

# Findings from a Third-Party Assessment of the U.S. Forest Service's Risk Management Assistance Teams

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## Executive Summary

Wildfire management is an increasingly complex task that requires decision makers to consider tradeoffs among a variety of risks to firefighters, natural resources, and communities. In 2016, Forest Service leadership formed Risk Management Assistance (RMA) teams. These teams included experienced line officers and analysts who traveled to incidents in 2017-2018 to support agency administrators (AAs, who are line officers that are the decision makers on a fire incident) by offering enhanced risk analytical approaches to improve decision making on wildland fires. Traveling teams were not meant to be a permanent activity, but remote RMA continues to be available. In 2019, our team of Colorado State University researchers conducted a third-party assessment of the RMA effort. Our goal was to understand the factors that influenced the implementation and effectiveness of the approach and to provide insights about integrating RMA concepts into fire management going forward.

## Methods

As of November 2019, we had conducted a total of 33 semi-structured interviews with both: 1) agency personnel who served as RMA team members, delivering products and support to fire managers (i.e. “deliverers”), and 2) fire managers who received the support during an incident in either 2017 or 2018 (i.e. “receivers”). Interviewers with “receivers” primarily included line officers/AAs on fire incidents, and a smaller number of analysts, incident commanders (ICs), operations chiefs, and other agency personnel. Our confidential interviews were recorded, transcribed, and analyzed using qualitative social science analysis techniques to identify emergent themes.

## Background on the Intent of RMA

Interviewees explained that RMA was intended to support line officers by providing them with improved tools and approaches to manage complex risks. More specifically, we learned:

- RMA teams assisted AAs to more comprehensively consider tradeoffs, incorporate local context and values with other fire management and safety considerations, and effectively communicate decision rationale with stakeholders, local government representatives, and other agency cooperators.
- RMA also aimed to improve decision-making accountability and transparency, allow for better understanding of cost drivers in incident management, and provide rationale and tracking for costs and resource use during an incident.

## Perceived Value of RMA

Receivers generally agreed that RMA spurred valuable discussion about risk management, helped them to explain to staff and partners why some decisions were preferable, and validated line officer decisions. We did not find strong evidence that RMA changed fire management decisions; however, line officers valued RMA tools for clarifying the rationale for their decisions and improving communication with partners and stakeholders. Some challenges included the timing of the arrival of RMA teams during incidents, tensions created with local fire staff or incident management teams, and some perceived subjectivity or redundancy of RMA approaches with other tools. Specifically, we found:

- RMA teams provided valuable analytical tools, data, capacity, and support for line officers.
- Receivers agreed that RMA processes spurred discussion about strategic alternatives for incident response and deliberation about values at risk among local political leaders, partners, and agency/fire management personnel. Those discussions allowed for more structured and coordinated decisions.
- Interviewees agreed that having experienced line officers on the RMA team to mentor less-experienced line officers helped to ensure line officers/AAs had considered all relevant data, values at risk, and other confounding factors in their decision making.
- RMA offered evidence to support line officers' decisions, often providing validation for what already had been decided and, in most cases, increasing a line officers' confidence in those decisions.
- Challenges associated with RMA included perceived subjectivity in the trade-off analysis exercise, redundancy among RMA and other

analytical tools, integration with other processes such as the Wildland Fire Decision Support System (WFDSS), and some questions about model reliability and reflection of on-the-ground conditions.

### *Contextual Factors that Affected RMA Implementation*

Deliverers said RMA had influenced decisions but often not to the fullest extent possible. We investigated the factors that affected the receptivity to RMA with decision makers on a fire. Interviewees offered the following factors as the primary variables:

- The ability to consider a variety of management response options depends on local social and political pressure and local relationships. Local biophysical conditions, fire history, and social and political pressure can leave AAs with limited space to consider anything other than aggressive attack, according to some line officers.
- In some places, different agencies have varying interpretations of acceptable levels of risk to firefighters and other values during fire events.



- Organizational factors complicating the adoption of RMA included: existing norms about who bears responsibility for decision making on fire incidents; disparate understandings among personnel of risk management principles; resistance to change; and a lack of clear leadership direction or incentives to embrace risk management approaches.
- Multiple exposures to RMA and personal relationships with RMA personnel increased the receptivity to RMA.
- Interviewees said line officer personality, such as being open to mentoring and incorporating scientific analysis, also affected receptivity to RMA. Years of fire experience did not necessarily relate to RMA receptivity, although most interviewees perceived RMA as more beneficial for line officers with less fire experience.
- Timing mattered in that interviewees preferred pre-season exposure to RMA to increase comfort and familiarity with the tools and understand the intent of RMA. Interviewees also said the approach worked better when RMA teams arrived prior to key decision points or during incident management team (IMT) transitions. Increased outreach about RMA in early 2018 helped clarify the team's intent and generally improved the receptivity of the team among line officers and IMTs compared to 2017.

### *Broader Challenges and Considerations*

A number of more general challenges and conflicts in fire management complicated the application of RMA. These include the following:

- There is a need for a more comprehensive and common understanding of risk among RMA deliverers, line officers, and fire staff, both within the agency and among partners.
- There is disagreement about levels of acceptable risk to firefighters and how those vary depending on other values at risk.

- Interviewees said there is a bias on incidents towards aggressive fire response, rather than an equal sense of responsibility for and acceptability of a variety of fire management decisions.
- Integrating RMA into fire management requires balancing the value some place on experiential knowledge with the increased use of analytics.

### *The Future of RMA Tools and Approaches*

A key question for our work was how to diffuse RMA principles throughout the agency. People offered the following observations and suggestions:

- There is a need for stronger agency-wide commitment and leadership around risk-informed decision making.
- Increased awareness of RMA and enhanced accessibility of the analytical tools are important next steps.
- Embedding RMA skills and tools at the Regional or Forest-level would improve local or regional capacity to implement RMA and minimize negativity that can arise towards outside support.
- Continuing to infuse risk management principles among agency leadership, staff, and line officers through training and clear expectations would improve the effectiveness of future RMA implementation. Pre-season integration, exploration, and training on RMA principles may increase RMA integration.
- Future RMA implementation could be targeted to incidents with less experienced personnel, more complex or longer-duration fires, and before or during IMT transitions.



## Recommendations and Conclusions

Most line officers said RMA support and associated tools increased clarity and transparency for line officers, staff, and partners about the factors considered when deciding among alternative courses of action on a fire. Many indicated they would like to be able to request RMA and suggested that efforts continue to be made to streamline the process, including through use of remote assistance.

We identified several key areas for future work. These include:

- Finding ways to embed RMA locally, either through Regional or Forest-level staff or as members of IMTs, and integrate RMA tools into existing processes.
- Pursuing more interagency dialogue around risk management assistance.
- Continuing to improve risk management training, including exposure to RMA tools and training in how risk management principles vary at different organizational levels.

- Creating clearer leadership direction, incentives, and expectations to: utilize strategic risk management approaches; empower line officers to play the central role in decision making on fire incidents; and employ a range of fire response tactics that might be desirable depending on conditions and values at risk.
- Continuing to monitor how RMA interacts with political pressures and internal agency dynamics that affect the range of acceptable decisions when managing a fire.

We recommend developing a strategy, with objectives and a plan to assess progress, to guide the RMA effort going forward. Efforts to assess how RMA products were used during a fire compared to other inputs could be integrated into existing systems or processes, such as WFDSS or the After Action Review, or through surveys and discussions during or immediately after an incident. Further efforts to focus on long-term risk management, improve leadership direction, and change perceptions around responsibility and flexibility for responses other than aggressive attack will take concerted effort and long-term investment to facilitate organizational learning and change.





## Introduction

With an increase in wildland fire frequency, size, intensity, duration, and complexity, managing wildland fire has become increasingly challenging for the U.S. Forest Service and its cooperators. In 2016, Forest Service fire leadership discussed approaches to address a number of challenges, including the emergence of more complex fires, ongoing concerns for protecting firefighter safety and values at risk, and the need to improve cost and decision-making accountability internally and to Congress. The result was the formation of the Risk Management Assistance (RMA)<sup>1</sup> teams, which were tasked with supporting line officers with refined risk analytics and in-depth discussions to improve decision making on fires.

RMA teams traveled to fire events during 2017-2018, but they were not meant to be a permanent structure. A long-term goal has been to support ongoing learning in this arena and to institutionalize RMA practices and tools so that they can be used by line officers and their teams on fire events throughout the agency into the future. During Summer 2019, our team from Colorado State University, at the request of the Forest Service, conducted a third-party assessment of RMA efforts.

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<sup>1</sup> The original acronym was Risk Management Assistance Teams (RMAT). RMAT dropped the "T" from the acronym for the 2019 fire season. For consistency purposes, we use 'RMA' throughout this report and we recognize that the term 'RMAT' was used during 2017 and 2018 by keeping the RMAT phrase used in quotes by interviewees.

The goal of the assessment was to help the agency understand the efficacy of the RMA approach and options for expanding use of RMA concepts into fire management going forward.

**This report addresses several primary sets of questions that guided our assessment. These included the following:**

- 1) What is the perceived value of RMA from the perspective of fire management personnel who received RMA support?
- 2) How do contextual factors, such as incentives, roles and norms for decision making, and local variables, interact with RMA to affect how the tools and information provided are used?
- 3) What are the broader challenges and considerations interviewees raised regarding Forest Service fire management?
- 4) For the future of RMA-associated principles and tools, what ideas do RMA team members and line officers have for implementing better risk-informed decision making, spurring adoption of RMA tools and processes, and facilitating improved critical thinking about risk management and operational decision making?

In the sections that follow, we describe our methods, provide background on RMA intent, report on our findings across the four key questions above, and conclude with a section that summarizes our key findings, recommendations, and next steps.

## Assessment Methods

We initiated the assessment with a review of relevant documents accessible from the RMA website,<sup>2</sup> which provides background information on the effort and documentation for 2017 and 2018 fire incidents that RMA teams supported. We conducted several preliminary informational interviews with RMA team leadership to help design our study and provide us with additional background information. These individuals recommended initial interviewees and provided us with the names of additional people on the RMA advisory committee and RMA deliverers.

We then conducted semi-structured and confidential phone interviews. Semi-structured interviewing relies on an interview guide, with a list of questions to ask all interviewees, but also allows for flexibility to discuss topics that emerge during the interview and are of particular relevance for that interviewee. We interviewed RMA deliverers (n=12), including line officers, operations experts, and analysts, who were part of RMA teams that traveled to incidents or offered remote assistance; some of these individuals were also on the receiving end of RMA at some point. We then pursued interviews with those who received RMA, particularly focusing on the line officers who received RMA in 2017-2018. We also selected additional interviewees from several 2018 fires that deliverers thought might reveal valuable lessons learned; we focused on 2018 fires because interviewees had difficulty remembering details from 2017. We chose fire events that people recommended as events involving RMA that we could learn from in terms of both successes and failures. For these fires, we interviewed line officers and others involved in RMA discussions, including incident commanders (ICs), analysts, other agency personnel, and operations chiefs.

As of November 2019, we had conducted a total of 33 interviews. In this report, we identify as much as we

can about interviewees without compromising confidentiality; this means that when individuals are associated with a fire, we do not identify their role, since this would reveal their identity to others who worked on the same fire. Interviewees are denoted by their unique number and by "RMA," which indicates a deliverer, or, when appropriate, a title such as "line officer" or "fire staff," when individuals were receivers of RMA.

Interviews ranged from approximately 30-75 minutes. All interviews were recorded and transcribed by a third-party transcription service. We then used Dedoose, a software program, to assign codes to segments of text. Coding is a social science process for analyzing text that allows us to identify themes in our interviews, collate excerpts for these themes across many interviews, and then analyze our findings across hundreds of pages of interview text. This approach allows us to address our research questions while also identifying emergent themes that we may not have expected.

## Background on the Intent of RMA

RMA teams were deployed to dozens of wildland fires in 2017 and 2018 with the intention, according to the RMA website, "to assist line officers and incident commanders with the decision-making tools, enhanced analytics, and alignment with response strategies needed for making risk informed choices when managing wildfires." RMA deliverers we spoke to distilled this down to two primary intents of the RMA effort: 1) to support line officers to improve decision making and risk management and 2) to improve oversight and accountability.

