatments towards their targets, although acres treated through natural ignitions that burn for resource benefit are still counted at the national level). A BLM employee raised another dynamic around increasing prescribed burning, explaining, "I don't want them pushing getting prescribed fire work done to meet our target, because once we start doing that, then we can end up putting fire on the ground when we shouldn't be."

Interviewees across all states also believed risk aversion was an important factor in willingness to burn. At the local level this tended to reflect concerns about personal liability in case of an escaped fire. At the higher level it tended to reflect political considerations. One interviewee explained: "It gets to that risk aversion component with our line officers or even our burn bosses. And I would say with the burn bosses . . . it probably gets more back into those liability questions, tort claims, and the potential consequences if there's an escape that's created some risk aversion with our implementers for sure. I think at the agency administrator level, it's probably more the social/political components that create or contribute toward that risk aversion."

- **At the local level, interviewees felt that the liability and career risk associated with prescribed fire is a deterrent from being more proactive with fire**. Some burners, especially with the Forest Service, said they were not always sure the agency would support them in case of an escape, whereas others felt confident that they would have legal protection from the agency as long as they acted within the scope of their duties and parameters of their burn plans. Some said they were encouraged to hold private insurance; others said this was not necessary. Another challenge may rest with the different liability laws across states; as one interviewee stated "Anytime you do prescribed fire, different states have different liability laws. Some are vague . . . . Some are limited liability or simple negligence . . . . there's gross negligence, simple negligence and strict liability." Several people noted that because the incentives to burn are few and hurdles to burning are many, if a line officer or FMO is more risk-averse, prescribed fire activities will be minimal on that unit.
- **Among high-level decision makers, political risk aversion and other agency practices can pose major barriers to putting fire on the landscape.** If an elected official does not support prescribed fire, this can significantly limit burning, even on federal lands. One interviewee in Washington said, "[The] personality of the person that's talking to the burner, the person signing the permit, all the way up to the Commissioner of Public Lands, who's an elected official . . . if the elected official is extremely risk-averse, that pretty much shuts down burning. If [that person] is very proactive about forest health, we can have a little bit of risk, and maybe an intrusion and learn from it." In Colorado, one person explained that there have been limitations on their prescribed fire programs statewide due to moratoriums on burning after the escaped Lower North Fork prescribed fire and during times when fires are active on the Front Range, even when burning conditions may be excellent in other parts of the state. Due to several escaped burns in the early 2000s, the BLM put in place a system of checks and balances that make it a more lengthy and difficult process to implement prescribed burns. According to a BLM interviewee, this process still exists and is in need of updating in light of improved training and practice.

Other challenges: Burn windows and other conditions on the ground

Limited burn windows, coupled with the challenges of getting adequate capacity during those windows, are a significant barrier in some places. Even when the conditions meet the prescription, burn windows often coincide with other considerations: a high visibility fire elsewhere, a weekend with a local festival, or a time when personnel are not available. In Arizona, one interviewee said that drought conditions meant that fuels were often too dry to burn (i.e. locations were not within prescriptions for prescribed fire). In high elevation areas, we heard that burn windows are short, because fuels can be under snow or too moist, and often come at the height of wildland fire season, making it difficult to get capacity to burn.

Other landscape conditions, like fuel types and topography, can create challenges for increased prescribed burning. Discussing fuel loads, one interviewee said, "It took a long time to get into this problem, and it's probably going to take quite a long time to get out of it. I mean, we've been suppressing wildfire for over 100 years, and it's led to a larger fuel buildup." Many BLM interviewees discussed invasive cheatgrass as a prominent barrier, as the presence of cheatgrass makes use of prescribed fire particularly challenging, providing additional incentive to rely on mechanical treatments. A Forest Service employee also described the issue, saying, "Cheatgrass, of course [it's a] huge limit to prescribed fire . . . . We're actually buying mechanical equipment because we know we can't put fire on the ground." Some places said their steep topography made burning difficult, while others said topography that facilitates inversions into populated areas makes it difficult to manage potential smoke impacts.

