Understanding Policy Leverage Points for Integrating Public Health and Increased Use of Prescribed Burning in California, Oregon, and Washington

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Executive Summary

This report is intended to complement the 2019-2021 Science for Nature and People Partnership (SNAPP) project "Integrating human health risks from fire into forest restoration planning" by The Nature Conservancy in partnership with the University of Washington's Department of Environmental and Occupational Health Sciences. The intended audience of this report is SNAPP working group members. The goal of this project was to better understand potential policy leverage points for integrating public health and ecological restoration-based forest planning practices, notably prescribed burning, for California (CA), Oregon (OR), and Washington (WA) states.

Research activities included:

- A review of existing literature on regulatory barriers and facilitators for prescribed burning in the Western United States
- A review of federal and state policies related to smoke management, prescribed burning, and wildfire management
- A review of state-level regulatory processes for prescribed burning
- An analysis of policy barriers and facilitators for implementing prescribed burning in CA, OR, and WA
- An analysis of key stakeholders for developing a collaborative approach to identifying and communicating human health and health equity considerations to prescribed fire

While changing federal policies was not identified as a priority strategy for increasing the scale of prescribed burning, an overview of the major provisions of the Clean Air Act and how it pertains to state implementation plans, as well as a brief overview of several other major federal policies, is included to provide context for decision-making and regulatory structures.

Primary barriers to implementing prescribed burning in the three states included themes of lack of funding capacity, risk aversion and liability, lack of staff capacity, agency culture and incentives, resource sharing, and public opinion. Facilitators for prescribed burning included interagency collaboration, communication/outreach, leadership, local collaboratives, and reducing liability. These barriers and facilitators are explained in greater detail in the Barriers and Facilitators sections of the full report.

The first set of recommendations focuses on leveraging public health partnerships to incorporate human health and health equity considerations into prescribed burn planning and implementation:

1. Increase opportunities for collaboration between the forest management, public health, air quality, and fire management sectors at state and local/regional levels
2. Increase the availability and use of public health data and modeling to justify long-term risk reduction of prescribed burning vs. wildfire exposure
3. Utilize public health pathways and expertise for communications and outreach around potential impacts of prescribed fire smoke
4. Increase available funding and support for community-level planning and preparedness
5. Invest in tribal stewardship and Indigenous-led prescribed burn programs

The second set of recommendations aims to increase the scale of prescribed burning in CA, OR, and WA:

1. Foster a culture of “good fire” around prescribed burning
2. Develop and streamline pathways for resource-sharing among agencies, including qualified staffing
3. Address issues of risk aversion and concerns around liability
4. Invest in interdisciplinary collaboratives at the local/regional level
5. Leverage and increase support for local/regional collaborative planning

Detailed summaries of these recommendations are included under the Recommendations sections.

Contents

Background

Prescribed burning, as part of an ecological restoration-based forest management strategy, is an essential tool for restoring and building resilience for fire-adapted forest landscapes and ecosystems. Prescribed fire has long been practiced by Native and Indigenous peoples in the Western United States as part of a larger practice of holistic fire and land stewardship, reflecting the essential role of fire in adapting to local environmental conditions and mitigating the impacts of catastrophic fire events (1). While the benefits of using prescribed fire are widely acknowledged, its use is still well below levels needed to effectively mitigate the impacts of fire and meet land management goals (2,3).

Overview of Prescribed Burning in California, Oregon, and Washington

Rates of prescribed burning in the Western United States have remained relatively stagnant, or even decreased, compared to other regions (4). In CA, OR, and WA, the majority of forestland is federally owned by the United States Forest Service (USFS), Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA), National Park Service (NPS), and United States Department of Fish and Wildlife (F&W), with large portions also owned by private corporate landowners and private non-corporate landowners, including individuals, families, NGOs, land trusts, and tribes, followed by states (5).

A study from the University of Idaho showed that in the Western United States, between 1998 and 2018, the Northwest, Northern California, and Southern California regions decreased prescribed burning by 1.9, 2, and 2.3%, respectively (4). Of agencies analyzed nationally, the study found that the majority of prescribed burning was being implemented by the USFS (41.3%) and state/other agencies (39.5%) (4). Of federal agencies, only the BIA significantly increased the scale of its prescribed burning (3.7% increase), and prescribed burning by federal agencies overall decreased from 90% of the total to 30% over the 21-year study period (4). Additionally, prescribed burning by state/other entities accounted for 93% of the increase in prescribed burning (4).

Prescribed burning includes multiple types of burning, including pile burning, underburning, and in some cases other types of burning such as agricultural burning. In understanding the scale of prescribed burning, it's important to acknowledge that these categories of burning contribute to wildfire risk reduction in different ways; compared to pile burning, underburning is considered most critical to reducing wildfire severity, and the true scale of its use may be obfuscated by aggregated data (2).

Smoke and Human Health Impacts

With growing intensity and frequency of wildfires projected under almost all climate change models, a growing body of research is investigating the human health impacts of wildfire smoke. Of primary concern are ambient air pollutants, notably fine particulate matter ($PM_{2.5}$). Short-term acute exposure to $PM_{2.5}$ has been associated with irritation of the eyes and respiratory tract, reduced lung function, pulmonary inflammation, bronchitis, exacerbation of asthma and other lung diseases, and exacerbation of cardiovascular diseases (6). An analysis of hospital data following the historic 2019-2020 wildfire season in Australia estimated smoke-related health costs of greater than 1.42 billion USD, more than nine times the median cost of the previous nineteen years (7). Little is currently known about the health impacts of cumulative exposure from wildfires occurring over multiple days or multiple consecutive fires (6).

Of key concern are communities at highest risk of health impacts due to wildfire smoke exposure. This heightened risk is determined by the intersection of exposure to wildfire with a number of demographic and social factors, including age, household income, education level, poverty, and employment status, as well as biophysical factors such as presence of pre-existing health conditions (8,9). Exposure is highest for communities living in the wilderness-urban interface (WUI) and in areas of high air pollutant concentration; however, large wildfire events can blanket communities with unhealthy smoke at the regional scale (9). A study by Davies et al. in 2018 estimated that over 29 million Americans live in areas with significant potential for extreme wildfires, and of those, an estimated 12 million are considered "economic or

socially vulnerable," meaning they have limited adaptive capacity to weather the impacts of wildfire (8). The same study showed that census tracts that were majority Black, Hispanic, or Native American experienced a 50% greater vulnerability to wildfire compared to other census tracts, indicating disproportionate burden of the impacts of wildfire by communities of color (8).

Other populations of concern include people with limited English proficiency (LEP), who may lack access to traditional communication channels and warnings of elevated smoke due to wildfires, and outdoor workers, including agricultural and construction workers, who may experience disproportionate exposure to the impacts of wildfires and other climate hazards (10). Additionally, it's important to consider the occupational exposure of wildland fire fighters, who not only experience high exposure to both wildfire and prescribed fire smoke, but, as in the case of the estimated 40% of California's wildland fire fighters that are currently incarcerated, may lack adequate occupational protections (11,12).

In discussing this disparate vulnerability to the impacts of wildfire, it is also important to acknowledge the role of systemic inequality and racism through practices, such as redlining or the breaching of tribal treaty agreements, in constructing the conditions in which certain populations experience disproportionate exposure and vulnerability to the effects of wildfires (10,13). These conditions are often the result of structural discrimination, perpetuated both in policy outcomes as well as traditional top-down policy-making and implementation processes that often fail to include the perspectives and priorities of communities most impacted (13). It is also important to acknowledge the limitations of this discussion in not considering factors that promote resilience to wildfire impacts in addition to vulnerability.

While there is mounting evidence of the efficacy of prescribed burning in mitigating the severity of wildfires in areas that have been treated and reducing smoke, more research is needed on the differences in smoke composition between prescribed fire and wildfire and its implications for human health and health equity (14,15).

Clean Air Act and State Implementation Plans

The Clean Air Act of 1970 is the primary law regulating air quality standards in the United States (16). Smoke and emissions from prescribed burning are regulated by two components of the federal Clean Air Act: 1) National Ambient Air Quality Standards (NAAQS), and 2) visibility and regional haze requirements in Class 1 areas (3). The Clean Air Act establishes the framework for which emissions and smoke are regulated at the federal and state levels and has been commonly cited as a barrier for implementing prescribed burning. However, a qualitative study by Schultz et al. with BLM and USFS employees at state and regional offices found that with the exception of WA and OR, which were in the process of revising their smoke management plans at the time of the interview, air quality regulation was not considered a significant barrier to planning and implementing prescribed burning (3).

NAAQS

Under the Clean Air Act, the Environmental Protection Agency is required to develop and regulate NAAQS for six pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_x), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2) (3,17). The EPA sets primary standards for these pollutants based on permissible levels for human health and environmental safety. Areas that adhere to NAAQS thresholds are referred to as "attainment areas," whereas areas that exceed these standards are known as "nonattainment areas," or "unclassifiable," if unknown (16). Of key concern in relation to smoke and emissions from wildfire and prescribed fire are both course (PM_{10}) and fine ($PM_{2.5}$) particulate matter, and to a lesser degree, O_3 and CO, which are associated with respiratory and cardiovascular health impacts (6).

State Implementation Plans and Smoke Management Programs

Under the federal Clean Air Act, individual states are required to develop legally-binding state implementation plans (SIPs) to outline their strategies for achieving, regulating, and enforcing these standards (3). SIPs must include strategy to not exceed thresholds set by the NAAQS at a minimum, however they have authority to designate stricter standards than those set by the Clean Air Act. Each state has a smoke management plan, which in the case of WA and OR, is administered by their state forestry and natural resource departments, the Washington State Department of Natural Resources (DNR) and Oregon Department of Forestry (ODF). In CA, the Smoke Management Guidelines, which outline standards for smoke management programs for individual air quality districts, is housed by the California Air Resources Board (CARB). Each smoke management program differs in scope and procedure, and state-specific regulatory and complaint processes. A detailed comparison of CA, OR, and WA smoke management plan documents can be found in Appendix 2 and 3.

Visibility and Regional Haze in Class 1 Areas

In 1977, amendments were passed to the Clean Air Act to remedy and protect further visibility degradation to federal Class 1 areas, which are primarily designated wilderness areas of over 5,000 acres in size, or National Parks of over 6,000 acres (3). In 1990, additional amendments were made to protect visibility in Class 1 areas from nearby regional haze, which is considered visibility impairment resulting from a multitude of sources (17). Additional promulgations of the Clean Air Act required states to adjust SIPs to include a long-term strategy for reducing haze and achieving "natural visibility" by the year 2064 (17). A 2017 amendment allowed emissions from certain prescribed burns to be considered "natural" or "non-anthropogenic," and exempt from emissions thresholds, as prescribed burning has not significantly contributed to haze in the few Class 1 areas that have experienced degradation (3,17).

Exclusion of Prescribed Burning Emissions from SIP and Non-Attainment Determination

In recent years, the EPA has shown increased support for prescribed burning and acknowledgement of the role that prescribed fire can play in ecosystem health and mitigation of the impacts of wildfire (3). The EPA's Exceptional Events Exclusion Rule (EER) of 2015 allows for the exclusion of certain prescribed fire emissions from SIP-related determinations around exceedances of NAAQS (17). To qualify for an Exceptional Events determination, a prescribed burn cannot be planned to trigger an exceedance and must demonstrate that a spike in emissions was due to the prescribed burning event, that smoke management was deployed, and that the fire was included in a land management plan (3). It is important to note that states may have varying levels of comfort and different cultures around the acceptability of using the EER to exclude emissions from prescribed burning, despite the EPA's ruling.

Smoke Sensitive Receptor Areas

Smoke Sensitive Receptor Areas (SSRAs) are areas that receive the highest level of protection from smoke intrusions, under Oregon state law and the Oregon State Management Directive (18). These are areas with a history of smoke incidents, high population density, and/or other legal status related to visibility (18).

Other Notable Federal Policies

The National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA), which impose additional regulatory limitations or processes on planning and burning under certain circumstances have also been noted to hinder prescribed burning (3,19–21).

Prescribed burning is subject to regulation under NEPA, which ensures that an extensive environmental review is completed, potential areas of environmental impact and appropriate mitigation strategies are identified, and that procedures are put in place to ensure environmental impact information is made available to public officials and citizens before implementation (22). The NEPA environmental analysis process interacts with air quality regulation, in that it anticipates and documents the potential environmental tradeoffs and impacts of prescribed burning with other forms of fuels management, including emissions and smoke produced during burning (22).