### 1. Supporting Line Officers to Improve Decision Making and Risk Management

**One intent of RMA was to give line officers, who act as the agency administrator (AA) or decision makers on a fire, more experience and tools to manage complex risks and effectively participate in fire management decisions.** RMA deliverers brought a process to help line officers access the best available data and analytical tools to support decision making. Although some line officers have extensive fire experience and actively participate in decision making on incidents, other line officers rely primarily on the



expertise of the fire staff and incident management teams (IMTs). RMA deliverers who we interviewed agreed that AAs need to be more empowered during incident decision making in light of several factors:

- IMTs may favor more aggressive approaches than AAs, even when probability of success is lower;
- AAs have land management responsibility and are better positioned than IMTs to consider long-term fire management goals in a specific place; and,
- AAs are often the face of the Forest Service and fire response with local officials and the public, making their knowledge and engagement critical to success.

**RMA deliverers said their intent was to support line officers both in incorporating analytical tools in decision making and effectively communicating decision rationale with stakeholders, local government, and other agency cooperators.** Deliverers explained that RMA provided tools and processes to inform, validate, and explain decision making during a fire with a more comprehensive and data-informed approach based on principles of risk management.

RMA teams assisted in developing strategic options and assessing associated impacts for values at risk (see Appendix A for an example). Overall, deliverers thought that RMA could help AAs better consider tradeoffs and incorporate local context and values with other fire management considerations. In the words of deliverers:

*RMA reaffirms what you've been doing if you have had the right conversations, but if you missed stuff, then I think RMA introduces some new elements for you to consider (8\_RMA).*

*[A goal of RMA was supporting] better-informed decisions around risk management and how we allocate resources to firefighters, whether [those are] ground based or aerial based, in a way that allows the agency administrator to look at the various strategic approaches to fighting fire. And look at what we call the trade-off analysis—where those values at risk are at, where we are employing resources, and whether or not that action, in terms of employing those resources, is...going to be successful in terms of risk, in minimizing exposure, [and in terms of] the values that we're trying to protect on the landscape (32\_RMA).*

[RMA] gave [AAs] a lot of scientific data, and it provided them with concrete data to show partners and stakeholders why decisions were made. That is valuable because one of the things that influences decisions in fire management...is the sociopolitical pressures from stakeholders, partners, and communities. This allowed them to communicate the 'why' a lot better because of the analytics they received through RMA (5\_RMA).

## 2. Improved Oversight and Accountability

**Deliverers explained that another goal was to improve decision-making accountability and better understand cost drivers in incident management.**

One person explained, "RMA was really important in understanding some of the financial outcomes that we had with regards to incident management" (7\_RMA). Another deliverer explained, "The agency has important reasons why they need to pursue this as far as the accountability piece" (8\_RMA). Interviewees also said that tracking costs is challenging because of the multiple agencies working on fires and because individuals may feel second-guessed about their decisions during an emergency. One of the products provided by RMA teams, the incident timeline, appears to have helped efforts aimed at tracking costs and resource use (see Appendix A for an example of an RMA incident timeline developed for the 416 Fire). The RMA incident timeline typically tracks the size of the fire, estimated cost, percent containment, and the number of personnel assigned to the fire on the same graph along with other key decision points (e.g. fire management strategies documented in WFSS [Wildland Fire Decision Support System] and the ICS-209 form).

**Interviewees articulated the importance of discussing rationale and procedures for resource use.**

A line officer stated, "We have to think smarter about the resources that we do have and the resources that we're going to deploy in the right place at the right time" (26\_line officer). One deliverer explained, when talking about the need for improvement, "We aren't an analytical organization. We don't consider fundamental data [to improve decision making]" (1\_RMA). Interviewees said this is an important area where Congress and agency leadership are seeking information to improve decisions, resource use, and outcomes. They said RMA could provide tools to enhance transparency and accountability in these areas.

**The growing complexity of fire management and fire incidents will require new approaches, roles, and mindsets for fire management, which will take time to establish; deliverers said RMA can serve an important role in these efforts across the agency.** Several people said the increasing complexity of land management has heightened the need to improve decision-making processes, clarify agency roles, and resource tracking and allocation.

## Findings

### 1. Perceived Value of RMA

RMA deliverers and receivers discussed their perceptions of whether RMA effectively supported improved decision-making processes during wildfires. They also discussed key challenges that arose with RMA team involvement on a fire. In this section, we share perspectives from both line officers and RMA team members about the perceived value of RMA.



## 1.1 Support for Line Officers' Decision Making and Risk Management

**Many interviewees agreed that RMA created opportunities to develop strategic alternatives for incident response.** Both deliverers and receivers of RMA generally agreed that RMA support did not directly change the decision making outcomes during a fire. Several line officers perceived the greatest value of the effort to be the discussion based on the analytical products developed by RMA teams. For example, people said:

*I think what I got the most value out of was the conversations I had with the RMA group. It wasn't necessarily the models and the documentation, but it was good to be able to bounce some ideas off of those highly experienced folks that are on those teams (33\_line officer).*

*The discussions we had with the ICs were shaped by knowledge we gained from the RMA around what that longer-term strategy needed to be. 'Do we need to look at control lines on the next ridge over than what the IC was thinking about originally.' They made some of those kinds of decisions jointly with the ICs, I think, based on RMA's input (22\_line officer).*

**The conversations that resulted from the RMA process and presentation of products during a fire helped participants consider values at risk across the landscape.** The trade-off analysis in particular was discussed as a useful tool and opportunity for considering different perspectives that may have been missed without a formal and structured conversation. Some interviewees discussed how these types of conversations can also help inform bigger picture discussions about values at risk and fire management on the landscape. For example, interviewees said:

*It gave both of those two people, the district ranger and the forest supervisor, the opportunity to have these conversations in the trade-off analysis with the incoming Type 1 team. That wouldn't have happened if RMA hadn't been there.... As we went through the process, it became very apparent*

*to all of those on the local unit that were involved in the process that it was not only very helpful, but it probably contributed to a better outcome than if they hadn't gone through the process (12\_RMA).*

*It outlines those tools that we can use to look at the situation differently. It's those tools as well as the process. By the process I mean...that dialogue and being able to lay out all of those values on the table so that you can talk about them together. Because what I have in my head as the important things on the landscape may or may not be on somebody else's radar...and they might have something different (19\_line officer).*

*We have to get fire back on the landscape [through] natural ignition, because I can't plan enough fire to do it. RMA and some of the tools might be able to help us identify where those [opportunities] might be. I don't know that RMA and those tools are absolutely all there, but...I think they can help stimulate and generate that discussion (29\_line officer).*

**RMA facilitated discussions among parties for more structured and coordinated decisions.** Several line officers appreciated the platform RMA provided for a transparent and open discussion with cooperators. Some said this allowed line officers new to communities to include and build trust with community partners and cooperators. Example statements include the following:

*I brought in my partners to listen to all of the presentations that were given by RMA because my partners had all this mistrust. When I'm talking partners, I'm talking county commissioners, tribal reps, environmental leaders, industry leaders.... They all got to see [RMA data] in real time—they were in the room. That helped bridge this gap of mistrust, and it set the tone for the rest of the summer (31\_line officer).*

*The challenge is all politics are local. Being able to use fire for resource benefit is really about having that conversation in a very*

*deep way with partners, communities, well ahead of smoke in the air. RMA can give you some intel and tools and rationale to do so (16\_line officer).*

*[RMA] helped me--as a district and as a forest-figure out how to have those conversations. It's a strategic conversation about who I should be talking to, coordinating with, and some of those management action points to start putting on a map. It helps in terms of developing a strategy and making sure I have the right players at the table (6\_line officer).*

**Interviewees agreed that having experienced line officers on the RMA team to mentor less-experienced line officers helped to ensure line officers, when acting as AAs, had considered all relevant data, values at risk, and other confounding factors in their decision making.** Several deliverers and receivers of RMA believed RMA was a good way to have support for decision making on complex wildfires. As one person explained:

*Our decisions now have even larger ramifications potentially, and it's wise to [have] another experienced forest supervisor, [agency administrator], and the technical folks that can you can get advice and information from to help make better decisions (14\_line officer).*

**Several interviewees said that RMA teams provided evidence to support line officers' decisions. This support often validated decisions already made, and, in most cases, resulted in an increase in line officers' confidence in those decisions.** A few fire staff and line officers perceived the RMA team's role in validating decisions as redundant, particularly from the perspective of fire staff. However, they also discussed the utility for line officers in augmenting their understanding of the various considerations and options for fire management. Interviewees noted that on several incidents, fire management decisions had already been made, and line officers described the difficulty in changing their course of action. RMA analytics, nonetheless, were used to support or re-evaluate those decisions. In their own words, people said:

*When RMA shows up and tries to validate those decisions that have already been made, and we've already put our time and effort into that...I had a hard time with that, [but] I think that this is probably the positive part of RMA. I think that it could help validate what I've been advising to my supervisor where I couldn't [previously] show [them because] it's more of a conversation. With RMA, you see the whole process.... If it can help line officers to visualize better what we're trying to explain, that is probably a positive thing (18\_fire staff).*

*RMA gives you a high degree of confidence that your decisions are sound. When you reach a decision, you are confident it's the right one given the circumstances (13\_line officer).*

*We were already well on our way. It was more of a validation, but it brought up the main concerns, [showing that] no matter the alternative, we were still going to have smoke impacts to communities (27\_line officer).*

**RMA teams also provided analytical tools<sup>3</sup> that added data, capacity, and support for line officers. Several people said they appreciated the presentations and visual depictions brought by RMA teams for clarifying the utility of the newer tools** (see Appendix A for examples of the RMA products most commonly mentioned in our interviews). Multiple analytical products were perceived as valuable, particularly the Suppression Difficulty Index (SDI) map, Potential Control Location (PCL) map, and trade-off analysis exercise. The aviation-use summary was not mentioned by many interviewees. However, two line officers said they valued the tool and expressed a desire to utilize that data in the future. Although several people spoke positively about the Ground Evacuation

<sup>3</sup> Available analytical products that can be delivered virtually or on-site by RMA for 2019 include: incident time-lines, resource timeline, management direction alignment table, course of action/trade-off analysis exercise, Aviation Use Summary, Suppression Difficulty Index map, Potential Control Location map, snap hazard map, ground evacuation map and injury/illness information, and exceedance probability curves.

Map, several line officers did not perceive value from it, noting that it did not accurately reflect actual conditions on-the-ground or injury/illness information. Others offered the following statements:

*I needed more information, but I didn't really know what information I needed. [RMAT] helped me frame those analytical objectives that I could have used to help inform my decision making (6\_line officer).*

*The team loved the Suppression Difficulty index. It was a great map and it was a good way for us to show what we were talking about by going indirect. 'If it has a high difficulty index, how are you going to get people out of there?' And, 'Is it really worth putting people in there?' (27\_line officer).*

*Real-time retardant tracking was really helpful for me as it's a black box. No one really knows how much retardant is dropped or where... RMAT used real-time tracking and sent me a map. I shared that with the team [when we] talked about priorities for retardant (27\_line officer).*

## 1.2 Challenges to Integrating RMA Processes and Products with Fire Management Activities

**Primary challenges discussed around integrating RMA products and information related to perceived subjectivity, model reliability, and redundancy.** A couple line officers thought trade-off analyses were subjective in nature. One line officer expected an “outside, objective, science-driven look at probability of success” but felt they had received “a really subjective evaluation of what we were doing” (6\_line officer). They further explained, “When I was pushing back on some of those ratings, it felt like that decision or discussion had already been made, and [the RMA team] didn't really want to go there. I don't think the timing was right, and I don't think that the [cooperator/partner] attendees were quite right.” Another line officer said the potential for subjectivity with the trade-off analysis process can be heightened with the inclusion of more people in the process, explaining:

*That analysis is really subjective. As a line officer, I know what those values on my unit are. One of my cooperators may not. In a big room with a lot of cooperators, it was really*

*tenuous and didn't work well. Depending on who is filling out the spreadsheet, you will get different answers. There were so many varying inputs (33\_line officer).*

**A couple receivers perceived that some RMA products relied on too many assumptions and did not accurately reflect on-the-ground or present conditions.** One line officer described an incident in which emergency and evacuation data were presented by RMA teams that did not account for conditions that limited access to certain roads. They explained that this inconsistency or inaccuracy limited the utility of the products and even exacerbated levels of risk. In this person's own words, they said:

*It's all based upon information that people assume to be correct. I had fires [where] if people made decisions based upon that document it would actually be harmful for the firefighters. People were making decisions about where to put emergency services based upon a faulty picture.... The material was not [what were] actually the on-the-ground conditions. When you're wrapped up in the analytics, you miss the real world, real-time information, adding risk to the situation (28\_line officer).*

**Others said that RMA was repetitive with other already occurring processes.** One line officer felt that sometimes these RMA discussions or model outputs were distracting or led to less optimal decisions. Some interviewees noted that RMA data and analytical capacity already exists, but there was not complete agreement on this perspective. For example, people said:

*What RMAT brought was more refined; WFDSS has cursory, clunky [data] (13\_line officer).*

*We have basics around [long-term fire behavior and weather outlook], but having a really experienced long-term analyst, they are far and few between.... Having some of that more long-term weather and fire behavior forecasting is something that I appreciate (16\_line officer).*

There were also challenges associated with the timing of RMA support that we discuss in section 2.4.

