From flexibility to feasibility: identifying the policy conditions that support the management of wildfire for objectives other than full suppression

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ABSTRACT

Background. Intentional management of naturally ignited wildfires has emerged as a valuable tool for addressing the social and ecological consequences of a century of fire exclusion in policy and practice. Policy in the United States now allows wildfires to be managed for suppression and other than full suppression (OTFS) objectives simultaneously, giving flexibility to local decision makers. **Aims.** To extend existing research on the history of wildfire management, investigate how wildfire professionals interpret current policy with respect to OTFS management, and better understand how they translate policy into implementation. **Methods.** Interviews were conducted in south-west United States with wildfire professionals to explore policy's impact on OTFS management. **Key results.** Respondents reported that while flexible federal policy and inter-agency guidance was important, suitable landscape conditions, organisational capacity, support from national and regional leadership, updated management plans, increased monitoring capacity, and adequate performance measures also influence the decision to use OTFS strategies. **Conclusions.** Translating flexible options into feasible operations requires aligning many layers of policy and people using proactive, collaborative, ongoing preparation. **Implications.** Our research may prompt targeted discussions between management agencies and policymakers to determine how to best support successful management of wildfires OTFS.

Keywords: land management planning, managed fire, other than full suppression, Planning Service Groups, public policy, reporting, risk, suppression, USDA Forest Service, wildland fire.

Introduction

Intentional management of naturally ignited wildfires has emerged as a valuable tool for addressing the social and ecological consequences of a century of fire exclusion in policy and practice (Thompson *et al.* 2018; Wasserman 2020; Hagmann *et al.* 2021; Iglesias *et al.* 2022; Hjerpe *et al.* 2023). Reference to such fires is a newer development in the wildfire management policy of the United States and refers to a strategy whereby naturally-ignited (i.e. lightning) wildfires can be managed using strategies other than full suppression (OTFS) as allowed by appropriate planning documentation (Fillmore *et al.* 2021). Rather than actively suppressing a wildfire, OTFS strategies entail taking indirect approaches for reasons such as reducing firefighter exposure (Thompson *et al.* 2016a, 2016b), finding potential control locations that have a higher probability of success than direct attack (Dunn *et al.* 2020; Thompson *et al.* 2021), or allowing wildfire to function as an ecological process (Huffman *et al.* 2017; Stoddard *et al.* 2020). The role of wildfire as an ecological process has been understood by Indigenous peoples for centuries across an array of landscapes, including Canada (Christianson *et al.* 2022), Australia (Abbott 2003; Prober *et al.* 2016), New Zealand (Baillie and Bayne 2019), and the United States (Kimmerer and Lake 2001). However, historical colonialism and governmental exclusion pushed these perspectives out of land management, especially in the United States (Vinyeta 2022). Although the ecological value of fire has been

increasingly acknowledged by Western science over the past century, (Leopold 1924; Leopold *et al.* 1963; Botti and Nichols 1978; Kimmerer and Lake 2001; Huffman *et al.* 2020), public policy governing wildfire has struggled to articulate how best to allow for natural ignitions in fire management (van Wagtendonk 2007).

Research suggests that a constellation of techniques, including naturally-ignited wildfire, prescribed fire, and mechanical fuel treatments, are needed to achieve the pace and scale for landscape-level restoration of fire-adapted ecosystems in the United States (North *et al.* 2012; Korb *et al.* 2019; Stoddard *et al.* 2020). Huffman *et al.* (2020) conducted a review of ecological research in the western United States on the use of natural ignitions to address restoration goals and found that while many natural ignitions have ecological benefits, they often cannot fully accomplish restoration objectives if not used in tandem with other techniques like mechanical thinning or repeated fire entry (Huffman *et al.* 2020). Furthermore, divergent use of terminology in policy and guidance related to OTFS strategies has fragmented opportunities for shared discussion and public messaging related to these strategies. Barriers to proactive use of OTFS management during wildfire incidents, such as risk avoidance and lack of agency support or resources, may also restrict their application in favour of suppression (Fillmore *et al.* 2021; Pietruszka *et al.* 2023; Fillmore *et al.* 2024). Together, these and other complexities indicate that translating the option to use OTFS strategies from written policy and guidance into management action may achieve varied success.

There is a growing need to examine the long-term outcomes of policy regarding natural ignitions and their role in reestablishing fire adapted social and ecological systems in the United States (Edgeley 2023). The ongoing and evolving nature of wildfire management, especially regarding OTFS strategies, warrants examination of its history to the present day to better inform decisions and policies going forward (Paveglio 2021). While research has assessed the effects of policy in translating broader goals of restoration or resilience into action (Steelman and Burke 2007; Abrams *et al.* 2021), or used more specific quantitative assessments of a single policy shift for OTFS wildfire (Young *et al.* 2020; Iniguez *et al.* 2022), comparatively less has investigated the confluence of these topics using social science methods and theory (Fillmore *et al.* 2024). The research presented here seeks to extend existing research on the history of wildfire management, investigate how wildfire professionals interpret current policy and guidance with respect to OTFS management, and better understand how wildfire professionals translate policy into implementation. Our intent is to highlight realities associated with OTFS techniques that are not yet well documented in the literature and expand upon whether on-the-ground decisions are affected by the current hierarchy of policies and guidance. To do this we interviewed 26 professionals that implement OTFS strategies in the United States, including fire management officers, incident commanders, agency administrators, and fire ecologists.

Literature review

History of wildfire management relevant to OTFS strategies

Van Wagtendonk (2007) categorised the history of wildland fire use in the United States from the late 19th century to the turn of the 21st into four eras: (1) Fire Protection (1871–1967), characterised by the widespread and singular focus on wildfire suppression; (2) Experimentation (1968–1977), where a growing body of ecological research led to the creation of 'prescribed natural fire' programs that used natural ignitions for ecological objectives; (3) Re-evaluation (1978–1989), in which multiple escaped incidents led to a suspension of these programs until Land Management Plans (LMPs) that articulated how wildfire would be used were updated; and (4) Maturation (1990–2000), which included the first wholistic update of federal wildland fire management policy, but was largely characterised by the tragedy and destruction of fires like the South Canyon Fire of 1994 and Cerro Grande fire of 2000. Van Wagtendonk's (2007) work left the time from 2001 onwards as simply 'the Years Since Cerro Grande.'

