Pre-Season Planning for Wildland Fire Response: An Assessment of the US Forest Service's Potential Operational Delineations (PODs)
Addendum: Lessons from the 2019 Fire Season

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Executive Summary

Potential Operational Delineations or "PODs" use risk management principles to identify potential fire control locations on a landscape in advance of ignitions to enhance safe and efficient fire response. Developed by the US Forest Service (USFS) and partners at Oregon State University along with the Colorado Forest Restoration Institute at Colorado State University as a critical contributor, the PODs approach involves both a process and tangible outcomes. The process involves fire managers engaging with non-governmental partners, tribes, state and local agencies, and agency scientists to share knowledge, and build agreement about fire management options outside of the incident management context. We investigated the development and trajectory of PODs on national forests to understand the utility of the approach, the primary factors that impact the ability to apply PODs, and the opportunities to improve PODs going forward.

Overview and Methods

Our work involved two phases of data collection to examine both the expected and the realized outcomes of PODs in its early stages of use. During the spring of 2019, the first phase of this research, we explored how land managers intended to use PODs, and the contextual factors anticipated to influence utilization. We interviewed 36 fire managers and external partners involved in planning and implementing PODs on four national forests in the western United States (Box 1). Most interviewees anticipated PODs would facilitate stronger communication among multiple agency levels and partners about forest management and wildfire response. Interviewees also focused on the potential of PODs to enhance decision making during incidents and leverage untapped options for fire response. They said that USFS leadership support and, where it exists, local social and political pressures to immediately suppress all unplanned ignitions were the most substantial factors anticipated to affect PODs implementation. We reported on these pre-fire season findings in our PODs Practitioner Paper (Greiner, Schultz, Kooistra 2020)[1]

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1   Our pre-season PODs Practitioner Paper can also be accessed through the following website: https://sites.warnercnr.colostate.edu/courtneyschultz/practitioner-papers/

This report serves as an addendum to our PODs Practitioner Paper and focuses on how PODs were used during fire events, the primary factors that impacted use, as well as general benefits and challenges expected as the approach continues to develop. In this second phase of research, during August 2019-January 2020, we completed 25 "post-fire" interviews with individuals who actively used PODs during the 2019 fire season. With advice from our partners at the Rocky Mountain Research Station (RMRS), we selected national forests for our post-fire interviews that had an unplanned ignition during the 2019 fire season and that had gone through the PODs workshop process. We selected USFS Regions with multiple forests that met these criteria, which meant regional leadership would be familiar with the PODs intent and process. The selected post-fire forests were the Carson and Santa Fe, the Tonto, and the Apache-Sitgreaves National Forests in Region 3, and the Pike-San Isabel and San Juan National Forests in Region 2. Most (84 %) of the participants were new participants in Phase 2, although a few of them were interviewed in both phases if their forest experienced an unplanned ignition (Carson, Santa Fe and Tonto).

Key Findings

PODs were used in a variety of ways that enhanced communication among multiple entities during the 2019 fire season. Interviewees across all forests said they referenced PODs in briefing papers and calls between responders, incoming incident management teams, and line officers within the USFS to help form a coordinated understanding of operations. Some interviewees used PODs to help guide conversations with external partners and the general public. On the ground, responders referenced PODs maps to validate their thinking and provide guidance for drawing planning areas.[2] Interviewees found referring to pre-identified control lines and evaluating risk prior to the fire season was helpful for confirming where to safely engage fire. Responders said using PODs also gave them more credibility with line officers when discussing response strategies. This enhanced credibility, they said, offered some opportunities to manage fire for resource benefit.

According to interviewees, the use of PODs was limited by the relatively slow fire season, the newness of the tool to most forests, low risk tolerance in some places, and low staff capacity. On the Tonto, for example, high precipitation levels created some challenges for using PODs in the Sonoran Desert ecosystem because the abnormal seasonal conditions shifted vegetation conditions and typical fire response strategies. Across all forests, interviewees said the regional office and key individuals at the forest level strongly influence fire management culture. Managing fire for resource benefits is not incentivized in all places, which can discourage the use of PODs for this purpose. Low staff capacity to both develop and upkeep PODs year-to-year was another challenge interviewees frequently spoke about. These outcomes aligned with the anticipated factors we found in our pre-season interviews.

