Assessing How Fuel Treatments are Considered During Incident Response

Michelle Greiner, Katie McGrath Novak, and Courtney Schultz

Public Lands Policy Group at Colorado State University

Public Lands Policy Group Practitioner Paper # 17 Spring 2023

WARNER COLLEGE
OF NATURAL RESOURCES
COLORADO STATE UNIVERSITY

PL
PG
Public Lands
Policy Group

About the Authors

Michelle Greiner is a Research Associate with the Public Lands Policy Group, Colorado State University.

Katie McGrath Novak is a Research Associate in the Public Lands Policy Group, Colorado State University.

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

Acknowledgments

This study was made possible with funding from the US Forest Service Washington Office, Fire and Aviation Management. We thank Jim Menakis with the USFS for providing funding, identifying management questions, and helping with project design. We also acknowledge support in designing this research from Drs. Nathaniel Anderson and Matthew Thompson with the Rocky Mountain Research Station. Many thanks to all our interviewees whose time, insights, and perspectives informed this research.

Back cover photo courtesy of Michelle Greiner. Other photos and maps are public domain from the US Forest Service and US Department of Agriculture Flickr accounts or Inciweb. Document cover design by Hannah Brown, Colorado Forest Restoration Institute, Colorado State University.

For more information, please contact:
Dr. Courtney Schultz
Department of Forest and Rangeland Stewardship
Colorado State University
Fort Collins, CO 80523-1472
970-491-6556
courtney.schultz@colostate.edu
sites.warnercnr.colostate.edu/courtneyschultz/

COLORADO STATE UNIVERSITY

Colorado State University
Public Lands Policy Group

Research Brief for Practitioner Paper #17
Spring 2023

ASSESSING HOW FUEL TREATMENTS ARE CONSIDERED DURING INCIDENT RESPONSE

Michelle Greiner, Katie McGrath Novak, and Courtney Schultz

We investigated how incident management teams consider and incorporate US Forest Service (USFS) fuel treatments into wildfire response. Our goals were to: 1) understand how forest and fire personnel communicate about existing treatments; 2) understand what treatment characteristics they look for to meet different objectives; and 3) gather recommendations for improving fuel treatments to support incident management. We conducted 59 interviews with fire and fuel personnel in the western United States. This work included seven case studies of 2020 and 2021 wildfires where existing fuel treatments were considered in incident response. Herein we report on our key findings.

Key Findings

Fire management personnel and fuels planners agreed that existing fuel treatments are useful during incidents for tactical advantage (e.g., initial fire assessment, burnout operations, visibility, and access points) regardless of whether the fire directly intersected the treated area. In some cases, treatments are used for contingency planning. Most interviewees also stated that fuel treatments allow for increased time efficiencies, responder safety, and enhanced containment opportunities.

Fuel treatment information is typically shared during the initial incident briefing and then informally passed along to new incident management teams (IMTs). During incidents, the process of sharing information about existing treatments varied based on individual personalities, experience in the local fuel type, leadership direction, and team culture and composition. Most interviewees encouraged the use of existing decision support tools (e.g., PODs, WFDSS) to support communication about treatments between the agency and other response partners, even before fires start. Interviewees did not recommend a formal agency-wide process to distribute local fuel data, but they did recommend that forests have readily available treatment information to share with incoming teams.

When deciding to utilize a treated area during an incident, interviewees said they consider characteristics such as the fuel treatment's age, (which affects whether fuels have grown back), proximity to roads or other sites, connectivity, and scale of treatments. Strategic treatment placement and ongoing maintenance are also key elements for optimal treatment utility during a fire. Interviewees emphasized that contextual factors such as weather, fire behavior, wildfire location, resource and staff availability, and unit dynamics also influence the decision to use a fuel treatment.

Our findings revealed that consistent treatment maintenance, the culture of communication about treatments, local expert knowledge, and unit/team composition are important components of how fuel treatments are evaluated and integrated during incident response. Ongoing challenges for fully capitalizing on fuel treatment utility during incidents include a lack of investment in staffing and equipment required to implement and conduct regular maintenance. Interviewees said divergence in forest-level leaders' acceptance and willingness to support strategically implementing and using fuel treatments was another barrier.

Recommendations

The following is a synthesis of the key recommendations our interviewees offered regarding how to best support the integration of existing fuel treatments into wildfire incident response:

- To support fire incident response and integration of treatments, communication among USFS staff members and potential fire response personnel (including state and local fire response partners) builds relationships, trust, and understanding of the local fuel management plans; this is important to do before fire season starts.
- Direct and purposeful communication among fuels planners and IMTs (i.e., between IMTs and fuels planners, and from one IMT to the next) would allow for more consistent information transfer during incidents.
- The USFS as an organization and forest-level leadership should encourage the integration of decision support tools and resources designed to support coordinated communication during incidents and provide easily accessible fuel treatment information.
- The USFS should commit resources to address staffing and equipment limitations to support strategic fuels planning, implementation, and regular maintenance of treatments to create and maintain fuels treatments that can be useful during future incidents.

More Information

Find reports and other publications about this research at:
https://sites.warnercnr.colostate.edu/courtneyschultz/plpg-practitioner-papers/

For more information about this project, contact:
Dr. Courtney Schultz
Courtney.Schultz@colostate.edu
Colorado State University
Fort Collins, CO 80521-1472

This study is made possible through funding from the USFS Washington Office of Fire and Aviation Management.
All photos used are public domain from the USDA Forest Service Flickr site.

Table of Contents

Common Acronyms

AA	Agency Administrator
FTEM	Fuel Treatment Effectiveness Monitoring
IC	Incident Commander
IMT	Incident Management Team
USFS	United States Forest Service
WUI	Wildland Urban Interface

Common Wildland Fire Management Terminology

Anchor point	"An advantageous location, usually a barrier to fire spread, from which to start constructing a fireline. The anchor point is used to minimize the chance of being flanked by the fire while the line is being constructed."[1]
Burnout operation	"Setting fire inside a control line to consume fuel between the edge of the fire and the control line."[1] Often also called *burnouts* or *burning off*.
Backfire/ backburn	"A fire set along the inner edge of a fireline to consume the fuel in the path of a wildfire or change the direction of force of the fire's convection column."[1] Note: Some of our interviewees used the terms backfire and backburn interchangeably, and for the purposes of this report they are synonymous.
Fuel treatment	"Any mechanical, silvicultural, or burning activity whose main objective is to reduce fuel loadings or change fuel characteristics to lessen fire behavior or burn severity" (Reinhardt et al., 2008, p. 1998). Examples include prescribed fire and mechanical thinning. In this report, we refer to fuel reduction treatments and hazardous fuel treatments as fuel treatments.
Fuel break	"A natural or manmade change in fuel characteristics which affects fire behavior so that fires burning into them can be more readily controlled."[1]
Safety zone	"An area cleared of flammable materials used for escape in the event the line[2] is outflanked or in case a spot fire causes fuels outside the control line to render the line unsafe." "Safety zones may also be constructed as integral parts of fuel breaks; they are greatly enlarged areas which can be used with relative safety by firefighters and their equipment in the event of blowup in the vicinity."[1]
Staging area	"Locations set up at an incident where resources can be placed while awaiting a tactical assignment."[1]

[1] Definitions from the National Wildfire Coordinating Group's (NWCG) *Glossary of Wildland Fire*. Accessed 16 November 2021. https://www.nwcg.gov/glossary/a-z

[2] Line in this context refers to either a control line (all constructed, natural, treated barriers used to control a fire) or a fireline (dug or scraped part of a control line).

Introduction

Fuel treatments, usually consisting of tree removal, mastication, prescribed fire, and pile burning, are used to facilitate wildfire management and minimize the adverse effects of wildfires (Reinhardt et al. 2008, Vaillant & Reinhardt 2017, Prichard et al. 2021). Fuel treatments, sometimes referred to as simply "treatments," can also be used to meet several other land management objectives, including improved wildfire habitat, post logging slash removal, improved responsiveness to wildfire, and protection of highly valued structures and natural resources. The U.S. Department of Agriculture's (USDA) Forest Service (USFS) implements fuel treatments on the National Forest System and neighboring lands nationwide to protect communities and mitigate negative impacts from wildfire.

Fuel treatment effectiveness is typically evaluated on whether treatment interactions moderate fire effects, affect fire behavior, and enhance the safety and effectiveness of fire suppression operations. The USDA and Department of Interior (DOI) Fuel Treatment Effectiveness Monitoring program (FTEM) is designed to document the effectiveness of fuel treatments on fire behavior when a fire interacts with a fuel treatment (e.g., overlaps or is adjacent to a wildfire). A related issue is how existing fuel treatments are incorporated into strategic and tactical decisions during wildfire incident management on USFS lands. While significant work through the FTEM program and other initiatives has focused on the effectiveness of fuel treatments in terms of fire behavior and impacts, gaps remain in understanding how treatments, even if they did not directly overlap with the wildfire, are potentially used during incident responses.

The purpose of this research project is to understand the perspectives, knowledge, and experiences of practitioners in the field (i.e., incident commanders and first responders, fuels planners, line officers) regarding fuel treatments in an incident management context. This project was conducted in two stages: in the first stage, we conducted regionally focused interviews to understand general perceptions of how fuel treatments were integrated into decision making; in the second, we examined in-depth five wildfires that took place in 2020 and 2021. In late 2021, we issued an interim report on our regional interviews and 2020 fire (available here); this is our complete and final report on this study.

This effort was completed in cooperation with the USFS Rocky Mountain Research Station (RMRS). Our research team consisted of co-principal investigators Drs. Courtney Schultz (Colorado State University (CSU) and Nathaniel Anderson (RMRS). Research associates Michelle Greiner (CSU) and Katie McGrath Novak (CSU) led data collection and analysis. Jim Menakis (USFS) and Dr. Matthew Thompson (RMRS) served as advisors for this project, assisting with identifying research questions. No USFS employees had knowledge of our interviewees' names or positions. Per our pre-project agreements, CSU retained editorial independence in publishing findings.

Approach

The following research questions, regarding use and perceptions of fuel treatments in an incident management context, guided our study:

1. To what extent do treatments during suppression operations align with land managers' intended purpose for those treatments from a design and planning perspective?
2. How do incident commanders, other fire management personnel, and forest personnel communicate about existing fuel treatments and their value during incident response?
3. How do fire managers[3] view treatments and incorporate them into operations, including situations when treatments are not expected to interact directly with fire?
4. What characteristics do fire managers look for when considering using a fuel treatment to support their wildfire management strategy?
5. What recommendations do interviewees have for improving fuel treatments to support incident management of a wildfire?

We conducted semi-structured interviews for this study with two primary groups between late 2020 and early 2022. First, starting in late 2020, we interviewed two people in each western USFS Region (Regions 1-6) who had experience in both fuels planning and tactical operations. We refer to this purposive sample of 12 interviewees as 'regional interviewees'. These interviews were conducted to gain a broad perspective about the use of treatments to support operations and to identify potential fires for additional study.

Next, we conducted interviews on each of seven specific wildfires with individuals who had direct experience with suppression operations and were knowledgeable about how treatments were considered during incident response. These fire-specific interviews took place over two wildfire seasons, 2020 and 2021.

