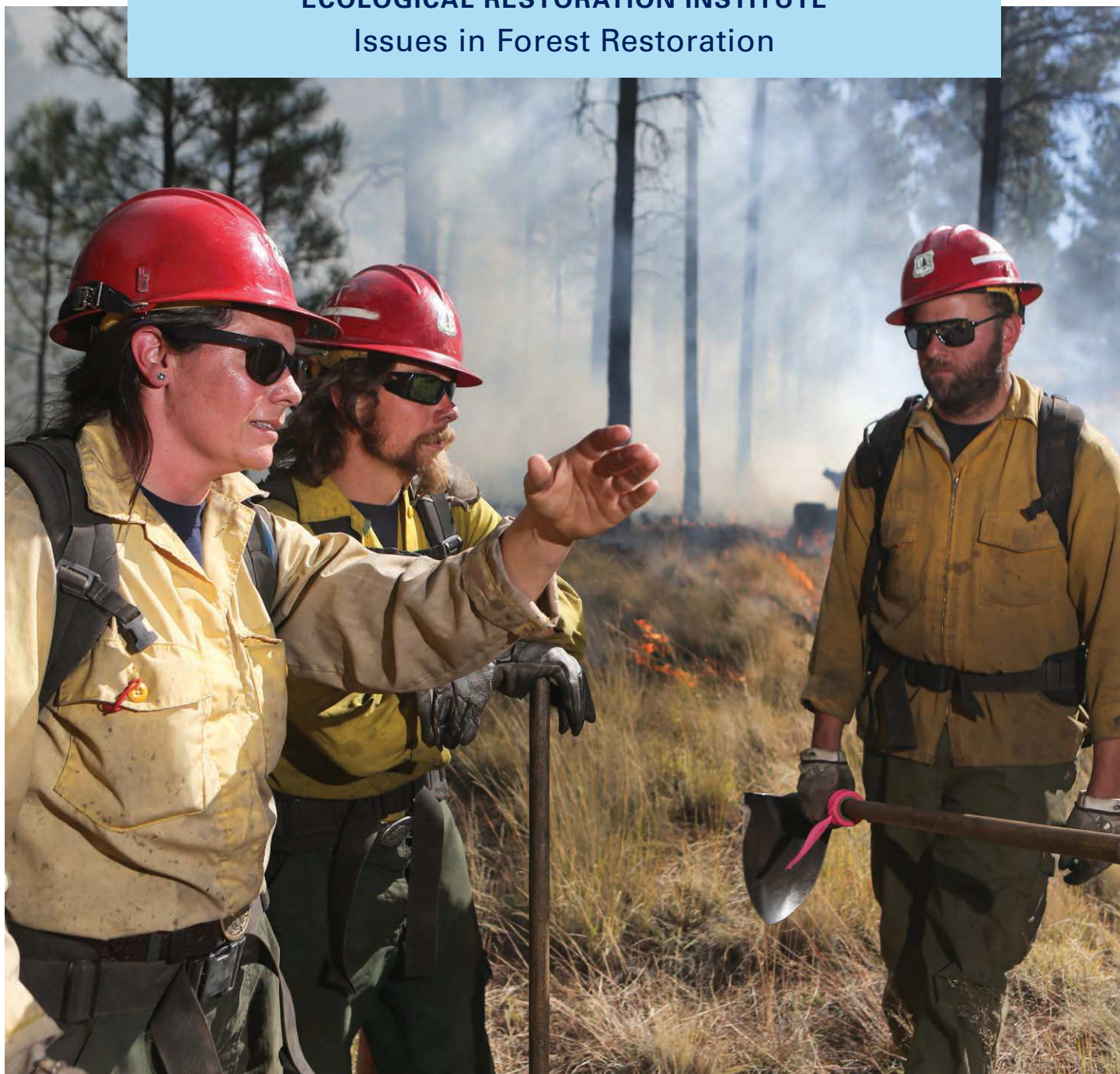


ECOLOGICAL RESTORATION INSTITUTE
Issues in Forest Restoration



**Planning for and Implementing
Prescribed Fire in Fire-Dependent Forests**

**NORTHERN
ARIZONA
UNIVERSITY**

Ecological
Restoration Institute

The Ecological Restoration Institute

The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of dry, frequent-fire forests in the Intermountain West. These forests have been significantly altered during the last century, with decreased ecological and recreational values, near-elimination of natural low-intensity fire regimes, and greatly increased risk of large-scale fires. The ERI is working with public agencies and other partners to restore these forests to a more ecologically healthy condition and trajectory—in the process helping to significantly reduce the threat of catastrophic wildfire and its effects on human, animal, and plant communities.