Under the ESA, habitat for threatened and endangered species is subject to certain protections and protocols for land management. In the case of the spotted owl, whose habitat stretches across CA, OR, and WA, forest managers are disincentivized from treating areas in which there are owls with prescribed fire to reduce administrative burden and potential risks to owl habitat (23).

While these specific policies can be interpreted as restrictive to prescribed burning, other federal policies have supported its expanded use, such as the 2003 Healthy Forest Restoration Act (HRFA), which prioritizes hazardous fuel reduction projects and encourages the development of Community Wildfire Protection Plans, the Collaborative Forest Landscape Restoration Program (CFLRP), and the 2009 Federal Land Assistance, Management and Enhancement (FLAME) Act and ensuing National Cohesive Wildland Fire Management Strategy (NCWFMS) (19,24). Additionally, the National Forest Management Act (NFMA) establishes a fundamental framework for forest administration and development of forest and vegetation management plans on national forest land (25). These policies make clear the need for increased fuels management, including prescribed burning, for forest resiliency and wildfire prevention on federal lands (19).

Understanding the Decision-Making and Regulatory Process of Prescribed Burning

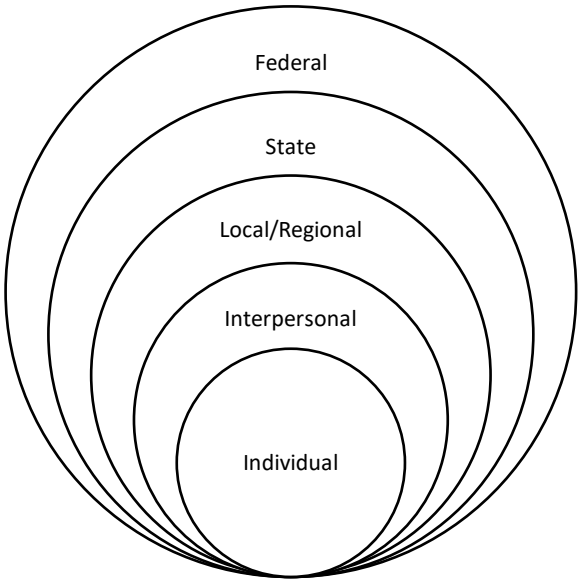
The decision-making and regulatory process around when, where, and how to burn is complex and multi-level (26). To acknowledge this complexity, it is important to delineate between policy barriers that are: 1) codified into federal law; 2) resulting from the interpretation of federal and state policies (e.g. guidelines for implementation); 3) resulting from agency culture or habit; or 4) resulting from individual-level decision-making, made within the context of their social environment and individual attitudes (3,27).

Figure 1 shows the hierarchy of decision-making for non-tribal bodies around the implementation of prescribed burning. The process is hierarchical; for example, decisions made at the individual level are subject to interpersonal norms, local/regional authority, state regulation, and federal policy.

At the federal level, smoke from prescribed burning is subject to restrictions under the Clean Air Act and Regional Haze Rule. At the state level, each state is responsible for developing smoke management plans/guidelines and SIPs. At the local/regional level, air districts have the authority to make a “go/no go” approval for prescribed burns within their jurisdiction, and county governments can institute burn bans. The interpersonal level relates to agency and community norms, protocols, and culture around prescribed burning, including perceived social acceptance of burning. At the individual level, decisions are made within the context of individual risk aversion and cost-benefit analysis.

Within the context of how federal policy shapes policy and decision-making at subsequent levels, it is also important to note the difficult and often slow-moving process of shaping federal policy, and potential discrepancies between how policy is written and implemented. Taking this into account, changing policy at the federal level is not considered a priority for increasing the scale of prescribed burning at this time, and action that can be taken at the state, local/regional, interpersonal, and individual levels is prioritized throughout the remainder of this report.

Figure 1: Hierarchy of decision-making around prescribed burning



Prescribed Burning on Tribal Lands

Several federal policies ensure tribal sovereignty in planning, regulating, and implementing prescribed burning on tribal land. The Tribal Authority Rule (TAR) authorizes federally-recognized tribes' rights to implement tribal air programs, and secures treatment under the Clean Air Act to be the same as states (28). Under the TAR, full authority is given to eligible tribes over air resources within tribal reservation boundaries, and tribes are encouraged, but not required, to develop tribal implementation plans, similar to SIPs for monitoring and enforcing air quality standards (28). To support tribes in developing their own programs, the EPA has dedicated funding and resources, and provides technical support in monitoring air quality (28).

In Idaho, Oregon, and Washington, the Federal Air Rules for Reservations (FARR) establish a set of air quality thresholds and standards for tribal reservations, in the absence of any tribal implementation plans in those states (29). While the FARR is an important step for protecting air quality and health for people living on tribal reservation land in these three states, it places enforcement authority solely with the EPA (29).

Approach

Initially, a literature review of existing articles and analyses related to policy and regulatory barriers and facilitators was used to understand the context and range of factors that influence prescribed burning in the Western United States. This was complemented by interviews with fire ecology and forest management experts from The Nature Conservancy, University of Washington, and United States Forest Service.

A second activity included an analysis of major federal and state policies impacting the use of prescribed fire and smoke management (Appendix 1: Notable Federal and State Policies Related to Prescribed Burning Implementation and Smoke Management). Federal and state-level policies were compiled throughout the literature review process and by searching in congressional and state legislative databases. Additional policies were identified through analyses of state implementation plans of the Clean Air Act and Smoke Management Plan/Guideline documents. After compilation, policies were summarized, referenced, and determined to be "hindering," "neutral," or "enabling" to prescribed burn

implementation based on their role in constructing the regulatory environment for prescribed burning and forest management.

Third, a review of state-level regulatory and smoke complaint processes, which are found in state smoke management plan/guideline documents, was used to better understand the regulatory landscape at the state-level. Regulatory processes were outlined in visual form and compiled in a single document for ease of access (Appendix 2: Regulatory Processes for Prescribed Burning, by State). A matrix of the three smoke management plan/guideline documents was created to compare similarities and differences across various components and elements of the plans (Appendix 3: Comparison of State Smoke Management Plan/Guideline Documents).

Dedoose qualitative coding software was used to analyze references to specific themes of barriers according to geographic scope and stakeholder type, as identified through the literature review (Appendix 4: Barriers and Enablers to Prescribed Burn Implementation). Additional analysis was done to identify opportunities for expanding the scale of prescribed burning and integrating public health considerations into prescribed fire planning, which were cross-referenced with the literature and notes from interviews with fire ecology and forest management experts.

Lastly, a stakeholder analysis (Appendix 5: Stakeholder Analysis) was done to better identify dynamics and motivations of various stakeholders and partners to integrating health and health equity considerations into prescribed burning planning and forest management. Stakeholders were identified through references in the literature review and collaborative brainstorming with SNAPP project partners. Stakeholders were then analyzed for impact to policy making, impact from policy making, and influence over policy making process, as well as motivations and stake.

Results

Barriers to Prescribed Burning

The following reflect the most common and significant barriers found throughout the literature review process and analysis. See Table 2 and Appendix 4: Barriers and Enablers to Prescribed Burn Implementation for an overview of themes analyzed.

Summary of Barriers of Prescribed Burning

Funding Capacity

Challenges associated with adequate funding and resources were consistently reported to be the leading barriers for prescribed burn managers at all levels, from federal land managers to private landowners. This challenge was most significant when hiring qualified staff to plan, prepare for, and implement prescribed burning at a landscape scale (3). Increasing demands on USFS fire suppression budgets have reduced available funding and resources for fuels management, and BLM employees reported shifting funding for states with sage grouse populations as a barrier (3,24,30). Reduced funding for state air quality agencies was also noted as a significant barrier to collaboration with burn managers (3). For private landowners, high costs disincentivized them from implementing prescribed burns on their property (31).

Risk Aversion and Liability

Across sources, risk aversion and concerns around liability were noted as significant barriers to prescribed burning. For private landowners, the fear of liability around an escaped fire is a key concern (31). Gross negligence is considered a more extreme form of negligence, compared to simple negligence, and generally requires significant recklessness or lack of care for potential harm to self or others (32). WA is the only state that currently offers Certified Prescribed Burn

Manager (CPBM) program and protection of liability only under gross negligence, whereas CA and OR both have stricter liability laws (33,34).

Staff Capacity

A lack of qualified personnel to implement prescribed burns was another significant barrier, both in terms of numbers of staff and adequate training and capacity. In CA, the growing intensity and frequency of wildfire events strains already limited staff capacity and qualified prescribed fire staff are often not available during ideal burn windows (3,21,24). High staff turnover in USFS regional offices and national forests reduces staff capacity to move through the lengthy administrative planning and environmental review processes needed for prescribed burning (30).

Agency Culture/Incentives

USFS, and to a lesser extent, BLM, agency culture has been shown to act as a barrier to increasing the scale of prescribed burning. Ambiguous definitions around the role of fire in USFS programs, in particular the Fire and Aviation Management program, have incentivized short-term wildfire risk reduction over holistic forest restoration (24,30). In addition, long histories of fire suppression within the USFS and BLM have led to the development of incentive structures that do not support prescribed burning (3).

Resource Sharing

Administrative hurdles around lack of flexibility with sharing resources is a challenge for federal agencies, impacting their ability to implement burns across boundaries. Multiple federal employees noted a need for more nimble mechanisms of sharing staff and resources, as well as clear agreements and pathways for moving resources across agencies (3,30).

Public Opinion

With growing development in the WUI and increasing frequency of wildfires, more communities are being exposed to smoke and the impacts of fire. This is especially significant because of the role of the public in shaping policy and agency incentive (21,24,30). Lack of awareness of the long-term benefits of prescribed fire and fears around smoke have led to an often-negative public perception of prescribed burning, particularly in OR and WA (3). This can be exacerbated by poor communication and outreach with the public (30).

Table 2: Barriers to prescribed burning, by state

Adapted from *Schultz et al. (2018). Prescribed Fire Policy Barriers and Opportunities: A Diversity of Challenges and Strategies Across the West.*

California	Oregon	Washington
• 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)	• Short and unpredictable burn windows due to weather • Concern about potential for smoke intrusions 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 prescribed fire	• Lack of capacity • Short burn windows due to weather • Topography (valleys) and concentrated populations in areas with smoke sensitive populations • State contains five class 1 federal areas • Visibility protection in SMP restricts weekend burning • Lack of consistency in regulatory understandings between

• Political pressure to not burn during wildfires • Qualified personnel sometimes not available to fill BLM positions • Intermixed landscape across private/federal/state lands	• 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 prescribed burning and public health tradeoffs	agencies and local and state level entities • Technical glitches with burn requests online • Limited public acceptance of smoke and fire

Facilitators of Prescribed Burning

Summary of Facilitators of Prescribed Burning

The following reflect the most common and significant facilitators found throughout the literature review process and analysis. See Table 3 and Appendix 4: Barriers and Enablers to Prescribed Burn Implementation for an overview of themes analyzed.

Interagency Collaboration

Collaboration between air quality and land managers was noted as essential for increasing scale of prescribed burning and developing relationships to sustain successful partnerships. Examples of successful interagency collaboration are the CA Fire MOU Partnership, where air quality regulators, CAL FIRE, federal land managers, and NGO groups work together to understand and address barriers to prescribed fire use (3,21). NGOs, because of their flexibility, have emerged as promising partners for facilitating government agency collaboration through Prescribed Fire Councils, or other forums (3,33). Relationships between federal agencies was also identified as essential to facilitate resource sharing and addressing issues of funding and staffing capacity (2,30,35).

Communication/Outreach

With increasing frequency of wildfires, public awareness of the urgency of mitigating impacts to communities is growing, however this can be catalyzed by increased outreach and communication with communities before, during, and after burning (3,30). Additionally, revisions in the Oregon Management Plan have included greater provisions for communications with potentially impacted communities, and a review of communication best practices was included in the Washington Forest Health Resiliency Burning Pilot report (18,35).

Leadership

Leadership of agencies authorizing and implementing prescribed burning that is risk tolerant and believes in the benefits of prescribed burning was shown to be effective in dedicating resources, staff, and funding to advancing the use of prescribed burning, especially at the local and forest scale (30). Leadership within federal and state agencies is also positioned to affect incentive structures and performance measures, which have historically disincentivized the use of prescribed burning (19).

Local Collaboratives

Federal policies such as the CFLRP and the HRFA are structured to incentivize localized, collaborative planning efforts with community stakeholders, including the development of Community Wildfire Protection Plans and forest management plans (19). Under the National Cohesive Wildland Fire Strategy, the establishment of fire-adapted

communities is encouraged, which has been supported by NGO partners, such as The Nature Conservancy, to affect change at the local level (19,30).