2   Planning Areas are physical areas that include all the land a fire could burn during the life of the current incident; it includes the area used for analysis and planning to manage a fire. They are required for documenting a decision.

The most common recommendation that interviewees shared after employing PODs was to encourage more involvement with stakeholders and other agency specialists outside of fire in the PODs process. Continually updating PODs and improving the approach to allow for seasonal weather dynamics was also commonly suggested but interviewees recognized the challenge of this given limited staff capacity. These recommendations were echoed in our pre-season interviews.

Looking ahead, interviewees broadly anticipated PODs would continue to be useful for improving communication and enhancing safe and strategic decision making during incident response. Interviewees anticipated that as PODs develop, the approach could strengthen rationale and public support for managing fire for resource benefit through a shared understanding of fire management objectives. As we found in our pre-fire season interviewees, interviewees are still interested in using PODs to prioritize fuel and restoration treatments, although this use has yet to happen. Several interviewees anticipated local political and social culture would impact PODs in years where fires are larger and burn across jurisdictional boundaries. These findings were consistent with our first round of interviews.

Conclusions

PODs can contribute to stronger communication among multiple entities during fire events, help validate for operational decisions, and help enhance opportunities to manage fire for resource benefit. USFS organizational commitment from leadership and dedication of resources are needed to maximize the potential of PODs. It is important for the agency to encourage and support early involvement of land management partners and a variety of agency disciplines. Future research should track PODs use and impact on fuel and vegetation treatments. It also remains to be seen how PODs are utilized when fires cross jurisdictional boundaries and in places where various fire management options, such as using some fire for resource benefit, are less acceptable to partners.

Introduction and Methods

Our research team has been investigating the development and use of Potential Operational Delineations, or "PODs," on national forests in the western US. PODs are developed collaboratively and then used to identify potential control lines and fire management options prior to ignitions and incident response. Our PODs research consisted of two phases of data collection. In the first phase, conducted between May-July 2019, we interviewed 36 individuals who helped develop PODs. At that time, interviewees had participated in workshops to develop PODs, but most of them had not yet used PODs during fire events. We focused on the anticipated use of the approach, factors that would affect the use of PODs, and where there were opportunities for improvement. We published those findings in 2020 in the Public Lands Policy Group Practitioner's Paper #5 (Greiner, Schultz, Kooistra, 2020). Key findings from Phase 1 are summarized in Box 1.

Box 1. Pre-fire season (Phase 1) findings

Key findings about PODs anticipated value and factors that could impact its use:

- PODs and the associated development process were anticipated to facilitate stronger communication among multiple agency levels and partners about forest management and wildfire response. Most interviewees said that PODs could enhance transparency and create a shared understanding between Forest Service staff (resource specialists and line officers), incoming incident management teams, the community and land management partners.

- PODs were expected to enhance efficient decision making during incidents and leverage more options for fire response. Many interviewees anticipated coordination during pre-season planning would improve coordination during incident response. Some reported that as a data-driven tool, PODs could add credibility to decisions and illuminate decision options and rationale. Some said this might create more opportunities to explore indirect attack strategies.

- There was some interest in using PODs to inform fuel and vegetation treatment plans. Interviewees said PODs could be used to highlight areas for treatment, identify and prepare control lines, and prioritize future projects, such as restoration treatments, fuels thinning, and prescribed fire.

- Local social and political pressures to immediately suppress all unplanned ignitions and USFS leadership support were the most substantial factors anticipated to affect the use of PODs. Some interviewees said existing ecological contexts, USFS staff attitudes towards shifting fire management approaches, and staff capacity issues might impact PODs.

- PODs require committed leadership and investments in partner and interdisciplinary staff member engagement with the approach. Interviewees said this would support commitment and understanding among partners and staff to use and improve the approach over time.

- Interviewees said incorporating seasonal conditions, variable weather conditions, and local conditions would add value to PODs. They also recommended ongoing sharing of lessons learned and dedicating staff capacity to maintaining PODs.