Cover photo: Firefighters discuss fire behavior conditions and smoke dispersion during a prescribed burn at Gus A. Pearson Natural Area near Flagstaff, Arizona. Photo by ERI



P.O. Box 15017
Flagstaff, AZ 86011-5017
(928) 523-5088
nau.edu/eri

Publication date: June 2018

Author: Bruce Greco

Reviewers: Mike Elson, District Ranger, Coconino National Forest; Vic Morfin, Fuels Management Officer, Coconino National Forest; Travis Woolley, Forest Ecologist, The Nature Conservancy

Series Editor: Tayloe Dubay

Please use the following citation when referring to this paper:

Greco, B. 2018. Planning for and Implementing Prescribed Fire in Fire-Dependent Forests. ERI White Paper—Issues in Forest Restoration. Ecological Restoration Institute, Northern Arizona University. 11 p.

Northern Arizona University is an equal opportunity provider.

In accordance with Federal law and U.S. Department of Agriculture policy, this institution is prohibited from discriminating on the basis of race, color, national origin, sex, age, or disability. (Not all prohibited bases apply to all programs.) To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call (800) 795-3272 (voice) or (202) 720-5964 (TDD). USDA is an equal opportunity provider and employer.

This publication made possible through a grant from the USDA Forest Service.



Table of Contents

Executive Summary	2
Introduction	2
Defining Prescribed Fire	3
Prescribed Fire Policy, Plans, and Authorities Across Jurisdictions	3
Federal Policy, Strategies That Direct Local Objectives	4
Planning for Prescribed Fire: The Process	4
Implementation — Striking the Match	7
<i>Prescribed Fire Ignition Plan</i>	7
<i>Contingency Planning</i>	7
<i>Managing Smoke</i>	8
<i>Unwanted Wildland Fire Declaration: The Appropriate Management Response</i>	9
Action Reviews: Measuring Burn Success	9
Conclusion	10
References	11

Executive Summary

Over millions of years, western forests co-evolved with fire. Regular ground fire reduced excess tree seedlings, released nutrients, and helped support and maintain forest health. However, due to fire suppression in the late 1880s, many forests of the West are overgrown and degraded, and therefore susceptible to unnatural, catastrophic wildfire. To restore western forests that depend on low intensity fire, land managers actively reduce forest density by thinning excess small trees and then conduct a prescribed fire.

Research recommends that fire should occur on a cycle consistent with historic timeframes in order to promote ecosystem health (Neary et. al 2005). However, implementing prescribed fire can be a complex process that requires coordination of many different agencies. This white paper details the steps that are required in order to conduct a safe and effective prescribed burn.



A firefighter uses a drip torch to ignite a prescribed fire in a wetland area.

Photo courtesy of USDA Forest Service, Coconino National Forest

Introduction

Due to more than a century of fire suppression, forests are now experiencing less frequent, but more severe fires. Many western forested ecosystems, such as ponderosa pine, depend on periodic ground or low-intensity fire to naturally remove excess tree seedlings and reinvigorate soil and grasses. When fire is excluded from the landscape, these ecosystems become degraded and unhealthy. One outcome is that trees and vegetation become stressed by overcrowding. Plant species that depend on fire can disappear, and hazardous fuels build up to dangerous levels.

Prescribed fire is a valuable tool for reestablishing natural balance to fire-dependent ecosystems. An objective of prescribed fire is to safely return fire that is consistent with the historic intensity and frequency appropriate for that forest ecosystem. A prescribed fire may be designed to create a mosaic of diverse habitats for plants and animals, benefit endangered species habitat, reduce fuels and the threat of a destructive fire, or to restore the natural fire regime to the landscape. All prescribed fire planning incorporates public safety as well.

As management with prescribed fire increases, the visual and smoke impacts have become a source of public concern. Prior to implementing a prescribed burn, the trade-offs and benefits (such as smoke) must be carefully assessed and planned. Clear objectives, specific desired outcomes, application of best available science, public safety, and best management practices are important elements of successful prescribed fire programs.