Reducing Liability

CPBM programs can address concerns around liability and individual capacity for burn implementers, including private landowners. Of the three states examined, Washington is the only state to be currently implementing a CPBM program, whereas Oregon has a program under state law that has yet to be implemented, and California's is currently under development (34). Under Washington state law, CPBMs face liability only under gross negligence, as opposed to Oregon and California, which operate under simple negligence (33,34).

Table 3: Facilitators to prescribed burning, by state

Adapted from *Schultz et al. (2018). Prescribed Fire Policy Barriers and Opportunities: A Diversity of Challenges and Strategies Across the West.*

California	Oregon	Washington
• 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 • Finding opportunities to better utilize burn days, address policy issues, and identify opportunities through MOU16 partnership • Creating more local and strategic air quality decisions based on better monitoring, data, and communication • Potential to improve Forest Service strategic planning to identify and support more opportunities	• Improved communication between DEQ and Oregon Department of Forestry • Partnerships with NGOs to burn (e.g. TNC, Prescribed 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 prescribed fire • Opportunities to bring forestry and public health experts together to create and revise relevant policy	• Interagency communication improved prescribed fire understanding • Forest Resiliency Burning Pilot to identify opportunities for prescribed fire • Interagency and partner resource sharing to burn • Community outreach through local fire departments, Prescribed Fire Council • Prescribed fire trainings build capacity • Opportunities with SMP revision: more burn days/changing burn thresholds, earlier burn approval, improved communication

Recommendations

Recommendations for Leveraging Public Health Partnerships

The following recommendations reflect the SNAPP project goal of understanding the human health and health equity impacts of wildfires versus prescribed burning and describe potential avenues for leveraging public health partnerships to mitigate the impacts of increased scale of prescribed fire on communities at high risk of impacts.

Recommendation 1: Increase opportunities for collaboration between the forest management, public health, air quality, and fire management sectors at state and local/regional levels

Historically, there have been few forums for interdisciplinary engagement and collaboration between the forest management, public health, air quality, and fire management sectors, and a key step in leveraging these partnerships is to create a shared understanding of how these fields intersect. Projects such as SNAPP are important in setting this foundation for aligning the goals of these separate fields of work and establishing a framework for continued collaboration. Public health and air quality have historically been viewed as being in opposition, or as a barrier, to prescribed burning, due to the potential smoke impacts; however, it is being shown that increased collaboration and meaningful engagement in the prescribed burn planning process can actually identify new pathways for long-term, holistic smoke impact risk reduction through prescribed burning.

Opportunities for collaboration include the evaluation, planning, and revision of smoke management program documents and policies. The Washington and Oregon Smoke Management Plans were recently updated in 2018 and 2019, respectively, to better facilitate the safe, expanded use of prescribed burning, and included some provisions on risk mitigation and communication with at-risk communities (3,18,36).

The Central Oregon Prescribed Fire, Smoke, and Public Health Collaborative is a project based out of Bend, OR, and brings together the Central Oregon offices of the Oregon Health Authority, Oregon Department of Forestry, Oregon Department of Air Quality, Deschutes County Health Services, and other governmental and NGO partners to centralize resources on wildfire and prescribed fire smoke for the general public (37). By involving the Oregon Health Authority and Deschutes County Health Services, the collaborative can leverage public health expertise in health communications and planning, as well as public health partnerships, to reach a wider audience.

It is important to also note the role of NGO partners, such as The Nature Conservancy, in acting as a convener and facilitator for interdisciplinary partnerships. NGOs have been, and will continue to be, essential in promoting active collaboration between different stakeholders.

Recommendation 2: Increase the availability and use of public health data and modeling to justify long-term risk reduction of prescribed burning vs. wildfire exposure

Currently, little data exists measuring the health impacts of smoke exposure from prescribed burning compared to wildfires. The Washington Forest Resiliency Burning Pilot Project included some monitoring of smoke impacts, but was limited in its applicability to demonstrate how prescribed fire might mitigate the smoke impacts of future wildfires (35). There is mounting evidence showing that wildfire smoke in forest areas treated by prescribed burning may be less harmful in its composition than areas that were not treated, and that repeated prescribed fire treatments produce less smoke over time, more research is needed in this area to make informed decisions around when, where, and how to use prescribed fire in a way that minimizes smoke impacts to nearby communities (14,15).

Recommendation 3: Utilize public health pathways and expertise for communications and outreach around potential impacts of prescribed fire smoke

Many state and local/regional public health departments have existing pathways for risk communication around emergencies, including smoke impacts from wildfires, which can be leveraged to communicate with populations at highest risk of impacts from prescribed fire. An example is the inclusion of protocol and infrastructure for communicating about potential smoke impacts within local/regional emergency planning efforts.

Public health expertise and methods could also be used to identify populations at greatest vulnerability to the impacts of prescribed fire smoke and design targeted prevention, intervention, and outreach. Local public health departments often have existing systems and partnerships, including nonprofits, translation services, health clinics and hospitals, schools, and other community institutions that can be used to reach populations at high risk and build capacity for communications and outreach. An example of this is outreach to agricultural workers, who often face legal, linguistic, cultural, and social barriers to accessing information about smoke impacts and public health, but experience

disproportionate exposure to wildfire and prescribed fire smoke, through nonprofits and advocacy group serving these populations, such as the Yakima Valley Farm Workers Clinic in Yakima, Washington.

Recommendation 4: Increase available funding and support for community-level planning and preparedness

As the frequency and intensity of wildfires are expected to increase, there is a growing need for investment in community-level planning and preparedness to smoke impacts from both prescribed fire and wildfire.

Often, these programs are implemented through local government institutions, including the local/regional public health department, clean air agency, and fire department. An example of this is the City of Ashland Free Air Purifier Program, which provides free HEPA filters for low-income families in Ashland, Oregon to mitigate the impacts of smoke from wildfires and prescribed burning (38).

The Fire-Adapted Community Learning Network, which provides a forum for community-based preparedness and adaptation to the use of fire in landscape management and wildfire prevention, is an example of NGO-led planning efforts, and is administered through a partnership between The Nature Conservancy, USFS, United States Department of the Interior agencies, and The Watershed Center (39). Another example is the National Fire Protection Association's FireWise Communities program, which works to educate communities on fire prevention and mitigation in the WUI, though there is less emphasis on the role of prescribed burning and adaptation to fire (40). Programs like these provide a model for working with communities to develop plans and prepare for increased wildfire and smoke from prescribed fires.

Recommendation 5: Invest in tribal stewardship and Indigenous-led prescribed burn programs

Indigenous and Native peoples of the Western United States have been practicing prescribed burning long before the arrival of European settlers as part of both a holistic practice of environmental stewardship and necessary adaptation for living in landscapes defined by fire (1). While the ongoing legacy of colonization has limited the practice of cultural and traditional burning, there is a growing acknowledgement of the significance of these practices in shaping fire-adapted landscapes in CA, OR, and WA, and of the need to preserve and center Indigenous and Native perspectives and knowledge on prescribed burning and fire stewardship (1).

Much of the foundational forest and fire policy in the Western United States was guided by European American concepts of forest and natural resource management that are culturally and ecologically very different from the actual forests of WA, OR, and CA (41). Tribal and Indigenous fire stewardship differs in its approach to prescribed fire compared to that of federal and state agencies and is often guided by cultural values and traditional ecological knowledge in partnership with forestry science (1,41,42). These practices have developed over generations of intimate connection and attentiveness to land and place, and often integrate holistic perspectives of community health and wellbeing, including how to coexist with smoke and fire (1).

An example of how federal and state agencies are working with tribal groups to partner in prescribed burning is through the Western Klamath Restoration Project in Northern California, which is led through an agreement by the Karuk Tribe, the Mid Klamath Watershed Council, Salmon River Restoration Council, and USFS (1,43). In partnership with The Nature Conservancy's prescribed fire training exchange program (TREX), the Western Klamath Restoration Project is using prescribed and cultural burning to restore the ecological landscape in a way that aligns with the Karuk peoples' priorities and invests back in local communities through fire impact mitigation, education, job creation and cultural preservation (1,43).

Recommendations to Increase the Scale of Prescribed Burning

This second set of recommendations acknowledges the need to increase the scale at which prescribed fire is implemented in the Western United States to be effective in meeting forest and fuels management goals. While this perspective on the use of prescribed fire is not universally held, it is the author's opinion that the use of prescribed fire

must not only be scaled up, but that it is possible to do so in a way that mitigates disproportionate impact on communities at high risk of impacts.

Recommendation 1: Foster a culture of "good fire" around prescribed burning

Historically, forest and wildfire management in the United States has emphasized mechanical treatments and the use of fire suppression, which has in turn, contributed to a culture of fear and avoidance around the use of managed wildfires and prescribed fire (19,24). While there is a growing recognition of the need for a more aggressive strategy to mitigating the impacts of wildfires on nearby communities, ingrained patterns of risk aversion and negative perceptions of prescribed fire impede its use at all levels, from the individual to federal. Policy is often shaped by public perception and vice versa, and to push forward a larger cultural shift in which prescribed fire is viewed as an acceptable tool for forest management at scale, targeted effort must happen at all levels.

In the past few decades, federal wildfire policy has been generally supportive of the use of prescribed burning; however, agency cultures and incentive structures have not always reflected this shift in attitudes. Chief among these is the USFS, which accounts for more than 40% of total acres burned in the United States and is well-positioned to lead other federal agencies in increasing the scale of their burning (4). Despite this, prescribed burning by the USFS has been relatively stagnant over the past twenty years; between 1998 and 2018, the agency only increased its acreage of prescribed burning by 0.7% (4). Much of this can be attributed to competition for resources; in 2017, wildfire management cost the USFS roughly 2.4 billion dollars, with an additional 821 million dollars supplied by the FLAME Act Wildfire Suppression Reserve Fund, together accounting for roughly 56% of the total USFS budget, and this is only expected to grow over the next decade (44). Long-standing agency culture and performance measures that favor short-term risk reduction further disincentivize land managers and leadership to use their limited budgets for fuels management (3,19). Additionally, current USFS standards create competing objectives within resource management, for example between fuels treatment and wildlife, which can create an antagonistic relationship between divisions and further disincentivize prescribed fire (30).

At the state level, forest and wildfire management decisions and strategy are often defined by State Foresters and forestry agencies, which are held accountable to both their constituents and to federal oversight and policy (21,26). In the case of WA, leadership of state forestry and wildfire agency is elected by the public, and in OR and CA the position is appointed by the governor, and therefore subject to public support or disapproval of forest and wildfire management strategies which can influence levels of risk tolerance around fire. Additionally, state wildfire and forest management policy is often responsive to public perception and advocacy; after two particularly destructive wildfire seasons in 2014 and 2015 in Washington, state legislature introduced a number of new proposals, including ESHB 2928, or the Forest Health Resiliency Burning Pilot, and HB 2733, a Certified Prescribed Burn Manager program, to increase the scale of prescribed burning (35). The same pattern occurred in CA after the 2017 and 2018 fire seasons (21).

Personal experience and familiarity with prescribed burning can be associated with positive perception and acceptance of its role in managing wildfires and landscapes by members of the general public (45,46). Additionally, trust in the agency implementing the burn can influence public perception, and collaborative outreach and messaging from local, trusted institutions can increase public tolerance of prescribed burning in fire-prone areas (35,46). Another opportunity for building public approval is through TREX programs, which can help generate media coverage and bring together stakeholders from various sectors to participate in, feel ownership over, and learn more about the benefits and risks of prescribed fire use (35,36).

Recommendation 2: Develop and streamline pathways for resource-sharing among agencies, including qualified staffing

As the demand for resources dedicated to fire suppression will likely increase in the coming years, it is imperative to build pathways for resource sharing amongst all agency partners, particularly federal agencies such as the USFS and those housed within the Department of the Interior (BLM, BIA, F&W, and NPS) to expand capacity for prescribed burning. Currently, federal agencies each fund their own fire crews, and resources deployment and national crews are coordinated through the National Interagency Fire Center (NIFC) (24). Some resources-sharing agreements already exist

between agencies, however discordant bureaucratic systems and lack of clarity in jurisdiction and authority can impede motivation and ability to share resources across divisions (3,30). This is especially relevant for the sharing of qualified prescribed fire staff, who are often called away during wildfire season to work on fire suppression projects, or are unavailable during burn windows (30).