2020 wildfires | We conducted 15 interviews total across two 2020 wildfires. We selected fires based on a compilation of referrals from the regional interviewees and regional fuel program leads. We asked these people to recommend one or two 2020 wildfires that may have interacted with fuel treatments, including either treatment locations that were burned during the fire or where fuel treatments were used (or not used) during incident response. Our compiled list of recommended 2020 wildfires was then assessed by the project team and USFS advisors using multiple criteria (Table 1). Our intention was to select fires representative of the different ways fuels are considered during operations.

2021 wildfires | We conducted 32 interviews total across five 2021 wildfires. Wanting to cast a broader net, we utilized fire history data from the Wildland Fire Interagency Geospatial Service Group (WFIGS) rather than seeking referrals from regional interviewees again in 2021. The dataset we selected, "Wildland Fire Locations Full History" consisted of over 200,000 data points representing all reported wildland fires in the United States dating back to 2003. We accessed the records on February 18, 2022. We applied the following filters to narrow the results consistent with our study selection criteria (Table 1):

- Fires must be categorized as a "wildfire" (as opposed to a "prescribed fire" or "incident complex").
- Fires must have lasted a minimum of 30 days from date of "Fire Discovery" to "Containment Date".
- "Fire Discovery" date and "Containment Date" must have both happened in 2021.
- "Calculated Acres" must be greater than or equal to 50,000.
- Fire must have taken place in a state located in US Forest Service Regions 1-6.
- Fires that were missing data from any of the above categories were excluded.

[3] For the purposes of this report, the term fire manager includes both fuels and wildfire (aka operations) managers.

We checked the remaining records in Inciweb to ensure they occurred primarily on federal forestland and were fairly simple regarding jurisdiction and management. We also looked them up in the FTEM database to ensure they were in proximity to a variety of fuel treatments.
Using these criteria, we narrowed the selection to 24 fires. After fact-checking information in Inciweb, we ruled out an additional three fires that did not meet our criteria. We then contacted representatives from 11 of the remaining 21 fires, prioritizing fires with over 100 treatment interactions and fires that took place in geographically diverse areas. We further narrowed down our selection to five case studies based on support from forest leadership and employee responsiveness to interview requests.

Table 1 Criteria for the selection of case studies (this structure was adapted from a study by Mackenzie et al., 2012).

Selection criteria category	Criteria
Meets Basic Study Parameters: 2020 and 2021 wildfires where fuel treatments were used (or not used) in some way during incident response	• Fire footprint primarily on western federal forestland (regions 1-6) • Proximity to existing USFS fuel treatments (based on referrals or FTEM) • Treatment interactions recorded in FTEM during the time of our sampling period (this criterion was preferred but not necessary due to variable data input)
Research Relevancy and Opportunity: Opportunity for case diversity and study richness	• Minimum of 50,000 acres and 30 days duration • Variety of fuel treatment uses during suppressions (e.g., enhanced containment opportunities, provided firefighter safety, changed fire behavior, treatments not used) • Fires that offer opportunity for regional diversity • Fire recommended by multiple informants (2020 fires only; 2021 fires were selected via online database rather than through informants)
Pragmatic: Practicality of successfully completing interviews	• Support from the Forest Supervisor's Office to conduct the study • Willingness, interest, and availability of staff to participate • Relatively simple regarding jurisdiction and management (e.g., limited joint command and or extreme weather incidents)

For the 2020 fire season, we selected the Cameron Peak Fire (n=10 interviews), and the Bighorn Fire (n=5); for the 2021 season, we selected the Cub Creek 2 (n=6), Lick Creek (n=8), McCash (n=4), Trail Creek (n=7), and Windy (n=7) Fires (Table 3), for a total of 59 interviews.

Table 2: Case study locations

Case Study	Fire Duration	US National Forest and state	Size of fire (total acres burned)	No. of Interviewees
Cameron Peak Fire	August 13 - December 13, 2020	Arapaho and Roosevelt, CO	208,913	10
Bighorn Fire	June 5 - July 23, 2020	Coronado, AZ	119,978	5
Cub Creek 2 Fire	July 16 - October 1, 2021	Okanogan-Wenatchee, WA	70,186	6
Lick Creek Fire	July 7 - September 2, 2021	Umatilla, WA	80,421	8
McCash Fire	July 31 - October 27, 2021	Six Rivers, CA	94,962	4
Trail Creek Fire	July 8 - October 12, 2021	Beaverhead-Deerlodge, MT	62,013	7
Windy Fire	September 9 - November 15, 2021	Sequoia, CA	97,528	7

Once these fires were identified, we strove to interview at least one Incident Commander (IC), one Agency Administrator (AA), and a forest fuels planner for each case study, as well as three to five additional people suggested to us by these interviewees who could address our questions. The additional interviewees recommended to us included, for example, Fire Management Officers and Operations Section Chiefs. Across all case studies, we interviewed a total of 12 ICs, 10 AAs, 6 Fire Management Officers (including Assistant Fire Management Officers), 9 Fuel Planners, Managers, Specialists, or Assistants, 10 Operations personnel, and 3 others that were recommended for playing a major role in fire management. Some people played multiple roles on a single fire; thus, there were 50 roles represented by 47 interviewees.

Interviews of non-federal personnel by referral took place when such personnel were critical in managing incident response. For both fires, some individuals did not respond to our request for interviews. For instance, given limited responses, on the Bighorn Fire only five people were interviewed, but the information provided was largely consistent among interviewees (exceptions are noted below in our findings).

Interviews were voluntary and confidential. They were recorded, transcribed, and coded for analysis to identify key themes. We summarized findings for our regional interviews and the themes that we identified across different fires. Illustrative quotes from interviewees are provided and speakers are distinguished by confidential identification numbers.

Findings from Regional Interviews

All regional interviewees said incident commanders (ICs) and other fire management personnel actively consider existing fuel treatments during wildfire incident management. Interviewees said they commonly use treatments for tactical advantage during incidents, using them to conduct burnouts and as access points, particularly when treatments are along roads, or occasionally for other purposes such as staging areas. Some said that any treatments that alter the fuel profile are useful during incidents because they change the risk profile, broaden decision space, and create more options for suppression. As one interviewee explained, "Options, I think, is a keyword there. When you have these [treatments] out away from the fire, you've got options to work with" (6). Another added, "[The treatment] gave us some decision space. . . It gave us a plan A and plan B, instead of just a plan B" (10). Almost all regional interviewees were positive about the value of fuel treatments in incident management. In addition to the tactical advantages outlined above, interviewees commonly cited the following as benefits of fuel treatments during incidents:

- Firefighter safety | Most interviewees said fuel treatments can enhance firefighter safety during incidents by providing easier and safer access points for crews to engage fires and allowing greater opportunity to consider indirect approaches, which are typically less aggressive methods that lessen firefighter exposure to heat and smoke.

- Resource efficiencies | Several interviewees explained that the time and resources required to prepare an area during an incident can be reduced or reallocated if the area has been previously treated. For example, one interviewee said, "It sure helps a lot when I get a map and there's already a fuel treatment on a road. And I'm like, 'Oh, great, I don't need to commit resources to that to prep that road or prep that ridge. It's already done'. . . It helps to keep those pressures on resources down if we've got treatments already completed" (8).

- Opportunity to manage natural ignitions for resource benefit | Some interviewees in USFS Regions 3 and 4 said that having fuel treatments in place can build better support for the consideration of managing natural ignitions for resource benefit if conditions permit, as opposed to immediately suppressing the fire.

Interviewees explained that treatments are typically planned with multiple goals in mind, most commonly including community protection from wildfire, providing tactical advantage during suppression operations, enhancing wildlife habitat, and restoring fire-adapted ecosystems. Most interviewees expressed that implementing treatments during suppression operations is generally aligned with their intended purpose. However, about a quarter of our regional interviewees explained that this was not always the case. Timber harvests were said to be the priority management goal

for the agency, a policy that sometimes dictates the size and placement of treatment areas. Such treatments, they said, sometimes cause increased fire behavior when slash or snags are not properly removed mechanically or with prescribed fire after harvests.

Interviewees said their consideration of how and whether to utilize a fuel treatment during incidents is contingent upon several dynamic variables, such as the fire behavior, fuel type, and the age of the treatment. Interviewees described the primary features they look for when considering use of fuel treatments:

- Strategic placement | Almost all regional interviewees said that strategically placed treatments, particularly those near roads, ridges, or the wildland urban interface (WUI) often offer greater utility during incidents. Fuel treatments near roads and other potential control locations can provide safer firefighter access than treatments in remote or steep areas.

- Treatment size and connectivity | More than half of our regional interviewees expressed that large or contiguous treatments are often more advantageous during fires. Many interviewees, however, expressed that it is difficult to implement fuel treatments that are strategically connected and occur at the landscape-level, noting constraints associated with policy, funding, and habitat preservation requirements. Several interviewees mentioned that planning projects around jurisdictional boundaries can limit treatment size and continuity, therefore constraining their utility during incidents. A few interviewees explained that fire scars, due to their size, are often more reliable during incident response than fuel treatments. Several interviewees agreed that a lack of treatment size and connectivity was a main barrier inhibiting the full potential of utilizing fuel treatments during incidents.

- Treatment age and maintenance level | About half of our interviewees said that treatment effectiveness diminishes over time, and that conducting ongoing maintenance of existing treatments is limited by agency funding and capacity. In describing a capacity problem related to maintaining fuel treatments, one interviewee explained, "The problem, if you're going to alter landscapes, especially when [the ecosystem is] used to disturbance really frequently, is that your workload has to double every six to ten years, just for you to maintain that previous investment that you put on places" (1).

Regional interviewees shared various ideas to help address challenges and improve the utility of fuel treatments during incidents. We grouped the most common recommendations into five topics.

1) Encourage prompt and coordinated communication during incidents. Interviews revealed there is not a systematic process within the USFS for obtaining, communicating, and using existing fuel treatment data during incidents. Many said unit culture and leadership styles affect how existing treatment data is integrated during incidents, and that some local forest units and Incident Management Teams (IMTs) are more open to sharing and receiving treatment information than others (see Box 1). Almost all interviewees agreed that there is room to improve communication about existing fuel treatments to IMTs. Interviewees suggested that having timely access to fuel treatment data through briefing packets and maps could enhance fuel treatment utility. Some interviewees conjectured that a more standardized process for sharing fuel treatment information during incidents could be valuable.

   Most interviewees said that personnel will scout the area to verify current treatment conditions regardless of having fuel treatment information. This is done not because of lack of trust or aversion to using the information, but rather out of caution. Interviewees noted that local knowledge about treatments is extremely valuable in speeding up the ground-truthing process.

Box 1: Examples of fuel treatment communication processes

"I've been on numerous fires where I spend two or three days just driving all over the place trying to figure out: where are we going to draw that line in the sand, what's the best opportunity for a containment line? [If] this data is provided to you when you first show up, then all you're doing is going out and confirming that these are good locations. Or, these are good locations, but we still need to put some resources to actually put in a hand line, or we need to bring in some equipment to put in a dozer line or do some tree thinning. [Having treatment data readily available] could save me two or three days of work, which time is obviously a critical component when responding to a fire" (2).

"You know how I spoke earlier that each forest has their own way of communicating to a team their fuel treatments and fuel breaks? I wish that there was a way that can be standardized and/or made a higher priority across the whole agency . . . My forest is behind the curve when it comes to that, and it's frustrating that I can go to an incident on another forest and see the products they produce . . . I'm like, 'Man, this is a great product. I wish we could provide this to a team when they come to my forest'" (8).