Forests interviewed for our pre-fire season PODs work included the Tonto and the Carson and Santa Fe in the US Southwest, and the Rogue River-Siskiyou and Fremont-Winema in the Pacific Northwest. For more detail on these findings, please see our primary PODs Practitioner Paper ([Greiner, Schultz, Kooistra 2020](#)*).*

The second phase of our research, and the focus of this addendum to Practitioner Paper #5, involved a separate round of interviews with individuals who actively used PODs during the 2019 fire season (referred to herein as our "post-fire" interviews). These interviews were conducted between August 2019-January 2020. Our goal in this phase was to understand the value of PODs in practice. We also aimed to collect general information about the expected utility of PODs in the future as the approach is still developing. This addendum addresses the following primary set of questions that guided this phase of our investigation:

1. How were PODs used during the 2019 fire season and was this consistent with what was intended?

2. Which contextual factors, such as social, environmental, or organizational variables, have influenced the utilization of PODs on national forests and adjacent lands?

3. What are PODs users' recommendations for improving PODs based on experience during fire events?

4. What are the general perceptions of the utility and barriers of PODs going forward?

For our post-fire interviews, with advice from RMRS partners, we identified forests that had gone through the PODs workshop process and had an unplanned ignition during the 2019 fire season. We selected two Forest Service regions with multiple forests that met these criteria for a richer opportunity to explore regional office influences. These forests were: the Apache-Sitgreaves, the Tonto, and the Carson and Santa Fe (two forests working together on fire management and planning) in the Southwestern Region (Region 3), and the San Juan, and the Pike and San Isabel (two forests administratively combined) in the Rocky Mountain Region (Region 2).

We began interviewee outreach with key Forest Service staff engaged with PODs on each forest that was identified for us by RMRS and other colleagues with the Colorado Forest Restoration Institute that had worked with these forests on PODs development. We then used a referral method from these initial contacts to identify other potential interviewees

actively involved with PODs planning and fire response on these forests and specific incidents. This population included Fire Management Officers (FMOs), assistant FMOs, fire analysts, planners, and ecologists, battalion chiefs, fuels program managers, and line officers. We conducted semi-structured phone interviews with 25 individuals, and on each forest we kept interviewing until we were not hearing new information or had spoken with everyone who had been referred to us and who we could identify as being a relevant interviewee for our work. Table 1 summarizes our interviewees. About 16% of interviewees in Phase 2 were also interviewed in Phase 1 because the Carson and Santa Fe and Tonto National Forests were selected for both phases. Nationally the 2019 fire season was relatively less active. Local resources were available to assist on fires and external firefighting partners were not as involved during fire events, so our interviewees were almost all internal to the USFS and worked locally either on or near these forests.

Interviews ranged from approximately 30-75 minutes. Interviews were digitally recorded, transcribed, and then coded using Dedoose software. This qualitative data analysis software allows us to systematically apply codes to portions of text to organize and analyze for key themes. Our report presents a synthesis of findings among forests, including representative interview quotes to demonstrate examples of our findings. Each interviewee is denoted by a unique number to maintain confidentiality. With more specific quotes (e.g., direct references to regions, forest names or fires), no numbers are given to protect confidentiality.

	US National Forests	Total Interviewees
Region 3	Carson and Santa Fe National Forests	7
	Tonto National Forest	7
	Apache-Sitgreaves National Forest	3
Region 2	San Juan National Forest	4
	Pike and San Isabel National Forests	4
		25

Table 1. Summary of Interviewees

Findings

In this section we first share our Phase 2 findings organized by our research questions. Findings were generally consistent across all forests and both regions unless otherwise noted.

How were PODs used during the 2019 fire season?