Defining Prescribed Fire

Due to more than a century of fire suppression, forests are now experiencing less frequent, but more severe fire. In 1976 the US Department of Agriculture (USDA) and US Department of Interior (DOI) created the National Wildfire Coordinating Group (NWCG) to develop consistent standards and a framework for planning, training, implementing and managing fire on all lands. It includes nine member agencies: the Forest Service, Bureau of Land Management, National Park Service, Bureau of Indian Affairs, US Fish and Wildlife Service, National Association of State Foresters, US Fire Administration, Intertribal Timber Council, and the International Association of Fire Chiefs.

The NWCG defines prescribed fire as “any fire intentionally ignited by management actions in accordance with applicable laws, policies, and regulations to meet specific objectives” (2012). Thus, a prescribed fire is a planned fire, often referred to as a “prescribed burn” or “controlled burn,” where fire managers “prescribe” the use of fire to benefit natural resource management or to accomplish specific management objectives, including research. It includes lighting a fire in a pre-designated area to achieve desired outcomes after deliberate and thorough planning and under carefully controlled and monitored conditions.

“[To] provide national leadership to enable interoperable wildland fire operations, among federal, state, local, tribal, and territorial partners.”

– NWCG Mission

Prescribed Fire Policy, Plans, and Authorities Across Jurisdictions

Laws, regulations, policies, and authorities for the management of all fire, including prescribed fire, originates through 36 congressional legislative acts at the federal level. At the state level, prescribed fire is governed by statutes and policy direction promulgated by the state. Each agency, bureau, and department then provides specific guidelines, directives, and plans to implement federal and state policy, laws, and regulation. This guidance is incorporated into handbooks, manuals, and guides that are specific to regional, state, and local applications. There is considerable effort to standardize and coordinate fire management program applications between and within all federal agencies—and state and tribal programs at each level—to ensure clear direction and a shared vision of desired outcomes (see Box 1).

BOX 1

Federal Wildland Fire Policies

The national offices (USDA and DOI) have developed broad national standards and procedures for planning, establishing program priorities, and implementing hazardous fuels management and prescribed fire programs. Collectively, these policies dictate that wildland fire programs should be implemented equally, consistently, and concurrently, as a means to protect, maintain, and enhance resources (USDA; USDOI 2001).

Federal Wildland Fire Management: Policy and Program Review (1995 and 2001)

The principles outlined in this policy guide federal prescribed fire programs.

Guidance for Implementation of Federal Wildland Fire Management Policy (2009)

This policy guides federal wildland fire policy.

Federal Policy, Strategies That Direct Local Objectives

For decades, federal agencies, along with state and tribal partners, have taken the lead in promoting hazardous fuels management and using fire as a management tool in their Land and Resource Management Plans (LRMPs) and Statewide Resource Assessments. All land management agency partners coordinate strategically to plan and implement prescribed fire programs on a landscape scale. Strategic components of this collaboration include the assimilation of individual agency fire policy and directives that incorporate the National Cohesive Wildland Fire Management Strategy, known as the Cohesive Strategy, initiated by the Federal Land Assistance, Management and Enhancement (FLAME) Act of 2009 and procedural guidance from the NWCG (see Box 2). Guidelines from the NWCG set the standards for oversight, monitoring systems, risk assessment and approvals, implementation, and effectiveness reviews.

The National Wildfire Coordination Group develops operations standards with the intent of universal adoption by member agencies. At regional and state levels, leaders establish direction and oversight mechanisms to also ensure that risk-based, strategically planned and coordinated prescribed fire practices occur with state and local cooperators and partners.

BOX 2

The Cohesive Strategy: An All-Lands Approach

The Federal Land Assistance, Management and Enhancement (FLAME) Act of 2009 established a separate federal funding account to address the escalating costs of suppressing wildfires and reduce the need to transfer funds from other agency programs to wildfire suppression. A provision of this bill required the Secretaries of Agriculture and Interior to develop a set of a cohesive wildfire management strategies to address national wildland fire problems. The resulting National Cohesive Wildland Fire Management Strategy includes all stakeholders across all landscapes in a collaborative push to understand the complexities of managing wildfire risks across the country. The Cohesive Strategy sets the vision for national wildland fire management policy while complementing existing federal wildland fire policies (see Box 1).

Planning for Prescribed Fire: The Process

The prescribed fire planning and implementation process is dynamic, variable, unpredictable, and site-specific. It requires professional judgments and adaptability. Reasonable discretion and guidance provided by agency and partner directives is a critical part of the process. The guides and directives offer detailed information regarding best available science, best management practices, and lessons learned. The essential guidance for prescribed fire implementation outcomes is framed by LMRPs and agency-specific plans.