2) Explore and invest in pre-fire planning and decision support efforts. Most interviewees were enthusiastic about the potential for pre-fire planning and modeling efforts to improve the use of fuel treatments during incident management. Interviews referred to multiple planning and decision support approaches that are often used to efficiently share data including treatment maps loaded into the Wildland Fire Decision Support System (WFDSS), Forest Service Activity Tracking System (FACTS), and Potential Operational Delineations (PODs). Interviewees valued the integration of these tools, describing the potential for sharing readily available information about existing fuel treatments.

   A few interviewees were more critical about adopting PODs and other tools that utilize computer models. For instance, some interviewees brought up challenges with the perception that these tools undermine expert knowledge, indicating a need to address the persistent tensions between local knowledge and data-driven models. Some also noted that different forests were at varying stages of developing PODs, and that non-local responders had differential awareness and familiarity about using them during incident response.

3) Enhance integration with other resource specialty areas during treatment planning and design. Interviewees noted that in many cases, resource specialists are less supportive or less aware of fuels and fire management, which leads to resistance to strategic planning and implementation of fuel treatments at the scale needed. Interviewees felt that there could be more integration with resource specialists during the design and planning stages of fuel treatments. We heard that direct involvement and exposure to fire management can help foster an understanding of the need to get 'good fire' on the ground and accomplish forest restoration and habitat objectives.

4) Support and implement landscape-level boundary-spanning efforts. Interviewees emphasized that addressing the wildfire problem means working beyond their land management boundaries, and that treatments can be more effective if implemented at a larger, cross-jurisdictional level. Some interviewees expressed an interest in tools that would allow them to share fuel treatment information and products more easily among external agencies, states, and other landowners.

5) Dedicate resources to address equipment and staffing capacity limitations. Solving capacity issues related to both fuel treatment scale and maintenance would require a dedicated investment and cultural changes within the agency, interviewees said. As a result, interviewees recommended strategically planning treatments that maximize the utility of limited funds, such as by conducting prescribed burns near values at risk and telling the story of fuel treatments to Congress and the public to help sustain funding and workforce needs. We note that recent appropriations for fuel treatments will substantially increase funding, but capacity to implement treatments, connectivity of treatments, and treatment maintenance (e.g., with prescribed fire) will require ongoing attention.

Findings from Case Studies

Below, we share themes from across all case studies, organized by research questions. For more details about individual fires, see our case summaries in Appendix A.

Research Question 1: *To what extent do treatments during suppression operations align with land managers' intended purpose for those treatments from a design and planning perspective?*

Across all seven case studies, most fuel treatments were designed by interdisciplinary teams with wildfire mitigation and defensible space around structures as primary goals. Other goals often included improving overall forest health, enhancing wildlife habitat, range management, commercial timber production, and safety and accessibility for visitors in beetle-killed areas of the forest.

Most interviewees explained that treatments often, but not always, were planned and implemented with the intent to provide general tactical advantage during wildfire suppression. However, a few treatments on the Cameron Peak, Bighorn, and Windy Fires were designed with particular wildfire suppression operations in mind; they were intended to be used for backfires or as fire breaks, for example. A few interviewees noted that treatments in or near the Wildland Urban Interface (WUI) tend to focus more strongly on structure protection during wildfire suppression operations, while treatments further from the WUI have more of a holistic landscape restoration design. A Bighorn Fire interviewee discussed possible ways fire managers might consider using a fuel treatment to their advantage, saying:

> *"The whole idea is that if a fire happens, [fuel treatments] give firefighters or fire managers a place to better understand and control the fire before it reaches the values at risk. That can be burning off the edge of it without using the whole thing, or if the fire starts in the treatment, the fire behavior is reduced because the fuels are reduced. … The treatment is done for all those reasons, not just one. … If a fire starts, [IMTs] use it to the best of [their] advantage. … It's based on the fire behavior at the time."*

Some treatments, also particularly on the Cameron Peak and Windy Fires, were useful in suppression operations, although that was not the treatment's intended purpose. On the Windy Fire, one treatment that was widely considered by interviewees to be the most useful in protecting key values at risk was originally intended to increase access and enhance visitor safety from snags. One Windy Fire interviewee said most land managers knew during planning and implementation that the treatment could be used for fire suppression purposes if needed, but that this was not explicitly stated as a primary objective of treatment design. On the Cameron Peak Fire, interviewees described a prescribed burn that was not originally intended for community wildfire protection, but that ended up achieving this objective by slowing the fire down and giving IMTs time to protect values at risk ahead of the fire. A Lick Creek Fire interviewee explained that during a fire, treatments were considered and used regardless of their original intended purpose, stating:

> *"Whether it was stated in the burn plan that [the purpose of the treatment] was hazard fuel mitigation, I don't know. I never saw the burn plan. But it definitely helped, regardless. What they're doing it for is a moot issue. It's still a benefit on all angles when they treat it."*

Research Question 2: *How do incident commanders, other fire management personnel, and forest personnel communicate about existing fuel treatments and their value during incident response?*

Interviews revealed there is not a systematic process within the USFS for obtaining, communicating, and using existing fuel treatment data during incidents, though there were consistent, informal norms across our case studies. On the Cameron Peak and Bighorn Fires, local staff briefed the first IMT that arrived, then trusted that IMT to relay the information to subsequent incoming IMTs. Interviewees on the other fires said that, while the initial briefing may be the most in-depth, all teams got an initial briefing, followed by ongoing smaller group meetings throughout their stay. A few interviewees wanted a more standardized process for concisely communicating about existing fuel treatments to non-local teams, but more commonly interviewees expressed concern that formalized processes would add bureaucratic 'red tape' to time-sensitive incidents.

Information about fuel treatments was typically shared in the form of geospatial databases, paper maps, pre-assembled information packets, tours, and most importantly, through verbal descriptions from local staff. Interviewees across most fires emphasized the importance of local staff for sharing detailed, nuanced descriptions of treatments that geospatial databases cannot capture, including information about their current state and recommendations for how they might be used in operations. Local staff members who were involved at all stages of the treatment – planning, implementation, and monitoring – had the greatest depth of knowledge about treatments; a couple interviewees noted that forests with high turnover risk losing this long-term, in-depth knowledge of treatments that experienced employees bring to the table. In particular, interviewees on the Lick Creek and Trail Creek Fires spoke positively about their experience with communication during the fires, which they attributed to involvement of local staff, low forest turnover, up-to-date maps, and pre-existing relationships between IMTs and local staff. Interviewees from the Umatilla National Forest (Lick Creek Fire) described a workplace culture that encourages collaboration and working across specialty areas. A few interviewees from this case study said that the Umatilla National Forest has not seen much turnover in recent years, so the staff there are deeply familiar with treatments. One person said,

> *"I think [the reason partnerships were so strong on the Salmon-Challis and Beaverhead-Deerlodge] was the forest supervisors, to be honest with you. It sounded like, on the ground, those foresters had differences of opinion on how they would lay out those fuels treatments, but those forest supervisors made it pretty clear that they were going to work together, and they were going to make it work. I've known that whole group of forest supervisors in that area for a while, and they're just really good leaders."*

In general, interviewees who worked on IMTs and had pre-existing relationships with local staff (e.g., from past fire assignments or personal friendships) were open to receiving information about existing fuel treatments. One interviewee, who worked on an IMT during the Lick Creek Fire, said they called a personal friend on the Umatilla National Forest and got an overview of fuel treatments before they arrived on the scene. In other cases, interviewees who had been assigned to past wildfires in the area remembered information about fuel treatments and simply needed a refresher.

Some interviewees, most commonly on the Cameron Peak and Bighorn Fires, said that IMTs' receptivity to fuels information varied based on team culture, individual personalities, and varying levels of experience and comfort with fire behavior in a given ecosystem. While this was not a common challenge across all cases, it was a significant challenge when it did arise. One interviewee from the Cameron Peak Fire explained:

> *"Teams are like individuals, they have personalities. Some are more open to that sort of local integration, others not so much. Teams also have different confidence levels in different fuel types . . . As far as the teams, or individuals on the teams, taking advantage of or listening to some potential opportunities to use these units or treatments, that also was hit or miss . . . convincing the teams that this is going to be the most likely area to be successful, it was a hard sell at times"*

A few interviewees across cases said COVID-19 restrictions on face-to-face interactions presented unique challenges for communication in general. One interviewee on the McCash Fire said that fuel information is typically shared on an ongoing basis, often through informal, face-to-face interactions throughout the fire's entire run. During both fire years, but particularly 2020, some communication was limited to phone or email under COVID-19 protocols, making information flow slower and less constant. Interviewees on the Cameron Peak and Bighorn Fires said that COVID-19 restrictions caused IMT transitions, in particular, to go less smoothly.

Research Question 3: How do fire managers view treatments and incorporate them into operations, including situations when treatments are not expected to interact directly with the fire?

Fuel treatments were used in a variety of ways during wildfire suppression operations; most commonly, treatments were used for conducting burnout operations, establishing anchor points, contingency planning, easing firefighter or equipment access, and even increasing visibility of spot fires. Interviewees on nearly every fire said fuel treatments were used for burnouts, for anchor points and for better access. On about half the fires, interviewees said they used treatments as alternate, contingent, or emergency lines in contingency planning. In some places on the McCash, Cameron Peak, and Trail Creek Fires, the fire directly intersected a treated area and reduced fire behavior which allowed for more direct attack. A couple interviewees across case studies said that treated areas offer better visibility, allowing firefighters to notice spot fires before they get too large.

The most common benefit of fuel treatments across all fires was that treatments reduced the amount of time and resources required to prepare an area for a given use, thus allowing IMTs to reallocate limited resources to other areas of the fire. Interviewees said that treatments nearly always require some "cleaning up," or clearing of additional material, before they can be integrated into operations, but that this process is more efficient in areas with existing treatments compared to starting from scratch in a completely untreated place. Almost all interviewees said this efficiency is especially important considering fires in the west are becoming more frequent and more intense over time. On the Cub Creek Fire, one interviewee described a situation where defensible-space treatments gave firefighters the opportunity to safely enter, clear the area, and wrap a tower before the fire arrived. On the McCash Fire, one interviewee said:

> *"When we're prepping homes and someone's already done that thinning and created that defensible space, instead of simply removing material from people's homes, we have the ability to increase the effectiveness or the depth of the treatment. … When a lot of the mechanical work has been done, then it gives the firefighters time to install things like sprinklers and put pumps in … so that these homes have a greater likelihood for survival."*

Across most fires, many interviewees emphasized the importance of having flexibility in fire management and said treatments offer a greater number of options for places to hold line, conduct burnouts, use as contingency lines, etc. Interviewees agreed that, though some treatments were more easily utilized than others, any change in fuel composition on a landscape diversified the management options available to fire managers.

Other common benefits from treatments across all fires included preventing loss of structures and other values at risk, moderating fire behavior, and increasing firefighter safety. In many cases, when asked how outcomes might have been different without fuel treatments in place, interviewees hypothesized that more structures would have been lost, or that the fire perimeter would have been larger. In all cases, firefighter safety was of paramount importance, and treatments made areas more safely accessible.