Given that van Wagtendonk's (2007) categorisation only included events and policy up to 2001, Franz *et al.* (2023) expanded these efforts and proposed two new eras: (1) Fire Classification (2001–2008); and (2) Operational Flexibility (2009–present). Table 1 shows a subset of landmark policies within each era and their relation to OTFS management. In the Fire Classification era, the 2001 Review and Update of Federal Wildland Fire Management Policy directed agencies to incorporate wildfire's essential ecological function in their planning process for restoring and sustaining landscapes and allowed for the use of natural ignitions but deferred to LMPs for articulation of appropriate management responses (USDA and USDI 2001). The term 'wildland fire use' also gained traction at this time and received a separate classification from prescribed fire or wildfire. The most recent shift in wildfire management policy came from the 2009 Guidance for Implementation of Federal Wildland Fire Management Policy (henceforth the 2009 Guidance), which allowed managers the operational flexibility to manage wildfires for multiple objectives simultaneously. Hence, the era from 2009 to present is referred to as the era of Operational Flexibility. It also created two distinct classifications, prescribed fire and wildfire, which included human and natural ignitions. Together, these efforts to characterise policy eras highlight ongoing social and institutional change relative to fire use and forest management in the United States, which are likely to continue evolving over time.

Table 1. Landmark policies that influenced management of natural ignitions in the United States.

Policy Era	Landmark policies (corresponding abbreviation)	Relation to OTFS management
Fire Protection (1872–1967)	Executive Order 6101 (E.O. 6101)	• Created the Civilian Conservation Corps (CCC), which dramatically increased the personnel available to build roads and suppress wildfire in wilderness areas
	Memorandum to Regional Foresters, 1935 (10 am Policy)	• Declared that Forest Service wildfire response will aim to put all wildfires out by 10 am the morning following detection
Experimentation (1968–1977)	*National Environmental Policy Act* of 1969 (NEPA)	• Required analysis and public comment for proposed actions with environmental impacts • Established three classes of action to determine NEPA compliance: Environmental Impact Statement (EIS), Environmental Assessment (EA), and Categorical Exclusion (CE)
	National Forest Management Act of 1976 (NFMA), *Federal Land Policy and Management Act* of 1976 (FLPMA)	• Required Land Management Plans (LMPs) for all land units of agencies in the Department of Agriculture (NFMA) and Department of the Interior (FLPMA). An LMP requires an EIS.
Re-evaluation (1978–1989)	National Forest System Land and Resource Management Planning rule of 1982	• Revised the planning rule governing how agencies create and revise LMPs to try to clarify and simplify the process
Maturation (1990–2000)	1995 Federal Wildland Fire Management Policy & Program Review (1995 Policy)	• Directed agencies to create an organisational culture that supported properly planned and implemented programs to reintroduce wildfire
	Interagency Standards for Fire and Aviation Management (Red Book)	• States, references, or supplements policy and provides program direction for fire and fire aviation program management across all five land management agencies (updated annually). • Provides operational guidance referenced in agency handbooks (i.e. NPS RM-18, Forest Service Manual, Indian Affairs Manual, etc.).
Fire Classification (2001–2008)	2001 Review and Update of Federal Wildland Fire Management Policy (2001 Update)	• Removed formal prescription requirement for OTFS strategies, separating it from the protocol used for prescribed fire. Use of fire will be based on an approved LMP. • Added policy directives to build systematic education, communication, and evaluation programs
	2003 Interagency Strategy for the Implementation of Federal Wildland Fire Management Policy (2003 Strategy)	• Declared that only one management objective can be applied to a wildland fire, either suppression or resource benefits, not both, and that all human ignitions must be suppressed
	Healthy Forests Restoration Act of 2003 (HFRA)	• Emphasised the maintenance and/or restoration of pre-fire suppression conditions, prioritising fuel reduction projects for areas with a Community Wildfire Protection Plan (CWPP)
Operational Flexibility (2009–present)	2009 Guidance for the Implementation of Federal Wildland Fire Management Policy (2009 Guidance)	• Allowed multiple management strategies on a wildfire, including suppression and resource objectives simultaneously (initial action on human ignitions remains suppression)
	Collaborative Forest Landscape Restoration Program (CFLRP)	• Enacted via the *Omnibus Public Land Management Act* of 2009, it encouraged science-based, collaborative restoration, including through reintroduction of wildfire
	Federal Land Assistance, Management and Enhancement Act of 2009 (FLAME Act)	• Mandated the creation of a national cohesive wildland fire management strategy (see 2014 NCS) and established the FLAME fund to support the cost of suppressing large wildfires
	National Forest System Land and Resource Management Planning rule of 2012	• Aimed to support more frequent LMP amendments • called for new plans to consider wildfire and opportunities to restore fire-adapted ecosystems
	2014 National Cohesive Strategy (2014 NCS)	• Named OTFS management as a tool to help restore and maintain landscapes and sets three primary national goals: restore and maintain landscapes, fire-adapted communities, and safe and effective wildfire response
	2022 Wildfire Crisis Strategy (2022 WCS, FS-1187)	• Set 10-year goals for treating National Forest System lands and federal, state, tribal, and private lands at a rate of up to 4–5 times the pace of recent decades

Policies are given in a tabular crosswalk, starting with the era it falls into (as identified by van Wagtendonk (2007) and Franz *et al.* (2023)), the name of the policy (with its corresponding abbreviation), and its relation to OTFS wildfire management.

Current state of social science knowledge regarding OTFS implementation

Existing literature in the United States has focused on current barriers and facilitators to the use of OTFS strategies (Young et al. 2020; Fillmore et al. 2021, 2024; Davis et al. 2022; Iniguez et al. 2022; Pietruszka et al. 2023). A recent mixed methods review investigated the decision factors that influence the choice to manage a wildfire with OTFS strategies using literature from prior to the 2009 Guidance, finding six key thematic areas: (1) institutional; (2) operational; (3) sociopolitical; (4) environmental; (5) risk perceptions; and (6) fire outcomes (Fillmore et al. 2021). Fillmore et al. (2024) validated this framework with decision makers on active wildfires in a management and policy context following the release of the 2009 Guidance. Barriers for decision-makers that consider OTFS strategies include, but are not limited to, physical barriers (i.e. operational risk of human injuries and fatalities or structural loss in the event of an escaped wildfire), personal barriers (i.e. perceived personal risk to careers and reputations, legal liability), and sociopolitical barriers (i.e. potential loss of trust from the public or elected officials; Fillmore et al. 2021). These barriers are made more difficult to overcome given the challenge of communicating through the risk aversion prevalent in agencies and the public (Pietruszka et al. 2023; Fillmore et al. 2024). While the 2009 Guidance afforded managers increased flexibility, it has not significantly changed the geographic and jurisdictional characteristics of observed OTFS wildfires (Iniguez et al. 2022). Policy and guidance governing use of OTFS strategies exists in both centralised interagency contexts and de-centralised local contexts, as such its capacity to facilitate attempts to reintroduce wildfire depends on the quality of public awareness, interagency cooperation, and policy conditions in those areas (Davis et al. 2022).