The NWCG Interagency Prescribed Fire Planning and Implementation Procedures Guide, along with the Prescribed Fire Plan, contains the site-specific legal implementation documents that establish minimum national interagency standards (NWCG 2017a). The NWCG guide develops common language and unified direction and guidance for all NWCG member agencies to help support informed decisions when approving and implementing prescribed fire actions. Agencies may choose to provide more restrictive standards and policy direction in addition to implementing the minimum standards. However, any organization or agency providing resources to fill a national interagency request for all types of wildland fire incidents must meet the minimum NWCG requirements.

Key documents that provide the framework for preparing individual Prescribed Fire Plans include agency LMRPs, Fire Management Plans, NEPA documents, State Resource Plans, and general agency policies and directives. Operational procedures for planning and implementing a prescribed fire project are standardized and inclusive of all jurisdictions affected by the project.

Wildland fire management policy directs the use of the best available science and emerging technologies, direction, and guidance found in statutes and federal regulations. Policies are consistent throughout the USDA and DOI and promote and encourage interoperability with other non-federal wildland fire organizations and entities. Policy communication (handbooks, directives, initiatives, etc.) can differ between agencies, but the overall goal is coordinated application at the project level.

*"To safely and effectively
extinguish fire when needed;
use fire where allowable;
manage our natural
resources: and as a Nation,
live with wildland fire."*

*– National Cohesive
Strategy Vision*

Prescribed Fire Plan

Before any prescribed fires are permitted, agencies must first complete a Fire Management Plan, or other comprehensive plan that provides general program objectives, and a Prescribed Fire Plan detailing site-specific plans and prescriptions. The Prescribed Fire Plan identifies, or prescribes, the best conditions to burn unwanted forest debris, trees, and other plants to safely achieve the desired results. These plans consider factors such as temperature, humidity, wind, vegetation moisture, and smoke dispersal conditions (NWCG 2017c).

Prescribed Fire Plans identify the qualification level of the personnel assigned to implement the burn. Specifically, the burn boss, firing boss and holding boss assigned must meet the NWCG fire qualifications. These are complex plans that include 21 detailed sections and several appendices that cover pre-implementation data, steps to guide the planning and implementation process, procedures, and certifications to be completed before ignition.

A Prescribed Fire Plan is required for each fire that is ignited by management, outside of wildfire suppression tactics. The plans are prepared and approved by qualified personnel, and include criteria for the conditions and prescriptions under which the fire will be conducted. The Prescribed Fire Plan should be reviewed and signed by the agency administrator annually to ensure the plan is current (e.g., identifies changes on the project, policy changes, new objectives, etc.).

The Prescribed Fire Plan must be signed by qualified personnel who prepares, reviews, and approves the plan. Plans are generally specific to an administrative unit or a single project, but agencies are moving toward programmatic plans that can cover multiple jurisdictions or geographic areas. Signees must have the required training, experience, and current qualifications. Every plan receives a technical review prior to agency administrator approval. The technical reviewers and plan preparer must be qualified or have been previously qualified as a prescribed fire burn boss. An off-unit technical review is encouraged to provide an additional independent perspective.

The plan also includes the approved Agency Administrator Ignition Authorization, authorizing the plan to be implemented between specified dates. It provides direction on briefing and documentation requirements by fire managers. This authorization identifies and assigns responsibilities to the designated/qualified burn boss responsible for successful burn implementation. Also included are detailed discussion items to help guide discussions with the burn boss and to help the agency administrator/decision official understand the risks and benefits associated with the project.

Prescribed Fire Project Area Description

The project area description is a detailed summary documenting all pertinent attributes, including descriptions of vegetation and fuels, unique features, and natural resources. The plan requires maps of the vicinity of the burn, project area, ignition units, and the location of values or assets at risk. Also, commonly included are additional maps indicating significant or sensitive features, fuels, or fuel modeling outputs, and areas expected to be impacted by smoke.

Burn Prescriptions and Prescribed Fire Objectives

Burn prescriptions provide burn bosses with the data needed to understand and meet established objectives, manage smoke emissions, and address any identified constraints outlined by the agency administrator. The burn prescription outlines the criteria during which a prescribed fire may be ignited to meet the prescribed fire objectives. The prescription will describe the acceptable range of limits for the environmental or fire behavior considerations required to meet prescribed fire objectives.