## 2. Contextual Factors Affecting RMA Implementation and Uptake

A primary objective for our work was understanding the suite of factors that affected the receptivity to RMA. Although most deliverers thought that RMA improved decision making and line officers' confidence in their decisions, many felt the information was not utilized as much as it could have been. One deliverer stated, "I'm not sure the [RMAT] strategy worked at all. I think out of the 30 or 40 fires that we visited there was maybe one or two [AAs] that did something different, and almost all of them should have done something different. They all seemed to be very interested and receptive. The team sat and listened respectfully, but then afterwards they didn't seem to do anything different" (4\_RMA). Therefore, our goal was to understand the contextual factors that affected receptivity to RMA. Interviews revealed four different sets of factors that affect RMA implementation, including 1) local conditions and relationships, 2) organizational factors, 3) line officer characteristics, and 4) challenges related to timing and being an outside team.

### 2.1 Local Conditions and Relationships

**Interviewees noted that local biophysical conditions and fire history affect line officers' decision space. These factors can limit the ability to fully embrace some of the dialogue and tools that RMA offers for considering tradeoffs and response options.** In areas where conditions on-the-ground are likely to lead to long-duration and hazardous fires, or where fire has been extensive in recent years, line officers perceived social and political pressure to suppress fire at the smallest possible size. People said, for instance:

*If we don't catch something in initial attack, then we're dealing with it until it's a season ending event. I think that the way that things align with topography and weather and history here, I look at [fire management] very differently than I did in other places. There are definitely local factors that can influence [the application of RMAT principles] (24\_line officer).*



*[If a forest] has fire all the time, every employee will tell their ranger, 'we already have had too much fire on this district, you can't let anything else burn. You need to put it all out as quickly as possible...' It's a dynamic that happens for forests that have been plagued with fire.... (10\_RMA).*

**Interviewees also said the ability to consider a variety of management response options during the RMA process and have a robust dialogue with partners depends on local relationships.** People repeatedly noted that there are few social and political incentives for taking a less aggressive stance towards a fire. They said relationships with local elected officials and partners have a substantial impact on decision making. In their own words, people said:

*If the county commissioner, state fire organization, county fire organization or other players in the local community have strong opinions about what should be done in the fire, the AA is going to respond to those probably more than science. We see that on fire after fire. It takes a strong, courageous AA to do something other than try to handle the fire at the smallest size possible (4\_RMA).*

*It's much easier to talk to your community and your politicians and [face] that political societal pressure and say, 'We did everything we could to put that fire out. It's not our fault that it got big...' When choosing to do something other than a really aggressive initial attack, it's harder to communicate that to the public and not feel like you're going to get shot (6\_line officer).*

*It depends on the [agency administrator] and what their relationship is with locally elected folks, what the history of fire is in that area, and...how that AA communicates the thought process to those--it doesn't even have to be elected officials, it can be informal community leaders--because that can often times change perception or change what's possible (19\_line officer).*

**Another set of challenges interviewees identified includes the different risk perceptions and understandings of risk among other agencies and with IMTs.** Deliverers and receivers of RMA recognized the need for more interagency work around risk-informed decision making. In 2018, some RMA teams tried to address this challenge by engaging more with other land management agencies and other government officials. For example, one deliverer described having “conversations with externals, including political, elected officials. [We] presented our analytics to those folks [and] started to help them understand why we were saying what we were saying and help the line officer have a bit more decision space when they're working with cooperators” (8\_RMA). Other perspectives included the following:

*The inconsistencies in approaches to risk exist within our own agency, but they're magnified when you bring in other agencies like CalFire or [Oregon Department of Forestry] or, to a lesser degree, the State of Utah. The view of risk and what is acceptable risk from a federal standpoint vs. local [can be different] (25\_RMA).*

*We have to understand the challenges and opportunities for different agencies and validate that. We've got to get the state foresters involved and an interdisciplinary team or interagency team, not just Forest Service, to build a process and develop the credibility that you need way ahead of time (26\_line officer).*

*Fire is pretty much separate from the National Forest System.... These IMTs that currently exist, most of them are 60% non-Forest-Service people. They [don't care] about getting more fire on-the-ground, resource benefit, or any of that.... For [the RMA approach] to be really successful, it has to be shared and accepted on an interagency basis, at least in the wildland fire community (5\_RMA).*



## 2.2 Organizational Factors

**Several line officers and RMA deliverers said that RMA challenges norms about decision-making roles on fire incidents.** Incorporation of RMA principles hinges on the AA-IMT dynamic, and RMA represents a change in that it elevates the role of the AA in decision making compared to the past. When discussing the fact that RMA was intended to empower AAs as the final decision makers on an event, people said:

*The reasons we have variable experiences is because we're challenging a long-held cultural belief on the relationship between a line officer and the fire management officer on a unit (3\_RMA).*

*When AAs have started to take back their responsibility of helping set those objectives and help create and approve strategies employed to manage fire on the landscape, that has brought some disagreement from some IMTs, but also from some fire staffs around the country that believes it's their role to put out fires (19\_line officer).*

**To make progress, several people expressed the need for clearer direction from agency leadership about the roles, responsibilities, and expectations among the AA, IC, and Fire Management Officers (FMOs).** More consistent and clear definitions of the various roles across Forest Service positions would help create space for successfully integrating new tools, such as RMA, that are designed to empower line officers and support the use of improved analytics in the agency's decision-making process. A line officer explained:

*I'm a little bit concerned about the lack of expectation as well as the slippage of what the role definitions are between an agency administrator, an agency administrator representative, [and] fire staff. We're at a bit of a crossroads. Without clear direction from agency leadership, and I think that leaves us vulnerable right now (19\_line officer).*

**There also were some tensions around the notion of risk-sharing, related to roles and responsibilities in fire management.** Early in the formation of RMA, there was some discussion of new ways to share risk with line officers, until the RMA personnel realized that the notion of "sharing" risk with fire personnel on-the-ground was not realistic. RMA team leaders settled on the more feasible approach of supporting line officers in better managing risk and firefighter safety. Line officers agreed that RMA was only "providing support, [because] you can't really share responsibility" (14\_line officer). Line officers universally expressed ownership of responsibility for decision making and outcomes on a fire. One deliverer added to this, however, explaining that the agency is responsible for training and equipping line officers to make good decisions, stating, "You happen to have delegated responsibilities. But at the end of the day, we are all responsible as an organization. We're all in the same boat" (5\_RMA). Still, they said that there is not a broad sense of shared risk in the organization, and ultimately line officers as AAs feel they bear responsibility for decisions.

Line officers also spoke to the importance of better leadership direction and incentives to embrace strategic risk management. One person explained that there is a general, internal understanding that minimal resources will be made available for strategies other than direct attack, which in turn drives people to focus on aggressive direct attack or report they are

doing so in order to keep resources at hand. Others said there are not strong incentives, either formal (e.g. performance measures) or informal (e.g. political and social support), for responses other than aggressive attack of fires. However, one person said, *“On the positive side, we’ve gotten more encouragement from the Chief and from Regional Foresters on down to implement risk-based decision-making principles and the RMAT framework in a more formal way. I think those incentives are there”* (20\_line officer). Overall, RMA deliverers felt that the inherent bias towards managing short-term risk, lack of incentives to utilize risk management approaches, and to do anything other than direct attack are all pervasive throughout the agency; they said without clear direction and incentives, implementation of strategic risk management approaches will be difficult to achieve.

**Other factors complicating the adoption of RMA principles stem from resistance to change, professional training, and pride.** Many interviewees emphasized that all fire fighters are trained in risk management, and this can complicate receptivity and understanding of different types of risk management (e.g. operational hazard versus strategic risk management at the incident level). Bringing in new people or new systems, such as RMA, may be received less positively if it is unclear how they improve existing systems or augment existing knowledge. Examples of what we heard include the following:

*We’re implementing [changes to fire management] in a system where it takes you a long time to gain the qualifications, so you tend to have seen a lot and you may be set in your ways. I do think there is a cultural resistance* (8\_RMA).

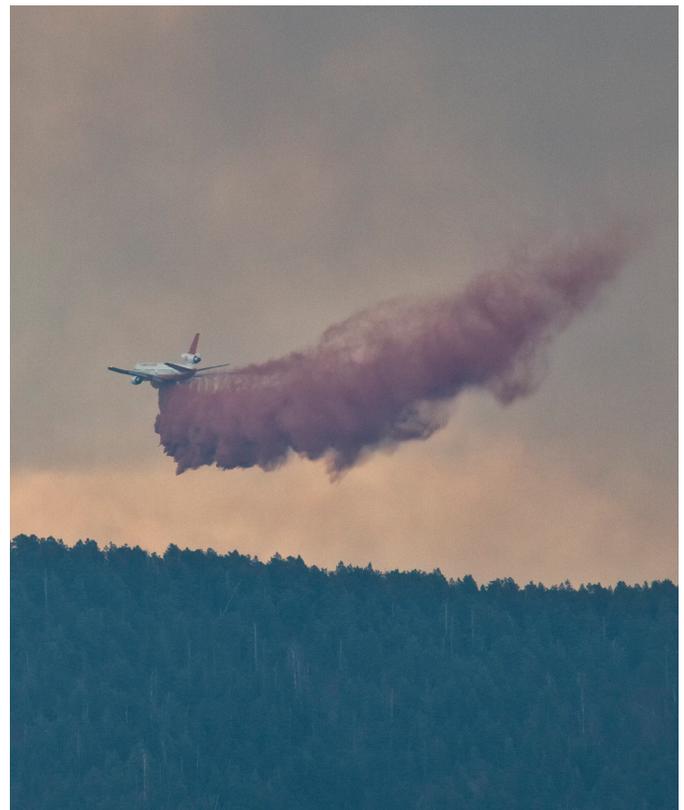
*[When] you introduce a new concept, people are not going to subscribe to it right away. It’s going to take time and validation that the products and services actually have value and credibility* (26\_line officer).

**Multiple (positive) exposures to RMA and respect for RMA personnel helped RMA in gaining more traction among line officers and IMTs.** Both deliverers and recipients of RMA said important factors were whether the AA or IMT knew RMA deliverers, if the RMA team members were perceived as credible based on deliverers’ past experience in fire management,

or whether local staff were familiar with RMA team members or principles based on other experiences, such as potential wildland fire operations delineation or “PODs” workshops. One deliverer discussed how deployment of RMA teams evolved over 2017 and 2018 with RMA teams being more attuned to the need to build trust with line offices and IMTs to improve receptivity. Regarding the ongoing need to build trust and exposure, people said:

*I think it’s exposure. The successes have been where there’s been exposure at higher levels, usually like the forest supervisor level, where those line officers have some knowledge and understanding of the RMAT teams and the concepts there. And then, when we have that connection with those kinds of line officers at those higher levels, they tend to be the ones pushing it down to the district rangers and having them utilize RMAT teams* (32\_RMA).