Policy and guidance for OTFS fires

Policy is broadly considered to be not only the laws and standards that establish problems and objectives for organisations, but also the strategies, guidance, plans, funding, and metrics that organisations develop to solve policy problems and accomplish objectives (Calkin et al. 2011; Thompson et al. 2013; Schultz et al. 2019a, 2019b; Essen et al. 2022). Wildfire policy in the United States is both vertically layered, from federal laws like the *Federal Land Assistance, Management, and Enhancement (FLAME) Act* down to LMPs written for a specific national forest or park, and horizontally distributed, as LMPs exist for any land unit in the jurisdiction of land management agencies across the United States (Franz et al. 2023). Other countries, despite differences in policy context, also grapple with similar spatial and temporal complexities (AFAC 2015; Howard et al. 2020). Maintaining alignment across wildfire policy from vision to implementation presents a challenge, given the duality of wildfire as both a destructive and restorative force and the wildfire management paradox that emerged as a result of historical suppression (Arno and Brown 1991). The wildfire crisis fits the 'wicked problem' trope, meaning it is the symptom of a higher-order problem, but there is disagreement on the nature of that problem (Allen and Gould 1986; Carroll et al. 2007), resulting in multiple attempts to reframe the wildfire management paradigm in the United States (DeBruin 1974; USDA and USDI 2009; USDA Forest Service 2022).

Variable framing of wildfire management, combined with cultural inertia in the United States of a status-quo bias towards suppression, makes change towards OTFS management elusive (Calkin et al. 2015; Schultz et al. 2019a). Table 2 shows a subset of policies that frame wildfire as either primarily a destructive threat, or both a destructive threat and restorative opportunity. How policies characterise

Table 2. Wildfire management problem definition and framing across levels of policy since 2001.

Policy level	Frames wildfire primarily as a destructive threat	Frames wildfire primarily as both a destructive threat and a restorative opportunity
Federal	*Healthy Forests Restoration Act* of 2003	Collaborative Forest Landscape Restoration Program (CFLRP)
	Federal Land Assistance, Management and Enhancement Act of 2009 (FLAME Act)	2001 Review and Update of Federal Wildland Fire Management Policy (2001 Update)
		National Forest System Land and Resource Management Planning rule of 2012
Interagency	Interagency Strategy for the Implementation of Federal Wildland Fire Management Policy (2003 Strategy)	Guidance for the Implementation of Federal Wildland Fire Management Policy (2009 Guidance)
		National Cohesive Strategy (2014 NCS)
		Interagency Standards for Fire and Aviation Management (Red Book)
Agency	2022 Wildfire Crisis Strategy (2022 WCS, FS-1187)	2018 Toward Shared Stewardship (FS-1118)
	2023 Forest Service Budget Justification	2022 Forest Service Manual
Local	LMPs, depending on completion date, could be either	

Adapted from Franz et al. (2023).

and fundprotection and restoration could predispose units towards short- or long-term risk goals, complicating the ability to understand, measure, and meet objectives (Stephens *et al.* 2016; Schultz *et al.* 2019*b*). Adaptive management literature indicates that inherently dynamic social and ecological contexts require institutions to adopt transparent and flexible strategies (Abrams *et al.* 2021; Essen *et al.* 2022). Flexibility in policy often results in goal ambiguity, whereby higher levels of policy stay broad to remain both politically salient and locally applicable (Rainey and Jung 2015). The challenge is building stable and consistent standards at higher levels of government while staying adaptable to local contexts, especially given the dynamic nature of ecosystems and wildfire (Craig *et al.* 2017). As a result, policies fail to meet their intended objectives more often due to flaws in their implementation, rather than flaws in their philosophy (Pahlka 2023).

Performance measurement in wildfire management

Since the *Government Performance and Results Act* of 1993, federal agencies in the United States must develop strategic plans linked to measurable outcomes, set forth in agency budgets (P.L. 103-62 1993). Goal ambiguity and the complexity of modern government make it extraordinarily difficult to identify goals and measure against objectives (Kravchuk and Schack 1996). Performance measures are one means by which objectives are identified and incentivised within agencies but remain challenging as scale and timeframes change in dynamic environments (Radin 2006; Schultz *et al.* 2018). Simple metrics, like acres treated and initial attack success, provide utility for policymakers but fail to capture whether wildfire risk has been reduced and progress has been made (Donovan *et al.* 2008; Thompson *et al.* 2018; Calkin *et al.* 2021; Schultz *et al.* 2022). To adequately determine progress towards a goal or metric, robust monitoring strategies must be developed to assess landscape conditions (Schultz *et al.* 2016; Wurtzebach and Schultz 2016). Because monitoring is neither standardised nor easily scalable and risk management is scale-dependent, it is difficult to connect local, place-based outcomes into broad, long-term, national-level performance measurements (Schultz *et al.* 2022).