A couple interviewees noted that treatments can exacerbate fire behavior, particularly if they are not followed by prescribed fire or maintained. One interviewee said that the Sequoia National Forest had only recently burned piles in one of the treated areas that was utilized on the Windy Fire; they believed that if the piles had not been burned before the wildfire, the treatment would have had an adverse effect on fire behavior. Most interviewees did not discuss potential negative effects of treatments.

Many interviewees across case studies considered use of wildfire scars in operations in the same way they would consider man-made treatments. Wildfire scars were mainly used in the suppression of the Cub Creek, Lick Creek, Trail Creek, and Windy Fires. On the Windy Fire, a few interviewees agreed that wildfire scars were the ultimate factor influencing the fire's ultimate perimeter, while manmade treatments were used for protection of specific values at risk. A few interviewees across cases noted that, while wildfire scars are sometimes the most effective in moderating fire behavior, their high number of snags and shrubby regrowth can create hazardous terrain for firefighters.

When the fire was not expected to directly interact with a treatment, some interviewees said treatments were often still useful for contingency planning and increasing safe access for firefighters and equipment. On the Bighorn and Trail Creek Fires, interviewees pointed out that planned, but not yet implemented, prescribed burns were useful for IMTs because planners had pre-identified possible escape routes and holding features already, which could easily be transferred to wildfire response. On the Lick Creek Fire, one treatment was used as a helispot; on the Lick Creek and Cameron Peak Fires, treatments were used as staging areas.

Interviewees also noted that treatments could reduce negative post-fire effects on the landscape, both because treatments help reduce severity of the burn, and because treated areas require less machinery intervention during firefighting efforts. Though at the time of interviews there was not much post-fire recovery data available on the case studies we examined, a few interviewees noted that, in general, treated areas tend to see less severe post-fire effects.

Although most interviewees across all fires thought treatments were beneficial to the overall management of the fire, or considered during incident response, there were a few interviewees who said treatments did not contribute to suppression operations. According to these interviewees, some treatments were rendered ineffective during operations because extreme fire behavior and weather conditions overwhelmed the treated areas, or because treatments were too small to have an effect on fire behavior.

Research Question 4: What characteristics do fire managers look for when considering using a fuel treatment to support their wildfire management strategy?

The most common characteristics interviewees said they look for when considering using a fuel treatments are the location in relation to roads and natural holding features, and the availability of equipment and staffing required to effectively use the treated area in operations. Interviewees said treatments located along roads are generally useful because roads are wide, free of fuel, and are easy to access. Other natural features, like ridgelines and rivers, offer natural holding locations, so treatments near these locations are useful as well. Because treatments almost always have to be cleaned up before use in operations, interviewees on most fires said that the number of resources available can impact whether they decide to utilize a treatment in their suppression strategy. For example, if responders think it will take three days to clean up a treated area, and the fire is moving at such a rate that it will reach the area in two days, they would either need to find more resources to clear the area faster or deem the treatment unusable. A Cameron Peak Fire interviewee described a situation where there were not enough resources to properly utilize treatments, explaining:

> *"If you don't have the resources and/or the time to do whatever that work is, then that fuel treatment is no longer a viable option . . . if we had full resources we could have connected all those dots. But, with the reduced staff that we did have, we just [didn't] have the time and space to do what we needed to do to be successful."*

Most interviewees also commonly considered the amount and type of residual fuel in treated areas, how recently the area was treated, the accessibility for firefighters and equipment, and how well the treatment had been maintained since implementation. Interviewees looked for treatments with very few ground and ladder fuels remaining because they said those areas are generally safer and more effective for certain operational tactics. Treatments conducted in the last five years were typically considered to be the most useful, because there had not yet been significant regrowth of fuels. A couple interviewees noted, however, that in areas that have been very recently harvested, there may be large amounts of slash on the ground, which can intensify fire and create more hazardous conditions for firefighters. Finally, interviewees looked for how well the treatment has been maintained over time, noting that well-maintained treatments can be safer and tend to require the least amount of clean up.

Large, wide treatments, or multiple smaller treatments that could be connected to one another, were most useful for influencing overall fire behavior, interviewees said, while small, WUI-focused treatments helped protect values at risk. In most cases, interviewees emphasized that larger, landscape-level treatments, or multiple small treatments that could be connected to one another, can be used on a larger scale as a fireline, ultimately influencing the perimeter of the entire wildfire. However, interviewees on the Bighorn, McCash, Cub Creek, and Trail Creek Fires also emphasized the importance of small, WUI treatments in protecting values at risk. A Cub Creek Fire interviewee shared their perspective that small, WUI treatments are the greatest 'investment', saying:

> *"My own philosophy on this is, the best investment is defensible space. Because [firefighters] are pretty much bound to the protection of infrastructure when it's threatened. And that prioritizes where our resources go. If defensible space work is already done in an area, then we don't have to invest resources on that, and we can invest the resources more in perimeter control. So, defensible space is where the biggest bang for the buck is."*

One Windy Fire interviewee summarized the value of both small and large treatments, explaining:

> *"For structure protection and to protect a Giant Sequoia Monarch, they were very effective. As far as controlling fire behavior across the landscape? Wasn't enough to do anything. You need something that's more of a landscape approach to change fire behavior on the landscape."*

Treatment characteristics were one of many factors interviewees looked at in determining their suppression strategy; ultimately interviewees said their utility depended on external factors like weather, fire behavior, and resource availability. Several interviewees across all case studies said that, as fires get larger and more intense over time, it is becoming more difficult to rely on treatments in suppression operations. While nearly every interviewee maintained that treatments are useful, they also noted sometimes conditions are such that treatments will not have a significant effect on fire management. As one Windy Fire interviewee explained:

> *"When I first came to California, that [was] the first question. I was like, 'Does anything matter when you have fires like this?' ... So it's not a yes or no answer. It's a gradation. It's like, under the average fire, under these conditions, it works. Under other conditions, there's nothing you can do."*

Discussion & Recommendations

Because most treatments across cases were planned with broad goals in mind and treatment utility during wildfire management was highly dependent on contextual factors, most treatments' use seemed to align with land managers' intended purpose. Wildfire mitigation was almost always a goal of treatments, but was one of many. There were only a few cases where fuel treatments were designed with a specific operational use in mind or with no indication of intent for use during incident response.

Interviewees recommended forests have readily available treatment information, support direct communication from local staff members to IMTs, and support communication from outgoing IMTs to incoming IMTs to facilitate consistent transfer of treatment information. This was particularly emphasized on the Cameron Peak Fire, which consisted of many IMT transitions and happened during a time of stick COVID-19 limitations on social interactions. They also cautioned against formalizing too much the information sharing process, which would leave little room for flexibility and potentially add bureaucratic 'red tape.'

Interviewees agreed nearly unanimously that, as weather and fire conditions become more extreme over time, there is a need to increase the pace and scale of treatments. Some treatments, particularly on the Cub Creek and Trail Creek Fires, were not used in suppression efforts, usually either because the fire burned through the treatment before it could be incorporated into planning or because the treatment was not large enough to moderate such fire behavior. With more, and larger, treatments available, interviewees said there would be more opportunities to utilize them to facilitate incident response and moderate fire behavior.

Interviewees indicated that landscape-scale treatments tended to be more beneficial for management of overall fire behavior, while smaller treatments were most useful for protecting specific values at risk. They explained that a mix of both strategies is needed to maximize benefits for point protection and overall fire management efforts during incident management.

In addition to increasing the pace and scale of new treatments, interviewees recommended increasing investments in maintenance of existing treatments, which was a common characteristic they looked for in determining whether or not to incorporate a treatment into incident management. Treatments that were either more recently completed or better maintained over time saved crews time and resources because they did not have to do as much additional clearing, or 'cleaning up,' of residual fuel.

Interviewees also recommended investing in relationship-building across boundaries before wildfires hit. This can help ease communication about fuel treatments, potential management strategies, and local priorities during an incident.

A limitation of this study is that, despite multiple attempts, we were unable to capture the perspectives of every desired role on each case study, in part due to people's busy schedules. On one fire we were unable to talk to any incident commander, and on another we could not connect with the Fire Management Officer. Despite these missing perspectives, our findings were fairly consistent across fires. We also note that while we were interested in treatment effects on fire suppression, we did not talk to national forest staff across resource areas to determine treatment effects on other resources or post-fire recovery.

Future studies on this topic might include a more in-depth temporal analysis, examining treatment use at different times during a fire. For example, one interviewee said treatments are sometimes used less in the early days of a fire when IMTs are still getting settled and learning what is on the landscape. Another interviewee noted that during periods when resources were stretched across multiple fires, treatments might not be utilized as much until resources are more readily available. Interviewing personnel who were deployed at different times in the fire might reveal if and how treatments are considered over time. We also recommend studies that follow different IMTs to understand how team dynamics and experience influence their consideration of treatments and associated decisions during fire management.

References

Mackenzie, J., Tan, P. L., Hoverman, S., & Baldwin, C. (2012). The value and limitations of participatory action research methodology. *Journal of Hydrology*, 474, 11-21.

National Wildfire Coordinating Group (NWCG). *Glossary of Wildland Fire*. Accessed 16 November 2021. https://www.nwcg.gov/glossary/a-z

Reinhardt, E. D., Keane, R. E., Calkin, D. E., & Cohen, J. D. (2008). Objectives and considerations for wildland fuel treatment in forested ecosystems of the interior western United States. *Forest Ecology and Management*, 256(12), 1997-2006.

USDA Forest Service (2018). Coronado National Forest Land and Resource Management Plan. Accessed 16 November 2021. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5440343.pdf

Vaillant, N. M., & Reinhardt, E. D. (2017). An evaluation of the Forest Service Hazardous Fuels Treatment Program—Are we treating enough to promote resiliency or reduce hazard? *Journal of Forestry*, 115(4), 30.

Case Profile: Cameron Peak Fire

Overview | The Cameron Peak fire (CPF) burned over 200,000 acres of steep, rugged terrain under extreme temperature, drought, and high wind conditions. Interviewees told us opportunities to take a direct approach were limited due to the remote location of the ignition, difficult access, and extensive tree mortality from beetle outbreaks. Responders identified a large planning area ("big-box" approach), prioritizing structure protection and strengthening control lines.

Our study on the CPF focused on fuel treatment considerations during the first 60 days (August 13-October 12th) before the fire made a second large run under extreme weather conditions starting on October 14th.

Notable Themes by Research Question

To what extent do treatments during suppression operations align with land managers' intended purpose for those treatments from a design and planning perspective?

- The ARP's fuels treatment goals are to conduct a strategic ribbon of wide treatments to reintroduce fire and protect communities from future wildfires.
- Treatments mostly aligned with their intended purpose.

How do ICs, other fire management personnel, and forest personnel communicate about existing fuel treatments and their value during incident response?

- The Canyon Lakes Ranger District packaged local fuels treatment information for communication, which they expected to be consistently transferred among IMTs.
- COVID-19 protocols limited face-to-face interaction; this strained typical communication practices, especially with the high number of team transitions on the fire.
- Some interviewees perceived that non-local IMTs were hesitant to consider utilizing treatments in management decisions and tactical strategies; they attributed this to individual personalities and levels of confidence working in unfamiliar fuel types.

How do fire managers view treatments and incorporate them into operations, including situations when treatments are not expected to interact directly with fire?