One way to improve efficiency would be through the creation of a dedicated interagency prescribed fire crew, coordinated and deployed through the NIFC or some other centralized body (3,24,30). Some individual agencies have already created dedicated prescribed fire crews, however due to limited capacity and increasing need for fire suppression, are often unavailable during optimal burn windows (21,24). By placing deployment authority with the NIFC, these crews could be reserved exclusively for fuels management without competing with resources for fire suppression.

Master state-wide agreements between federal agencies can foster resource-sharing between federal and state agencies and remove barriers for larger, landscape-scale burns, which can involve multiple landowners (30). Including flexible line items in USFS and BLM budgets allows for the ordering of resources from multiple agencies with less reliance on interagency agreements (3). State agency and USFS partnerships through the Good Neighbor Authority also allow for flexible land stewardship between state and federal agencies (47).

A co-benefit of increased resource-sharing across agencies is the potential to increase communication and partnership. An example of this is the USFS Region 6 collaboration with the BLM to increase the scale of prescribed burning (3). Many local, state, and NGO partners have additional resources and capacity to facilitate increased burning at the landscape scale, but the systems for sharing resources don't easily facilitate cross-agency sharing.

Recommendation 3: Address issues of risk aversion and concerns around liability

Risk aversion and concerns around liability were consistently ranked high among perceived barriers to increasing the scale of prescribed burning. Liability is generally dictated by state policy. For example, in Washington, Certified Prescribed Burn Managers (CPBMs) are only considered liable for damages caused by prescribed burning under evidence of gross negligence, whereas in Oregon, one can be considered liable under simple negligence, and in California, burn implementers can be held to strict liability (33).

Currently, only Washington has implemented a CPBM, which not only reduces liability but increases confidence and capability of land managers and private landowners to implement prescribed burns safely and appropriately (33,34). Oregon authorized a program under law in 1999 but has yet to implement their program, and California's program is under development (34).

Risk aversion can also be addressed through communications and outreach to the general public, who may feel reservation or fear around the presence of smoke from prescribed fire or fear of escaped fire, especially in communities that have experienced catastrophic wildfires in the past (30,35). The Washington DNR found in its Forest Health Resilience Burning Pilot that partnership with local community organizations and institutions such as schools and chambers of commerce helped build trust and acceptance with the public in areas they were piloting burn projects, as well as by inviting community members to join or observe prescribed burn projects (35). A study in the Southeastern United States found that district court judges, who are often the first to hear cases around liability, had more favorable attitudes towards prescribed burning if they had personal experience, either as a community member or private landowner, in implementing prescribed burning (46). The same was found for air quality managers and county commissioners (3,46). Another example of how California is working around risk aversion from state private landowners is to offer assistance in implementing prescribed burning on private land through CAL FIRE's Vegetation Management Program, which is done at a sliding scale cost to the landowner (21).

Recommendation 4: Invest in interdisciplinary collaboratives at the State and Local/Regional levels

Due to the complex relationship between air quality management, forest management, public health, and fire management, greater interdisciplinary collaboration can help identify localized solutions to persistent barriers that restrict the scale of prescribed burning. An example of this is Prescribed Fire Councils, which work to address policy, outreach, education, and technical challenges to implementing prescribed burning. The Washington Prescribed Fire Council was central to the passing of HB 2928, which allowed for a forest health resiliency burning pilot, and the creation of a CPBM program to build qualified prescribed burn implementer capacity (33,35). Another example is the larger state-wide California MOU Fire Partnership, which includes CAL FIRE, several federal agencies, and NGO partners, and was developed to hold agencies accountable in increasing their use of prescribed burning (21,30)

Formal partnership between air quality agencies and land managers have also been shown to be a facilitating factor for increasing prescribed burning (3). The California Interagency Air and Smoke council was developed to provide a forum for fire managers, land managers, and air quality managers to discuss technical issues around air quality and smoke management (3). Additionally, having dedicated air quality or smoke management liaisons working with land management agencies, as well as state-level smoke and airshed communication and coordination groups, have been shown to be helpful in identifying and implementing during optimal conditions (3,30). This can also work to improve measurement and tracking of smoke generation and dispersion and help identify additional windows for prescribed burning (3).

Recommendation 5: Leverage and increase support for local collaborative planning

Local/regional and state-level efforts to increase prescribed burning through collaborative planning present an opportunity to increase the scale and effectiveness of prescribed burning programs by engaging with diverse stakeholders to develop locally relevant plans for fuels management and forest health. Engaging communities through Community Wildfire Protection Plans, Forest Health Collaboratives, and community forests can increase community investment and acceptance of prescribed burning while opening avenues for prescribed burning at the local scale (30).

The CFLRP establishes a funding for collaborative national forest management plans developed by the USFS with local stakeholders for fuels management on National Forest System lands (45). Plans developed with CFLRP funds must include fuels management and restoration strategies over a period of ten years, on landscapes of at least 5,000 acres, and must be economically and socially viable (45). Collaboration with community stakeholders is central to the CFLRP, and the interdisciplinary nature of the program can provide a forum for innovation and problem-solving while working at larger scale than has typically been done in the past; however, the program is currently limited in scale due to funding (45).

The Forest Resiliency Burning Pilot in Washington state emerged from the passing of ESHB 2928 and piloted the use of prescribed burning in fifteen pre-identified areas to support forest health, while monitoring local air quality and engaging community members through outreach and communications (35). From this pilot, a series of recommendations was developed and integrated into the 2019 Silvicultural Smoke Management Update, reducing regulatory barriers in the Washington Smoke Management Plan for prescribed burning within the state (35,36).

Conclusion

As the intensity and frequency of wildfires in the Western United States is projected to increase with climate change, the need for mitigation strategies is growing in urgency. A growing body of evidence is demonstrating that prescribed burning, as part of an ecological restoration-focused forest management strategy can reduce the severity of wildfires and potential impacts to communities, however prescribed burning is still under-utilized in CA, OR, and WA due to a multitude of factors. This report outlines some of the primary barriers and facilitators for prescribed burning in these states and presents a set of recommendations for leveraging public health partnerships to better understand strategies that can be used to mitigate these impacts on communities at high risk and to engage public health partners in

understanding the long-term risk reduction of health impacts from wildfires made possible by prescribed burning. Additionally, in recognition that the benefits of prescribed burning will only occur if prescribed burning is increased in scale, a set of recommendations is included for expanding the use of prescribed burning in these states.

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Appendix 1: Notable Federal and State Policies Related to Prescribed Burning Implementation and Smoke Management

Table 1: Federal and state policies related to prescribed burning implementation and smoke management, by impact on implementation

**"Enabling" defined as policies supportive to the increased scale of prescribed burning; "neutral" defined as policies that do not have a significant impact on the scale of prescribed burning; "hindering" defined as policies restrictive to the increased scale of prescribed burning*

LEVEL	"ENABLING" POLICIES	"NEUTRAL" POLICIES	"HINDERING" POLICIES
Federal	- Treatment of air quality monitoring data influenced by exceptional events - Congressional declaration of purpose (visibility protections in Class 1 areas) - Healthy Forest Restoration Act (HRFA) - Collaborative Forest Landscape Restoration Program (CFLRP) - Federal Land Assistance, Management and Enhancement (FLAME) Act - National Cohesive Wildland Fire Management Strategy (NCWFMS) - USDA Federal Wildland Fire Management Policy and Program Review - National Fire Plan (NFP) - Farm Bill 2018, Good Neighbor Authority - Wildfire Suppression Funding and Forest Management Activities Act (WSFFMAA)	- Clean Air Act - Control of pollution from Federal facilities - Federal Air Rules for Indian Reservations (FARR) (ID, OR, WA) - Tribal Authority Rule (TAR) - Occupational Safety and Health Act (OSHA) - NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) - Identification of State Implementation Plans (CA, OR, WA)	- Regional haze program requirements - Visibility protection for Federal class I areas - Endangered Species Act (ESA) - National Forest Management Act (NFMA) - National Environmental Policy Act (NEPA)
State	- Senate Bill 901: Wildfires (CA) - Senate Bill 1260: Fire Prevention and Protection (CA) - CEQA Vegetation Treatment Program Impact Report (CA) - Oregon Fire Protection of Forests and Vegetation - Senate Bill 225 (OR) - ESH 2928: Forest Resiliency Burning Pilot Program (WA) - HB 2733: Establishment of Certified Prescribed Burn Manager Program (WA)	- Smoke Management Guidelines (CA) - OR Environmental Protection Act - Forest Protection Laws (WA) - 2019 Smoke Management Plan Update (WA) - WA Clean Air Act	- CA Environmental Quality Act (CEQA) - OR Smoke Management Rules - Smoke Management Plan (WA, 1998 version) - State Environmental Policy Act (SEPA) (WA)

Table 2: Summary of federal and state policies related to prescribed burn implementation and smoke management

Level	State	Year Enacted	Policy Name	Policy Reference	Impact on Rx Burning
Federal		1963	Clean Air Act	42 U.S.C. § 7401	Neutral
Federal		1970	National Environmental Policy Act	Pub.L. 91–190	Hindering
Federal		1970	Occupational Health and Safety Act	29 U.S.C. ch. 15 § 651 et seq	Neutral
Federal	OR	1971	Identification of Plan	40 CFR § 52.1970	Neutral
Federal	WA	1972	Identification of Plan	40 CFR § 52.2470	Neutral
Federal		1973	Endangered Species Act		Hindering
Federal	CA	1974	Identification of Plan	40 CFR § 52.220	Neutral
Federal		1976, 2012 Promulgation	National Forest Management Act (NFMA)	16 U.S.C. § 1600	Hindering
Federal		1995, updated 2001, guide for implementation 2009	USDA Federal Wildland Fire Management Policy and Program Review		Enabling
Federal		1998	NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP)		Neutral
Federal		1998	Tribal Authority Rule	40 CFR Parts 9, 35, 49, 50, and 81	Neutral
Federal		2000	National Fire Plan		Enabling
Federal		2003	Healthy Forest Restoration Act (HRFA)	P.L. 108-148	Enabling
Federal	WA, OR, ID	2005	Federal Air Rules for Indian Reservations	40 CFR Parts 9 and 49	Neutral
Federal		2007	Treatment of air quality monitoring data influenced by exceptional events	40 CFR § 50.14(a-c)	Enabling
Federal		2009	Federal Land Assistance, Management and Enhancement Act	H.R. 1404	Enabling

Federal		2009	Collaborative Forest Landscape Restoration Program; established by Congress under Title IV of the Omnibus Public Land Management Act of 2009	H.R.146	Enabling
Federal		2009	National Cohesive Wildland Fire Management Strategy	Title V, Section 503, H.R. 1404	Enabling
Federal		2009	Visibility protection for Federal class I areas	42 U.S.C. 7491(a)(1).	Enabling
Federal		2010	Control of pollution from Federal facilities	42 U.S.C. § 7418	Neutral
Federal		2010	Congressional declaration of purpose	42 U.S.C. § 7470	Hindering
Federal		2012	Regional haze program requirements	40 CFR § 51.308	Hindering
Federal		2018	Farm Bill 2018, Good Neighbor Authority	P.L. 115-334, Title VIII,	Enabling
Federal		2018	Wildfire Suppression Funding and Forest Management Activities Act	P.L. 115-141	Enabling
State	CA	1970	California Environmental Quality Act	PRC § 21000	Hindering
State	CA	2001	Smoke Management Guidelines for Agricultural and Prescribed Burning		Neutral
State	CA	2018	Fire Prevention and Protection	SB 1260	Enabling
State	CA	2018	Senate Bill 901 Wildfires	SB 901	Enabling
State	CA	2019	California Environmental Quality Act: State Board of Forestry and Fire Protection: vegetation treatment program: final program environmental impact report	SB 632	Enabling
State	OR	2018	Oregon Environmental Protection Act	HB 2250	Neutral
State	OR	1999	SB 225	SB 225	Enabling
State	OR	2019	OR Smoke Management Rules	OAR 629-048	Hindering
State	OR	2019	OR Fire Protection of Forests and Vegetation	ORS 477	Enabling
State	WA	1967	WA Clean Air Act	RCW 70.94	Neutral
State	WA	1983	WA State Environmental Policy Act	RCW 41.23	Hindering

State	WA	1986	Forest Protection Laws	RCW 76.04	Neutral
State	WA	1987	Prescribed Burn Manager Certification Program at DNR	WAC 332-24	Enabling
State	WA	1993, revised 1998	Smoke Management Plan		Hindering
State	WA	2016	Forest Resiliency Burning Pilot	ESHB 2928	Enabling
State	WA	2018	Prescribed Burn Manager Certification Program at DNR	HB 2733	Enabling
State	WA	2019	2019 Silvicultural Smoke Management Plan Update		Neutral