The combination of goal ambiguity in wildfire management policy, the layers of policy and bureaucracy separating vision from implementation, and the challenge of measuring, monitoring, and reporting progress from local to national scales leaves individual decision-makers with discretion to interpret how policies governing OTFS management fit into their work before, during, and after a wildfire. But little is known about how decision-makers navigate the complexity of using OTFS strategies to turn flexible options into feasible operations. Young *et al.* (2020) assessed the prevalence of OTFS wildfires before and after the release of the 2009 Guidance but does not account for regional

nuances like potentially outdated LMPs, nor the limitations of current reporting mechanisms to capture strategic decision-making on wildfires (Steelman and McCaffrey 2011; Pietruszka *et al.* 2023). Fillmore *et al.* (2024) focuses on agency administrators, the delegated authority for wildfire preparation and response (NIFC 2022), specifically during active wildfires managed with OTFS strategies. This leaves a gap in understanding of how wildfire professionals operate in this vagueness outside the confines of an active incident and how they translate operational flexibility throughout their organisations. As such, there is a research need for practitioner perspectives on the 'long-term outcomes of policies, plans, and regulations and the extent to which they achieved their goals' (Edgeley 2023, p. 1656). This study seeks to address these gaps via the following research questions:

1. How do managers translate policies and guidance into implementation for the planning and management of OTFS wildfires?
2. What barriers exist for individuals and districts to decide to use OTFS strategies?

Materials and methods

We conducted semi-structured interviews with 26 fire management professionals across Arizona and New Mexico in the south-west of the United States to examine manager interactions with, and interpretations of, policy and guidance governing OTFS strategies. Semi-structured interviews combine an initial protocol of questions asked to all participants with the flexibility to ask follow-up questions to allow novel information and ideas to emerge (Patton 2002; Bryman 2016). This method is well suited to elicit individual perspectives on wildfire management policies, strategies, and metrics while enabling researchers to probe deeper into emergent ideas or topics (Saldaña 2013).

To be eligible to participate in this study, potential interviewees must have met the following three criteria: (1) held a position within a US federal land management agency, state department of land management or forestry, or local wildland firefighting department; (2) earned one or more of the titles or qualifications (Fire Management Officer, FMO; Fire/Fuels Specialist; Fire Ecologist; Agency Administrator, AA; Incident Commander, IC; or Fire Staff); and (3) be primarily located in the geographic area bounded by the Southwestern Region of the U.S. Department of Agriculture Forest Service, which consists of the states of Arizona and New Mexico. This area has both frequent fire regimes and a history of managing wildfires OTFS with greater frequency than other regions (Huffman *et al.* 2020; Young *et al.* 2020; Iniguez *et al.* 2022), making it an ideal geographic area to study the effects and interpretations of US wildfire policy. Although these actors may have other powers, policies, or obligations that they are beholden to, we chose an array of

people across different jurisdictions (i.e. local and federal) because their perspective provides insight into how federal policy interacts with other jurisdictions. Multiple wildfire operations experts were consulted in the initial design of our study to develop these criteria for study inclusion. It was determined that together, they ensured that the sample frame encompassed the managerial, operational, and ecological components of OTFS wildfire.

Initial purposive sampling was conducted to identify potential participants, who were recruited via email. Individuals with appropriate wildfire management positions and qualifications were found via agency employee directories, interagency coordination centre websites, and employment outreach letters that listed personnel for districts within the Southwestern Region. Additional participants that met our inclusion criteria above were discovered via snowball sampling (Biernacki and Waldorf 1981), where participants were asked to suggest other qualified individuals to participate. This helped expand the sample population where target characteristics were not easily accessible, such as employee directories being out of date for the positions targeted in our study (Naderifar *et al.* 2017). Our final sample population spanned federal, regional, state, and local levels, and held positions including FMO, Fuels Specialist, Fire Ecologist, District Ranger, Forest Supervisor, and Regional Fire Staff. There were more male participants (*n*, 23) than female participants (*n*, 3). Though both the US Forest Service and National Park Service have female representation well below their proportion of the general population (National Park Service 2021; Westphal *et al.* 2022), our sample does not match their current gender distribution, and as such could lack some insight into how gender dynamics and discrimination have played a role in wildfire decision making (Reimer and Eriksen 2018). Interviews were conducted over 5 months from March to July 2023. Due to the geographic scope of our study area and the limited availability of wildfire management professionals, most interviews were conducted via video-conferencing software to maximise opportunities for data collection. Interviews ranged in length from 27 to 67 minutes, with an average of 48 minutes, and were audio recorded with the interviewee's permission. Recordings were transcribed verbatim for analysis.

Data were analysed using Dedoose, a software platform for qualitative and mixed methods research that provides data management, excerpting, coding, and analysis tools, to undertake an iterative, inductive coding process in three rounds. The first round used *in vivo* coding, in which codes are derived from the verbatim responses to capture meanings inherent in respondents' experience (Strauss 1987; Stringer 2004; Saldaña 2013), which was necessary to the process of determining individual interpretation of wildfire policy. The second round involved consolidating *in vivo* codes into descriptive codes that encapsulated more representative topics. For example, *in vivo* codes such as 'regional dialogue,' and 'struggle to communicate'

consolidated to 'communication,' while codes like 'acres treated' and 'fire effects' were grouped into 'monitoring and metrics.' The final round used thematic coding to identify consistent, higher-level themes that emerged across participants. These codes showed relationships among the descriptive codes, and how they aligned or differed between respondents (Saldaña 2013). Consistency in data analysis was achieved via inter-coder reliability (ICR); all three authors individually coded the same subset of transcripts, then compared and discussed the outcomes until they reached alignment on how codes were used to describe participant perspectives and shared consistent interpretation of data meaning (Joffe 2011; O'Connor and Joffe 2020). Research suggests that triangulation across researchers is limited, especially when both data and coder have unique social context and analysis occurs through digital tools that researchers have varied proficiencies in like Dedoose (Armstrong *et al.* 1997; McDonald *et al.* 2019). As such, ICR was marked as the unanimous agreement across all three researchers of basic themes, where research shows consensus to be more consistently achievable (Armstrong *et al.* 1997). Finally, researchers selected quotes representative of the various themes to demonstrate the results of the study.

Results

Interviewees identified numerous factors that enabled them to translate flexible options in policy into feasible operations in practice. These factors coalesced into six distinct conditions that interviewees felt were needed to successfully implement OTFS strategies: (1) appropriate landscape conditions; (2) sufficient operational capacity; (3) internal agency alignment; (4) adequate planning documents and assessments; (5) metrics and incentives to move from risk aversion toward risk management; and (6) means and mechanisms for reporting to internal and external audiences. The following sections describe each of these factors.