Species conservation requirements in some locations can conflict with application of prescribed fire. BLM interviewees all agreed that a major factor impeding the agency's ability to implement prescribed burn programs are the restrictions put into place to protect sage grouse. Another example is spotted owl habitat protection in western Oregon, which impacts burning ability, and is further exacerbated by fragmented land ownership patterns, creating, as one interviewee described, "layer(s) of Swiss cheese on the [land management] map. And [then] you're just trying to burn all the little pieces in-between that happen to be mid-slope or down in the creek, [which is] not ideal." These variables around threatened and endangered species habitat also can interact with other considerations. As one person said, "I think [it's] all the different regulations on the landscape from threatened and endangered species to just . . . trying to find that perfect time where you're in prescription, the weather's right because you're in prescription, you're in the right place at the right time, so the owls and the bugs are happy and the salamanders are happy . . . .And then also I think third on the list is the smoke management approval."

A few of interviewees indicated that getting through the NEPA process creates a barrier to accomplishing more prescribed fire. Some suggested that the federal agencies find greater opportunities to undertake project planning and NEPA analysis jointly. One person explained, "I think we should be looking at being able to share, do NEPA jointly and have the Forest Service take the lead and actually work on a landscape scale that includes all federal ownerships. And then we can maybe move through that process faster, and actually get more fire on the landscape on those fringe areas where we could do joint projects." A couple people expressed a desire for less NEPA requirements. One person said it was not the law that was the problem, as much as the details of decisions made through the NEPA process by interdisciplinary teams without a fire ecologist on staff; in these cases, their plans did not adequately anticipate or support prescribed fire.

III. Opportunities and successful strategies to maintain and increase prescribed fire programs

Most interviewees said that they were focused on opportunities to grow prescribed fire programs through addressing capacity and resource limitations. People in most states said air quality regulation was not their biggest challenge and pointed to the importance of the strategies they have in place that allow them to work well with air quality regulators. The exception was in Oregon and Washington where people said additional work is needed to find agreement on air quality regulations and space to increase burning with state agencies. In this section we discuss the strategies interviewees said they were using to maintain and increase their use of prescribed fire (see also Table 2, page 29).

Increased collaboration among all interested parties can be crucial to finding creative solutions to accomplish more prescribed fire. For instance, a creative opportunity is in place now in California, called the Fire MOU Partnership, which is a voluntary group that involves regulators, CALFIRE, federal land managers, and NGO partners. The group is focused on improving understanding of barriers to prescribed fire and opportunities. Working groups within this partnership are examining why burning does not occur on available burn days, and whether this is due to weather, lack of capacity, poor planning, or other variables. An agency staff member in another state explained the need for increased agency collaboration, saying, "it wouldn't hurt for us to have a little more collaboration with other agencies as far as trying to get fire on the ground . . . . We probably don't work with other agencies as much as we probably should . . . . We could probably work a little bit together to do more landscape type projects instead of we do our projects and the [other land management agency] does their projects." These types of partnership also allow groups to find creative opportunities for resource sharing. Such efforts to foster more prescribed burning have benefits beyond prescribed fire. One Forest Service interviewee explained this, stating, "because it's the working relationships during the prescribed fire season that jumps over into the suppression season, and you already know each other, and suppression goes easily because of having those relationships in fire and fuel management already."

Coordination among burners and between air quality regulators and land managers is essential to managing competition in airsheds and capitalizing on opportunities for burners with difficult burn windows and prescriptions. One example is the Montana-Idaho Airshed Group, which is run by and for major burners (federal and state land managers, and large private landowners) to coordinate burning activities and streamline communication with DEQ. The group has a system, something that people in several other states said they wanted, for inputting and tracking all burn requests online (provided by Air Sciences, Inc.). To avoid triggering air quality concerns, the group's coordinator, staffed as a rotating position among the burners, approves all burn requests, and communicates on behalf of the burners to DEQ, so that individual burn bosses do not have to. One person explained, "I think that smoke management is a genuine challenge. I think that we can work with what we have, which has been built by burners and has been iterated by burners over the last 30 years to be as unobtrusive a smoke management approval process, as we can figure out how to build [our programs]." Burners and regulators alike in Montana pointed to the fact that regulation in the state leaves some flexibility, which is valuable for finding creative solutions and promoting communication. As we discuss more below, other states also have air quality liaisons or meetings throughout the year to coordinate among burners.