- Treatments were used in operations to conduct burnouts, as access points, as anchor points to put in indirect lines, as safety zones, and in contingency planning.
- Some treatments directly moderated fire behavior, allowing for safer engagement, greater opportunity to protect values at risk, and, in some places, stopped the fire from progressing.
- Interviewees said treatments allowed for better security and time efficiencies, giving teams time to manage point protection around values at risk.

What characteristics do fire managers look for when considering using a fuel treatment to support their wildfire management strategy?

- Many interviewees viewed historical wildfires similarly to how they viewed planned treatments when considering 'treated areas' for use in operations.
- Most interviewees said large fuel projects completed in the last five years and close to roads were the most useful.

What recommendations do interviewees have for improving fuel treatments to support incident management of a wildfire?

- Interviewees primarily recommended increasing the extent and quantity of treatments, saying ideally there would be larger treatments that are closer and more connected to communities.
- Interviewees believed building community support and interagency collaboration were necessary to achieve this goal.

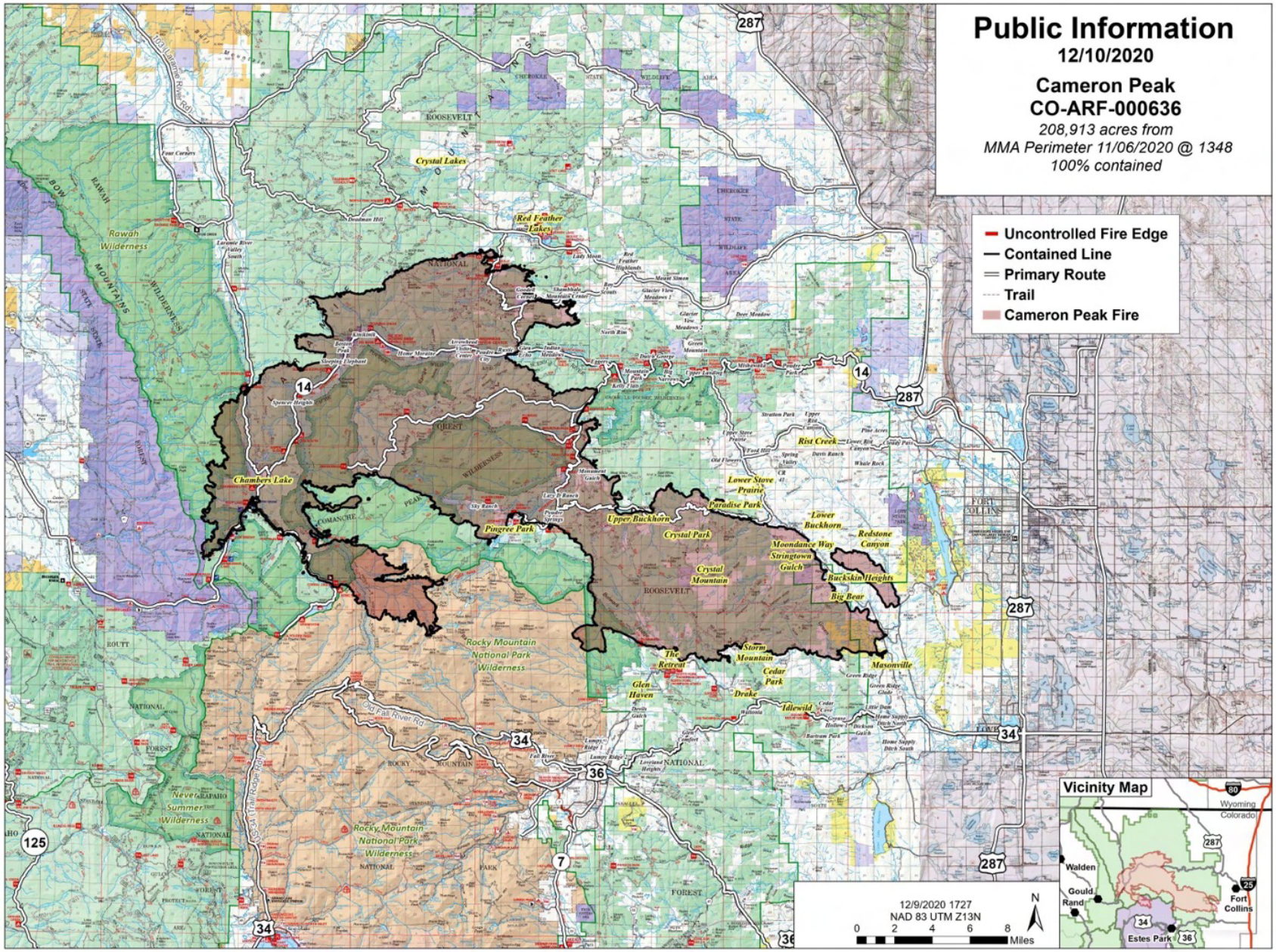

Figure 1. Cameron Peak Fire final perimeter map.

Case Profile: Bighorn Fire

Overview | The Bighorn fire started in steep terrain and burned 119,978 acres in the Pusch Ridge Wilderness Area of the Catalina Mountains north of Tucson, Arizona. Ninety percent of the fire burned in the Coronado National Forest, but private and state lands were also affected. The BHF was characterized by its proximity to property, difficult terrain, and extreme weather conditions driving unique fire behavior. The BHF was managed under a full suppression strategy. The fire was initially managed by a Type 3 IMT and was transferred to two Type 1 IMTs and one Type 2 IMT over the course of the fire. The Santa Catalina Ecosystem Management Area, where much of the Bighorn Fire burned, experiences the most visitors in the Coronado National Forest and is the site of many important values at risk. The Coronado National Forest Plan set a goal of treating 25% of the 260,194-acre Santa Catalina Ecosystem Management Area in 10 years using planned and unplanned fire ignitions and mastication techniques (USDA, 2018).

Notable Themes by Research Question

To what extent do treatments during suppression operations align with land managers' intended purpose for those treatments from a design and planning perspective?

- The Coronado National Forest has been strategically planning fuel treatments at a landscape level with multiple goals in mind including improving wildlife habitat, promoting forest ecosystem health, and mitigating the effects of large wildfires.
- Many treatments were planned with an emphasis on protecting structures in the towns of Oracle and Summerhaven from future wildfires.
- Most interviewees agreed that targeted treatments in the WUI were appropriate for protecting lives and property.

How do ICs, other fire management personnel, and forest personnel communicate about existing fuel treatments and their value during incident response?

- Information about treatments passed organically from IMT to IMT; local personnel were very open to sharing and IMTs were receptive to learning.
- There was not a formalized process for sharing information, but interviewees said sharing was effective and intuitive.

How do fire managers view treatments and incorporate them into operations, including situations when treatments are not expected to interact directly with fire?

- Most interviewees agreed that fuel treatments were instrumental in protecting values at risk during the Bighorn Fire.
- Treatments were most commonly used on the Bighorn Fire as anchor points, burnouts, and contingency lines.
- Prescribed burns that had been planned, but not yet implemented at the time of the fire, saved IMTs time because they had pre-identified anchor points, control lines, and contingency lines.

What characteristics do fire managers look for when considering using a fuel treatment to support their wildfire management strategy?

- Older treatments that have not been maintained took more time and manpower to prepare for use in operations.
- One interviewee said treatments with few snags were considered safer for firefighter entry, and another said they look to reuse holding that have successfully held fire in the past.

What recommendations do interviewees have for improving fuel treatments to support incident management of a wildfire?

- Several interviewees recommended treatment targets that are based on values protected rather than acres treated.
- A couple interviewees recommended prioritizing treatment maintenance so less time is required to re-clear the area for use in firefighting operations.

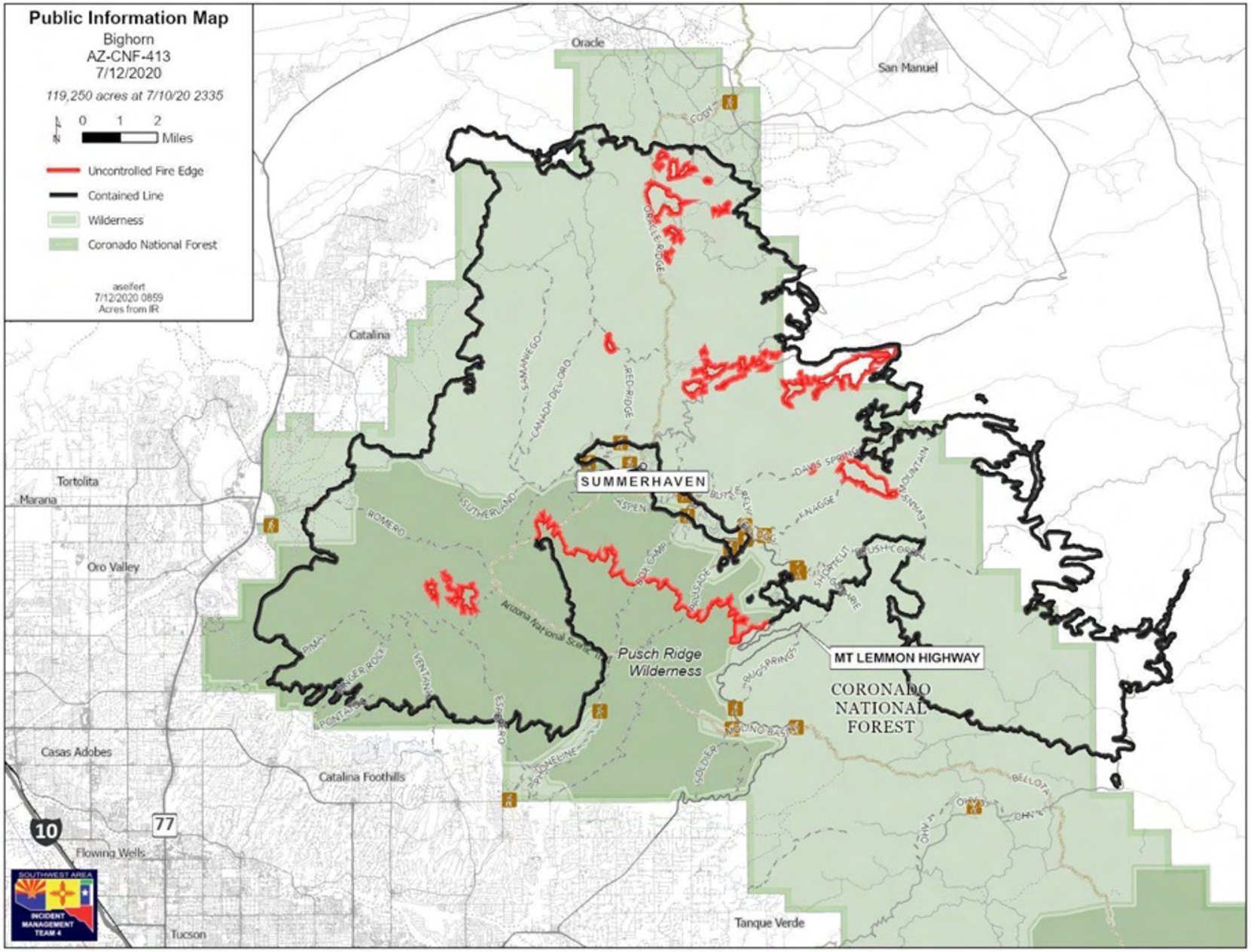

Figure 2. Bighorn Fire perimeter map as of July 12, 2020. By this time, the fire was mostly contained.