Appropriate landscape conditions

Local landscape conditions determined if OTFS strategies were viable in the first place, and respondents noted the limited windows they have with natural ignitions. They frequently cited the topography (i.e. steepness of terrain), seasonality (i.e. does the ignition occur in the middle of summer or after the summer monsoons in south-west United States.), accessibility (i.e. road networks through forested areas available for response), proximity to the wildland–urban interface (WUI; i.e. where uninhabited vegetation meets human civilisation), and wildlife habitat (i.e. protected areas for species like Mexican Spotted Owl; MSO) as factors for districts within the National Forest System or National Park System that required unique management approaches. Even if one of these factors was identical

between adjacent geographies, it still created unique conditions for long-term landscape-level policy. A District Ranger summarised how such policy must be adaptable to the locale:

> What works here in [city] is different than what will work on our neighbouring district… It's the exact same topography, the exact same terrain. They just don't have the [mountains] or a city of 100,000 people built right in it. They can probably burn more acres with less impacts to humans than we can … a one-size-fits-all policy wouldn't even work here.

Through a narrower lens, these conditions made each incident dynamic. Many participants interpreted the shift brought by the 2009 Guidance as an attempt to encapsulate the variability of fire management scenarios, while maintaining dynamic local decision-making authority on incidents. One Fire Ecologist explained:

> The reason we did that is to try to encompass all of these different, widely variable situations across the country, and then allow [practitioners] the ability to dynamically manage their incident… you might be full suppression on the left flank, and you might be allowing that fire to move on the right [flank].

Many participants considered this operational flexibility in policy as giving managers an array of tools to address land management objectives and the discretion to decide when and where is appropriate to use them given local landscape conditions.

Organisational capacity

Interviewees described the importance of organisational capacity to execute OTFS strategies in terms of funding and the quantity and experience level of personnel. They mentioned how budget reductions in recent years reduced personnel and increased turnover. Recent bills like the *Inflation Reduction Act* of 2022 and *Infrastructure Investment and Jobs Act* of 2021 were praised, but some respondents felt unsure of: (1) the long-term impact of one-time funding injections, given the time required to rebuild capacity; and (2) which objectives could be accomplished with that funding, referencing how, for example, national accounts to support suppression costs could not be used for proactive treatments. Regardless of agency, participants noted the difficulty of hiring and retaining qualified personnel, especially given the competitive labour market in the U.S. at the time. Furthermore, participants noted that because OTFS wildfires can have multiple objectives rather

than suppression only, they are inherently more complex, and thus, require more varied and specialised skillsets in the personnel tasked with achieving them. Teams that had a dedicated fire ecologist or fire effects monitor lauded the benefits they provided before, during, and after incidents managed OTFS. However, they also pointed out that fire ecology is not formally incorporated into firefighter training and education. As one Fire Ecologist put it:

> We as a fire ecology group, we don't have a core curriculum or any core competencies that are a part of [the Interagency Fire Program Management Qualification Standards and Guide], which are the qualifications needed to get [National Wildfire Coordinating Group] task books and to meet position requirements… The ecology programs are widely varied.

Even if a unit had the capacity to manage wildfire using OTFS strategies, agency decisions at the national level sometimes prohibited using that capacity. Participants consistently noted that, in wildfire management, capacity has been a zero-sum game. As the national Preparedness Level (PL) rose,[1] participants' willingness to pursue OTFS strategies dropped because the risks associated with an incident escaping rose when fewer extra resources were available. Furthermore, nearly all respondents stated that the biggest, recent obstacle to capacity came when the Chief of the Forest Service released a memo that temporarily halted OTFS management altogether (Moore 2021). One FMO summarised a recent instance:

> Further escalation, like what happened in 2021, where you get to [PL] 5, and then the Chief comes out and says nobody gets to manage fires because it's just spread too thin. We have been there a handful of times and that's really frustrating for us, knowing that we could manage some fires fairly small… It wouldn't take that many resources to do that… [but] we won't even bring that opportunity to the table because we've already been told no from a much higher level.

Though opportunities emerged locally, strategic options were sometimes dictated nationally. Combined with the zero-sum, this interagency game of capacity left the potential for conflict between local and national priorities.

Agency alignment

Explicit direction from leadership throughout agency hierarchies was seen as critical to building trust in OTFS management. While participants considered policy flexibility important, they acknowledged the need for agency

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[1]The National Multi-Agency Coordinating Group (NMAC) oversees allocation of equipment and resources, establishing priorities for active incidents NIFC 2024. It sets the national Preparedness Level (PL), a scale from 1 to 5 (5 being the highest) that indicates the quantity and severity of wildfire incidents across the country, and the percentage of resources committed to active incidents

alignment, given the power wielded by memos from national leadership to dictate the rules of engagement in wildfire management. Regardless of position, respondents felt that clear and explicit direction to use OTFS strategies was important for their (or their staff's) own motivation to do so. It gave them the feeling that leaders 'had their back' when taking the risk associated with OTFS strategies. Forest Service interviewees praised regional leadership for taking the time to build direct dialogue from district fire staff down to district rangers and managers and provide clear support for a paradigm shift away from total suppression. Multiple participants noted that some wildfires they managed with OTFS strategies likely would not have happened without the full understanding, support, and communication they had with a Regional Forester. As one FMO said:

> The Regional Forester made a point to visit each Forest and spread this message preseason to really drive home what he wanted to see in this instance on the landscape… then in turn, we had a Forest Supervisor that was very supportive, we had a handful of line officers that were on board and a handful of fire managers… it's very rare to have that alignment with the regional office and the forest level or the district levels. You have to have that to suggest you're going to try to do something [OTFS].

In contrast, they felt that further up the chain of command, national leadership had not facilitated this same sense of alignment and trust. A Forest Supervisor explained:

> Alignment up to the Washington Office is very important [for] the level of risk we're willing to take, why we're doing it, and what success looks like … I feel really good about the alignment we have with Regional Office, but it really does make that difference to hear [the Washington Office] say it. [It] doesn't have to be the Director, it doesn't have to be the Chief, just to hear that leadership, say "this is our expectation, that you will take these risks."

Several participants expressed concern about the rate of organisational culture change to better reflect the paradigm shift away from total wildfire suppression. There was agreement that land management agencies are making slow progress towards the operational flexibility granted by the 2009 Guidance; however, they believed clear support throughout the chain of command for using OTFS strategies when the conditions arise would expedite this culture change by establishing a consistent direction from national leadership to regional to local decision makers.