Dedicated positions and processes, particularly to navigate the intersection between prescribed fire and air quality, to bridge across land management agencies, and with air regulatory agencies, are essential. Interviewees said that open communication and trust are essential to understanding each other's concerns and finding opportunities to improve practice. As one person said, "I find that for our federal partners and for me, working with private landowners, having a strong relationship with our air quality districts, like a personal relationship, has been so important to getting projects done." The Montana/Idaho Airshed Group plays this bridging role. In most states today, the Forest Service has a dedicated liaison that works directly with air quality managers to find opportunities to burn and track multiple planned burns in airsheds. The first such position was in Arizona, where for years it was cofunded by the DEQ and Forest Service, which now funds the position entirely from the National Forest System budget; people credited this model for being essential to supporting effective burn programs. On the matter of trust, one regulator said, "When you're talking about the consequences of a decision being health consequences, if you don't trust that person or think that person might not be forthcoming with the amount of information that you may need to make a good decision, then we have to default back to a more conservative decision." This person explained that FMOs who proactively communicate within their agency and with county and regulatory partners often get their burns approved with more success than those who do not embrace communication.

People also emphasized the importance of relationships among land management agencies, at both the state and federal levels. One person gave the following example: "Those working under the FMO are very integrated and [on a] first-name-basis with their [state agency] counterparts on the fire side. And there's a good rapport and cooperation between the supervisor and the unit chief . . . . In the areas where we've had the biggest challenge, [that] is where either one or both of those relationships are not as strong. So I think where there's a will there's a way, and when there's not a will, there's not an incentive to find a way. And it very much does come down to those, in many cases, those relationships." In several states, people said partnerships among agencies allow them to find greater opportunities to burn, often by finding opportunities to share resources.

Communication, trust, and creative public outreach also are essential among agencies and the broader public. One person noted the importance of having interagency communication strategies and using multiple partners to communicate about fire with the public, both to build a united voice and use partners that have established trust with different stakeholder groups. Another person explained, "These [agencies] entities are basically working with . . . limited resources and 110% workload usu-

ally. So coordinating between the agencies, if it's not mandated typically falls off the plate . . . that's I think where a lot of the issues end up happening . . . that [lack of] communication . . . that translates into really mixed messages to the public. If people aren't saying what the issues are, or why we're using prescribed fire, it creates a lot of communication barriers."

People have in place some options to share resources, although these are limited and vary in their use by state. Interviewees stated that there are ways around agreement issues such as "if you just need an engine for a day or two, most folks are more than willing to say, 'Yeah, I'll send my engine over, you send yours over, we'll just kind of do a handshake;'" however, people said this was more challenging for high-cost items. In Arizona, the land management agencies are using a Joint Powers Master Agreement to support resource sharing within the state for prescribed fire. Other regional and state offices said they are working with units to coordinate agreements to create efficiencies. Other people said they were utilizing the Good Neighbor Authority or "Wyden Authority" to share resources with the states and indicated these were useful policy tools.[12] In Utah, the state established the Watershed Restoration Initiative (WRI) in the Conservation and Development Division. With a focus on wildlife habitat, WRI brings together funds and proposals from state and federal agencies as well as non-profit organizations to fund priority habitat restoration projects. Interviewees indicated that this facilitates prescribed fire projects and other fuels treatments by leveraging funding from multiple entities that has the flexibility to be used across diverse land ownerships and funding years. The program is one thing that helps provide "my fuel managers a lot more room to be strategic and to jump on when a window opens."

Improved monitoring data and smoke modeling efforts within the land management agencies can provide information that will support increased burning. As one person explained about their DEQ partners, "They've recognized that some of [their air quality requirements] really don't align with meeting the goals of protecting public health. We've got some of our meteorologists that work both for the BLM and for the Forest Service . . . we're deploying them when we do prescribed fire. And we're doing much more intensive monitoring of atmosphere conditions. And we're starting to question some of the models that have been used in the past to help determine what the ventilation index is on any given day, and therefore, how much we can burn." In both California and Utah, as well, people told us that air quality regulators and land managers are working together to identify opportunities to burn more at higher elevations, even when air quality in populated areas is poor. Doing so will require improved monitoring and modeling of smoke and could present opportunities for additional burning. In a few places, people said that individual regulators within a state sometimes would allow for different levels of burning; improved data from land managers and transparency in decision-making from air quality regulators both would be useful for making decisions more consistent and evidence-based. In some states, interviewees noted that their current or anticipated hiring of a dedicated meteorologist position in the state supports their increasing reliance on meteorology to inform smoke management in the state.