The burn boss uses information from the burn prescription as a framework, with set parameters, to guide burn ignition options and management considerations and ensure successful burn outcomes. The burn prescriptions also help guide all implementation actions deployed in the course of burn preparations, ignition, monitoring, assessments, and post-burn evaluations. It can be described as a scientific prescription for each fire, prepared in advance, describing its objectives, fuels, area, the precise environmental conditions under which it will burn, and conditions under which it may be suppressed.

The Go/No-Go Checklist

The plan provides a written checklist for the burn boss to certify with a no/yes determination whether 12 critical requirements, conditions, and steps have been satisfied prior to ignition of the burn. The burn boss must certify all questions can be responded to with a “yes” answer prior to ignition of a test-fire, otherwise implementation of the burn is not allowed.

Pre-Ignition Considerations

Additional pre-ignition considerations are identified in an analysis developed to determine the complexity of the burn, mitigation options, and burn outcomes identified in the NEPA decision and plan. Spot weather or local area forecasts are required prior to ignition on all ignition days. A smoke management forecast is obtained when residual smoke has potential to impact smoke-sensitive areas.

The burn boss will visit the burn area prior to fire ignition to evaluate site conditions. This helps to plan for successful implementation and for contingency plans in the event conditions of the prescription parameters change. Some of the coordination required includes assessing scheduling and costs, assigning resources, identifying timeframes, burn duration, and spot/daily weather forecasts, monitoring on and off-site conditions, and releasing burn notifications.



A burn crew gathers for a briefing before implementing a prescribed fire. Photo courtesy of USDA Forest Service, Coconino National Forest

Pre-implementation checklists are continually reviewed as an accountability measure. It is essential that all on-site preparations (control fire lines, personnel, equipment, communications, values, and infrastructure, etc.), including back-up contingency plans, are completed and verified. Outreach to adjacent landowners, agencies, partners, media, the public, and smoke-sensitive individuals is also conducted prior to ignition.

An analysis of the potential complexity of the prescribed burn informs planning for and securing needed resources for a successful burn. This complexity analysis helps specify the minimum required personnel resources, equipment, and supplies needed for each phase of the prescribed fire until the burn is declared out. The complexity analysis also identifies values at risk (in and out of the burn unit) and the level of technical difficulty required to protect them. A determination of higher levels of technical difficulty to conduct the burn requires more robust burn organizations and higher qualifications for key prescribed fire leadership positions.

Firefighter and public safety concerns are emphasized as priorities in the planning and implementation of all fire management activities (NWCG 2017b). All assigned personnel are briefed on the job hazard analysis or other agency-specific risk analysis at the beginning of each operational period. It is essential that prescribed fire objectives and operations are clearly defined and understood. This briefing helps ensure the organization and assignments follow NWCG standards. On-site pre-ignition briefings cover:

- The communications plan, prescribed fire objectives, and prescription.
- Description of the prescribed fire project area, including any values, special considerations, and sensitive features.
- Expected weather and fire behavior, the ignition process, holding and contingency plans, and assignments.
- In the event the burn exceeds the prescription and cannot meet requirements to return it to the prescription, then when, how, and who will make the wildfire declaration.
- Review of the safety and medical plan, and any local information to ensure successful implementation of the burn.

Implementation — Striking the Match

Prescribed Fire Ignition Plan

Before proceeding with burn ignition, prescribed fire specialists complete the Go/No-Go checklist and conduct a test fire. Every prescribed fire must meet all the conditions on the list. The test fire is ignited in a representative location where the fire can be easily controlled and the results are documented. The purpose of the test fire is to verify that the prescribed fire behavior characteristics will meet management objectives and to verify predicted smoke dispersion. Based on these observations, the prescribed fire burn boss determines whether to continue with active ignition (NWCG 2017b).

Before deciding whether to burn on a given day, specialists assess the results of the test burn and smoke dispersal monitoring. They then compare conditions on the ground to those outlined in the burn plan. Successful implementation of planned actions, after careful analysis and thorough preparations, can result in the right kind of fire at the right place at the right time. The firing and holding plan can be adapted or adjusted as conditions change during the burn, so prescriptions and desired objectives can be met. These adjustments may also occur during mop-up and patrol procedures.

Contingency Planning

The contingency plan analysis is the portion of the Prescribed Fire Plan that considers low probability, but high consequence, events. It identifies the actions needed to mitigate them. Contingency planning determines what additional actions, resources, or both are needed to keep the prescribed fire within the scope of the plan and to ensure preparedness for dealing with fire outside of the burn unit and/or project area.