Adequate planning documents and assessments

Alignment in policy and guidance was also identified as an important factor for justifying decisions to use OTFS strategies. According to most participants, one of the most

important links in the policy chain was the LMP, because it established how a unit will be managed to achieve the goals and vision set by interagency guidance. More importantly, without an approved LMP that declares how and where wildfire will be used, teams could not use OTFS strategies. While many interviewees recognised that full suppression wildfires could yield some positive ecological benefits, they could not claim such benefits as progress toward acreage metrics and found communicating those benefits to the public more difficult. One Forest Supervisor summarised the importance of updated LMPs:

> [My FMO] told me, "I can't wait till you get that [LMP] signed" and I'm like why? He says… it's the intent the plan brings and the discussion about natural fire being necessary to the objectives that we're going to try to achieve. We'll never get there [with] prescribed burning and the mechanical treatment alone, the acres are too much. [The LMP] talks about the amount of acres you want to treat, [it's] about six times what we're treating now. And so it's those numbers that give him the license to take those risks a little more than before.

These updated plans were not considered a 'ticket to burn,' but rather as the platform for determining how to balance benefits of wildfire with the wide array of values that must be considered in wildfire management as established by the LMP. Participants noted a range of human values like grazing allotments, infrastructure, and cultural or archaeological resources, as well as ecosystem values like watersheds and protected habitats. As such, they saw LMPs as a foundation that established the full array of values and priorities, which then allowed interdisciplinary teams to set more concrete objectives on a per-incident basis. One District Ranger described this process as such:

> It starts with the forest plan… then we refine that using local resource specialists. So we have our range managers, hydrologists, biologists, archaeologists… the full suite at the table early in the incident… [to] help shape what success would look like, whether we're going full suppression on all our parts of the fire or we're looking to manage that fire as part of its role in the ecosystem. So the forest plan sets the foundation and then our local input really helps dial that into the site and the landscape.

Participants noted that this process of defining success sometimes created a narrow lens that excluded OTFS strategies from the landscape. In the Southwestern Region, MSO was a commonly referenced species that restricted OTFS management to preserve nesting and foraging grounds. Values and priorities complicate further when respondents considered the jurisdictional complexity of wildfire management. Coordinating responses across both private and public

land depended on how well the LMPs for those areas addressed the nuances of complex landscapes.

Metrics and incentives to move from risk aversion toward risk management

Participants stated that while strategic flexibility and operational capacity were vital for OTFS management, the decision to use OTFS strategies still came down to the individual manager's willingness. Interviewees felt the need to balance the many values at risk around a potential incident, both human-centric and ecosystem-centric. Because interagency guidance defers authority to local documents like LMPs and the managers that implement them, interviewees felt responsible for analysing the risks and rewards at play. Most participants either implied or explicitly stated that giving the 'green light' to use OTFS strategies came down to the personal motivation and risk tolerance of the individual decision-maker. One District Ranger described in this way:

> We've got enough flexibility as a decision maker to manage fire in ways that you think are appropriate… the policy's giving that flexibility. So really, what's driving [OTFS] then? It's your local line officers and the fire managers. What's their personal views and opinions on the importance of fire, their willingness to accept the risk associated with having a fire get larger on the landscape? The easy button is to say I've done all I can to put this fire out.

To motivate individuals to engage with operational risk management, participants felt the need for suitable metrics and rewards that measure and incentivise taking appropriate risks. They noted both qualitative metrics and quantitative metrics currently used by administrators and policymakers to set objectives and measure success. Qualitative metrics varied in type and clarity across participants. Some focused on 'desired future conditions,' like replacing dog-hair thickets with lower-density canopies, while some considered simply 'getting any fire on the landscape' to be a success, given the suppression-bias of past policy and practice. Quantitative metrics included protected structures, habitats, cultural resources, infrastructure, and people (both firefighters and the public). Teams with fire ecologists or fire effects monitors had the capacity to measure fire severity and fuels reduction. In addition to incident-specific metrics, landscape targets set at regional and national levels tracked at larger scales, geographically and temporally. Most often, participants referred to acres treated as the common measurement used but one that lacked means of prioritisation between broad and specific goals. One city fire manager explained it like this:

> I want big acre targets… I want you to go [to the backcountry] and crank out 4000-acre prescribed burns, but at the same time, I need you to come in and do 300 acres right next to my house. So having the landscape-based

targets and then having the more nuanced, what we call "value at risk"-based targets and figuring out how to increase both without sacrificing [either one] … how do we value those needs appropriately?

Interviewees stated they felt recognition from their superiors when they hit treatment targets but expressed concern in whether those targets adequately captured local priorities. Furthermore, while mechanical treatments and prescribed burns have a relatively straightforward connection to acres treated targets set at a regional or national level, it was more difficult to count the acres burned by a natural ignition. Without an updated LMP that explicitly called for fire on the affected area and a NEPA assessment establishing a target for that area, the acres may not count towards those metrics. One FMO summarised the challenge with these incentives:

> The [2022 WCS] and our [LMPs] called for fire on the landscape, and the only acres that you ever claimed were areas that NEPA had been done, a burn plan had been written, and you went out and implemented [it]… our managers get a pat on the back for hitting a target. Meanwhile, we have all these acres [from natural ignitions] that are meeting the same criteria that are being identified, but not really identified. That's a huge barrier, right? It's just as simple as being able to put the right acres with the right outcomes into the achievement pile and being able to claim it as an accomplishment. When we can finally do that right, that's the incentive for a large amount of fire managers to consider.

Means and mechanisms to report progress

Beyond driving incentives, measurements of progress and success facilitated reporting to both internal and external audiences. Reports were grouped into two categories: those that are generated during an incident, and those generated after. The most referenced example of reporting during an incident was the ICS-209, which gave daily or weekly snapshots (depending on the incident) of incident information including cost, resource needs, fire behaviour and size, and management strategy. Though used by coordination centres to determine resource allocation, multiple participants agreed the ICS-209 limited communication of management strategies. One Deputy Director in the Washington Office of the Forest Service puts it this way:

> You need to describe what's happening on a fire, [and] it pigeonholes you into [confine], point protection, suppression, [and] monitoring. And for good or bad, folks use that 209 as a way to determine [management strategy]. So folks have learned to turn to it… I think as long as we've got simple one-word descriptors in the 209 folks are going to continually go to that and try to classify what we've done based on that one-word descriptor.