Several interviewees said that the land management agencies could incorporate air quality and human health considerations more effectively into their ethos. One person, said, for example "I still think land management in the Forest Service is still really lacking air quality as a resource as something this is part of our responsibility. It's vastly improved…[but] it's still lacking…. I think...until we do that, it looks to the regulators much like we're not taking this very seriously, as if air quality is not a part of the decision-making system." A suggestion was that air quality considerations and communications training be more embedded within the cadre of personnel conducting prescribed fire. Some suggested the need for dedicated prescribed fire teams for capacity reasons, and a couple people suggested that those teams could be especially trained in communicating around smoke impacts to improve practice.

Conclusions and recommendations

Our interviews did not yield clear indications that policy change is needed at the federal level at this time, as most interviewees said there were opportunities to increase the use of prescribed fire that would not require changes to law. However, realizing these opportunities will require creative problem-solving, and a commensurate input of staff time, funding and capacity, and leadership initiative. Two areas where policy change may be warranted are in smoke management programs in Oregon and Washington, where such revisions are underway, and potentially to facilitate easier approaches to interagency resource sharing. In addition, changes to incentive structures within the Forest Service may be warranted, and it is worth exploring possible internal practices that could alleviate current capacity limitations. We offer our targeted suggestions based on this phase of our research below.

Coordination among burners and between air quality regulators and land managers is critical to maintaining and increasing the amount of prescribed burning that occurs. Our interviews indicate that there is no "silver bullet" to increasing the application of prescribed fire, and that problem-solving requires local solutions that can only be identified through interagency coordination and problem examination. We recommend other states consider whether they would benefit from a statewide airshed group or partnerships following the models of Montana/Idaho Airshed Group and the California Fire MOU Partnership, or whether their existing partnerships and forums already serve this role. Other suggestions include the following:

- Ensure air quality liaisons or smoke coordinator positions are in place and staffed in all regions, with additional state-level positions as needed.
- Support state-level groups that promote communication among burners to manage competition within airsheds; these groups benefit from online platforms for tracking burn requests and related information.
- Improve measurement of smoke generation and dispersion to allow partners to find additional space to burn while navigating air quality concerns; targeted investment in necessary measurement techniques, equipment, and trained staff/meteorologists would be valuable.

The Forest Service, and the BLM to a lesser extent, would benefit from improved internal incentives to encourage more burning. Opportunities may include:

- Ensuring that leaders prioritize prescribed fire at all levels of the agency. One example comes from Utah, where several forest supervisors have, according to one interviewee, "set a million acre challenge in the next five years to help move the [prescribed fire] program;" the challenge is endorsed by the Governor in order to "help move the culture into more action on the ground."
- Examining targets to identify additional pathways to incentivize prescribed burning. For instance, there may be opportunities to provide targets at the national and regional levels that can only be met through prescribed fire, as compared to current fuels targets that can be met through wildland fire acres-burned or mechanical removal of fuels.
- Creating rewards or additional incentives for places that have the interest and a plan in place to increase burning. Options include dedicating funding to prescribed fire, which could be allocated by Regions or by Congress; recipients could be the agencies or collaborative efforts among community partners working together with federal land managers.
- Providing training to key fire management personnel and line officers about navigating personal liability concerns so that they are comfortable responding to positive incentives to burn more.

In a time of limited capacity and declining federal budgets, the federal agencies need more efficient avenues for sharing resources. Recommendations include:

- Providing consistent guidance on agreement mechanisms and associated requirements and developing additional personnel with the expertise to enter into and manage resource sharing agreements effectively. One option may be to reorganize contracts and agreements staff so that expertise is more centralized and advice is more consistent.
- Identifying a mechanism for sharing resources and dollars for prescribed fire activities that limits requirements for agreements. One possibility is to identify whether the Forest Service or BLM could have a budget line or authorities that would allow them to order resources from multiple agencies more efficiently, with less need for interagency agreements. As all resources are the property of the federal government, many people said they wanted to see easier ways to share resources, while still maintaining accountability.