Contingency planning can also address other unanticipated events like not meeting prescribed fire objectives, and critical holding points for controlling the burn. Other important considerations include smoke management objectives, impacts to critical smoke receptors, burn staffing, and response plans for accidents or emergencies during the burn.



A firefighter patrols the burn area during a prescribed fire. Photo by ERI

Managing Smoke

All prescribed burns must conform to the federal Clean Air Act (CAA) requirements, which is the primary legal framework in the US. Managing smoke emissions from the prescribed burn is a major objective, second only to public and firefighter safety considerations. Each western state has programs or departments that provide guidance for permitting and assisting agencies to adhere to air quality regulations and standards in smoke sensitive areas. The CAA directs that states and tribes, and in some cases local air pollution control agencies, should take the lead in implementing the majority of its provisions. These departments coordinate procedures that mitigate the impacts of prescribed fire on outcomes relating to visibility and clean air in mandatory Class I smoke management areas. These state regulations are based on the criteria of efficiency, economics, law, emission reduction opportunities, land management objectives (including best management practices for prescribed burn implementation), and reduction of visibility impacts from smoke (NWCG 2006).



Managing smoke emissions is a major objective throughout prescribed fire planning and implementation. Photo courtesy of USDA Forest Service, Coconino National Forest

Depending on site-specific conditions and circumstances, other federal and state regulations or land management agency rules may apply as well. Since each situation is unique, addressing conflicts between land management policy and smoke management is usually approached on a case-by-case basis. Basic Smoke Management Practices (BSMPs) are applied on prescribed fire projects to mitigate the impacts of smoke to public health, public safety and nuisance, and visibility (NWCG 2017b).

When acquiring burn permits and approvals, fire planners must identify smoke sensitive receptors, e.g., population centers, recreation areas, hospitals, airports, transportation corridors, schools, etc. This assessment typically includes computer modeling and mitigation strategies and techniques to reduce the impacts of smoke production. Prescribed fire and smoke will have some effects on human, plant, or animal populations, but the overall effects are substantially less than those from large wildfires, which are unpredictable and often uncontrollable events that produce heavy smoke compared to prescribed fire (Box 3).

BOX 3

Living with Smoke

Fire is a part of life in southwestern ponderosa pine forests. Seasonal prescribed burns do produce smoke, but smoke from a prescribed fire is not as heavy or long-lasting as smoke produced from a wildfire because land managers plan in advance to mitigate such impacts. Forest managers typically give the public advance warning of prescribed burns and their smoke impacts. Many agencies have plans to notify and accommodate people sensitive to smoke.

For many, tolerating occasional light smoke from controlled fires is more desirable than experiencing heavy smoke from unpredictable and destructive wildfires.

“Particularly in the western United States, public forestlands are overgrown and we are confronted with a choice between smaller amounts of smoke more often, or large amounts of smoke less frequently, and each of these choices carries trade-offs and long-term consequences” (Viers 2005).

Unwanted Wildland Fire Declaration: The Appropriate Management Response

The Prescribed Fire Plan specifies who has the authority to declare a prescribed fire a wildfire. A prescribed fire, or a portion of a prescribed fire, must be declared a wildfire by those identified in the burn plan with the authority to do so, when either or both of the following criteria are met:

- 1) Prescription parameters are exceeded and holding and contingency actions cannot secure the fire by the end of the next burning period; or,
- 2) The fire has spread outside the project area or is likely to do so, and the associated contingency actions have failed or are likely to fail, and the fire cannot be contained by the end of the next burning period (NWCG 2009).

A prescribed fire can be declared a wildfire for reasons other than those identified above, as determined by the burn boss and agency administrator. When the agency administrator is notified of a declared wildfire by the burn boss, they are then required to make the proper notifications in accordance with agency policy. This will be accomplished by analyzing key Prescribed Fire Plan and implementation criteria and gathering knowledge from the burn personnel and support resources.

When burn prescriptions are exceeded, if the contingency actions are successful at bringing the project back within the scope of the Prescribed Fire Plan within the established timeframes, the project may continue. The ability to successfully manage the unexpected depends on having comprehensive contingency plans and updating them as needed during implementation of the prescribed fire (NWCG 2009).