*I really came at this whole thing with the notion that it was about relationships...I needed to get people in a place where they were willing to listen and trust us* (10\_RMA).



**Most line officers said they valued pre-season exposure to RMA to understand the role and intent of RMA prior to their arrival on a wildfire incident** (see Box 1 below, for example). People indicated a preference for teaching and learning risk management principles outside of an emergency situation. As one person said, *"I responded with a 'heck yeah' to [RMAT's arrival]. We've gone through risk management training and [been] introduced to the [RMAT] concept. And, so we were familiar with what they brought with them, as far as skills and tools. We were really curious to see just how much they could help us out with managing the fire"* (13\_line officer).

### 2.3 Line Officer Characteristics

**Many interviewees cited personality as a major component in whether a line officer was receptive to RMA.** Some line officers described their "openness" to mentoring, science, and incorporating more refined analytics, such as RMA products, into decisions. For example, interviewees said:

*It's an individual thing. I think you have to have folks to welcome outside opinion and who are open to that and aren't offended by*

#### Box 1. The 416 Fire

**OVERVIEW** – The 416 Fire on the San Juan National Forest in Colorado ignited on June 1, 2018 and burned ~53,000 acres. An RMA team provided support from June 4-11. RMA support on the 416 Fire overall was well-received by the fire management team and agency personnel. This positive experience was influenced by several factors: 1) familiarity; 2) capacity; and 3) collaboration.

**FAMILIARITY** – Forest personnel were familiar with the RMA process due to pre-season exposure, and the RMA team made their intent clear immediately. They also had professional relationships with RMA team members and respected their expertise. This led to a positive reception and more efficient working relationship.

*I knew about RMAT before the 416 Fire, I had a pretty good idea of what to expect. I relayed that to the line officers that we going to be benefiting from RMAT.*

*Especially with our fire folks, knowing that a couple of those folks on the team had all this experience and were well respected. I think that makes a difference.*

**CAPACITY** – Local resources were fully engaged in the fire, so additional support was welcomed.

*Every single person on this forest was involved in that fire in one way or another... we were maxing people out. So outside resources were welcome.*

**COLLABORATION** – The Forest and partners had engaged in prior risk assessment work. These prior and collaborative efforts improved the efficiency and thoroughness of the trade-off analysis exercise.

*Everybody that should have been involved was there. We had the decision makers, and the advisors to those decision makers all present.*

*The local unit had done their part in identifying what was important to them. Then the task fell back to RMAT to begin to develop the [trade-off] process. After the values identification, RMAT looked at risk to those values and likelihood of impact and what the consequences might be. The local unit was also involved in the conversation about consequences.*

someone coming in and feel like their toes are being stepped on (17\_line officer).

For my personality type, I'm always a student. I know I don't know everything. It was great for me to have a candid conversation, one on one with [an experienced line officer] (31\_line officer).

Based on a personal level, I like to have talented, experienced people around me. When we're making tough decisions, it's always good to have more ears, eyes, and thoughts in the room. For me, that's not threatening. I never felt like it was a team that was coming to see what was going wrong. That's just how I operate (16\_line officer).

**Fire experience was not necessarily related to RMA receptivity. Both experienced line officers and line officers with less experience on fires expressed their receptivity to RMA during interviews.** Several experienced line officers suggested a preference for autonomy to request RMA if they felt like they needed the support. However, most interviewees perceived RMA as more beneficial for line officers with less fire experience. In their own words, people said:

RMAT is a great tool, but not for all fires, and not for all agency administrators.... It's good to bring [RMAT] in occasionally with experienced AAs because it does get you to think differently, but I don't think it should be all the time. What I like about the change this year is that we can request them.... RMAT is good in the right circumstances and for the right AA (33\_line officer).

Because I'm new, I think I'm more open [to RMAT]. Whatever resources could be at my disposal to help, I'm interested. If I were twenty years into it or more, I could see people maybe saying that they have been through enough and have their ways of managing fires (23\_line officer).

## 2.4 Challenges Related to Timing and Being an Outside Team

**A few people said the arrival of RMA teams after incident decisions had already been made led to a sense of being second-guessed.** As one person explained, "It feels like another oversight mechanism to question decisions. Monday morning quarterbacking after Sunday's game (18\_fire staff)." Line officers also said that they did not want to be perceived as not trusting of their local staff or the IMT when they brought in RMA teams. One person explained:

My concern was being perceived as the one pushing for [RMAT] with the risk of being perceived as 'I don't trust what other people are doing,' because that's one of those undercurrents.... My fear did come to fruition because the rumor was that I ordered [RMAT], [but] we overcame that (19\_line officer).

**Many line officers noted the difficulty of changing a course of action on a wildfire when RMA teams arrived following decision points.** If the intention of RMA is to support the line officer with overall objectives, line officers suggested that RMA team presence during WFDSS decisions would be more efficient compared to after WFDSS decisions are made. Others indicated that IMT transitions can be a good time to bring in RMA. In their own words, people said:

The timing could not have been worse for the AA. It made for a very stressful situation working with RMAT. It's hard [because] [the RMA personnel] don't know when fires are starting and when people are starting these WFDSS decisions.... Once you've already gone down that path as an agency, your buy in is pretty high in what you've set forth in that decision (33\_line officer).

Because we were going through a team transition, it was a really good time for them to be here to get that intel about the fire.... They could participate through that and get a lot of the intel they needed without having to impact the IMT or the district ranger as much (16\_line officer).

*If you could have an RMA show up as soon as the fire was detected and you were going through those first 48 hours of decision making and knowing the team was coming in, that you had to embrace them, that would be a very good time to have those sort of talks.... They're coming from all over. It takes time for people to travel. By the time they get there, usually, you're going down one course already. It's quite difficult to switch from that once you're already there (21\_fire staff).*

**Some line officers and fire staff discussed the extensive time they had to dedicate to the RMA process, and many expressed a preference for an abbreviated version.** One person explained, “[RMA] was very respectful of time, our partner’s time, and the IMTs time” (16\_line officer) but also described the challenges with limited time on incidents. Another line officer said, “It felt like it took a long time. We were working with that team for several days before we really felt like that was really any products out there” (26\_line officer). One receiver discussed the time to engage with the RMA team, saying, “The ops people that were working on the fire, you wish that they didn’t have to spend most of their time getting RMA up to speed, that RMA could have either used the in-briefing paperwork or talked to the regional level or elsewhere” (30\_fire staff). In Box 2, we discuss issues related to timing and other factors affecting RMA success discussed in this section.

**RMA deliverers discussed the impact of adjustments in the 2018 season based on lessons learned in the 2017 season. Many of these adjustments addressed complications around timing issues and the perceived value of RMA support.** For instance, one deliverer said, “The first year...we weren’t there before the teams came in. Then we discovered we needed to be there earlier to influence decisions. The second year, we made a real point to try to deploy and get there or arrive simultaneously, at least, with the large fire incident management teams that were in place. That was helpful because a lot of that dialog probably did influence what they were saying” (5\_RMA). Interviewees recognized the logistical challenges of arriving at the ideal time during incidents, but several people noted that remote assistance could also help address those challenges. Additionally, line officers said communication about RMA intent was key to avoiding this dynamic. RMA team members said that, compared

to 2017, in 2018 there was improved communication about the intent of RMA with line officers and pre-season to alleviate some of these concerns.

### **3. Broader Challenges and Considerations Regarding Fire Management and Risk-Informed Decision Making**

Throughout our interviews, we sought to understand broader challenges and considerations regarding Forest Service fire management and the implications for RMA. Next, we discuss how institutionalizing an understanding of risk management within the agency and across other agencies remains a fundamental consideration for cohesively bridging structural, operational, and other kinds of risk. Then, we explore how findings about the acceptable levels of risk to firefighters and other values revealed disconnects in the types of knowledge people value. We also discuss tensions in the agency around the decision space to take any fire management actions other than aggressive attack to achieve full suppression.

#### **3.1 Institutionalizing Understanding of Risk Management**

**In general, we heard that there is a need for a more comprehensive and common understanding of risk among RMA deliverers, line officers, and fire staff, both within the agency and among partners.** The concept of risk is ingrained in firefighters’ everyday practice from the first day on the job. Over the past decade, improved analytical tools, such as WFDSS, PODs, and now RMA, have supplemented experience and training in risk-informed fire response decisions. Interviewees said that aligning broader understandings of risk management for on-the-ground decision making requires leaders and staff to step back in order to discuss the bigger picture of risk-informed decision making and how it plays out for different kinds of decisions and decision makers. People explained:

*[There is a need for] a deeper, basic understanding of what risk really is and what [risk-based] decision making might look like (3\_RMA).*

## Box 2. Cougar Creek and Crescent Mountain Fires

**OVERVIEW** – The Cougar Creek Fire and Crescent Mountain Fires burned on the Okanogan-Wenatchee National Forest in Washington in 2018. The Cougar Creek Fire ignited on July 28 and burned ~43,000 acres. An RMA team provided support from August 4-7. The Crescent Mountain Fire ignited on July 29 and burned ~52,000 acres. An RMA team provided support from August 9-11. RMA teams learned important lessons on these fires about: 1) timing of RMA input; 2) bigger picture challenges facing the agency about integrating fire history, local knowledge, analytics, and varied approaches to fire management; and 3) critiques of the trade-off analysis exercise.

**TIMING** – RMA team members arrived during a time of explosive fire behavior after many key decisions had already been made about where and how to manage the fires. This made it difficult for line officers and fire staff to fully engage in the RMA process. It also led to decisions that had been made prior to RMA team arrival being second guessed.

*If I had to do it again, I would tell them that I was not able to participate in it. I know that they want to have a deliberate pause in operations, but I was not able to be a good participant.*

*I don't want to say that the process wasn't good and couldn't help us, it's just I didn't feel that it was necessarily timely where we were at in that incident.*

**INTEGRATION** – Tensions between the AAs and IMTs revealed the need to consider local knowledge and fire history and to better integrate RMA with other tools. Decision makers preferred an indirect approach that they felt posed lower risk. They perceived the RMA-driven trade-off analysis exercise to favor direct attack, which, according to interviewees, was not the most effective approach to containing the fire because of terrain, fuels, and weather.

*The [RMA] team that we had there at the time was used to going more direct and really aggressive. That wasn't what we were looking for because we had PODs already in place, which is what we wanted to use, which we know worked in '94 under similar conditions. . . They wasted several days of operations to go direct and didn't catch the fire.*

**TRADE-OFF ANALYSIS CRITIQUES** – Some people involved with these fires felt that the trade-off analysis process seemed subjective, redundant, and lacking utility for the amount of time spent.

*We needed to have some real clear definitions of high, moderate, low, and what consequence and what probability is, because it was super-subjective. We've spent all this time ahead of time identifying those values at risks, so it just seemed like, then, to have this free-flowing trade-off analysis, it didn't make sense to me.*

*I remember [RMAT] did our trade-off analysis and we were all like totally beat, it took too long, and we lost a lot of people.... I think being a little more succinct in using the information that we had already put into WFDSS is important.*

Within the Forest Service or all the wildland agencies, people talk about risk, and in most cases, they only talk about a piece of it. They don't talk about the totality of risk. And when I say the totality of it, I'm talking about risk to the landscape, the risk to the firefighters, both short-term, moderate-term and long-term. The actions that you take today, there is some risk associated with that today. There's also some change in risk in the future due to what you do today. And a lot of times there is not a recognition of that, or there is such a minimization of it that it's really not considered at the appropriate level (4\_RMA).