Case Profile: Cub Creek 2 Fire

Overview | The human-caused Cub Creek 2 Fire (herein, the Cub Creek Fire) started on private property near the Okanogan-Wenatchee National Forest in Washington on July 16, 2021. During the time of the Cub Creek Fire, several other wildfires were active nearby, most notably, the Muckamuck and Cedar Creek Fires. This made the logistics of managing the fire very complex, because at various points throughout the fire's run IMTs took on management of multiple fires at once. A few days into the fire, weather and fuel conditions aligned such that the Cub Creek fire grew from 8,255 acres to more than 30,000 acres overnight, quickly burning through several fuels treatments that the Okanogan-Wenatchee National Forest had implemented in previous years; thus, firefighters were unable to use most of those treatments in incident management. The treatments utilized on this fire included both commercial and small-tree thinnings, prescribed fire, defensible space work around values at risk, and even an old fire line from a previous wildfire.

Notable Themes by Research Question

To what extent do treatments during suppression operations align with land managers' intended purpose for those treatments from a design and planning perspective?

How do ICs, other fire management personnel, and forest personnel communicate about existing fuel treatments and their value during incident response?

- Interviewees learned about fuel treatments from local forest personnel and from previous experiences living or working in the area.
- A couple interviewees noted communication challenges related to high turnover in the US Forest Service; one said that treatments older than about 5 years are not typically well-communicated because the staff most involved in the planning and implementation have often moved on by then.

How do fire managers view treatments and incorporate them into operations, including situations when treatments are not expected to interact directly with fire?

- The primary treatments utilized on this fire were a treatment that moderated fire behavior enough for IMTs to move to a direct attach approach, and defensible space treatments around a fire tower that bought firefighters time to do additional point protection around the tower that saved it from burning.
- A number of treatments that interviewees thought could have influenced fire behavior were burned through in a 20,000 acre blowup toward the beginning of the fire's run; one interviewee noted that external factors like weather and fuel conditions have to align in order for treatments to be effective.
- Interviewees referred to historical wildfire scars as treatments, and said that the numerous fire scars on the Okanogan-Wenatchee National Forest played a more significant role in fire suppression than man-made treatments.

What characteristics do fire managers look for when considering using a fuel treatment to support their wildfire management strategy?

- The most common thing interviewees looked for in treatments was a location near a ridge, road, or other major fuel break.
- They also looked for large treatments, or multiple smaller treatments in close proximity to one another that could be "stitched" into one larger treatment, fuel composition with few ground fuels and wide crown spacing, and treatments that included prescribed fire, which they said was most effective in moderating fire behavior and increasing safety.

What recommendations do interviewees have for improving fuel treatments to support incident management of a wildfire?

- There were not consistent recommendations from interviewees on this fire.

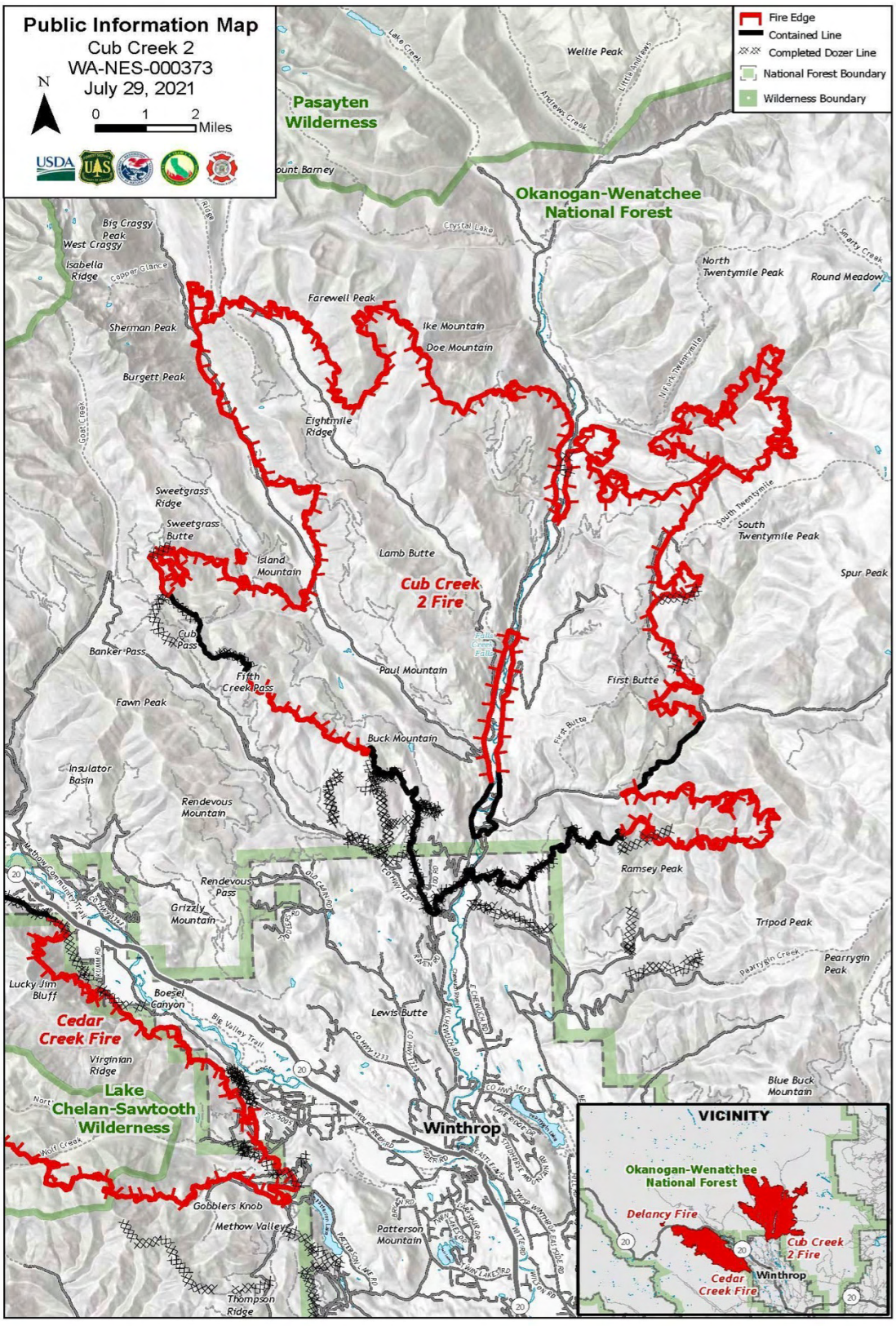

Figure 3. The Cub Creek Fire as of July 2021. The fire was not officially contained until October.

Case Profile: Lick Creek Fire

Overview | The 80,421 acre Lick Creek Fire was started by a lightning strike following several weeks of record-setting high temperatures and extremely dry fuel conditions in on the Umatilla National Forest in southeast Washington. The fire started in light, grassy fuels and after a few days became established in a higher-elevation timber fuel type. The same lightning storm started several other fires in the region at the same time as the Lick Creek Fire; these concurrent suppression efforts limited the resources available for each fire. The fire threatened several private grazing allotments in the area. Because there are multiple jurisdictions covering the area, leadership on the Umatilla National Forest indicated that they prioritized inter-agency relationships leading up to the Lick Creek Fire. Despite the area's complex topography, several interviewees expressed that the Lick Creek Fire was a relatively low-complexity incident.

Notable Themes by Research Question

To what extent do treatments during suppression operations align with land managers' intended purpose for those treatments from a design and planning perspective?

- Treatments on the Umatilla National Forest were typically planned with a variety of benefits in mind related to timber, watershed, range, wildlife, and fire management goals.
- Treatments that were ultimately utilized on the Lick Creek Fire tended to have fire management as a primary goal.
- Interviewees seemed to agree that treatments fulfilled their broad purposes.

How do ICs, other fire management personnel, and forest personnel communicate about existing fuel treatments and their value during incident response?

- Excellent communication and smooth collaboration stood out as defining characteristics of this fire; this was partially attributed to the fact that several individuals from non-local IMTs were familiar with the area from previous incidents and/or had pre-existing relationships with Umatilla staff.
- Some felt that low turnover on the Umatilla led to staff that was more deeply familiar with the landscape and its treatments than staff on forests with higher turnover.
- Umatilla staff emphasized that the forest's collaborative culture, which emphasizes cross-specialty work and communication, prepared them to work effectively as a team during the incident.

How do fire managers view treatments and incorporate them into operations, including situations when treatments are not expected to interact directly with fire?

- The treatments used on the Lick Creek fire included broadcast burns, thinned areas with pile burns, and old wildfire scars, particularly those along road systems.
- They were most commonly used as anchor points, to conduct backfires, for creating time and resource efficiencies, increasing confidence among operations personnel, and in improving firefighter safety and access.
- In some instances when the fire did not end up burning into or through existing treatments, they were still valuable for contingency planning.

What characteristics do fire managers look for when considering using a fuel treatment to support their wildfire management strategy?

- Most of the treatments utilized in operations on the Lick Creek Fire were chosen for their location along roads; the roads were the primary draw to the location but treatments allowed for efficient preparation.
- A few interviewees also said they looked for treatments bigger than 100 acres, that had been maintained over time, or were completed relatively recently.
- In general, interviewees said they look for the amount of residual fuels, the ability to 'stitch' multiple features together into one larger treatment, treatments that align with natural topographic holding features, and treatments that allow safe firefighter access.

What recommendations do interviewees have for improving fuel treatments to support incident management of a wildfire?

- There were not consistent recommendations from interviewees on this fire.