To overcome persistent capacity challenges, personnel must be available at critical times to conduct prescribed fires. We have three suggestions for consideration:

- Dedicated prescribed fire crews could be created, either within or across agencies, and utilized more extensively. These crews would not be available for wildland firefighting, except perhaps in special circumstances, and would be trained in the unique smoke management and outreach skills that are needed in conjunction with an active prescribed fire program.
- Fire personnel could be organized such that they are more easily moved from one forest to the next, depending on the need for to conduct priority burns. We suggest actively seeking ways to utilize fire personnel more nimbly throughout the year. For instance, one Forest Service region is exploring how to put individuals with prescribed burns qualifications into the Resource Ordering and Status System (ROSS)[13] to facilitate available personnel staff being shared across forests.
- Agencies could find ways to support greater involvement of non-federal personnel (The Nature Conservancy, local fire departments, etc.) on prescribed burns.

There are opportunities to improve planning to support increased application of prescribed fire. We suggest requiring that teams planning fuels reduction and forest restoration projects ensure they have members from both resource management and fire management. When this does not occur, proj-

ects often fail to incorporate plans and prescriptions for prescribed fire effectively. Regional and state program leads also should consider where there are opportunities to improve strategic planning to make sure the planning is completed and personnel are in place to capitalize on burn windows in areas that are high priority for fuels reduction.

Changes to air quality law and associated regulations at the federal level are not a priority, according to our interviewees, at this time. Most people said this was not their biggest barrier, and everyone suggested there was room for improvement related to internal agency dynamics, providing incentives, and ensuring capacity is available. In most states, people felt these factors should be addressed before focusing on air quality regulation; the exceptions were Oregon and Washington, where more collaboration and communication is needed at the state level to identify opportunities to accomplish more fire and navigate relatively more conservative air quality regulatory processes. People also said more strict PM2.5 standards will likely pose additional challenges compared to the current state of practice, and that this issue will need ongoing attention.

Among the major challenges moving forward will be finding opportunities to increase the spatial scale of burning. Landscape-level burning will generally require:

- Greater resource sharing both between agencies and other partnering organizations;
- Better engagement of private landowners, which in some places may require that the states address liability concerns for private burners; and,
- Identifying ways, given the need for such burns to last multiple days, to create flexibility with regard to air quality regulation.

Table 2 State-by-State Summary of Primary Challenges and Opportunities

	Primary reported barriers and challenges	Facilitators and opportunities	Interagency relationships for burning and air quality oversight
Arizona	▪ Many air-quality sensitive populations ▪ Limited personnel capacity; resources on wildland fire ▪ Utilizing agreement/funding mechanisms ▪ BLM funding redirected to states with sage grouse ▪ Non-attainment for PM 2.5 around Phoenix and Tucson ▪ Intermixed landscape across private/federal/state lands	▪ 4FRI[14] is a motivator for increased Rx fire in the state ▪ Agreements and partnerships across agencies and organizations to move resources and increase capacity. This includes the communities-at-risk agreement between BLM and State to administer private land projects ▪ Extensive interagency communication has identified greater opportunities to burn	▪ Joint Powers Master Agreement allows exchange of resources across boundaries outlines joint procedures/policies ▪ Working groups for individual counties ▪ Arizona Conservation Partnership brings agencies together to identify priority areas based on their goals and objectives ▪ USFS air quality liaison with DEQ in AZ ▪ Rx fire[15] council active to support burning
California	▪ Non-attainment areas for PM2.5 and ozone in places with high population (e.g. San Joaquin Valley) ▪ Competition in airsheds in terms of emissions from woodstoves, farm industry, manufacturing, cars, etc. ▪ Qualified personnel are limited and often not available due to trainings, vacations, or being pulled to wildland fire in other parts of state (year-round fire season) ▪ Political pressure to not burn during wildfires ▪ Qualified personnel sometimes not available to fill BLM positions ▪ Intermixed landscape across private/federal/state lands	▪ Strong communication across air quality and land managers ▪ Innovative public outreach strategies ▪ CAL FIRE increasing commitment to Rx fire, and partnering with USFS and the Nature Conservancy (TNC) to do more ▪ Findings opportunities to better utilize burn days, address policy issues, and identify opportunities through MOU[16] partnership ▪ Creating more local and strategic air quality decisions based on better monitoring, data, and communication ▪ Potential improve Forest Service strategic planning to identify and support more opportunities	▪ Online PIFRS (Prescribed Fire Incident Reporting System) to track multiple burn requests and facilitate permitting ▪ Interagency, daily smoke coordination call to consider effects and feasibility of multiple planned burns ▪ MOU between federal land managers, environmental organizations, Cal Fire, Rx fire councils, committed to common goal of increasing Rx fire and identifying problems and solutions ▪ Air and Land Managers group, which meets twice a year to problem solve ▪ CA and NV Smoke and Air Council ▪ Interagency Air and Smoke Committee dedicated to technical matters like monitoring strategies ▪ Three Rx fire councils active to support burning
Colorado	▪ Lack of capacity during short burn windows (resources often out on wildland fire) ▪ Short burn windows (fuels often under snow or too moist) ▪ Risk aversion by land managers and political leaders, especially after Lower N. Fork fire ▪ Challenges utilizing agreement mechanisms to share resources across agencies ▪ Mixed land ownership along Front Range ▪ Non-attainment zones for ozone around Denver (summer)	▪ Committed FMOs/burn bosses who capitalize on available opportunities to burn and communicate with regulators to maintain productive relationships ▪ Interagency resource sharing ▪ Group of stakeholders forming to meet annually with Air Pollution Control Division	▪ The Air Pollution Control Division meets biennially with burners ▪ CO Fire Prevention and Control reviews burn plans; all agencies operate under master agreement to share resources ▪ Colorado State Forest Service are employees of Colorado State University and cannot conduct Rx burns; they burn piles as DNR employees ▪ Rx fire council active to support burning ▪ Annual meetings with major burners and regulators occurring in last two years