**A lack of alignment between how agency leadership and fire personnel perceive risk and approach risk management is a potential barrier to implementing new tools and information.** The scales at which different people or positions within the agency view risk vary, which results in some disconnect between leadership and staff. A number of people spoke to this disconnect:

*One of the greatest dangers [risk managers] point out...is the gulf between leadership's understanding of risk and the [definition of risk among] people being exposed to risk. When that gulf is great, which it often is, there's a lot of danger, both increased danger to the people exposed to the risk, and increased danger to the leaders that don't quite get what risks are being taken (25\_RMAT).*

*When you're removed from the ground for so long, you have an unrealistic expectation of what risk may be when you're not dealing with it in your face day in and day out.... As firefighters, we live it, we train it, we breathe it every day. I don't know how to be able to get that perspective from the ground to those people that are trying to do the risk management, their worldviews are different (18\_fire staff).*

*There's a little bit of a disconnect. We're looking at different things. We are looking a lot closer at how our strategies and what*

*we're doing out there is going to affect the firefighter, and the RMA team is looking at things in a broader scale. The scales are not the same (30\_fire staff).*

**Forest Service leadership has worked to institutionalize risk-informed decision making during wildfire response on national forests. However, there is still room to improve understanding within the agency and with partners.** Efforts and progress were applauded by many RMA deliverers and receivers, yet understanding of risk within and outside the Forest Service remains inconsistent. In recognition of this disparity, agency fire leaders established training and additional requirements in risk management for line officers for 2019. RMA deliverers and receivers discussed how a common understanding of risk must also transcend jurisdictions and agencies. They also noted that there needs to be a better understanding within the fire management community of operational versus strategic risk. For example, interviewees said:

*There's probably not a common understanding of risk. That's what we're trying to do with Risk Management 101, just have the same language (27\_line officer).*

*It's an agency-only thing, and that's a problem. Some of the IMTs have no clue what you're talking about when you're talking about strategic risk assessment. When you're on a fire, you don't know who you're going to get. In order for [risk management principles] to be really successful, it has to be shared and accepted on an interagency basis (5\_RMA).*

*The agency is really good at operational risk. Very task-oriented risk assessments. We are not good at strategic risk and understanding the tradeoffs of decisions, and so that was the process we really focused on, how to take our view of potential risks, be it to firefighters, be it to a negative outcome on an incident, impacts to communities, and look at it from that perspective (11\_RMA).*

**Some thought that RMA has helped develop a common understanding and approach to assessing risk and informing decisions across all spectrums**

**of risk (e.g. risk to firefighters, individual and organizational, short term and long term, etc.).**

In discussing risk, several informants referenced the Forest Service's four-level risk diagram that incorporates enterprise, strategic, operational, and real-time risk management.<sup>4</sup> A line officer discussed how "RMA helps people understand those various levels of risk. If applied well and communicated well to firefighters, you can connect those levels of risk to firefighters" (19\_line officer). Following two fire seasons and supplemented by Forest Service leadership meeting with IMTs, deliverers mentioned how "we've gone a lot further in this last year [2018] because we set up the national risk framework" (15\_RMA) and clarified "the messages of RMA around risk, probability of success and frequency resonate" (7\_RMA). The RMA process can be an important opportunity to create shared understandings about risk management across different personnel and situations.

### 3.2 Perceptions of Acceptable Levels of Risk to Firefighters and Other Values

**Several line officers said there are differing opinions in the community as to acceptable levels of risk to firefighters in order to protect homes or other values.** A line officer summed this up, saying, "At the end of the day, the meat of the conversation is what's that level of risk we're willing to put our folks at in order to protect that value?" (19\_line officer). In addition to different understandings of risk and high valued resources, agencies have different thresholds with the level of risk they are willing to take for certain values at risk. There is a spectrum of how aggressively firefighters will attack a fire depending on the agency, team, and condition-dependent factors such as weather, fire

behavior, and fire history among other considerations. Another line officer questioned how to legitimately assess risk for the engagement of firefighters, considering challenges with cultural factors such as "the intense fear of humiliation and ridicule if we don't fulfill a mission, the biased can-do reaction [of firefighters] (26\_line officer). While interviewees said there is disagreement about acceptable levels of risk, people agreed firefighter safety is their top priority.

**Interviewees said there is a bias towards accepting aggressive fire response, rather than an equal sense of AA responsibility for any decisions as to how to engage a fire.** RMA deliverers and receivers discussed inherent challenges with prioritizing values at risk in light of the common understanding that aggressive attack is the most appropriate response, and anything else must be justified. People explained:

*Anytime you make a decision counter to throwing everything at [the fire], your personal risk as a line officer goes up tremendously. You may be mitigating other risks, but politically, you're not. That's a trade off in itself. Not fighting a piece of the fire is trading off firefighter risk for potential public or political risk (11\_RMA).*

*If someone gets hurt when they're suppressing...they were doing their job and putting the fire out, so it's okay. If I made a decision to back folks off to the ridge lines and manage risk or manage a fire for resource objectives and somebody gets hurt, that's my fault because I chose to do this other action (6\_line officer).*

**Deliberative dialogue among decision makers and cooperators became a cornerstone of RMA processes in order to discuss various risks.** One line officer said, "Those deliberate conversations about what truly are the values at risk—that is what I took away from RMA" (16\_line officer). Some deliverers appreciated the process but questioned the often unspoken, underlying premise. For example, one deliverer explained:

*Risk management assistance teams are...a lot about what risk we're willing to take for the values we're trying to protect. But to me, the greater discussion in this is, obviously,*

4 Four types of risk management include: 1) enterprise risk management is "an assessment of system level fundamentals that affect how strategic, operational and time-critical risk management choices are made;" 2) strategic risk management is "the application of a risk management process to a long-term project or plan where resources are available to invest in significant analysis and researching available data;" 3) operational risk management is "a continuous, systematic process of identifying and controlling hazards to increase the certainty of outcomes;" 4) real-time risk management is "an 'on the run' mental or verbal review of the situation using the risk management process, with or without recording the information" (USDA website: <https://sites.google.com/firenet.gov/operational-risk-management/terminology/risk-management-terminology?authuser=0>).

### Box 3. The Ferguson Fire

**OVERVIEW** – The Ferguson Fire burned in the Sierra and Stanislaus National Forests and Yosemite National Park in California. It ignited on July 13, 2018 and burned ~97,000 acres. An RMA team provided support from July 23-28. The Ferguson Fire illustrated how RMA can help: 1) multiple agencies acknowledge their different approaches to risk and fire management; 2) structure dialogue to better understand those different approaches; and 3) create a shared understanding of risk that leads to a unified management strategy.

**APPROACHES** – Participants recognized different approaches to risk and fire management across the agencies, and the RMA process helped them work through that systematically.

*There's such a bias when people are 'well that's a Forest Service thing or that's a Park Service thing.' I think we have to understand our own unique challenges, not challenges but opportunities for all the different agencies and validate that ...right up front.*

**DIALOGUE** – Interviewees from different agencies said that dialogue facilitated by RMA team members helped them understand how other agencies perceive and approach risk.

*[The RMA team members] weren't telling us what we should do. They were simply facilitating a conversation... Not just the Forest Service people in a dark trailer or tent, but with all of our most important management partners included in the trade-off analysis. We would have something to actually point to. Instead of just saying 'trust us,' we talked about it.*

**SHARED UNDERSTANDING** – Discussions between the Forest Service, National Park Service, Cal Fire, and county sheriffs, especially during the trade-off analysis exercise, created a shared understanding of risk and a unified approach to managing it that considered economic, ecological, and other values. RMA analytics helped facilitate these decisions that led to a response that favored suppression to minimize negative impacts to local communities.

*Being able to [discuss] those two competing values, and there were other values in there as well, those were kind of the end of each spectrum, at the same time let us have a cohesive discussion on how best to proceed so that we can all own that direction. And it's that dialogue that I find incredibly important.*

*the risk is important, but I'm not sure we're all on the same page as to what values we need to protect (5\_RMA).*

**Several line officers expressed appreciation for how the trade-off analysis “brought to the surface some of the conversations about competing values and why people look at the same problem and see it differently” (19\_line officer).** These conversations can be especially valuable on fires involving multiple agencies, across jurisdictions, and many different values at risk. For instance, on the Ferguson Fire in 2018, fire may have benefited the landscape. However, considerations

of the communities of Yosemite National Park, and their reliance on recreation and tourism during peak tourist season, led to a discussion among partners that resulted in containment at a smaller scale (see Box 3 for more information).

#### 3.3 Types of Knowledge People Value

**Several interviewees noted that, in the past, wild-fire management decisions were entirely based on experiential knowledge, while decisions today are also informed with analytics from diverse sources.** For instance, several interviewees highlighted

a disconnect between IMT analytics, the application of experiential knowledge, and utilization of RMA analytics. During a fire in 2017, outputs from one fire analyst did not corroborate analytical outputs from RMA for a particular fuel type that local fire personnel were familiar with. We observed considerable disagreement among individuals on this fire about where analytics had been wrong and who bore responsibility for what were ultimately less-than-ideal outcomes. One person involved with that fire said that this created “*more of a disconnect than any kind of shared understanding of risk. If [RMA] is coming up with wildly different results, it tends to deepen a wedge.*”

**In some cases, there appears to be a tension between risk management through analytics and using experiential knowledge to inform risk management.** As one person put it, “*Do I rely on science or do I rely on the advice of this very experienced, seasoned fire manager, the incident commander?*” (4\_RMA). Part of this tension may also stem from not all of the RMA tools or products applying to every situation or analytics not accurately reflecting on-the-ground conditions, as we discussed previously. Several line officers said in 2018, RMA teams did a better job of integrating analytics and experiential knowledge. While acceptance of newer concepts and tools can be challenging, one line officer explained a challenge, saying that “*[The tools are] new, and we're just not ready to give up our slide deck—not that RMA is asking us to give it up. They want us to combine our slide deck and all of our collective experiences with these tools to make better decisions*” (29\_line officer).<sup>5</sup>

### 3.4 Cultural Divides Regarding Fire Management Norms

**Broader debates about values at risk and responsibility are intertwined with diverging perspectives about the role of fire in the landscape.** Agency personnel have disparate perceptions of fire's role on the landscape, interpretations of how to integrate fire as a resource management tool, and perspectives on how to consider a wide range of response options. People said:

*We are very well split in the agency. Some fire folks see themselves as a fire organization, meaning they do suppression. They go every time the fire bell rings. They're in for war... Then there's another group of people in the fire organization that see themselves as resource managers, in a way, and their job, it's an art. How much fire do you introduce in order to make a sustainable ecosystem? It's a lot different (5\_RMA).*

*We're in the mindset that there's going to be an incredible amount of damage if we add fire...just because they're large fires doesn't mean they're 100% destructive. So, there's a media piece there and an education piece there that's continuing to validate the concept that wildfires are bad, and we really have to turn that around (26\_line officer).*



<sup>5</sup> Slide deck refers to all of the training, experience and knowledge gained over the years and used to inform decision making.



## 4. Future of RMA Tools and Principles

A key objective of this work was synthesizing RMA team member and line officer ideas for implementing better risk-informed decision making in general and for supporting more widespread adoption of RMA tools and processes in the future. Interviewees shared ideas about how to institutionalize and diffuse RMA approaches. They also had suggestions about incident types where receiving RMA would be more effective.

### 4.1 Supporting Adoption and Institutionalization of RMA Principles

**Interviewees said there is a need for stronger agency-wide commitment and leadership around risk-informed decision making.** RMA deliverers in particular felt that the approach was unlikely to be successful without communication and commitment from agency leadership about the importance of using improved analytics for decision making. For instance, one person explained, “Our culture is a significant hindrance to the acceptance of this type of activity just because it’s simply different.... A lack of general leadership strength really inhibits something like this being successful.... We have to be able to actually implement these ideas consistently and methodically

across the entire agency” (7\_RMA). Multiple interviewees added that without performance measures, incentives, and rewards for line officers, along with clear communication to line officers about expectations, RMA principles may not be widely adopted. As others stated:

*Right now, there are no accolades or incentives for that courageous line officer who says, ‘I’m going to do this despite the pressure I’m feeling from the local community because it’s the right thing to do.’ And if all of us keep doing what we’ve always done, things aren’t going to change, we’re not going to have better outcomes. It’s only going to get worse (4\_RMA).*

*Until we, as an agency, are much more aggressive to say, ‘This is what we’re supposed to do and this is the reason why,’ and we’re aggressive both with the fire folks and the communities...until there’s some sort of policy change put in place, it’s not going to culturally, systematically change much (5\_RMA).*

**Many indicated that greater awareness of RMA will be key to success going forward.** Several suggested that word has spread about RMA and its value, leading to a broader receptivity. Interviewees advocated for ongoing pre-season communication with IMTs and Forest and Regional Leadership Teams about RMA’s purpose and associated strategic plan (i.e. clarity about short, medium, and long-term goals for RMA and its role in fire management). On fires with multiple AAs, sometimes from other agencies, one person suggested that the RMA personnel should be sure to reach out and introduce themselves and the RMA concepts to all AAs.