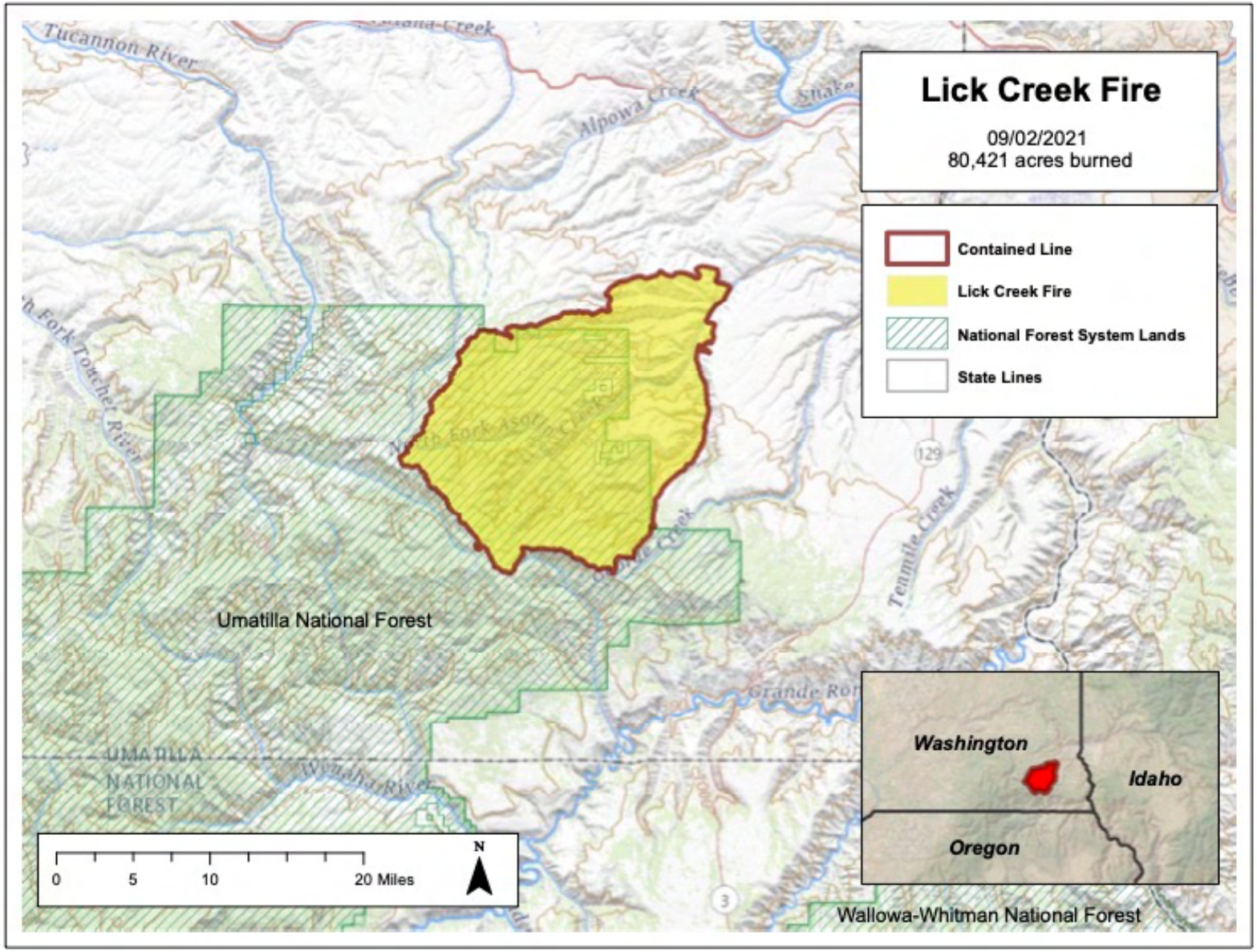

Figure 3. Lick Creek Fire final perimeter map. For an interactive map of the fire and others in the area, click here.

Case Profile: McCash Fire

Overview | The 94,962 acre McCash Fire started by lightning on the Ukonom Ranger District of the Six Rivers National Forest in July 2021. It was already a busy fire season in California, which limited the number of resources available for suppression operations.

Notable Themes by Research Question

To what extent do treatments during suppression operations align with land managers' intended purpose for those treatments from a design and planning perspective?

- Treatments were planned with multiple fire management goals in mind, including community wildfire mitigation in the WUI, firefighter safety during incident management, and reintroduction of fire on the landscape.
- Treatments seemed to align with these purposes, particularly with community protection and firefighter safety goals.

How do ICs, other fire management personnel, and forest personnel communicate about existing fuel treatments and their value during incident response?

- Interviewees stressed the importance of having local personnel communicate about treatments, since they were most familiar with the overall quality of each treatment and what factors might affect its usefulness in suppression operations.
- Most interviewees said sharing of fuel treatment information tends to be informal, but has become fairly consistent over time since most IMTs and forests believe fuel treatment information is important to have.
- One interviewee noted that COVID-19 restrictions at the time of the fire limited the amount of in-person interactions typical on wildfires.

How do fire managers view treatments and incorporate them into operations, including situations when treatments are not expected to interact directly with fire?

- Treatments utilized on the McCash Fire included prescribed fire, thinnings, pile burns, shaded fuel breaks in old logging roads and old dozer lines from previous wildfires, and defensible space treatments in the WUI.
- Treatments were primarily useful in easing resource strain during a busy fire season, and for contingency planning.
- Other benefits included conducting burnoffs from treated areas and the ability to use a direct attack strategy were treatments moderated fire behavior.
- A couple interviewees said that fuel treatments did not make a major impact on the overall management of the MCF (1,4). They said that extreme weather conditions and fire behavior, plus the relatively small size of treatments, limited their usefulness when it came to influencing overall fire behavior and management.

What characteristics do fire managers look for when considering using a fuel treatment to support their wildfire management strategy?

- Interviewees said they looked for treatments that were strategically located along roads, on ridges, in dozer lines from past wildfires, or near values at risk.
- A couple interviewees said wider treatments were more effective for moderating fire behavior or holding a fire.
- Other characteristics interviewees said they looked for in treatments included: the fuel type within the treated area, the treatment's stage of completion or time since completion, safe firefighter access points, holding features from past fires, and numerous treatments near one another that can be 'stitched' together into a larger treated area.

What recommendations do interviewees have for improving fuel treatments to support incident management of a wildfire?

- In light of extreme weather and fire behavior becoming more common, one interviewee recommended increasing the number of treatments to increase the number of opportunities available for use in suppression efforts.

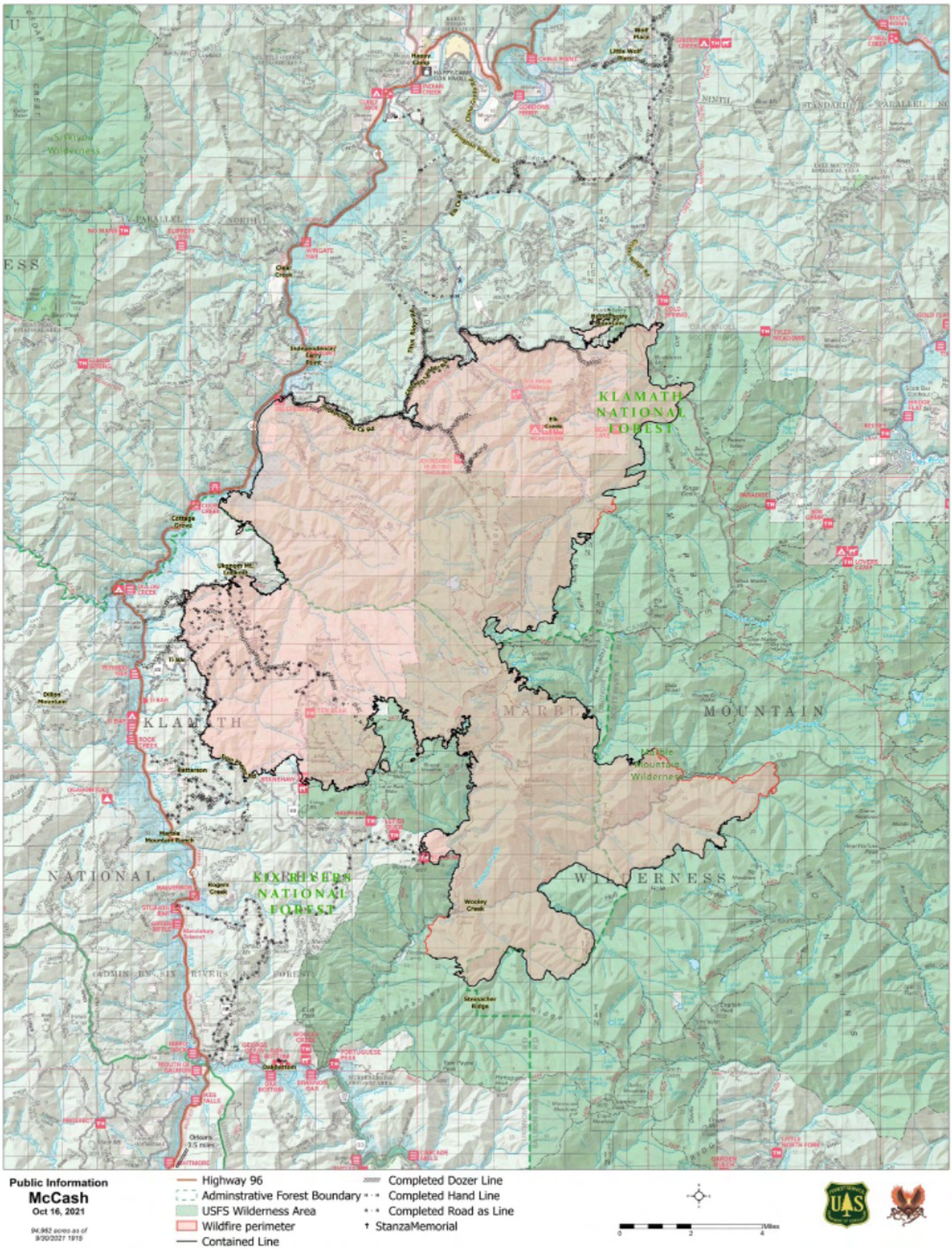

Figure 4. McCash Fire map as of October 16, 2021, when the fire activity had slowed and command had been transferred back to a type 3 IMT.

Case Profile: Trail Creek Fire

Overview | The lightning-caused Trail Creek Fire began on July 8th, 2021, early in the season for the Beaverhead-Deerlodge National Forest, and threatened ranches, hay fields, and cultural resources at a nearby National Battlefield. Most IMTs jointly managed the Trail Creek Fire with the adjacent Alder and/or Goose Fires, which were happening at the same time. An array of treatments existed in the area including prescribed burns, commercial and salvage timber harvests, roadside tree thinnings, old wildfire scars, recreational trails, and more. Nearly all the treatments utilized in suppression efforts first had to be "cleaned up," or have vegetative regrowth cleared before use; interviewees agreed this is standard practice and still saves time/resources compared to untreated areas. Treatments were used in a variety of ways including burning off, as holding features, and for firefighter access.

Notable Themes by Research Question

To what extent do treatments during suppression operations align with land managers' intended purpose for those treatments from a design and planning perspective?

- Treatments were planned with multiple purposes in mind including wildfire mitigation, wildlife habitat improvement, range management, watershed health, and commercial timber; interviewees said WUI treatments tend to be more strongly focused on wildfire mitigation than treatments outside of the WUI.

How do ICs, other fire management personnel, and forest personnel communicate about existing fuel treatments and their value during incident response?

- Several interviewees had pre-existing personal relationships with one or more local personnel from past fire assignments, previous jobs, or friendships, and said these relationships eased informal communication on the fire.
- Each IMT was briefed upon arrival and learned big-picture information about the fire, where treatments and old wildfire scars were located, and what had been done by previous teams so far.
- Fuel treatment information was most commonly shared in the form of GIS layers.

How do fire managers view treatments and incorporate them into operations, including situations when treatments are not expected to interact directly with fire?

- Treatments were burned off of, were useful in increasing safe access for firefighters, and in some cases moderated fire behavior enough to allow IMTs to use a direct attack approach.
- Interviewees said, even in cases when treatments were not directly used for suppression, they were useful because they gave IMTs additional options or flexibility in management.
- Interviewees noted that treatments need to be "cleaned up" before use in suppression efforts; this is when crews enter a treated area and remove remaining fuel loading to make it suitable for use as a holding feature. Several interviewees noted that treated areas require fewer resources to "clean up," thus allowing IMTs to reallocate machinery and personnel to untreated or higher priority areas.

What characteristics do fire managers look for when considering using a fuel treatment to support their wildfire management strategy?

- Interviewees said they looked for treatments with minimal snags and that were unlikely to be directly impacted by the fire, as these areas are most safely accessible by firefighters and heavy machinery.
- Areas with less residual slash and fuel loading were preferred because they required fewer resources to clear before use in suppression efforts.
- Interviewees noted that linear treatments (e.g. treatments along roads) must be sufficiently wide enough to moderate fires with long flame lengths.
- Interviewees also said they looked for treatments strategically located near the WUI, natural holding features, or other treatments.