	Primary reported barriers and challenges	Facilitators and opportunities	Interagency relationships for burning and air quality oversight
Idaho	▪ Short burn windows due to weather conditions and complex topography (valleys more prone to smoke intrusions) ▪ When burning can occur, there is competition in some airsheds among multiple burners ▪ Lack of funding and resources to conduct burning. ▪ Non-attainment areas are already at risk of violating air quality standards ▪ BLM funding redirected to states with sage grouse ▪ Public communication about Rx burning has historically been limited	▪ Strong interagency communication ▪ Burning goals based on available resources ▪ Improved understanding of burn policies and how to conduct Rx fire ▪ Dedicated meteorologist position ▪ Opportunities lie in building a more robust SMP[17] including more communication with the public. ▪ Potential opportunities to increase staff for burn paperwork administration, increase resources in field education, and improve interagency communication	▪ Montana/Idaho Airshed Group coordinates burn planning across both states among federal, state, and private burners working under a MOU; group leads coordinate and communicate with DEQ on behalf of burners during ventilation hotline period ▪ Annual burners meeting
Montana	▪ USFS' focus on meeting timber targets results in more mechanical thinning than Rx burns, especially when fuels acre targets until FY 18 could be met through wildland fire events ▪ Utilizing agreement/funding mechanisms ▪ Non-attainment for PM 10 around Missoula ▪ Public frustration about Rx fire when their use of woodstoves or other activities may be constrained during some seasons	▪ The MT/ID Airshed group facilitates communication across major and non-major burners ▪ Some burners work closely with the airshed group to make their needs known, which helps them get approval during tight windows ▪ Flexible regulatory structure at the state level	▪ Montana/Idaho Airshed Group coordinates burn planning across both states among federal, state, and private burners working under a MOU; group leads coordinate and communicate with DEQ on behalf of burners during ventilation hotline period ▪ Annual burners meeting ▪ State has agreements with BLM and FWS, which enables them to help federal agencies conduct pile burning
Nevada	▪ Limited funding and human resources, often due to being pulled to fire suppression ▪ Short burn windows for broadcast burns due to inversions ▪ Sage grouse and cheatgrass considerations for BLM ▪ Rx fire still somewhat sensitive in state due to Little Valley escaped Rx fire in 2016 where homes were lost. State forestry, which conducted the burn, hasn't done any burning since that fire ▪ Smoke from California limits air quality in airsheds ▪ No strong sense that a great deal more Rx fire is needed	▪ MOU between BLM and NDEP ▪ USFS-BLM fire resource sharing agreement in place ▪ Opportunities include increased outreach to the public and providing more burn trainings to increase capacity and skills of agency employees	▪ BLM and NV Division of Environmental Protection (NDEP) have an agreement for Rx burning that must be re-done every five years. BLM agrees to work with the state and follow the permitting process, and BLM agrees to provide NDEP the amount of pollution the agency produces and allows NDEP to come to their burns ▪ The USFS in R4, specifically NV, to address personnel capacity issues, has an agreement with BLM in which USFS sets aside money in an account, and if they need to use the BLM, BLM can charge to that account and be available on a fire ▪ In process of forming an Rx fire council