After an incident, one report that aimed to address this was a 'fire outcome report,' but because they were both optional and not standardised across the region, the quantity, quality, and frequency of such reports after incidents varied. One District Ranger tied reporting to capacity and policy (or lack thereof), saying:

> They're not required for every incident… we're blessed here to have somebody that's really engaged and enthusiastic in that work, so we do get a lot of outcome reports generated. But, to my knowledge… I don't believe that's anywhere in policy.

As to the content and delivery of a report, many emphasised the importance of having members of the public 'seeing it with their own eyes,' such as showing the state of the landscape before and after the incident. All participants described the difficulty they have in communicating OTFS strategies, how they related to management decisions, and progress made towards reintroducing fire to the general public. Most respondents believed that some form of visual information was crucial to help external audiences connect strategies to outcomes in complex incident management.

Discussion

As interagency wildfire management policy in the United States has evolved to allow managing wildfires for multiple objectives, individual decision makers are given more discretion to determine when an incident should be managed using OTFS strategies. This research aimed to understand how wildfire professionals in the south-west of the United States interpreted policies governing OTFS strategies and translated flexible options into feasible operations to assess the impact of the 2009 Guidance in implementation. Our findings from interviews with managers, ecologists, incident commanders, and administrators inform and extend existing literature on OTFS wildfire in three ways. First, we demonstrate the importance of aligning and communicating policies from national to local scales. While previous research examined the effect of 2009 Guidance on OTFS frequency and the factors affecting decisions during incidents (Young *et al.* 2020; Fillmore *et al.* 2024), this study explored pre- and post-incident timeframes. Second, we explore how factors outside the control of individual decision makers can determine whether OTFS strategies are viable, connecting these findings to key themes of the Fillmore *et al.* (2021) wildfire decision framework. Third, we examine how performance measures and the mechanisms of reporting progress influence risk management for wildfire management organisations. We corroborate existing research that highlights the difficulty of building meaningful local accountability that can connect to more generalised national metrics, connecting OTFS complexities to the concept of

'goal ambiguity' (Rainey and Jung 2015). The discussion below provides insight into organisational realities of OTFS management to prompt targeted discussions between management agencies and policymakers and determine how to best support the need for both suppression and OTFS strategies.

Alignment of people and policies

Our results suggest that policy translation occurs through many layers of both people and additional policies or guidance on its way to an individual decision maker's choice to use OTFS strategies. General interagency guidance must clarify down to local contexts through LMPs and NEPA assessments, while local practitioners both look up to leadership at the regional and national levels to set expectations and intent and look around to their local resource specialists to determine priorities. Participants expressed a desire for their organisations to align on expectations for OTFS wildfires, starting with letters from the Chief of the Forest Service, for example. The restrictions on OTFS strategies at times (Moore 2021) were interpreted as inconsistent support of these strategies from national leadership, which research has identified as a barrier to promote paradigm shifts in land management (Abrams *et al.* 2021). As the Chief can act as a gatekeeper, this is likely to remain an obstacle to organisational alignment, given that climatological trends and shrinking workforce will continue to bring more extreme weather and stretch available resources thin.

Further down the chain of command, participants applauded the involvement of regional leadership that clarified expectations and gave explicit support. The Southwestern Region's proactive approach to direct dialogue with forest and district personnel can serve as a model for other Regions, showing how to communicate and execute organisational alignment while trying to shift agency culture away from default suppression (Fillmore *et al.* 2024). Although the areas encompassed geographically by other Forest Service Regions have unique sets of individuals, organisations, and ecosystems, our results show that land management agencies can benefit from leadership that takes deliberate and proactive steps to translate policy expectations through each link in the chain of command, regardless of locale. Participants believed this communication helped build trust and experience in collective decision making, which may help facilitate OTFS strategies given the need for wildfire professionals to perceive risk as shared across many levels of the organisation, and that they will receive adequate support should taking an approved risk result in adverse consequences (Fillmore and Paveglio 2023; Fillmore *et al.* 2024).

Similarly, we found evidence that aligning policy directives (e.g. clear justification of LMPs) helps to give license for OTFS management. Existing research has pointed out the restrictions that managers can face if their respective LMPs are not updated to reflect current best practices (Steelman

and McCaffrey 2011; Davis *et al.* 2022). While the 2009 Guidance marks a notable shift, existing studies on its impact (see Young *et al.* 2020) paint an incomplete picture without exploring the regional nuances in planning documents and agency culture that impact OTFS strategies. Given the significant number of expired LMPs and the relative lack of focus on landscape planning compared to response (Brown and Nie 2019; Franz *et al.* 2023), policymakers should focus on providing the funding and personnel necessary to update these plans. The continued increase in wildfire management costs and its proportion of the overall budget created an incentive imbalance towards suppression response compared to planning (Steelman and Burke 2007; Stephens *et al.* 2016; Brown and Nie 2019). As such, there is no incentive to build by-unit capacity for LMP revisions. Instead, agencies could build independent capacity for revisions, like the Forest Service's Planning Service Groups, and deploy them to land units to combine policy-specific skill sets of planners with local place-based knowledge of practitioners.

An important caveat regarding LMPs are the restrictions that certain values and priorities place on wildfire management options. Among the most frequently cited were MSO Protected Activity Centers (PACs), which designate land areas for recovery of the threatened species. While potentially helpful for preserving habitat, participants noted it frequently made it more difficult or impossible to use OTFS strategies near PACs. In recent federal policy, an Executive Order mandated new amendments to LMPs to account for old-growth forests (Biden 2022). Again, while well intentioned, such amendments could limit opportunities for OTFS management if not implemented with proper nuance. While flexibility in interagency wildfire management policy has emerged, managers may be unable to utilise it if specific ecological restrictions remove options altogether, preventing alignment of flexible policy like the 2009 Guidance with feasible options on the ground.