**Increasing understanding of RMA principles and enhancing the accessibility of analytical tools will be a key next step for the future of RMA.** People on both the delivery and receiving end of RMA expressed a desire for generally making analytical tools more easily accessible. This particularly applies to AAs, who would need to be trained on the availability, location, and utility of the tools. A few interviewees mentioned RMA tools and processes appear overwhelming at first, but they noted that trainings and simplification of products have been useful and will support future success.

**Successfully integrating RMA into existing decision-making systems requires a clear articulation of how agency leadership envisions it contributing to or replacing existing tools and processes.**

Interviewees discussed challenges and opportunities around understanding whether RMA was just the “tool of the moment” or was an approach that will endure and be integrated into existing processes. Multiple people said integrating RMA with established processes such as WFDSS would support accessibility, understanding, and use of RMA. Remote RMA teams that are engaged on an as-needed basis could help alleviate concerns about additional personnel on an incident and provide more flexibility for the AA or IMT to use RMA output at their discretion or as directed by the agency.

**Interviewees emphasized that the future of RMA depends on continuing to infuse risk management principles for staff and particularly for line officers through trainings and well-communicated expectations.** Suggestions included the following:

- Making sure both staff and line officers are trained in and aware of risk management principles and the analytical tools that are available. People emphasized this needs to be incorporated into existing classes, trainings, and annual refreshers and that both staff and line officers need to present for risk trade-off conversations, so they understand the basis for future decisions.
- People said the new task book for AAs with risk management requirements and new competencies is a valuable improvement; interviewees said that emphasizing knowledge and experience with fire among line officers is key to future success.
- Many said that experiential learning is a critical format for training line officers in fire management; people suggested shadowing other line officers during fire events has value.
- Some suggested line officers need to better understand and embrace their role as ambassadors to the public and to political actors; this also would require improved training for line officers and more clear communication about expectations from agency leadership.

**Because of the importance of personal relationships, trust, and accessibility of trained personnel, many said the future of RMA requires having RMA-type analytical capacity available through personnel at the regional or forest level.** As some explained, in certain instances, “Line officers as well as FMOs kind of scoffed at the idea of an outsider coming in to tell you what was best for your forest” (20\_line officer). Many people suggested that RMA skills be embedded at the forest, multi-forest, or regional level, with new positions created to add capacity. Some suggested adding positions to IMTs or at the regional level to add risk-management analytical capacity. People had the following observations:

*It needs to be more localized. You can't rely on one or two national level teams to help deal with the problem because it's just not going to work just from a timing perspective (21\_fire staff).*

*I think it would be good to have that kind of skillset ideally on each forest.... And then maybe have a regional level if you can, and get it to every forest. It's nice to have that skillset more locally because they have that local knowledge and they understand a little bit more of what we're getting at (6\_line officer).*

*I could see adding positions to type-one teams especially...maybe looking at adding requirements for the qualifications or adding an additional position (14\_line officer).*

**More pre-season integration, exploration, and training on RMA principles and tools may increase the opportunity to integrate and learn about RMA in a more strategic, less-rushed format.**

Interviewees said that introducing RMA sooner could mitigate tensions and stress associated with the team arriving in the midst of a fire. Several people told us that RMA approaches worked well when they were introduced concurrently with IMT transitions. A few people said that PODs processes can incorporate some of the pre-season work to integrate RMA principles. In their own words, people said:

*It doesn't feel like the right time and place to be trying out new things. Stressful environments are not where we do our best learning.... I felt that this was something we should be trained on and teaching in the sand table exercise, not the day that the fire is actually burning (29\_line officer).*

*When we have those joint meetings together, which we do twice a year, once in the fall, once in the spring, we do that with our cooperators. That's the time, I think, to share information and get folks familiar with [RMAT], and then when you have an incident it's not a surprise to them (32\_RMA).*

*We have thought that some of the tools and the mapping would be helpful in sort of pre-season planning to really understand...what our strategy might be, whether it [would] be planning future vegetation treatments or what roads would make good fire breaks (23\_line officer).*

#### **4.2 Types of Incidents Where RMA Can Be Relatively More Effective**

**Multiple interviewees said RMA would be particularly useful for new personnel or those with less fire experience.** While people generally agreed, several deliverers observed that RMA had been embraced more readily by colleagues that were more experienced, particularly if they had managed complex fires in the past.

**Some suggested RMA was more practical and useful for complex or longer-duration fires, rather than during short-lived fires.** Interviewees said that RMA was most useful when the best course of action is unclear, although some indicated the tools are always useful. Several people appreciated that future iterations offer the opportunity to request physical or remote assistance depending on the complexity and duration of the fire and the extent of assistance needed. For instance, some interviewees said:

*I think you need to look at it on an individual situation, how complex it is.... Where we're just going to put a line around the whole thing and you think there's not a real question of our fighters' safety on that, I don't know that you need to bring in RMAT (17\_line officer).*

*I think that if it's a type of fire that, say, in southern California where there's homes that are burning, and that is not going to be a long-term fire, I don't think there's an opportunity for RMAT there (28\_line officer).*

## **Recommendations and Conclusions**

The primary focus on RMA was to support line officers in using principles of risk management to improve their decision making. According to most line officer interviewees, RMA and the use of associated tools increased clarity and transparency for line officers, staff, and partners about the factors considered when deciding among alternative courses of action on a fire incident. This perception was increasingly common among those who received RMA in 2018, when the process went more smoothly than in 2017 and when personnel had been introduced to RMA before the fire season. Our findings do not reveal clearly that RMA had a strong influence on decisions, but RMA often clarified tradeoffs or the rationale behind decisions.

Many indicated they would like to be able to request RMA, would appreciate more pre-season exposure to the associated tools, and suggested that efforts continue to be made to streamline the process, including through use of remote assistance. Even with these continued improvements, the space for engaging RMA support can be compromised by social and political pressures.

Our research indicates that there are several key areas for future work. These include:

- Finding ways to embed risk management assistance locally, either through Regional or Forest-level staff, or as members of IMTs, and integrate RMA tools into existing processes.
- Pursuing more interagency dialogue around risk management assistance so that all personnel in the interagency fire management context are familiar with efforts within the Forest Service.
- Continuing to improve risk management training and consistently emphasizing the different types of risk management that occur at different organizational levels.
- Creating clearer leadership direction, incentives, and expectations to: utilize strategic risk management approaches; empower line officers to play the central role in decision making on fire incidents; and employ a range of fire response tactics that might be desirable depending on conditions and values at risk.
- Continuing to monitor and characterize the role of decision support tools, such as RMA, in influencing other confounding factors, such as political pressures and a cultural divide within the agency, that affect the range of available decisions when managing a fire.

We recommend continuing to develop a multi-year strategy with objectives and opportunities to assess progress and guide the RMA effort. This would need to be done with ongoing engagement of a diverse steering committee to explore some of the persistent challenges in fire management. Effectively understanding how to best integrate RMA into the fire management decision-making process requires consideration of how it aligns with other resources and where overlap can be eliminated. For instance, continuing to find ways to incorporate other considerations, such as smoke or air quality, perhaps through the work of Air Resource Advisors, would be valuable.

Integrating a more formal analysis of the role of RMA during the After Action Review process or through other means (e.g. a survey in WFDSS or via email during or immediately after a fire) might provide insights into the weight of RMA products and processes compared to other factors that influence decision making. It can be

difficult in the months or years after a fire to accurately reflect on the specific tools, products, or discussions that had the most influence on decisions made during a fire. Incorporating a brief survey or discussion in existing processes could provide more real-time and immediate insights into where RMA fits in to the decision-making process during a fire.

There appears to be a need to communicate the importance of RMA concepts to the broader interagency community and throughout fire management staff within the Forest Service. There is also a need to assess opportunities to increase the focus on long-term risk management, particularly in the face of persistent decision bias towards managing short-term risks. Improving leadership direction and changing perceptions around responsibility and flexibility for responses other than aggressive attack will take concerted effort and long-term investment to affect predominant norms.



## Appendices

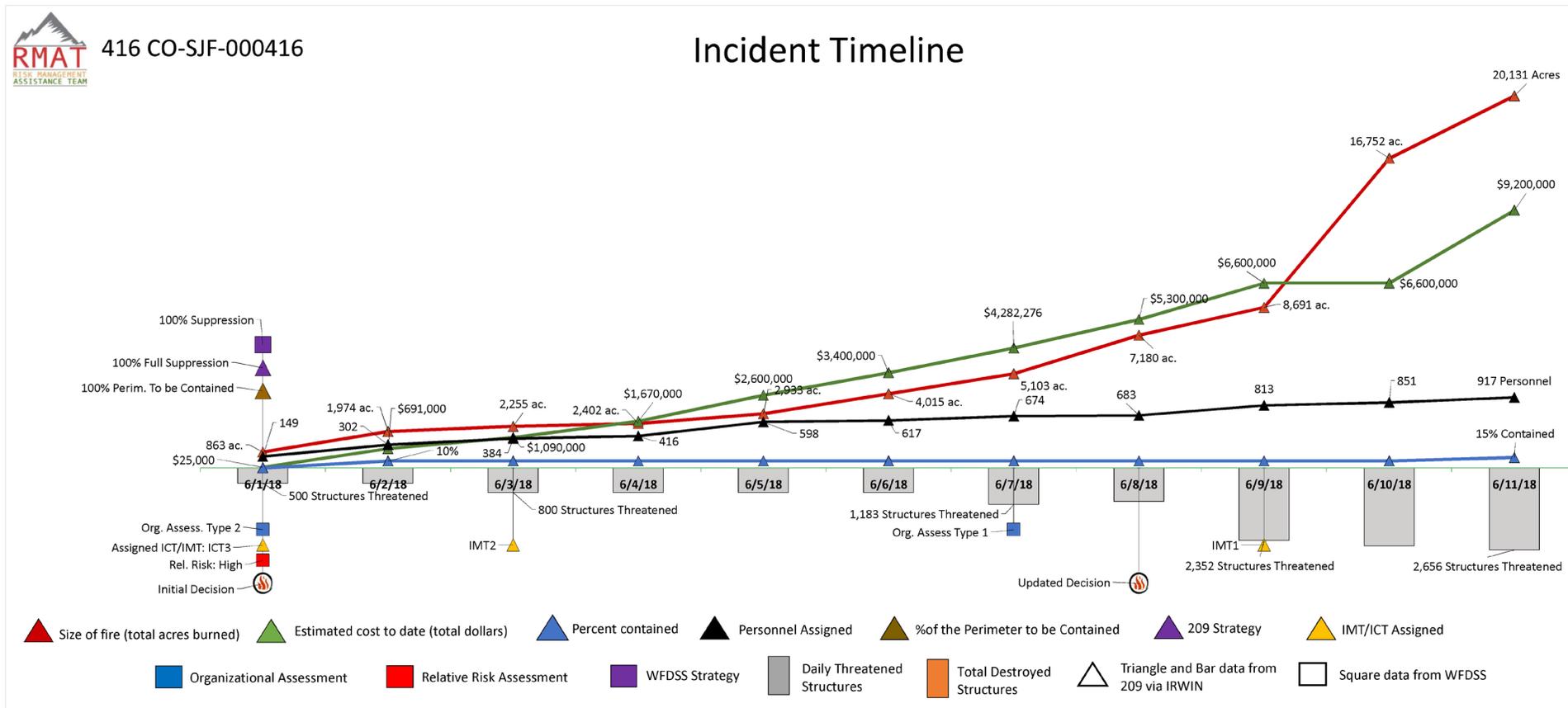
### Appendix A. Examples of 2018 RMA Products

- Figure A.1 – Incident Timeline from the 416 Fire
- Figure A.2 – Trade-off Analysis Exercise Output for the West Area of the 416 Fire
- Figure A.3 – Ground Evacuation Map for the 416 Fire
- Figure A.4 – Suppression Difficulty Index Map for the Cougar Creek Fire
- Figure A.5 – Potential Control Locations Map for the Terwilliger Fire
- Figure A.6 – Aviation Use Summary Map from the Mendocino Complex Fire



**Figure A.1 – Incident Timeline from the 416 Fire**

The incident timeline visually displays important information about the fire and decisions made about how to manage it. The following types of information are often included: fire size; cost or expenditures; number of personnel; percent containment; directed strategy; reported strategy; relative risk assessment, organizational needs assessment; assigned Incident Management Team; structures threatened/destroyed; and decision status. The timeline can help track and justify key decisions and resource use throughout the course of a fire.