Appendix 2: Regulatory Processes for Prescribed Burning, by State

California

Adapted from California Air Resources Board Smoke Management Guidelines (2001)

Table 1: Overview of Regulatory Processes for Prescribed Burning in California

Regulatory Processes for Prescribed Burning in California:

California Air Resources Board (ARB) requires all 35 air districts to develop Smoke Management Programs (SMPs) that include:

- Annual or seasonal registration of all planned prescribed burns in Prescribed Fire Information Reporting System (PFIRS)
- Smoke management plans for all burns 10 acres or greater, or that produce more than 1 ton of PM; for burns larger than 100 acres or that produce more than 10 tons of PM, plans must include:
- Identified meteorological conditions for burning
- Smoke management criteria used by land manager in making decisions around burning
- Smoke projections for both day and night
- Contingency actions
- Evaluation of alternatives to be considered in line with CEQA and NEPA
- Discussion of public notification procedures

Districts review smoke management plans and approve

Daily coordination between land managers and air district or ARB for large, multi-day burns that may affect smoke-sensitive populations

If naturally ignited fire occurs on a "no-go" day, decision to manage fire for resource benefit will be considered a "no-go" unless specific criteria are met

Post-burn smoke evaluation plans are required for fires greater than 250 acres as well as processes for public notification

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, ARB must normally announce whether following day is a "permissive burn day" or a "no-burn day" for each of California's 15 air basins
- Private landowners can either a) conduct and pay for burns through permitting process with CAL FIRE and local air board, or b) contract with CAL FIRE through Vegetation Management Program

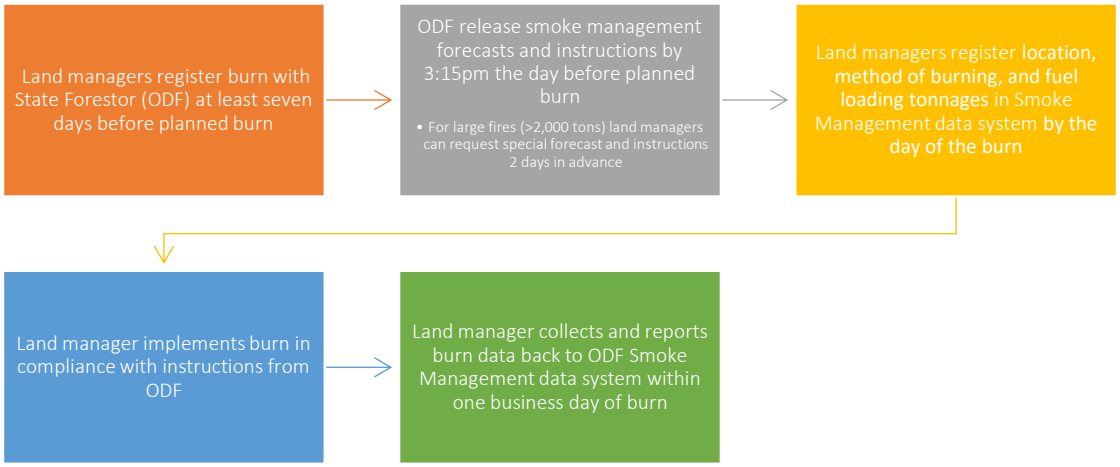
Complaints Process for Smoke Nuisances in California:

For prescribed burning occurring in the WUI or near smoke sensitive populations, district Smoke Management Plans must have an established complaints process

Oregon

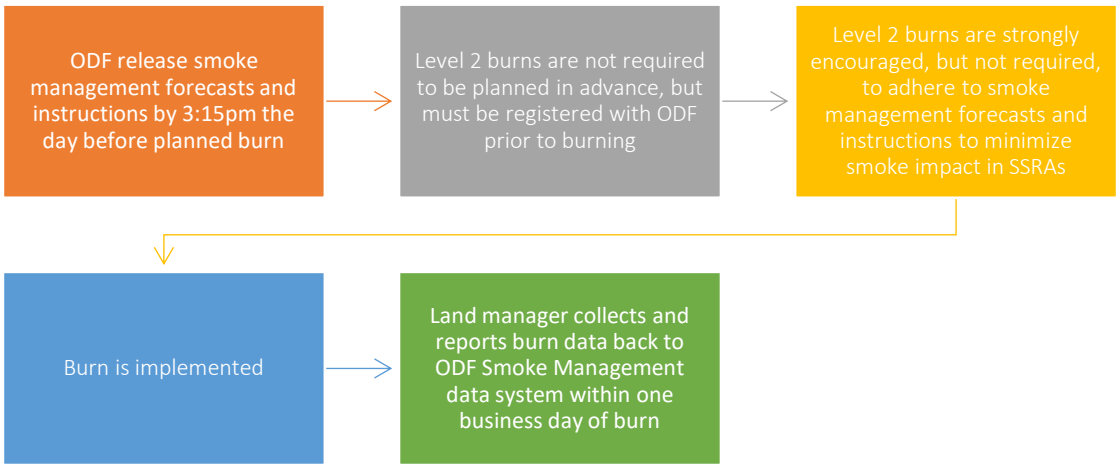
Adapted from Oregon Department of Forestry Smoke Management Directive (2019)

Figure 1: Overview of Regulatory Process for Prescribed Burning in Oregon on Class 1 Forestland



**Forestland Class 1 defined as: "timber class, includes forestland suitable for the production of timber and may include lands on which structures are present." (ORS 526.324)*

Figure 2: Overview of Regulatory Process for Prescribed Burning in Oregon on Class 2 Forestland



**Forestland Class 2 defined as: "*timber and grazing class, includes forestland suitable for joint use for timber production and the grazing of livestock and may include lands on which structures are present*" (ORS 526.324)*

Table 2: Overview of Complaints Process for Smoke Nuisances and Intrusions in Oregon

Complaints Process for Smoke Intrusions

- Complaint is received, filed, and responded to by District or Salem Smoke Management, under supervision by District Forester
- If event is ongoing, an ODF staff or collaborating agency will go to observe and document event
- After investigation, and with District Forester approval, complainant is notified of findings and follow-up action
- An investigation report or intrusion report, as appropriate, is submitted to ODF for each complaint received
- Report is kept on file at the local District Smoke Management office, the Salem Smoke Management office, and other agencies as needed

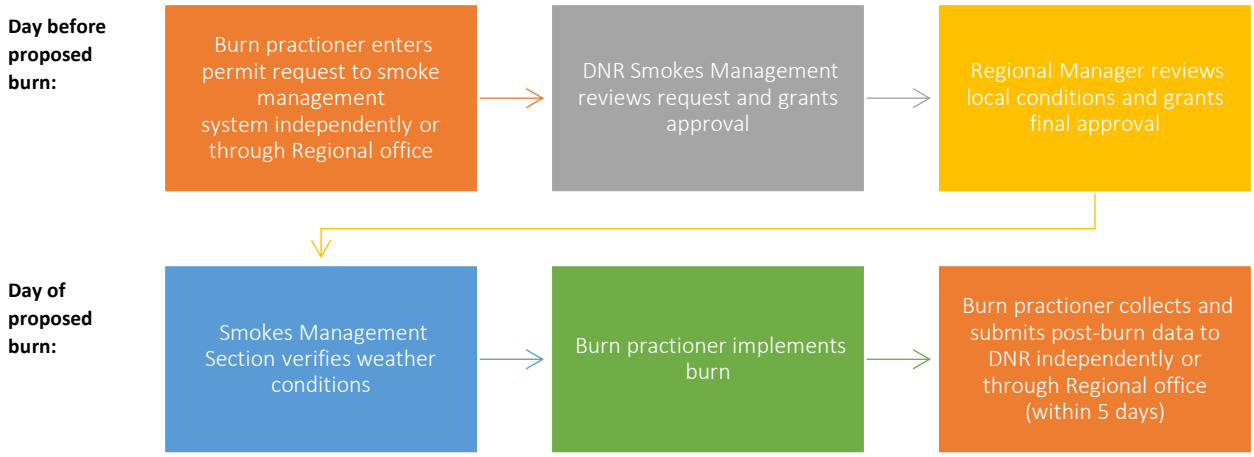
Reporting Process for Smoke Intrusions

- Preliminary report verbally relayed by Smoke Management forecaster to burn practitioner and DEQ
- Smoke Management forecaster prepares first section of report within two business days and sent to burn practitioner or district forester for completion
- Report is then returned to Smoke Management and other interested agencies
- If smoke intrusion meets or exceeds NAAQS (35 $\mu g/m^3$ of PM2.5), exceedances must be reported to Smoke Management and DEQ within one business day of completing burn
- ODF, DEQ, and burn practitioner will coordinate to development management plan for impacts of intrusion

Washington

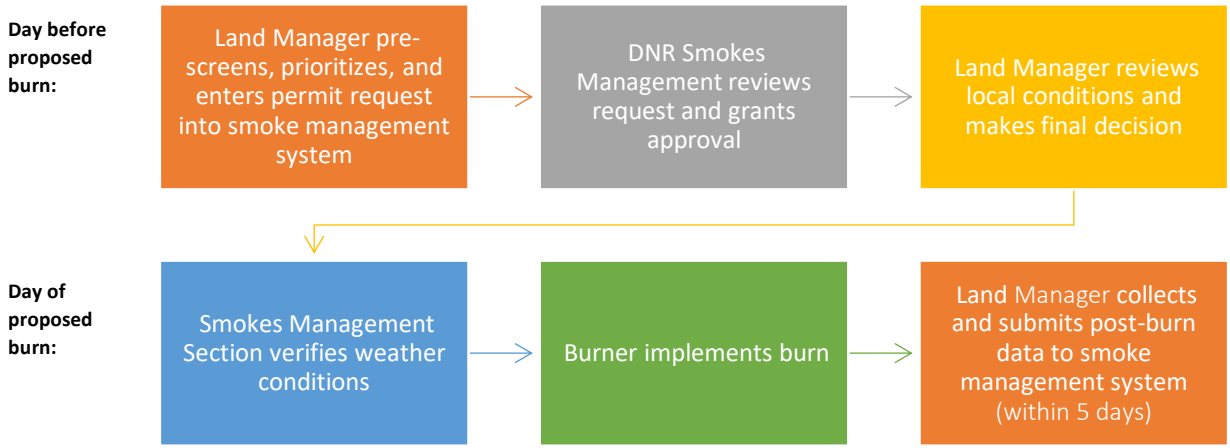
Adapted from Washington Department of Natural Resources Smoke Management Plan (1995) and 2019 Silvicultural Smoke Management Plan Update

Figure 3: Overview of Regulatory Process for Prescribed Burning in Washington on Dept. of Natural Resources-Protected Land



**Applies to "large fires," defined as " fires that have the potential to create significant smoke impacts beyond the immediate fire area. The threshold for what makes up a large fire varies by geographic area, topography, and distance to communities." -- Department of Natural Resources State of Washington Smoke Management Plan (1993, revised 1998)*

Figure 4: Overview of Regulatory Process for Prescribed Burning in Washington for Federal and Participating Tribal Land



**Applies to "large fires," defined as " fires that have the potential to create significant smoke impacts beyond the immediate fire area. The threshold for what makes up a large fire varies by geographic area, topography, and distance to communities." -- Department of Natural Resources State of Washington Smoke Management Plan (1993, revised 1998)*

Figure 5: Overview of Regulatory Process for Prescribed Burning in Washington for Large, Multi-Day Burns

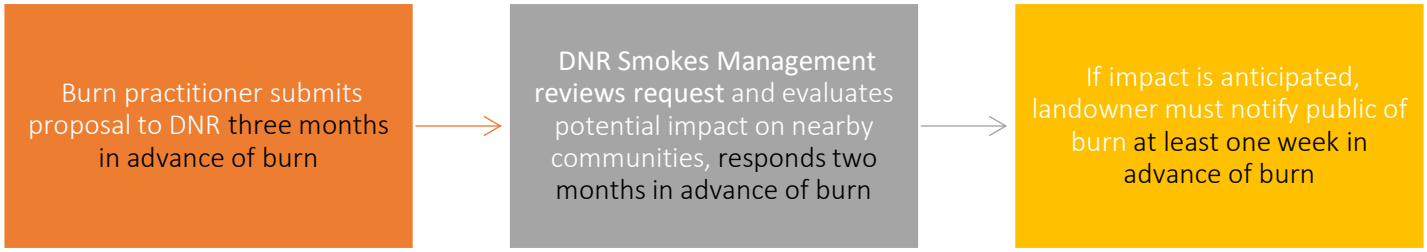


Figure 6: Overview of Complaints Process and Responsibilities for Smoke Intrusions and Nuisances in Washington

DNR Regions

- DNR Regions will notify the appropriate Wildfire, Communications and Outreach, and Region or Federal Land Manager (FLM) immediately upon receiving smoke or nuisance complaints
- If the smoke might impact the public in a neighboring Region or FLM, the source Region will immediately notify the appropriate Region or Federal Land Manager, Wildfire Division, and Communications and Outreach of the situation.
- All complaints (intrusion and nuisance) will be forwarded to source Region for documentation, investigation, enforcement and other appropriate response.