Action Reviews: Measuring Burn Success

After Action Reviews (AARs) are structured reviews of actions and mitigations identified from previous reviews of the project and a burn debrief. The AAR also evaluates whether the desired outcomes from the planned actions were accomplished, based on established performance standards and measurable outcomes. This review allows participants to discover what happened, why it happened, and how to improve performance and correct mistakes or weaknesses. After Action Reviews are effective when conducted with all resources involved.

After Action Reviews can occur at the end of each operational shift in order to recognize adaptive learning opportunities that increase safety and effectiveness of prescribed fire planning and implementation. The AAR can help answer questions such as, “What was planned?”; “What actually happened?”; “Why did it happen that way?”; “What should be sustained?”; and, “What can be improved?” The analysis and lessons learned from the need to declare the burn a wildfire are often well documented and disseminated for the benefit of the broader prescribed fire community (Black et. al 2012).

After Action Reviews conducted at the burn site can be especially helpful in understanding and measuring burn impacts and determining if desired outcomes were achieved. Documentation and experience from these reviews and shared lessons learned can be invaluable to help guide future prescribed fire planning and implementation.



Fire personnel review a model of the burn area prior to ignition.

Photo courtesy of Verde Valley All Hazards Training Association and USDA Forest Service, Coconino National Forest



Smoke disperses to the east from the Horseshoe Project prescribed fire north of the San Francisco Peaks, Flagstaff, Arizona.

Photo by True Brown, courtesy of USDA Forest Service, Coconino National Forest

Conclusion

As prescribed fire applications continue to increase in the western US, it is important to recognize the importance and benefits of returning fire to fire-dependent landscapes. Restoring forest health and function will help avoid the ecologic and economic devastation experienced by catastrophic wildfire events over the past several decades.

The principle goals in management of prescribed fires are to contain the fire within prescribed fire prescriptions, minimize smoke duration, and successfully accomplish the desired outcomes of the burn. Federal, state, and local agencies have exerted much effort and foresight into developing a framework for consistency and providing guidelines for successful planning and implementation of prescribed fire.

References

- Barkmann, G. 2003. Air quality and smoke management. In *Ecological restoration of southwestern ponderosa pine forests*, ed. P. Friederici. Washington, D.C.: Island Press. Pp. 371–386
- Black, A.E., J. Saveland, D. Thomas, and J. Ziegler. 2012. Using Escaped Prescribed Fire Reviews to Improve Organizational Learning. Joint Fire Science Program.
http://www.firesscience.gov/projects/10-1-05-1/project/10-1-05-1_final_report.pdf
- Neary, D.G., Ryan, K.C., and DeBano, L.F. (eds.) 2005. *Wildland Fire in Ecosystems: Effects of Fire on Soils and Water*. Gen. Tech. Rep. RMRS-GTR-42-vol.4. Ogden, UT: US Department of Agriculture, Forest Service, Rocky Mountain Research Station. 250 p.
- National Wildfire Coordinating Group. 2018. *Smoke Management Guide for Prescribed and Wildland Fire*. NWCG, PMS 420-2. <https://www.nwcg.gov/sites/default/files/publications/pms420-2.pdf>
- _____. 2009. *Guidance for Implementation of Federal Wildland Fire Management Policy*. National Interagency Fire Center. http://www.nifc.gov/policies/policies_documents/GIFWFMP.pdf
- _____. 2012. *Glossary of Wildland Fire Terminology*. National Wildfire Coordinating Group, PMS 205. <https://www.nwcg.gov/glossary-of-wildland-fire-terminology>
- _____. 2017a. *Prescribed Fire Complexity Rating System Guide*. Fuels Management Committee, National Wildfire Coordinating Group. http://www.nwcg.gov/pms/RxFire/complexity_analysis.pdf. PMS 424
- _____. 2017b. *Interagency Prescribed Fire Planning and Implementation Procedures Guide*. NWCG, PMS 484. <https://www.nwcg.gov/sites/default/files/publications/pms484.pdf>
- _____. 2017c. *Prescribed Fire Plan Template*. NWCG, PMS 484-1. <https://www.nwcg.gov/sites/default/files/publications/pms484-1.docx>
- U.S. Department of Agriculture; U.S. Department of Interior. 2001. *Review and Update of the 1995 Federal Wildland Fire Management Policy*. https://www.nifc.gov/PIO_bb/Policy/FederalWildlandFireManagementPolicy_2001.pdf
- _____. 2009. *Guidance for Implementation of Federal Wildland Fire Management Policy*. https://www.nifc.gov/policies/policies_documents/GIFWFMP.pdf
- U.S. Department of Agriculture, Forest Service; Department of the Interior, Office of Wildland Fire Coordination. 2011. *A national cohesive wildland fire management strategy*. Washington, DC: Wildland Fire Leadership Council. 43 p.
- U.S. Department of Interior, Office of Wildland Fire. 2017. *Wildland Fire Management*. Departmental Manual, Part 620. <https://elips.doi.gov/elips/0/fol/1854/Row1.aspx>
- Viers, J.A. 2005. *Smoke from Prescribed Burning*. ERI White Paper: Issues in Forest Restoration. Ecological Restoration Institute, Northern Arizona University. 21p.