	Primary reported barriers and challenges	Facilitators and opportunities	Interagency relationships for burning and air quality oversight
New Mexico	▪ Public opposition to smoke in some locations ▪ Intermixed landscape across private/federal/state lands ▪ Limited personnel capacity; resources on wildland fire ▪ BLM funding redirected to states with sage grouse ▪ Utilizing agreement/funding mechanisms	▪ Interagency resource sharing ▪ Returning Heroes Wildland Firefighter Program ▪ Future potential to review and update air quality regulatory processes; will be key to address processes for management of natural ignitions	▪ Annual interagency planning meeting ▪ USFS air quality liaison with DEQ in NM ▪ BLM and State Land Office partner in E. NM on cross-boundary burns ▪ Southwest Coordination Group (all federal burners) ▪ Oil and gas partnerships in place with BLM to facilitate communication to shut off the oil lines around burns ▪ Rx fire council active to support burning
Oregon	▪ Short and unpredictable burn windows due to weather ▪ Concern about potential for smoke intrusions[18] into Smoke Sensitive Receptor Areas (SSRAs). ▪ Non-attainment areas due to wood smoke are already at risk of violating air quality standards ▪ Endangered and threatened species protections limit Rx fire ▪ Lower public smoke tolerance after recent wildfires ▪ Lack of dedicated funding for burning; USFS prioritizing wildfires and BLM prioritizing sage grouse ▪ Historically, limited dialogue statewide about Rx burning and public health tradeoffs	▪ Improved communication between DEQ and Oregon Department of Forestry ▪ Partnerships with NGOs to burn (e.g. TNC, Rx Fire Council) ▪ Opportunities with SMP revision to improve techniques, increase public outreach, revise terminology ▪ Opportunities for greater investment (people and funding) in certain regions could increase Rx fire ▪ Opportunities to bring forestry and public health experts together to create and revise relevant policy	▪ BLM and Region 6 USFS partner together to develop supplemental interagency guidance for Rx burning ▪ Formal and informal partnerships between burners augment limited agency staff for burns events and can facilitate sharing of training, technical assistance, personnel, equipment, and communication ▪ Rx fire council active to support burning
Utah	▪ Single clearing index across entire state (500 or above within 50 miles of sensitive areas) is limiting as it doesn't allow elevational and geographic differences. Some exceptions being allowed at 450 or above ▪ Challenges of burning cheat grass discourages Rx fire ▪ Lack of staff with needed Rx fire qualifications ▪ Mechanical treatments more predictable in terms of capacity and funding than Rx fire to meet targets ▪ Limited burn windows due to winter inversions ▪ DEQ perception that agencies are writing burn plans that are overly complex ▪ Perceived public aversion to smoke ▪ Significantly less Rx burning being done than at the inception of the National Fire Plan, but there appears to be little interest in doing more burning in the state	▪ Flexible funding mechanisms through Watershed Restoration Initiative (WRI) facilitate Rx burns ▪ Interagency smoke coordinator increases communication ▪ FS working to address limited staff with Rx quals by improving the ability to share resources in the state (putting Rx personnel into Resource Ordering and Status System (ROSS)) ▪ Forest Supervisors set million-acre challenge in next five years to move the program, with support from the Governor ▪ Interagency committee working to consider how clearing index limits can be adjusted to create more local and strategic air quality decisions	▪ Interagency smoke coordinator working for federal land management agencies and state forestry ▪ Watershed Restoration Initiative (WRI) of Utah's Conservation and Development Division. Brings funds and proposals together from state and federal agencies and non-profits. Multi-agency teams rank, select, and allocate funding to projects that all parties consider high priority ▪ MOU between all burning partners conducting Rx burns according to the best management practice guidelines of the SMP. Includes state, federal, and tribes as part of UT Regional Haze SIP. The MOU group meets at least once a year to evaluate the effectiveness of the SMP