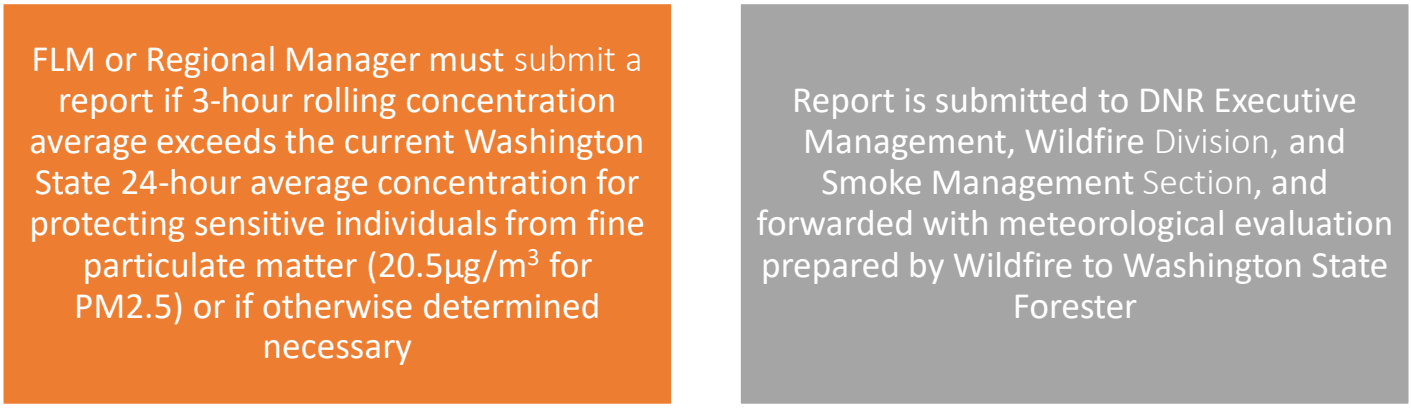
Federal Land Manager (FLM)

- FLM will notify Wildfire Division immediately upon receiving smoke or nuisance complaints.
- All complaints (intrusion and nuisance) will be forwarded to the source FLM for documentation, investigation, enforcement and other appropriate response.

Wildfire Division

- Complaints received from the public will be forwarded to the source Region or FLM for documentation and appropriate response.

Figure 7: Overview of Smoke Intrusion Reporting Process in Washington State



Appendix 3: Comparison of State Smoke Management Plan/Guideline Documents

	California	Oregon	Washington
Regulatory Body	California Air Resources Board	Oregon Department of Forestry	Washington Department of Natural Resources
Scope	Guidelines for development of 35 air district smoke management plans, includes agricultural burning	Statewide: required for all Class 1 forestland (private, state, and federal) and strongly encouraged for Class 2	Statewide: private and state-managed forestland, federally managed forestland, some tribal land
Purpose	"to provide direction to air pollution control and air quality management districts (air districts) in the regulation and control of agricultural burning, including prescribed burning, in California."	- minimize smoke emissions - provide maximum opportunity for essential forestland burning - protect public health - coordinate with other state SMPs - comply with air quality standards - promote development of techniques to reduce emissions	"to coordinate and facilitate the statewide regulation of silvicultural outdoor burning on lands under the authority of DNR and on unimproved, federally managed forestlands and participating tribal lands."
Last Revised	May 2001	March 2019	July 2019
Permit Authorization	required	required	required
Permit Fee	sometimes	yes	yes
Time of Permit Authorization ("Go/No Go" decision)	varies by district, at least 24 hours. CARB releases "go/no go" for air basins by 3pm day before burn	2:30pm day before burn	4:30pm day before burn
Smoke Intrusion Definition	none, CA does not have 24-hour average ambient air quality standard	“entrance of smoke from prescribed burning into a SSRA at ground level that exceeds 70µg/m^3 for any one-hour period and/or averages at or above 26µg/m^3 for a 24-hour period”	“smoke has entered a designated or sensitive area(s) at a 3-hour rolling average... at a concentration equal to or greater than Ecology’s 24-hour average goal for protecting sensitive individuals (20.5µg/m^3 of PM 2.5)”
Smoke Incident Definition	none	the "entry of smoke into Class I Areas, smoke sensitive areas, populated areas that are not designated as SSRAs, or SSRAs below the level of an intrusion"	none
Smoke Monitoring	required if potential impacts to smoke sensitive areas in WUI/wildland areas	as determined by State Forester; priority for marginal conditions or near SSRAs	required for large, multi-day burns and in case of exemption requests
Complaints Process	required in WUI/wildland areas	through Salem or regional offices, Intrusion Report required within two business days, one day if NAAQS are exceeded	through Region or FLM, Smoke Intrusion Report and investigation required for all intrusions
Communication Plan	required in WUI/wildland areas	ODF Salem develops framework; SSRAs encouraged to develop community plan/program	required for large, multi-day burns and exemption requests
Exceptional Events Demonstration	not mentioned	not mentioned	must submit request at least three months in advance
Reporting	in WUI/wildland areas, if greater than 250 acres, must submit Smoke Management Evaluation	accomplishment reports for Class 1 areas required day after burn: for Class 2, within one business day	burner or DNR region must enter into smoke management reporting system within five business days
Natural Ignition	require SMP if greater than 10 acres in size; if on "no go" day, must consult with district/ARB	not mentioned	not permitted; does not require data reporting

Appendix 4: Barriers and Enablers to Prescribed Burn Implementation

Table 1: Summary of barriers to prescribed burning implementation in the Western United States

Barrier									
	Schultz, et al. (2018)	North, et al. (2015)	Miller, Field, & Mach (2020)	Schultz, et al. (2020)	Kolden (2019)	Melvin (2018)	Busam & Evans (2015)	WA DNR (2018)	Quinn-Davidson & Varner (2012)
Stakeholder focus	USFS, BLM, and Air Quality	USFS	Federal and State, Legislative, Nonprofit, Academic	USFS and BLM	Federal agencies	State Forestry Agencies	Private Landowners	State agencies	Federal (USFS, BLM, NPS, F&W), state tribal, NGO, and private timber
Geographic focus	Western US (11 states)	National	California	Western US (CA, CO, OR NM)	National	Western US (16 states)	National	Washington	Northern California
Smoke Management	X			X		X		X	X
Funding Capacity	X	X	X	X	X	X	X	X	X
Staff Capacity	X	X	X	X		X	X	X	X
Agency Culture/ Incentives	X	X		X	X		X		
Leadership	X	x		X					
Risk Aversion/ Liability	X	X	X	X	X	X	X		
Resource Sharing	X	X		X				X	
Burn Windows/ Weather	X		X			X			X
Outreach/ Communication				X				X	
Public Opinion	X	X	X		X	X	X		X

Table 2: Comparison of barriers to prescribed burning by State

Adapted from *Schultz et al. (2018). Prescribed Fire Policy Barriers and Opportunities: A Diversity of Challenges and Strategies Across the West.*

California	Oregon	Washington
• 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	• Short and unpredictable burn windows due to weather • Concern about potential for smoke intrusions 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	• Lack of capacity • Short burn windows due to weather • Topography (valleys) and concentrated populations in areas with smoke sensitive populations • 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

Table 3: Summary of enablers for prescribed burning implementation in the Western United States

Facilitator	**Resource**								
	Schultz, et al. (2018)	North, et al. (2015)	Miller, Field, & Mach (2020)	Schultz, et al. (2020)	Kolden (2019)	Melvin (2018)	Busam & Evans (2015)	WA DNR (2018)	Quinn-Davidson & Varner (2012)
Stakeholder focus	USFS, BLM, and Air Quality	USFS	Federal and State, Legislative, Nonprofit, Academic	USFS and BLM	Federal agencies	State Forestry Agencies	Private Landowners	State agencies	Federal (USFS, BLM, NPS, F&W), state, tribal, NGO, and private timber
Geographic focus	Western US (11 states)	National	California	Western US (CA, CO, OR, NM)	National	Western US (16 states)	National	Washington	Northern California
Interagency Partnership	X	X	X	X		X		X	
Improved Modeling	X		X					X	
Coordination of Burns	X		X					X	
Communication/ Outreach	X		X	X			X	X	
Resource Sharing	X	X		X				X	
Dedicated Staffing	X	X	X	X			X		
Dedicated Funding	X	X	X	X			X	X	
Local Collaboratives		X	X	X		X	X	X	
Planning		X		X				X	
Leadership	X			X	X				
Reduce Liability			X		X	X	X		

Table 4: Comparison of enablers of prescribed burning by State

Adapted from *Schultz et al. (2018). Prescribed Fire Policy Barriers and Opportunities: A Diversity of Challenges and Strategies Across the West.*

California	Oregon	Washington
• 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 MOU16 partnership • Creating more local and strategic air quality decisions based on better monitoring, data, and communication • Potential to improve Forest Service strategic planning to identify and support more opportunities	• 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	• 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

Appendix 5: Stakeholder Analysis

Theory of Change:

IF: a multi-disciplinary team of experts from different sectors who are responsible for addressing the impacts of forest fire collaborate with each other and affected communities to integrate distinct scientific fields and develop a framework for integrating human health vulnerability to fire emissions into forest restoration planning and policy, and demonstrate that health risks can be mitigated by reducing the probability of extensive high-severity fires and moderating the adverse impacts of prescribed fires on communities,

THEN: the predicted widespread and severe human health impacts of increasing fire size and severity can more effectively be addressed, and the needed evidence to support decisions on where/when/how to implement ecological forest management, including prescribed burns and managed wildfire, while optimizing health will be available. This, in concert with efforts focused on community preparedness and resilience to fire will in turn significantly benefit the health and health equity of communities affected by wildfire smoke.

Introduction to Stakeholder Analysis

The goal of the proposed intervention is the prevention of human health impacts of wildfire and smoke exposure, and reduction of health inequity associated with these impacts. A secondary goal of this proposed intervention is to contribute to the body of evidence supporting the expanded use of ecological forest management strategies, including prescribed burns and managed wildfire. These goals were kept in mind while compiling an extensive list of stakeholders, and a combination of document review and key informant interviews to guide analysis of "Tier One" stakeholders, defined as those with regular engagement in policymaking for the potential impact to and impact by the outcomes of the policymaking process, as well as the scope of their role in developing consensus within the policymaking process (see Table 1). An additional list of "Tier Two" stakeholders, defined as those who may not participate regularly, but could be impacted by the outcomes of the policymaking process, was analyzed for the extent to which they may be impacted from wildfire and/or smoke exposure and by harm reduction approaches (see Table 2).

Using "importance to developing consensus" as a filter, a list of 25 "key stakeholders" was identified and further analyzed for motivations/stake in the policymaking process (see Table 3). In identifying these stakes, it is possible to identify areas of overlap in motivation (see Figure 1), or predict areas of potential discord, for moving forward a collaborative approach to identifying and communicating the health and health equity implications of wildfires versus ecological restoration-focused forest management, notably managed and prescribed fires.

TABLE 1: Stakeholder Analysis, Tier One Stakeholders, by sector[12]

Situation/Intervention: Development of a consensus-driven, evidence-based approach to identify and communicate the human health and health equity implications of wildfires versus ecological restoration-focused forest management, notably managed and prescribed fires.