**Figure A.2 – Trade-off Analysis Exercise Output for the West Area of the 416 Fire**

The trade-off analysis exercise helps decision makers consider different actions based on ratings of risk to firefighters, public safety, and other values potentially affected by the fire. The table utilized in a trade-off analysis exercise provides the framework for considering the different risk tradeoffs across a fire for the set of values identified by the management team.

<b>Fire: 416</b>		<b>Area: West</b>		<b>Date: 6/11/2018</b>	
<b>Strategic Alternatives</b>					
	<b>Strategy A: Flanking N &amp; S</b>		<b>Strategy B: Point Protection</b>		
<b>Description:</b>	Take actions to keep the 416 Fire south of East Fk Hermosa Cr and north of Junction Cr. Road. Burro fire is kept east of Hwy 145 and north of Burro Mtn and the 561 road. 416 and Burro fires are allowed to burn together. Firing operations are used to create barriers to prevent fire spread to the N and S spread. Purpose: Protect high concentration of values to the south and north, limit duration of smoke and economic impacts.		Establish MAPs to trigger actions to protect VARs to the south, Hwy 145, and north. Burro and 416 are allowed to burn together. Purpose: Limit risk to firefighters given expected onset of monsoons and low number of VARs between the two fires. Assumption: All MAPs will not need to be implemented at the same time.		
<b>Resource Commitment:</b>	6 hand crews, 15 engines, water tenders, dozers, T1/T2 helicopters, PSD		3 hand crews, 5 engines, water tenders, dozers, T1/T2 helicopters, PSD.		
<b>Duration:</b>	10-14 days for South, 10-14 for North		30-40 days		
<b>Risk to Values</b>					
<b>Prioritized Values</b>	<b>Risk</b>	<i>Comments</i>	<b>Risk</b>	<i>Comments</i>	
<b>PVT Residential / Commercial Development</b>		Strategy A: N & S Flanking		Strategy B: Point Protection	
Falls Creek	High		High		
Turtle Lake	Moderate		Moderate		
205 Rd Rural Residences	Moderate		Moderate		
204 Rd Rural Residences	Low		Moderate		
Upper Junction Creek	High		High		
Lightner Creek ranches	Low		Moderate		
Durango West 2	Low		Moderate		

<b>Prioritized Values</b>	<b>Risk</b>	<i>Comments</i>	<b>Risk</b>	<i>Comments</i>
Durango Ridge (Low density)	Low		High	
124 Rd Properties (South of Mayday)	Very Low		Low	
Mayday	Low		Low	
124 Rd Properties (North of Mayday)	Low		Low	
Rico Proper (Hwy 145)	Low		Low	
Hwy 145 (low density)	Low		Low	
Spring Creek Subdivision	Low		Low	Fuel type transition, aspen
<b>Infrastructure</b>				
Hwy 145 Power Lines Corridor	Low		Low	
Hwy 160				
KV Lines (Lightner Cr)	Low		Moderate	
Bear Creek area Camp Grounds	Low		Low	
<b>Firefighter Risk</b>				
Risk Assessment Rating	Quantity per Risk Rating		Quantity per Risk Rating	
<b>Critical</b>	<b>Jct Cr: 1, Burro: 0, East Fk: 0</b>		<b>Point Pro: 2</b>	
<b>Serious</b>	<b>Jct Cr: 6, Burro: 5, East Fk: 5</b>		<b>Point Pro: 5</b>	
<b>Moderate</b>	<b>Jct Cr: 13, Burro: 10, East Fk: 11</b>		<b>Point Pro: 4</b>	
<b>Minor</b>	<b>Jct Cr: 7, Burro: 8, East Fk: 12</b>		<b>Point Pro: 6</b>	
<b>Negligible</b>	<b>Jct Cr: 2, Burro: 3, East Fk: 2</b>		<b>Point Pro: 2</b>	

<b>Public Safety</b>		
Hwy 550 Closure	High	Very High
Residents Sheltering In Place	Moderate	High
Smoke Exposure	Moderate	High
Reduced capacity for Sheriff Office due to fire support	Moderate	High
Forest Closures	High	High
Community Stress	High	Very High
Stress on community resources from additional evacuees	High	Very High
Curious publics	Low	Low
<b>Partner / Cooperator Concerns</b>		
Grazing Permittees	High	High
Outfitters / Guides	High	High
Purgatory Ski Area	Very High	Very High
Train	Very High	Very High
Watershed Stakeholders	High	High
San Juan County	Moderate	Moderate
<b>Social / Political / Economic Concerns</b>		
Agency credibility	Low	Moderate
Transferring risk to the short-term future	Moderate	High
Current loss of tourism	Moderate	High
Future loss of tourism base	Moderate	Moderate
<b>Probability of Success</b>		
	Strategy A	Strategy B
Rating:	Moderate-High	Moderate
Comments:	Moderate confidence of being successful with Jct Cr. due to need for optimal conditions, but weather could bump confidence to High. High confidence that 561 rd will be successful containing Burro on south side.	Highly dependent on weather, time, and distance. High confidence that 561 rd will be successful containing Burro on south side.

### Figure A.3 – Ground Evacuation Map for the 416 Fire

The Ground Evacuation Map provides time estimates from different locations around a fire to the nearest care facility. It accounts for considerations such as road availability or conditions, slope, vegetation type, and driving speeds. These maps also provide up-to-date information about the extent of responder injuries and illnesses.

#### 416 Estimated Evacuation Time in the Planning Area & Current Responder Injuries\* As of 6/03/18

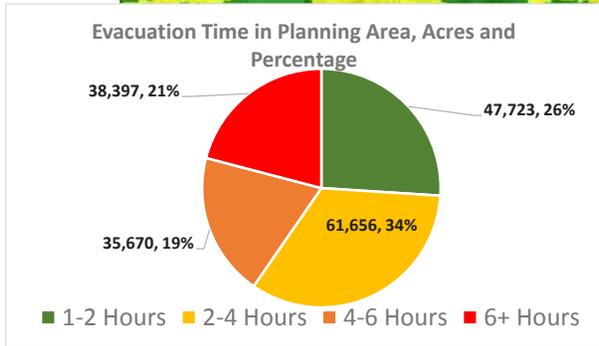
**Estimated Ground Evacuation Time Legend**

- 1 to 2 Hours
- 2 to 4 Hours
- 4 to 6 Hours
- More than 6 Hours

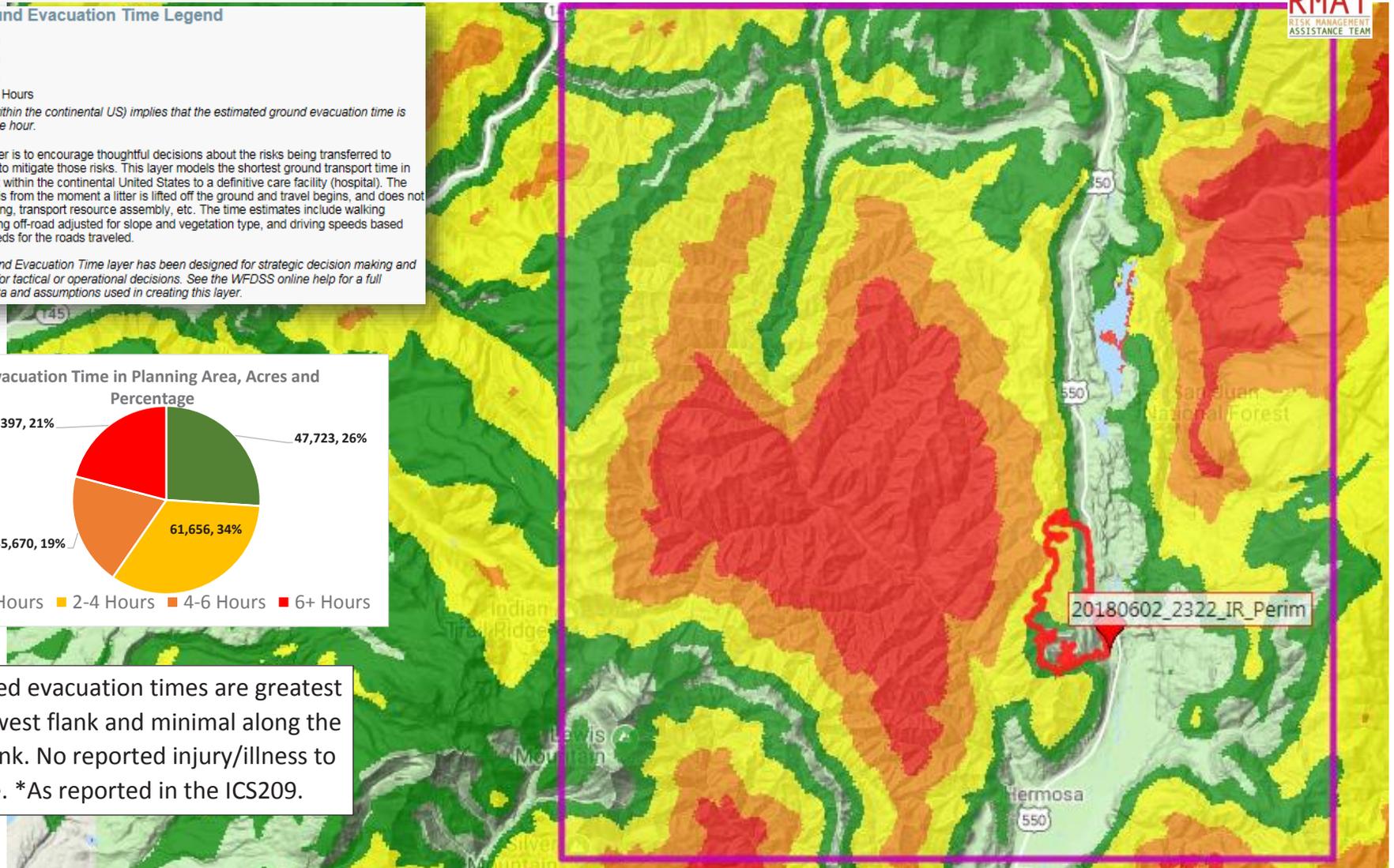
*\*No color (within the continental US) implies that the estimated ground evacuation time is less than one hour.*

The intent of this layer is to encourage thoughtful decisions about the risks being transferred to firefighters and how to mitigate those risks. This layer models the shortest ground transport time in hours from any point within the continental United States to a definitive care facility (hospital). The travel time estimate is from the moment a litter is lifted off the ground and travel begins, and does not include litter packaging, transport resource assembly, etc. The time estimates include walking speeds when traveling off-road adjusted for slope and vegetation type, and driving speeds based upon estimated speeds for the roads traveled.

The Estimated Ground Evacuation Time layer has been designed for strategic decision making and should not be used for tactical or operational decisions. See the WFDSS online help for a full discussion of the data and assumptions used in creating this layer.