What recommendations do interviewees have for improving fuel treatments to support incident management of a wildfire?

- There were not consistent recommendations from interviewees on this fire.

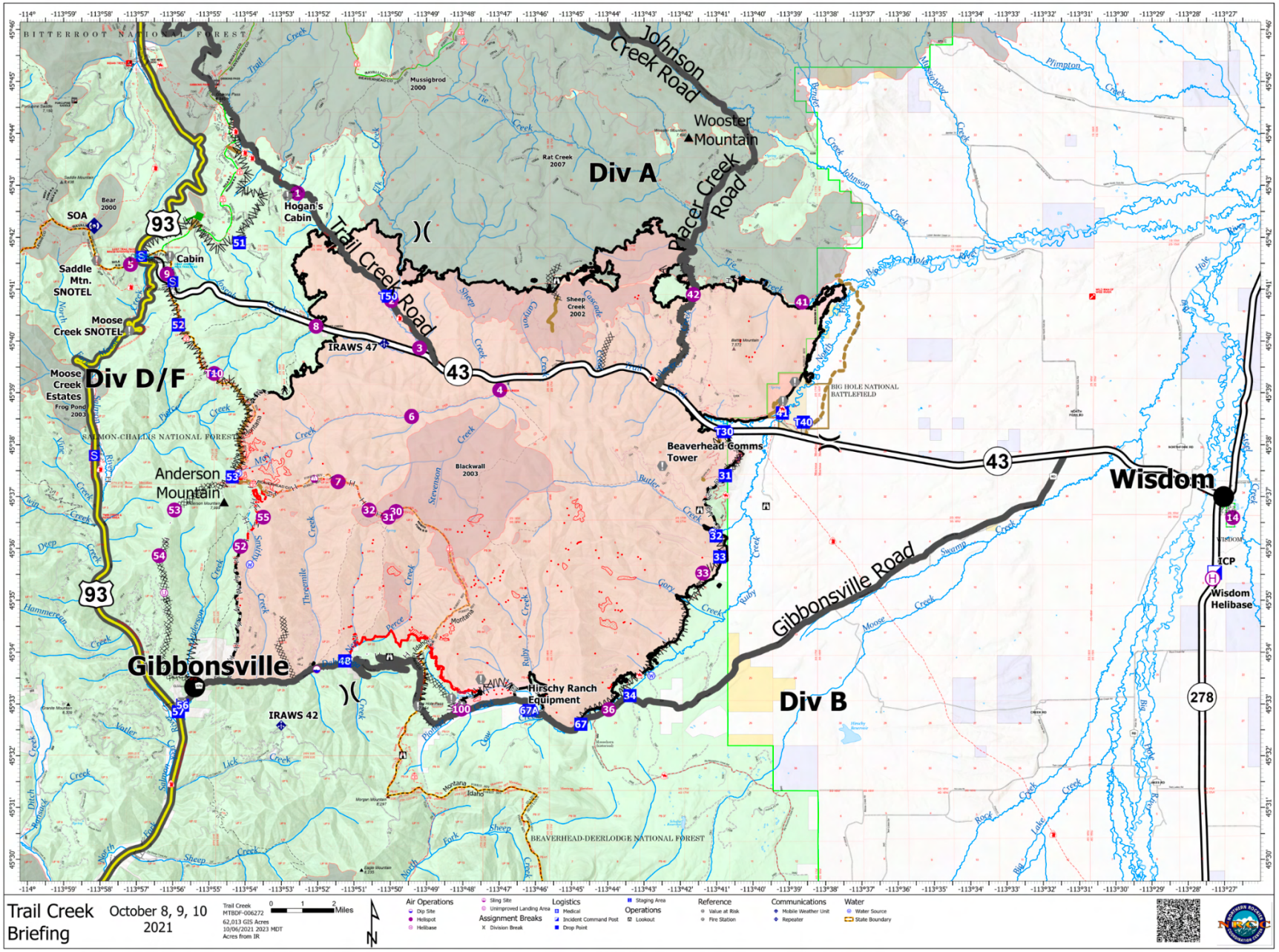

Figure 5. Trail Creek Fire perimeter map.

Case Profile: Windy Fire

Overview | The lightning-caused Windy Fire started on September 9, 2021 on the Tule River Reservation near the Sequoia National Forest, California. The same lightning storm started several other fires, most of which were quickly suppressed. The Windy Fire was characterized by its unique values at risk; in addition to structures (cabins and homes), the fire threatened giant sequoia trees, which are of ecological significance and bring high levels of visitor use to the Sequoia National Forest and surrounding area. Because the giant sequoias were a key value at risk on this fire, forest personnel and IMTs created a "Sequoia Strike Team" to go back into areas shortly after they were burned and put out flames persisting in the sequoias.

Interviewees agreed that treatments did not make a major difference in big-picture fire activity on the Windy Fire, but were integral in point protection, firefighter safety, and lowering fire severity in high-value visitor use areas.

Notable Themes by Research Question

To what extent do treatments during suppression operations align with land managers' intended purpose for those treatments from a design and planning perspective?

- Most treatments were planned with multiple benefits in mind including improving overall forest health, enhancing wildlife habitat, reintroducing a healthy fire regime, and to provide an advantage during suppression operations.
- On the Windy Fire, thin/pile/burn treatments around the Trail of 100 Giants, a popular visitor destination, were done to improve visitor safety from snags.

How do ICs, other fire management personnel, and forest personnel communicate about existing fuel treatments and their value during incident response?

- IMTs primarily relied on local forest personnel to communicate in-depth, up-to-date, and nuanced information about treatments.
- Resource Advisors played a particularly important role on the Windy Fire, giving special guidance to IMTs to protect sequoias as a value at risk and to ease their post-fire recovery (e.g. water tank placement, helicopter landing locations, bulldozer trails, and size of sequoias allowed to be cut under various circumstances).

How do fire managers view treatments and incorporate them into operations, including situations when treatments are not expected to interact directly with fire?

- Treatments moderated fire behavior, easing capacity constraints by allowing IMTs more time to build fireline before the fire reached an area, and by moving the fire to 'monitoring' status, which requires fewer firefighters on the scene.
- Treatments were used as firelines, for burnouts, and for creating suppression opportunities that otherwise would not have been available; most interviewees agreed that without treatments more values at risk would have burned.
- Treated areas were perceived to be safer for firefighters to access during suppression operations and in post-fire recovery.
- A few treatments were ineffective due to external conditions like weather, time of day, fire direction, and fire behavior.
- Old wildfire scars were instrumental in the suppression of the Windy Fire, ultimately being the holding line for much of the Windy Fire's boundary.

What characteristics do fire managers look for when considering using a fuel treatment to support their wildfire management strategy?

- Interviewees said larger treatments tended to be most effective in making a difference in overall fire behavior.
- Interviewees looked for treatments without many ladder fuels or ground fuels, which cause hazardous conditions for responders; more recent treatments tend to have fewer of these types of fuels.
- Treatments in close proximity to roads or natural holding features were considered more useful.

What recommendations do interviewees have for improving fuel treatments to support incident management of a wildfire?

- There were not consistent recommendations from interviewees on this fire.

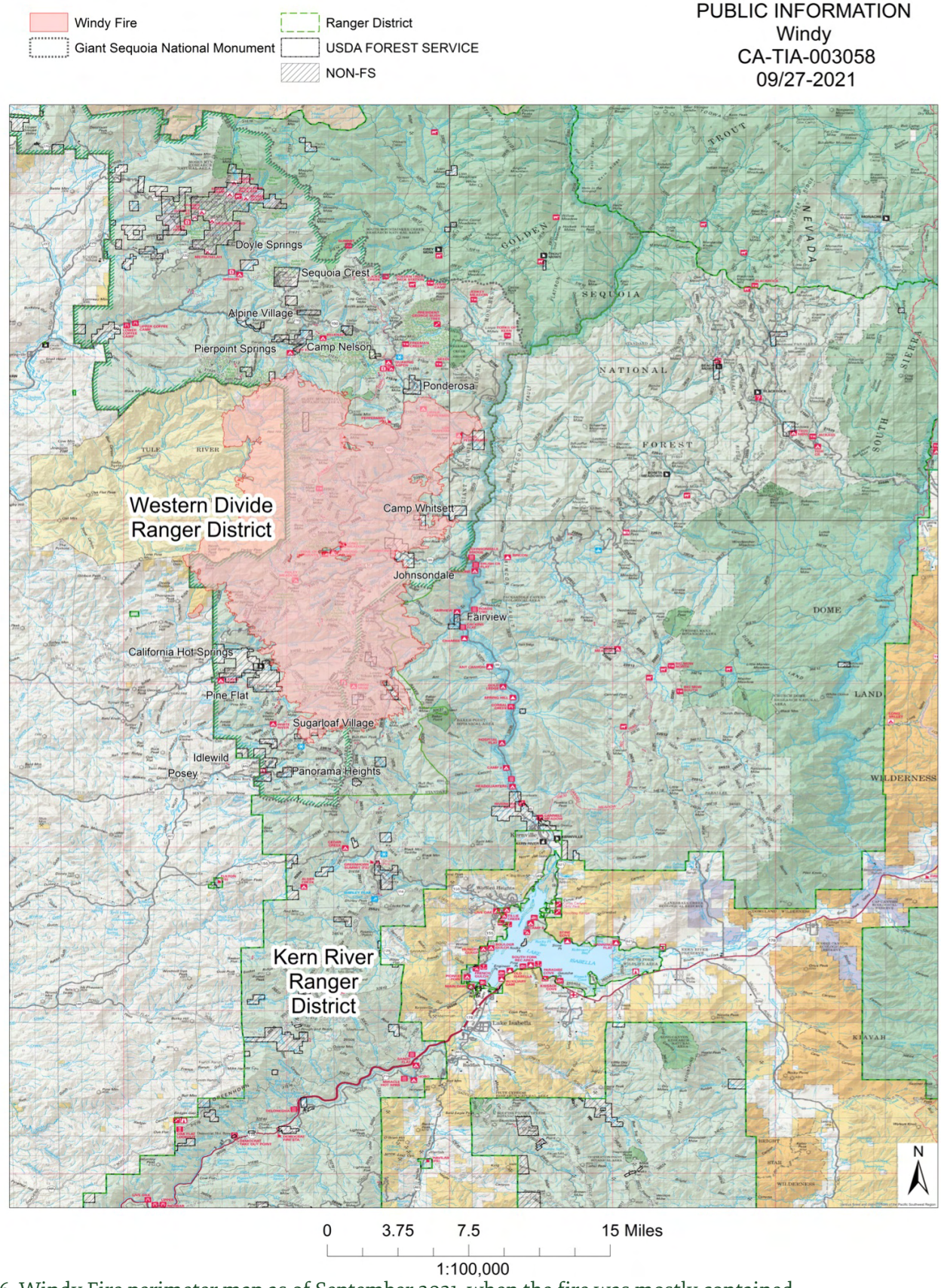

Figure 6. Windy Fire perimeter map as of September 2021, when the fire was mostly contained.

WARNER COLLEGE
OF NATURAL RESOURCES
COLORADO STATE UNIVERSITY

PLPG
Public Lands
Policy Group