TIER ONE STAKEHOLDERS: ***defined as regular engagement in the regulation/policymaking processes around health, wildfire, and prescribed fire***				
Sector	**Name of Stakeholder Role**	**Impact on Situation**	**Impacted by Situation**	**Influence on Driving Consensus[3]**
Forest and Land Management - Federal	United States Forest Service (USFS)	Leads policy and agenda-setting at national level. Determines priorities and funding for regional offices and programs. Oversees management of national forests. Historically, emphasized fire suppression ("no smoke is good smoke") and short-term risk mitigation. Incurs majority of wildfire suppression costs. Conservative culture. Few incentives for fuels management.	Potential shift in forest management strategy, funding, and agency culture. Positioned to take leadership role in policy development and implementation.	****
Forest and Land Management - Federal	Bureau of Land Management (BLM)	Oversees forest and wildfire management of federal public lands. Large geographic coverage but limited resources. Funding competition for sage grouse habitat preservation at regional level. Poor incentives for fuels management.	Potential shift in forest management strategy, funding, and agency culture. Positioned to support policy development and implementation.	***
Forest and Land Management -	Bureau of Indian Affairs (BIA)	Provides direct program management and funding for tribal wildfire management programs, including fuels management. Acknowledges long history of Indigenous prescribed burning and has historically been supportive of fuels management.	Potential shift in forest management strategy, funding, and agency culture. Positioned to support policy development and implementation.	***

Federal				
Forest and Land Management - Federal	National Park Service (NPS)	Oversees fire and land management in national parks. Some history of prescribed burning, but limited in scope in part due to resources and to Class I visibility restrictions	Potential shift in forest management strategy, funding, and agency culture. Positioned to support policy development and implementation.	***
Forest and Land Management - Federal	Department of Fish and Wildlife (F&W)	Leads policy and agenda-setting at national level for maintenance of healthy ecosystems and habitats for wildlife. History of leadership among DOI agencies in prescribed burning. Limited in scope and resources.	Potential shift in forest management strategy, funding, and agency culture. Positioned to support policy development and implementation.	***
Forest and Land Management - State	State Departments of Forestry, Natural Resources (WA DNR, ODF, CAL FIRE)	Oversees management of state lands and regulation of prescribed fire on state and private land. Houses states' largest fire departments and lead agency in fighting wildland fire. High degree of influence and credibility. Some interface with air quality and public health through smoke management plans. Limited resources for fuels management. In WA and OR, houses Smoke Management Plan.	Potentially elevated role in convening and overseeing partnerships with public health and air quality agencies. Positioned to lead policy development and implementation.	****
Forest and Land Management - Tribal	Tribal Natural Resource and Forestry Departments	Oversees management of tribal lands and regulation of prescribed fire on tribal land. Not present in all tribal governments. In some areas, motivation to preserve and expand burning as traditional and cultural practice, though practice has historically been prohibited. Under-resourced.	Potentially elevated role in promoting place of prescribed burning in environmental stewardship. Positioned to support policy development and implementation.	***

Forest and Land Management - Private	Private Landowners, Corporate	Oversee management and implementation of prescribed burning on private corporate-owned land. Motivation to preserve forests for industrial logging or other timber uses, but highly risk-averse.	Potentially shifted incentives and policy around implementing prescribed burning on land.	***
Forest and Land Management - Private	Private Landowners, Non-Corporate	Oversee management and implementation of prescribed burning on private non-corporate-owned land. Motivation to preserve land and property, but highly risk-averse.	Potentially shifted incentives and policy around implementing prescribed burning on land.	***
Fire Management - Federal	Federal Emergency Management Association (FEMA)	Leads policy and agenda-setting at national level. Determines priorities and funding for regional offices and programs. Oversees disaster prevention, preparedness, relief, and mitigation at national level, including wildfire. Does not interact with prescribed burning, but has motivation to reduce impacts of wildfires.	Positioned to support policy development and implementation.	**
Fire Management - State	State Fire Agencies: CAL FIRE, ODF, DNR	Lead fire suppression and management in State Responsibility Areas, as well as education, communication, and prevention efforts within each State. Oversees fire management education and training for fire management professionals. Limited resources but some agreements with federal, state, and local agencies to share resources and jurisdictions.	Potentially shifted funding and incentives to support ecological forest management. Positioned to lead policy development and implementation.	****
Fire Management - Local/Regional	Local Fire Departments	Lead fire suppression and management within local jurisdictions. Community-facing and generally trusted to provide services and information. Authority to declare local burn bans. In some areas, implement prescribed burning.	Potentially shifted funding and incentives. Potentially elevated role in public communications and education.	***
Fire Management - Tribal	Tribal Fire Departments	Lead fire suppression and management within tribal jurisdictions. Community-facing and generally trusted to provide services and information. Authority to declare local burn bans. In some areas, implement prescribed burning.	Potentially shifted funding and incentives. Potentially elevated role in public communications and education.	***

Air Quality - Federal	Environmental Protection Agency	AQI- principal communication program. Flag program - voluntary. Focus on NAAQS, Attainment Areas. High credibility with air quality. Low investment in public health strategies.]	Extreme air quality events driving need for new roles and shift in focus - may not be ready. Small agency budget.	***
Air Quality - State	State Clean Air Agencies (CA Air Resources Board, OR Dept. of Env. Quality, WA Dept. of Ecology)	Key air quality role: data collection, communication, regulation, enforcement. In CA, Air Resources Board houses Smoke Management Guidelines for local air quality districts.	Increase communication w/ health depts, forest management, other sectors and stakeholders. Shift in focus. Potential for leadership role in policy development.	****
Air Quality - Local/Regional	Local Air Quality Agencies	The "face" of air quality to local communities. High credibility. History/exp with communication efforts. Provide AQI data. Convener at local & regional level. In CA, each air quality district develops and enforces Smoke Management Plan.	Increase communication w/ health depts, forest management, other sectors and stakeholders. Shift in focus.	***
Air Quality - Tribal	Tribal Air Quality Agencies	Community-facing, viewed with high credibility and authority. Lead authority for tribal air quality, with support from EPA. Communications and education at local level.	Increase communication w/ health depts, forest management, other sectors and stakeholders. Shift in focus.	****
Public Health - Federal	Centers for Disease Control (CDC) – National Center for Environmental Health	Provide public health lens, incl generation of epi data, surveillance. High credibility. Limited role in air quality and human health to date.		*
Public Health - Federal	Occupational Safety and Health Administration (OSHA)	Oversees development and enforcement of worker safety standards, including fire management professionals, prescribed fire practitioners, and outdoor workers.		*
Public Health - State	State Public Health Agencies (CA Dept. of Public Health, OR Health	Essential communication role at state and regional scale. Env health, until recent, primary focus on food safety, sanitation.	Expanded communication and coordination role requires resources and shift in focus.	****

	Authority, WA Dept. of Health)			
Public Health - Local/Regional	City and County Health Departments/Districts	Essential communication role at local and regional scale. Env health, until recent, primary focus on food safety, sanitation. Tracking and interpreting health data.	Expanded communication and coordination role requires resources and shift in focus.	***
Public Health - Local/Regional	Community Health Centers	Essential communication role at local and community scale, particularly with low-income and LEP communities. History of engagement with population and issue-specific advocacy. Experience with CHWs and outreach with at-risk populations.	Potentially expanded communication and coordination role.	**
Public Health - Tribal	Tribal Health Departments	Essential communication role within tribal communities. Env health, until recent, primary focus on food safety, sanitation. Tracking and interpreting health data.	Expanded communication and coordination role requires resources and shift in focus.	***
Advocacy	The Nature Conservancy	Work with academic partners to develop and disseminate evidence-base. Centralized leadership and facilitation in working with stakeholders. Develops and organizes networks and spaces for collaborative learning (FLN, TREX). Respected. Long history of support and implementation of ecological restoration-focused forest management.	Positioned to take leadership role in policy development and implementation. Could diversify and build support for conservation and forest management goals.	***
Advocacy	Public and Environmental Health: Amer Lung Assn, Amer Heart Assn, NCHH, etc.	Advance policy agenda. Perceived as credible by public and decision-makers. Identify research and program gaps. Raise public awareness. Siloed messaging w/ respect to their disease or topic. Compete for grants. Limited operational funding in some cases. Could provide Medical CE credits and inform (ALA, AHA, AMA) healthcare field.	Science increasingly shifts etiology of their diseases to environmental exposures. They could be significant or threatened by strategy.	**
Advocacy	Local/Regional Asthma Coalitions	Educate and inform public, policymakers about asthma. Support policy change on behalf of people with asthma.	Would bring attention and resources to their mission.	**

Advocacy	Community-Based Organizations (ex. Airshed Groups, THHNW, etc.)	Provide a voice for those most seriously impacted. Call out disparities. Call out societal injustices. Call for change. Can be radical versus incremental in call for change. Important community organizer.	Would bring attention and resources to their mission.	**
Advocacy	Forest Health Collaboratives	Provide a forum for stakeholder collaboration on natural resource management and forest restoration. Lacks official decision-making power over national forest management, but partners with USFS to provide local input.	Would diversify support for conservation goals, but may require additional steps to address public health concerns that could feel out of scope of work.	**
Advocacy	Prescribed Fire Councils	Bring together stakeholders around training, education, policy advocacy, and training for prescribed fire use. Growing legislative influence.	Could diversify support for prescribed fire goals. Potentially elevate role in advocacy and communications.	***
Advocacy	National Tribal Air Association	Advances air quality policies and programs in alignment with needs and priorities of Native American and Alaska Native tribes. Advances capacity of tribal air quality programs.	Could diversify support for air quality goals. Potentially elevate role in advocacy and communications with tribal partners.	**
Advocacy	Farmworker Rights Associations	Advocate on behalf of needs and priorities of outdoor agricultural workers, including health and safety from smoke impacts. Linguistically and culturally-relevant outreach and education for farmworkers.	Could diversify support for farmworker advocacy goals. Potentially elevate role in advocacy and communications with farmworker partners.	**
Advocacy	Master Builder Associations	Advances land use and permitting policies and programs in alignment with builder association priorities. Can impact zoning and land use development at local and regional level, including building in the WUI.	Potential shifts in building/development agenda due to smoke from prescribed burns and fire risk.	**
Advocacy	Real Estate Associations	Advances land use policies and programs in alignment with real estate association priorities. Can impact how zoning and housing development happens at the local and regional levels.	Potential shifts in housing development agenda due to smoke from prescribed burns and fire risk.	**
Research/ Academic	Universities	Develop evidence-base and modeling for interventions. Generate and disseminate scientific and community-driven research. Collect/disseminate epi evidence. Focus on "more data" vs "act now," but central to designing approach. Assist	Potential openings for further research and funding. With climate	***

		advocacy and community organizations with interpreting and incorporating research findings to support priorities.	change, increasing urgency and opportunities.	
Research/ Academic	Research Centers/Think Tanks	Develop evidence-base and for policy interventions. Motivated by priorities of research centers and funding. Assist advocacy and community organizations with interpreting and incorporating research findings to support priorities.	Potential openings for further research and funding. With climate change, increasing urgency and opportunities.	**
Highly - Impacted Populations	Smoke Sensitive Populations (i.e. elderly, children, pregnant, pre-existing health conditions)	Adverse health effects (respiratory, cardiac, immunologic, carcinogenic, mutagenic), some of which preventable through reduced exposure. Illnesses impact quality of life, employment, health care expenses. High proportion of economically and socially vulnerable people. Highly impacted by policy. As individuals, low influence on policy process.	Prioritized in communication around prescribed fire and wildfire. Increased knowledge = ability to make informed decisions; reduced exposure; preventive actions known	*
Highly - Impacted Populations	Limited English Proficiency (LEP) Populations	Difficulty accessing traditional communication channels. High proportion of elderly, economically and socially vulnerable people. Adverse health impacts and impact to quality of life. Highly impacted by policy. As individuals, low influence on policy process.	Prioritized in communication around prescribed fire and wildfire. Increased knowledge = ability to make informed decisions; reduced exposure; preventive actions known	*
Highly - Impacted Populations	Outdoor Workers (agricultural workers, construction workers, wildfire fighters, etc.)	Disproportionate occupational exposure to smoke from wildfire and prescribed burning. High proportion of LEP, economically and socially vulnerable people. Differing level of control over exposure and occupational protections by occupation and legal status. Adverse health impacts and impact to quality of life. Highly impacted by policy. As individuals, low influence on policy process.	Prioritized in communication around prescribed fire and wildfire. Increased knowledge = ability to make informed decisions; reduced exposure; preventive actions known	*
Highly - Impacted Populations	Incarcerated People	High proportion of LEP, economically, legally, and socially vulnerable people. Occupational exposure if working on wildfire fighting team. Adverse health impacts and impact to quality of life. Highly impacted by policy with low influence or control over policy or exposure.	Prioritized in communication around prescribed fire and wildfire. Increased knowledge = ability to make informed decisions; reduced exposure; preventive actions known	*