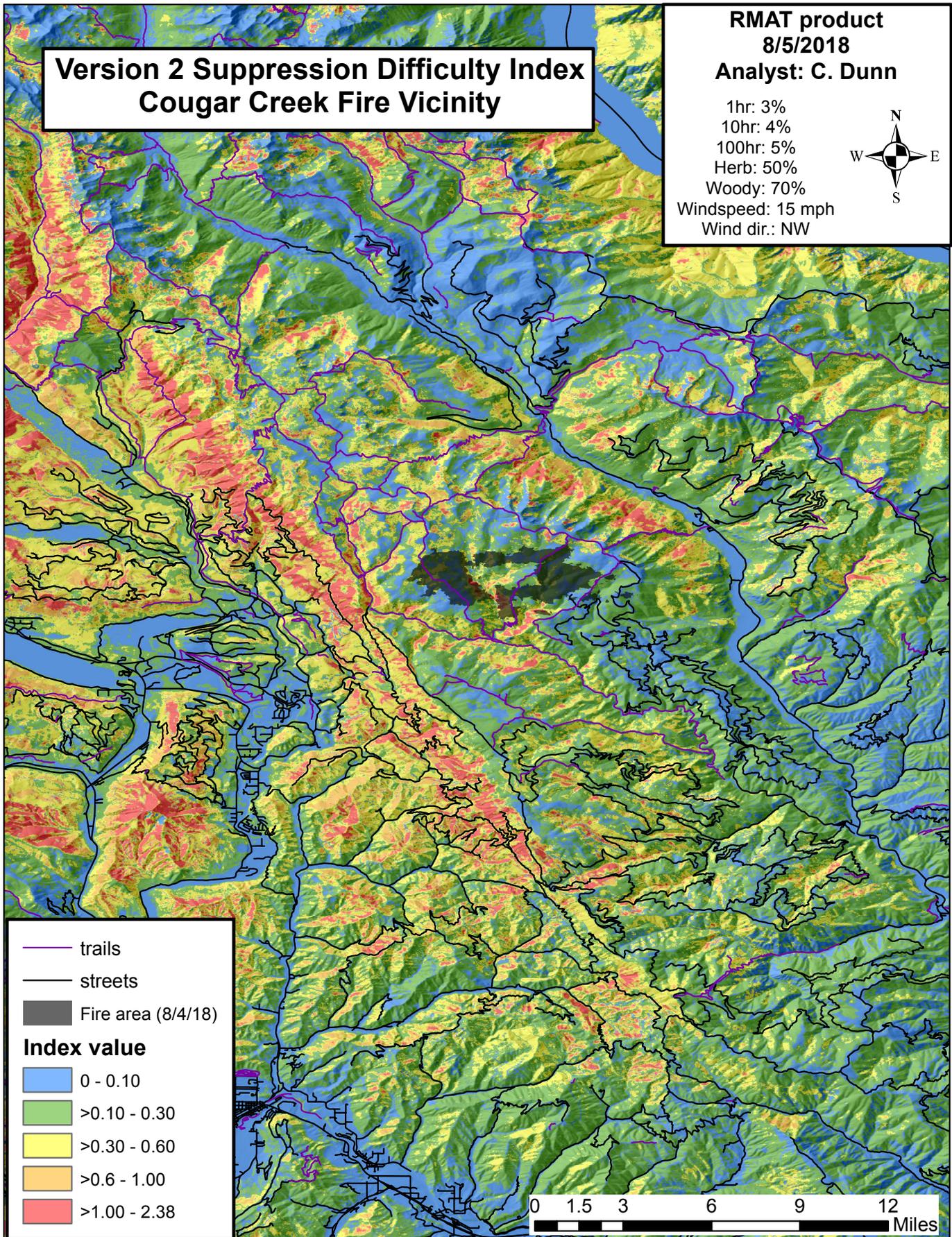


Estimated evacuation times are greatest on the west flank and minimal along the east flank. No reported injury/illness to date. \*As reported in the ICS209.



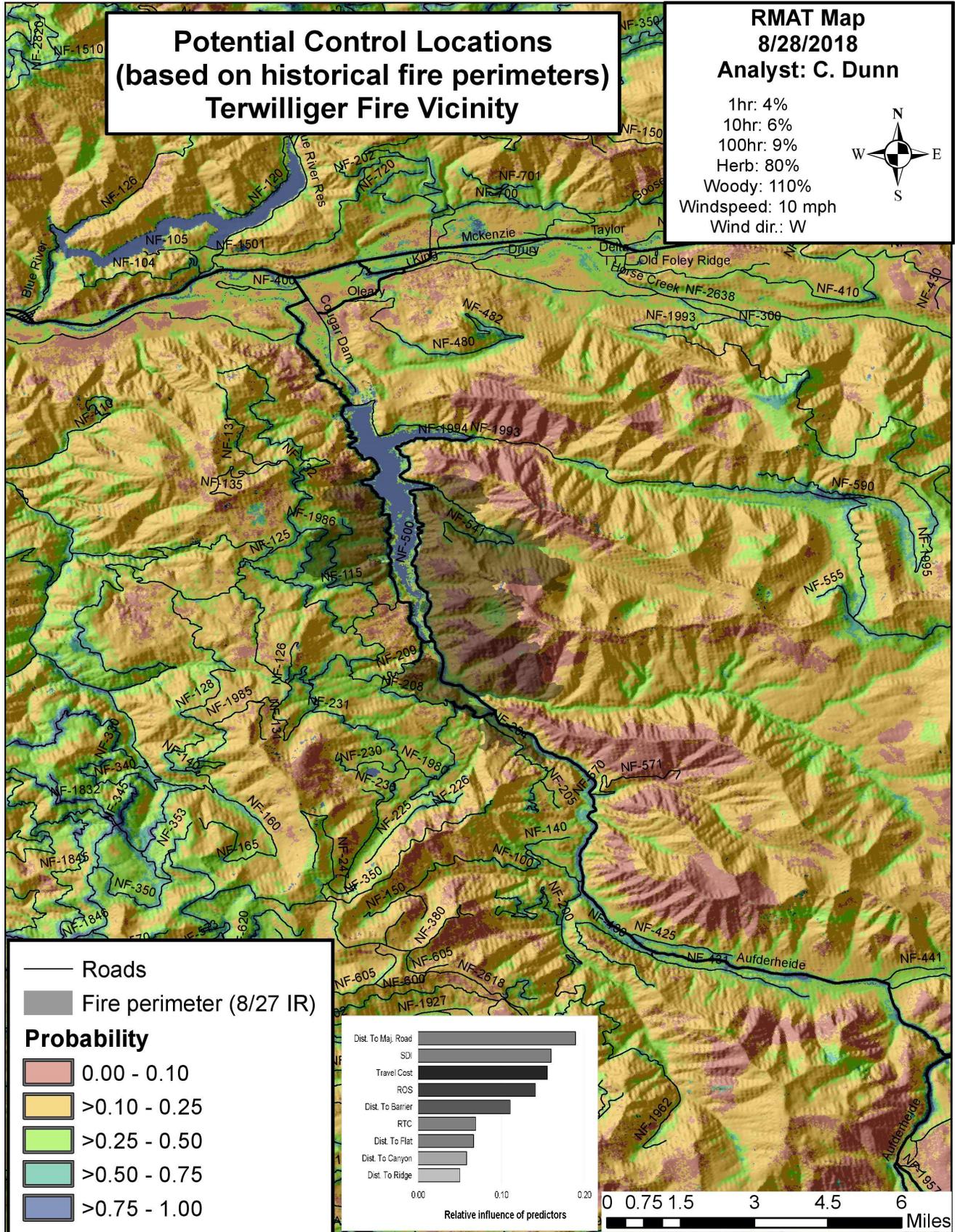
**Figure A.4 – Suppression Difficulty Index Map for the Cougar Creek Fire**

The Suppression Difficulty Index (SDI) assesses potential fire behavior and management considerations (e.g. accessibility, mobility, available fuel breaks, time to create line). Higher values on the SDI scale indicate a riskier situation or area.



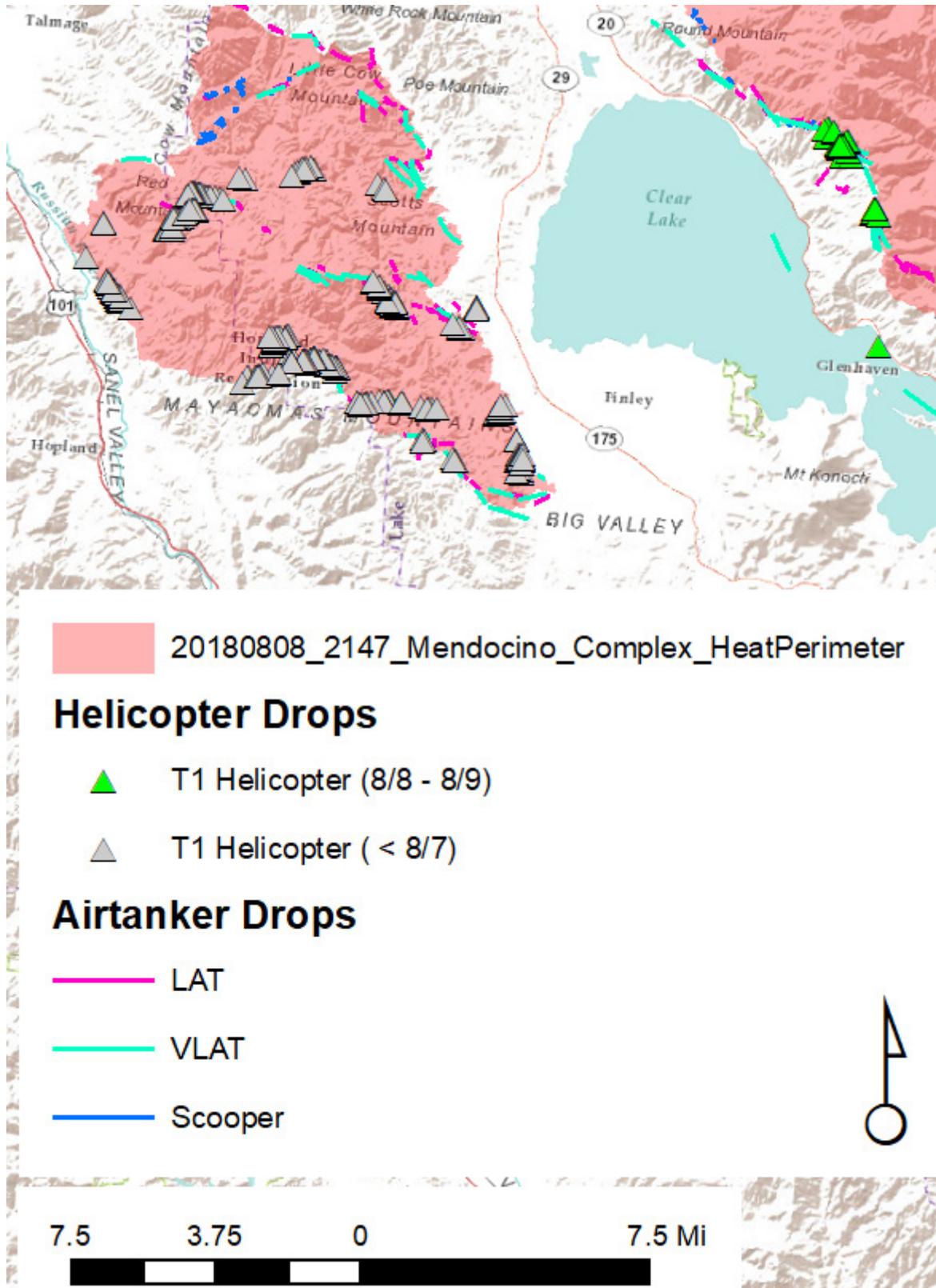
### Figure A.5 – Potential Control Locations Map for the Terwilliger Fire

The Potential Control Locations map shows the suitability for fire containment across the landscape using historical fire perimeters and other model drivers (e.g. fuel transitions, road networks, rate of spread, and suppression difficulty). Higher probabilities indicate better containment opportunities under current fire conditions.



### Figure A.6 – Aviation Use Summary Map from the Mendocino Complex Fire

The Aviation Use Summary map helps decision makers quantify and track aviation use on a fire through the duration of the fire. It spatially tracks the use different types of aircraft, including helicopters, large airtankers (LATs), very large airtankers (VLATs), and scoopers (planes that can quickly scoop water during flight). The information can be particularly helpful for tracking the use of retardant and guiding subsequent analyzes of the associated environmental impacts.





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