Factors outside control of individual decision makers

The stochastic nature of wildfire and the variability of climatological, ecological, and sociopolitical landscapes affecting it means that units must be prepared to leverage appropriate conditions when they arise. Our results showed that across the Southwestern Region different landscapes yield different opportunities for OTFS use, but corroborated existing research that OTFS management depends significantly on landscape factors such as WUI proximity and seasonal moisture and precipitation (Young *et al.* 2020; Iniguez *et al.* 2022). When the opportunities arise with the right conditions, units require adequate capacity to leverage them. The benefits of dedicated fire ecologists and fire effects monitors in local units were well documented amongst participants. The support they provided before and after incidents for planning, evaluation, and communication helped

bridge internal and external barriers to facilitate OTFS management. Recruiting and developing personnel to fill these positions is crucial to maintain local capacity and willingness for OTFS strategies. Such positions provide the skill sets necessary improve the planning, data collection, and reporting that provide the foundation for communicating the decision-making process, which research has identified as crucial institutional and sociopolitical components to facilitate OTFS management (Fillmore *et al.* 2024).

Operationally, managers preferred to use OTFS strategies on incidents that local Incident Management Teams (IMT) could handle, citing their experience with local factors compared to an IMT called from elsewhere to handle an incident that escalates in complexity and often transitions to a simpler, full suppression strategy (Fillmore *et al.* 2024). Units that lack local capacity in fire ecology may miss the windows of opportunity where OTFS strategies are viable. Given the variability of local actors and conditions, policymakers and agencies should explore how to address the lack of standardised competencies for fire ecology and fire effects monitoring, as enabling this social and institutional preparation may help facilitate OTFS strategies (Davis *et al.* 2022). Indirectly, additional capacity in management, ecology, and monitoring may reduce the chances of temporary bans coming from the Chief of the Forest Service if such capacity can convince national leadership to trust regions to handle OTFS wildfires on their own. Programs like the General Natural Resources Management and Biological Sciences Series 0401 or the more recently instantiated Arizona Wildfire Initiative are examples of existing efforts to create partnerships between agencies and academic institutions to better develop the workforce necessary to manage wildfire on the landscape, and incorporate training and education into local contexts (Arizona Wildfire Initiative 2023; Toth 2023).

Incentives, monitoring, reporting

Participants made it clear that even with operational capacity and leadership support, there needs to be incentives for the individual decision maker to take on the operational and personal risks of OTFS management. While acres treated was regarded as an important quantitative measure, without clarification in the local context, it lackedmeaning. Promoting wildfire's natural role in landscapes varies based on dynamic and site-specific ecological, political, and social conditions (Craig *et al.* 2017; Wilson *et al.* 2018; Paveglio 2021). We found that practitioners wanted some means of establishing priority acres based on how much treating those acres would effectively mitigate wildfire risk in the future. Furthermore, the difficulty of counting acres affected by OTFS wildfires and connecting them to agency-level performance measures presents a barrier to decision makers. The historical lack of emphasis on monitoring has left participants unable to consistently evaluate progress towards these performance measures.

Recent research suggests that co-creating performance measures and monitoring capacities with collaborators and partners, along with building consistent methodologies to evaluate positive and negative effects of wildfire, can supplement needed capacity for land management agencies (Schultz *et al.* 2022). A policy of performance measures without capacity to measure progress toward those measures represents a policy error, the same way aggressive suppression without means to address fuel accumulation resulting from suppression represents a policy error (Calkin *et al.* 2015). The difficulty is in bridging the gap between local place-based knowledge and the simplified metrics or ambiguous goals necessary in higher levels of policy (Rainey and Jung 2015). Here, the examination of pre- and post-incident context sheds further light on existing research. Fillmore *et al.* (2024) found that AAs felt that before and after incidents were the ideal times to communicate ecological benefits, outside of the tension felt during an incident. When outside of this mid-incident tension themselves, our participants corroborated the need for this local communication and relationship-building and further clarified the importance of place-based metrics, monitoring capacity, and a workforce able to translate that data up through their superiors, and out to their communities. We recommend agencies develop performance measures closer to land unit levels like national forests and parks, as it is important to tailor plans, metrics, and incentives to the unique local circumstances, socially and ecologically. Furthermore, those levels seem to be where transformative leadership is most effective (Schultz *et al.* 2016; Craig *et al.* 2017; Paveglio 2021). Without robust monitoring and metrics in wildfire management, public discourse around fire will gravitate toward overly-simplistic, 'more of the same' solutions to complex problems, as seen in media and legislative agendas in both Australia and the United States (Anderson *et al.* 2018; McClintock 2022).

Limitations

It is important to note some limitations with this study, beginning with our geographic focus. The Southwestern Region, though it is an area with clear ecological roles for wildfire and sees more frequent use of OTFS strategies, it is not representative of the entire United States, or other countries. As participants pointed out, favourable ecological and social landscape conditions are a fundamental piece of successful OTFS management. The definition of favourable and how often an area sees such conditions will vary greatly across different ecosystems and communities. Additionally, a significant majority of our sample population were male and worked in the Forest Service. While the Forest Service comprises a significant majority of firefighting resources, the number of participants from other land management agencies do not adequately represent those agencies. As such, our analysis and discussion are agnostic to agency,

instead focused on OTFS planning and implementation across the broader Southwestern Region. Furthermore, gendered hierarchies in both Australian and American wildfire management agencies limit the inclusion of ideas and perspectives of underrepresented female populations (Eriksen *et al.* 2016; Reimer and Eriksen 2018). Coincidentally, research argues that, similar to OTFS management, cultural change related to gender dynamics requires clear leadership, longitudinal learning for continuous feedback, and strong external partnerships (Reimer and Eriksen 2018).

Conclusion

Turning flexibility into feasibility for wildfire management hinges upon how well agencies and individuals translate general policies to local ecologies. When land units have explicit support from each level of leadership, clear justifications in management plans, pre-season coordination with relevant stakeholders, and the capacity to measure effects and report progress, they position themselves well to leverage the limited opportunities to use wildfire to treat landscapes at the scale necessary to confront the wildfire crisis. Adverse landscape conditions, a shrinking workforce, and competing messages and priorities create resistance to the paradigm shift away from full suppression to better living with wildfire. To move our cultural inertia away from suppression bias, managing wildfire with other than full suppression (OTFS) strategies must have clearer connections to the incentives structures that motivate individuals to take appropriate personal and operational risks. Future research could investigate how to connect local metrics with national goals and how to better incentivise individuals and agencies to consider using OTFS strategies. Given the nuance of ecosystems and communities across the U.S. and the world, performance measures should be developed collaboratively for a given locale and reprioritising monitoring and evaluation in management should remain a goal in pursuit of the wildfire paradigm shift.

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