Highly - Impacted Populations	Indigenous/Tribal Populations	Long history of prescribed burning as ecological and cultural process. High proportion of economically and socially vulnerable people. Adverse health impacts and impact to quality of life. Highly impacted by policy. As individuals, low influence on policy process.	Prioritized in communication around prescribed fire and wildfire. Increased knowledge = ability to make informed decisions; reduced exposure; preventive actions known	*
Policymakers - Federal	U.S. Congressional Committees	Consider bills and issues at federal level, oversee federal agencies within jurisdiction. Generalist understanding of issues and swayed by public opinion and testimony. Huge amount of influence on final policy decisions.	Potentially shifted approach to policy-making around ecological forest management and wildfire prevention.	****
Policymakers - State	State Legislative Committees	Consider bills and issues at state level, oversee state agencies within jurisdiction. Generalist understanding of issues and swayed by public opinion and testimony. Huge amount of influence on final policy decisions.	Potentially shifted approach to policy-making around ecological forest management and wildfire prevention.	****
Policymakers - Local/Regional	County Commissioners	Oversee development of county policies, including implementation, enforcement, and repeal of burn bans. Heavily influenced by familiarity and experience with prescribed burning.	Increased awareness and familiarity in making decisions around burning within jurisdiction.	**
Policymakers - Local/Regional	District Court Judges	Often oversee cases of liability around prescribed burning. Heavily influenced by familiarity and experience with prescribed burning.	Increased awareness and familiarity in making decisions around burning within jurisdiction.	**
Policymakers - Local/Regional	City and County Councils	Oversee planning and land use decision-making at local level. Generalist understanding of issues and swayed by public opinion and testimony. Huge amount of influence on final policy decisions.	Potentially shifted approach to policy-making around land use, funding for conservation and forest management.	***
Policymakers -	City and County Planning Commissions	Locally-elected board that oversees long term land use planning. Huge influence on where development occurs, including the WUI, and infrastructure/density. Little historical	Potentially shifted approach to policy-making around land use.	**

Local/Regional		interaction with public health, air quality, or forest management.		
Policymakers - Local/Regional	Zoning Boards, Development Review Boards	Locally-elected board that oversees land use zoning and development. Influences on where development occurs, including the WUI, and infrastructure/density. Little historical interaction with public health, air quality, or forest management.	Potentially shifted approach to policy-making around land use.	**
Policymakers - Non-Governmental	Lobbyists	Advocate for or against policy based on the interests they represent. Can hold a lot of political sway and influence.	Potentially increased opportunities for work either against or for policy supporting ecological forest management.	**

TABLE 2: Stakeholder Analysis, Tier Two Stakeholders, by stakeholder group

TIER TWO STAKEHOLDERS: *defined as not having regular engagement in the regulation/policymaking processes around health, wildfire, and prescribed fire, but potential impact or stake in the outcomes of the regulation/policymaking process*			
Stakeholder Group	**Name of Stakeholder Role**	**Impacted by Smoke from Prescribed Fire/Wildfires**	**Potential Impact of Harm Reduction**
Community Groups - Athletic	Amateur, Professional and Intramural Athletic Programs	Outdoor athletic activities increasingly modified (internationally and domestically) by degraded air quality or wildfire episodes. Periodically forces cancelled event. Some athletes at (unknown) risk if event not cancelled.	May not want to reschedule or cancel events.
Community Groups - Athletic	Middle School, High School and College Athletic Programs	Outdoor athletic activities increasingly modified (internationally and domestically) by degraded air quality or wildfire episodes. Periodically forces cancelled event. Some athletes at (unknown) risk if event not cancelled.	May not want to reschedule or cancel events.
Community Groups - Athletic	Outdoor Recreation Enthusiasts/Guiding Companies, Tourism	Outdoor recreation activities increasingly modified by degraded air quality or wildfire episodes. Some activities cancelled by events, may result in lost revenue. Complaints of smoke nuisance from prescribed burning.	May not want to reschedule or cancel events/trips.
Community Groups - Schools	State and Local Superintendents and Education Departments	Asthma and respiratory infections a common cause of absenteeism and lower academic performance.	Reduced exposure may improve student health and reduce illness that impacts attendance.

Government - Federal	US Dept. of Health and Human Services – Medicare/Medicaid Division	One of largest payers for excess/preventable health care utilization. Medicaid growing federal burden w/ aging population.	Cost savings/ROI from reduction in health care utilization.
Government - Federal	USDA Rural Economic Development program	Oversees federal policy and program making about economic development in rural areas.	Potential adjustments needed to improve housing quality, utilities from smoke impacts in rural areas.
Government - State	State Medicaid Programs	One of largest state expenditures - excess costs for health-care utilization are preventable. Medicaid growing state burden w/ aging population.	Cost savings/ROI from reduction in health care utilization.
Healthcare	Hospitals	Absorb some of cost of excess utilization related to smoke events. Community health role increasing. Treatment and discharge papers do not include env exposure/risk factors. No follow-up.	Potentially elevated role in identifying and communicating with at-risk people.
Healthcare	Physicians (General and Specialists)	Treat patient symptoms. Secondary and tertiary prevention. Pharmacological treatment is focus. Limited patient interaction. No precedent for screening to assess exposure/risk.	Potentially elevated role in identifying and communicating with at-risk people.
Healthcare	Private Insurers and Managed Care Organizations	Fiscal impact due to excess/preventable health care utilization. Many competing client-health factors (obesity, opioids, housing).	Lost revenue/ROI from reduction in health care utilization.

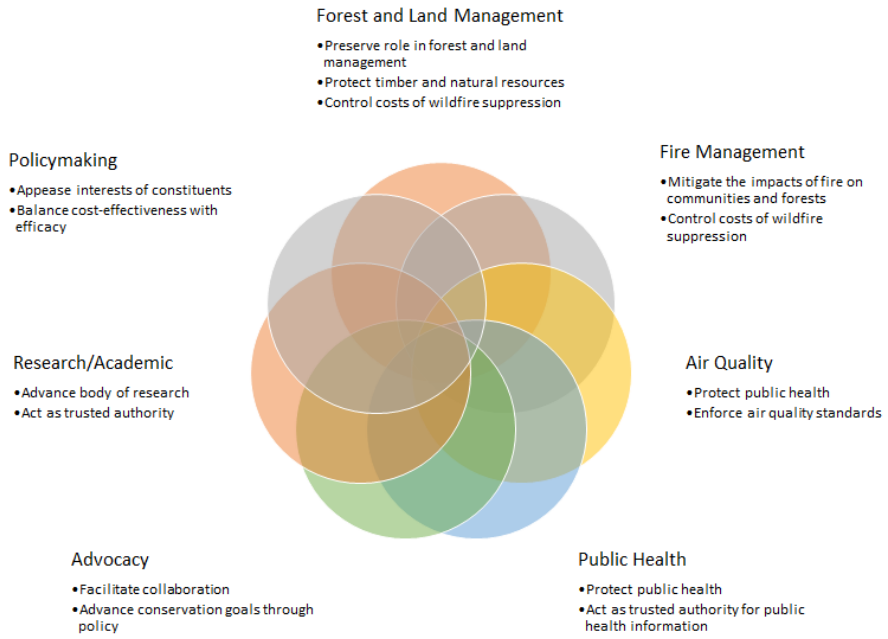
TABLE 3: Summary of Stakes for Key Stakeholders[4]

SECTOR	STAKEHOLDER ROLE	STAKE/MOTIVATION	IMPORTANCE[5]
Forest/Land Management	USFS	To preserve role as lead agency in wildfire and forest management	***
		To control costs of wildfire suppression	***
		To protect timber and natural resources on NFS lands	****
		To mitigate liability for escaped fire or wildfire	**
		To increase funding and resources	**
	BLM	To preserve role as lead agency in management of public lands	***
		To control costs of wildfire suppression	***
		To protect timber and natural resources on public lands	****
		To mitigate liability for escaped fire or wildfire	**
		To increase funding and resources	**
	BIA	To reduce impacts of wildfire to communities and natural resources on tribal lands	***
		To control costs of wildfire suppression on tribal lands	**
		To act as a facilitator between US federal government and Native American/Alaska Native tribes	***
		To increase funding and resources	**
	NPS	To preserve natural resources and national park forestland for recreation from impacts of fires	***
		To control costs of wildfire suppression in national parks	***
		To increase funding and resources	**
	F&W	To preserve/restore ecological habitat for fish and wildlife species	****
		To increase funding and resources	**
	State Depts. of Forestry, Natural Resources	To act as lead agency in smoke management (WA, OR) and natural resource management	****
		To control costs of wildfire suppression on state lands	**
		To protect timber and natural resources on state lands	****
		To increase funding and resources	**
	Tribal Depts. of Forestry, Natural Resources	To protect cultural and natural resources on tribal lands	****
		To increase funding and resources	**
	Private Landowners, Corporate	To protect assets and property	****
		To mitigate liability for escaped fire or wildfire	***
	Private Landowners, Non-Corporate	To protect assets and property	****
		To reduce risk and liability for escaped fire	***
		To reduce impacts of smoke to neighbors, community members	**
Fire Management	State Fire Agencies	To control costs of wildfire suppression	***
		To mitigate impacts of fire on communities around the state	***

		To increase funding and resources	**
	Local Fire Depts.	To control costs of wildfire suppression	***
		To increase funding and resources	**
		To mitigate impacts of fire on communities	***
		To be seen as leaders in community	**
	Tribal Fire Depts.	To control costs of wildfire suppression	***
		To increase funding and resources	**
		To mitigate impacts of fire on communities	***
		To advocate for tribal sovereignty and preservation of traditional practices	**
Air Quality	EPA	To act as an effective steward of air and climate	****
		To be viewed as fair enforcer of air standards	***
		To maintain and increase funding, resources, and congressional power	**
	State Clean Air Agencies	To protect public health and air quality	****
		To increase funding and resources	**
	Local/Regional Clean Air Agencies	To protect public health and air quality	****
		To build and maintain relationships with local community	**
		To increase funding and resources	**
	Tribal Clean Air Agencies	To protect public health and air quality on tribal land	****
		To be seen as a local authority and trusted resource for public health information	***
		To advocate for tribal sovereignty	**
		To increase funding and resources	**
Public Health	State Public Health Agencies	To use data and surveillance to protect public health and identify health disparities	****
		To increase funding and resources	**
	Local Public Health Depts.	To protect public health	****
		To be seen as a local authority and trusted resource for public health information	***
		To increase funding and resources	**
	Tribal Public Health Depts.	To protect public health within tribal jurisdiction	****
		To be seen as a local authority and trusted resource for public health information	***
		To increase funding and resources	**
Advocacy	The Nature Conservancy	To use research to influence policy and legislation around conservation	****
		To leverage fluidity as non-governmental organization to develop innovative solutions	***
		To lead in bringing together stakeholders to develop collaborative approach	**
	Prescribed Fire Councils	To advocate for and influence policy around ecological forest management	****
		To troubleshoot and develop solutions for local issues around prescribed burning	***
		To house collaborative efforts to advance use of prescribed burning	***
Research/ Academic	Universities	To be viewed as a trusted authority and expert	***
		To advance body of research	****
		To attract funding and resources to institutions	**

Policymaking	US Congressional Committees	To appease interests of federal constituents and lobbyists	**
		To balance cost-effectiveness with efficacy of policy	***
		To maintain political power and influence	**
	State Legislative Committees	To appease interests of state constituents and lobbyists	**
		To balance cost-effectiveness with efficacy of policy	***
		To maintain political power and influence	**
	City and County Councils	To appease interests of local constituents and interests	**
		To balance cost-effectiveness with efficacy of policy	***
		To maintain political power and influence	**

Figure 1: Venn Diagram of motivations for "key stakeholders," by sector



Acronyms Used:

AHA	*American Heart Association*
ALA	*American Lung Association*
AMA	*American Medical Association*
AQI	*Air Quality Index*
BIA	*United States Department of Interior - Bureau of Indian Affairs*
BLM	*United States Department of Interior - Bureau of Land Management*
CAL FIRE	*California Department of Forestry and Fire Protection*
CE	*Continuing Education*
CHW	*Community Health Worker*
EPA	*Environmental Protection Agency*
FEM	*United States Department of Homeland Security - Federal Emergency Management Agency*
FLN	*Fire Learning Network*
F&W	*United States Department of Interior - Fish and Wildlife Service*
LEP	*Limited English Proficiency*
NAAQS	*National Ambient Air Quality Standards*
NCHH	*National Center for Healthy Housing*
NPS	*United States Department of Interior - National Park Service*
ODF	*Oregon State Department of Forestry*
THHNW	*Tribal Healthy Home Network*
TREX	*Prescribed Fire Training Exchange*
USFS	*United States Department of Agriculture - United States Forest Service*
WA DNR	*Washington State Department of Natural Resources*
WUI	*Wilderness-Urban Interface*