Intermountain West Frequent-Fire Forest Restoration

Ecological restoration is a practice that seeks to heal degraded ecosystems by reestablishing native species, structural characteristics, and ecological processes. The Society for Ecological Restoration International defines ecological restoration as “an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability... Restoration attempts to return an ecosystem to its historic trajectory” (Society for Ecological Restoration International 2004).

Throughout the dry forests of the western United States, most ponderosa pine forests have been degraded during the last 150 years. Many ponderosa pine areas are now dominated by dense thickets of small trees, and lack their once diverse understory of grasses, sedges, and forbs. Forests in this condition are highly susceptible to damaging, stand-replacing fires and increased insect and disease epidemics. Restoration of these forests centers on reintroducing frequent, low-intensity surface fires—often after thinning dense stands—and reestablishing productive understory plant communities.

The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of dry, frequent-fire forests in the Intermountain West. By allowing natural processes, such as fire, to resume self-sustaining patterns, we hope to reestablish healthy forests that provide ecosystem services, wildlife habitat, and recreational opportunities.

The ERI Issues in Forest Restoration series provides overviews and policy recommendations derived from research and observations by the ERI and its partner organizations. While the ERI staff recognizes that every forest restoration is site specific, we feel that the information provided in the series may help decision-makers elsewhere.

This publication would not have been possible without funding from the USDA Forest Service. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the United States Government. Mention of trade names or commercial products does not constitute their endorsement by the United States Government or the ERI.

ERI—Issues in Forest Restoration

1. Forestlands Health and Carbon Sequestration: Strengthening the Case for Western Forest Restoration
2. Smoke from Prescribed Burning: Issues on Public Forestlands of the Western United States
3. Public Perceptions of Forest Restoration in the Southwest:
A Synthesis of Selected Literature and Surveys
4. Integrating Ecological Restoration and Conservation Biology: A Case Study
from Southwestern Ponderosa Pine Forests
5. Communications between Forest Managers and Property Owners in Pine Flat, Arizona:
A Case Study of Community Interactions in a High Fire Hazard Area
6. Wilderness Management and the Restoration of Fire: An Analysis of Laws and Regulations
in Northern Arizona
7. Navigating the Motives and Mandates of Multiparty Monitoring
8. Forest Service Contracting: A Basic Guide for Restoration Practitioners
9. Case Study of Community Stewardship Success: The White Mountain Stewardship Contract
10. What to Expect from Collaboration in Natural Resource Management:
A Research Synthesis for Practitioners
11. Southwest Ecological Restoration Institutes (SWERI) Biophysical Monitoring Workshop Report
12. Carbon Credits for Restored Western Forests?
13. Ecological Restoration as Economic Stimulus: A Regional Analysis
14. Exploring the Potential of Obtaining Carbon Credits for Restoration Activities on Navajo
Tribal Forest Lands
15. Integrating Domestic and Wild Ungulate Grazing into Forest Restoration Plans at the Landscape Level
16. Workforce Needs of the Four Forest Restoration Initiative Project: An Analysis
17. A Full Cost Accounting of the 2010 Schultz Fire
18. Forest Restoration Treatments: Their Effect on Wildland Fire Suppression Costs
19. The History of the Four Forest Restoration Initiative: 1980s–2010
20. Administrative and Legal Review Opportunities for Collaborative Groups
21. Flagstaff Watershed Protection Project: Creating Solutions through Community Partnerships
22. The Four Forest Restoration Initiative (4FRI): The Role of Collaboration in Achieving Outcomes

**NORTHERN
ARIZONA
UNIVERSITY**

Ecological
Restoration Institute

P.O. Box 15017
Flagstaff, AZ 86011-5017
eri.nau.edu



1003338

Non-Profit Org.
U.S. Postage
PAID
Northern
Arizona
University