	Primary reported barriers and challenges	Facilitators and opportunities	Interagency relationships for burning and air quality oversight
Washington	▪ Lack of capacity ▪ Short burn windows due to weather conditions ▪ Burn approvals on the day of the burn come too late to mobilize resources to burn ▪ Topography (valleys) and concentrated populations in areas with smoke sensitive populations impacts burning ▪ State contains five class 1 federal areas ▪ Visibility protection in SMP restricts weekend burning ▪ Lack of consistency in regulatory understandings between agencies and local and state level entities ▪ Technical glitches with burn requests online ▪ Limited public acceptance of smoke and fire	▪ Interagency communication improved Rx fire understanding ▪ Forest Resiliency Burning Pilot to identify opportunities for Rx fire ▪ Interagency and partner resource sharing to burn ▪ Community outreach through local fire departments, Rx Fire Council ▪ Rx fire trainings build capacity ▪ Opportunities with SMP revision: more burn days/changing burn thresholds, earlier burn approval, improved communication	▪ BLM and Region 6 USFS partner together to develop supplemental interagency guidance for Rx burning ▪ Rx fire council active to support burning
Wyoming	▪ Unpredictable weather and inversions ▪ Non-attainment zones for PM 2.5 around Sheridan and Ozone around the Upper Green River ▪ Sage grouse-related restrictions for BLM	▪ Strong interagency resource sharing of equipment to help increase capacity ▪ Opportunities may lie in finding options in sage grouse habitat, and in creating a web-based program to document burns	▪ DEQ holds an annual smoke management meeting to discuss burn requirements and provide an overview of the burn program ▪ BLM has agreements with USFS and USFWS to share equipment on Rx burns ▪ Land management agencies partner with NGOs to conduct Rx burns: Rocky Mountain Elk Foundation, Mule Deer Foundation, Trout Unlimited, Wyoming Wildlife and Natural Resource Trust

Endnotes

1 Prescribed fire, or planned fire used to meet management objectives is a term synonymous with prescribed burns, and planned or controlled burns or fires. In our work we focused on planned ignitions in our questions, although some interviewees also shared perspectives about management of unplanned ignitions.

2 The 11 western states include: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming.

3 This information is drawn from D. Braddock & Alec C. Zacaroli, Meeting Ambient Air Standards: Development of the State Implementation Plans, in The Clean Air Act Handbook, pp. 49-87 (Julie R. Domike & Alec C. Zacaroli eds. 2016).

4 For more information, see generally M. Lea Anderson, The Visibility Protection Program, in The Clean Air Act Handbook, pp. 219-248 (Julie R. Domike & Alec C. Zacaroli eds. 2016).

5 81 Fed. Reg. 26,942, 26,946 (2016).

6 40 CFR § 51.308(d)(1)(i)(B).

7 40 CFR § 51.308(d)(3).

8 81 Fed. Reg. 26,959 (2016).

9 40 CFR §§ 50.1(j),(k) & (m) through (r), 50.14, and 51.930.

10 Smoke intrusion: "smoke from prescribed fire entering a designated area at unacceptable levels" (NWCG, 2012).

11 Quoted material in this column is drawn from the applicable law indicated for the state in column 1.

12 The "Good Neighbor Authority" (16 U.S.C § 2113a) allows the U.S. secretaries of Agriculture and Interior to enter into cooperative agreements or contracts with states pursuant to which state agencies can perform "forest, rangeland, and watershed restoration services" (including "activities to reduce hazardous fuels") on Forest Service and BLM land. The "Wyden Authority" (16 U.S.C. §§ 1011 & 1011a) allows the departments of Agriculture and Interior to enter into "cooperative agreements" with other federal agencies, tribal, state, and local governments, and private and nonprofit entities/landowners for the protection/restoration/enhancement of fish/wildlife habitat "and other resources on public or private land" and for "the reduction of risk from natural disaster where public safety is threatened."

13 https://famit.nwcg.gov/applications/ROSS.

14 "Four Forest Restoration Initiative (www.fs.usda.gov/4fri).

15 Rx fire: prescribed fire.

16 MOU: Memorandum of Understanding.

17 SMP: Smoke management plan.

18 Smoke intrusion: "smoke from prescribed fire entering a designated area at unacceptable levels" (NWCG, 2012).

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