Interviewees said PODs were used in a variety of ways that enhanced communication and trust, aligning with interviewee's expectations of how PODs could be useful. Most interviewees reiterated the value of participating in the PODs development process itself (e.g. workshops and drawing PODs maps). Interviewees said this helped

strengthen agency coordination and preparation because the PODs process was collaborative and done proactively, prior to fire incidents. As one person explained, *"Getting firefighters and line officers and other ologists to sit in a room and look at maps and be on the same page ahead of fire season and just in general to have those conversations early versus nine o'clock at night on a Sunday, that's been helpful"* (49). Also, interviewees found the PODs approach helped create a shared vocabulary and cohesive talking points which facilitated discussion among staffs. Interviewees said they referred to PODs during fires to guide conversations, calls, and agency briefings with incoming incident management teams. The following quotes are some examples of how PODs were employed as a communication tool when responding to an incident:

> *"The [fire staff] all have it in their iPads, so when they're going out onto a fire and they're getting ready to look at what the fire's doing and where they're at, they'll check the POD map… And they'll communicate that back to [the FMO] and then we'll have those conversations with line officer at that point. [It is] super accessible. Really easy to use"* (42).

> *"This POD concept plays out in daily briefings and preparing our on the ground resources, our Types 3, 4, and 5 Incident Commanders. What is our response going to look like in this part of the district, knowing where our available control features might be and whether or not we want fire in this ecosystem? We use it to brief our local firefighters and incoming resources [to] consider what's really at risk out there and what is the appropriate level of response as they get out there on scene"* (52).

> *"I definitely think that because we had the workshop, and we had that common language, and common understanding as to what something like this might look like, [PODs] certainly helped with communicating our strategy and the action that we were taking. It helped our partners understand and be more open and receptive to what we were doing"* (48).

Some interviewees valued using PODs to support external communications with the local public when conveying management decisions. Interviewees reported that PODs facilitated trust building with their local communities, as the agency staff members had a more common understanding and clear reference point to speak from. As one interviewee said, *"Because of the vocabulary that we have now with PODs and because of the emphasis of thinking landscape scale strategically over the last decade [or more], we're able to communicate that to the public at community meetings during the fire and ... [explain] the reason that we're allowing this fire to be managed and expand beyond what we could do if we went in and just hammered it with full suppression"* (60).

At the ground level, several interviewees said PODs did not drive decision making, but rather were a tool that helped validate operational decisions and affirmed their course of action. In our Phase 1 interviews prior to fire season, a couple interviewees anticipated using PODs as a reference to help validate decisions during incidents; comparatively this finding was a lot more prevalent in our post-fire interviews after more forests had actively used PODs. Fire managers generally referenced PODs during initial response to help affirm values at risk and where to effectively engage fire for a safer and more successful response. For example one interviewee said, *"We were able to drill down and say, 'we think this is where we can have a high probability of success and limit the exposure of our folks out into the hazards that we have out there' "* (40). Some also referenced POD maps to assist with drawing Wildland Fire Decision Support System (WFDSS) Planning Areas.[3] Also, interviewees said PODs were useful for relaying tactical information to line officers. Interviewees explained:

> *"[PODs] provides a product of information sharing. Instead of just us out there freelancing, it paints a picture that we're actually taking calculated risks.... It's a good product to show the transparency that we're thinking things through.... It helps with your strategic planning and it facilitates safer and more effective responses"* (55).

> *"It was helpful for me as agency administrator to tell the story to the Regional Forester and to my boss. We could show it on a map where this makes sense. And so, [PODs] did help us that way to tell the story in terms of our articulating why we wanted to manage the fire or what or what strategies and actions we were taking"* (49).

Interviewees from the Carson and Santa Fe in Region 3 said they used PODs to manage some fires for resource benefit during the 2019 fire season. Managers in these forests explained that referencing PODs data provided greater validation in operational strategies, which reinforced decisions where the staff was considering the option to manage a fire for resource benefit. One employee from the Carson and Santa Fe explained for example, *"The way we used PODs throughout the fire season was as a validation tool when determining courses of action and developing strategy for a naturally caused wildfire... [responders] went back and double checked and said, 'Okay, this portion of the POD we don't really have any HVRAs[4] that will be negatively impacted by fire.' So, they went ahead and managed fire for resource benefit."* Box 2 below provides an example of how PODs were used during the Gurule Fire, one of several fires managed for resource benefit this season on the Carson National Forest. Also, some interviewees found that developing PODs prompted more discussion within the agency about reorienting fire management towards opportunities to manage fires for resource benefit in the future. For example, one person shared how PODs concepts were integrated into forest plan revision, *"[PODs] led to a greater discussion about what that district actually [would look] like in the future and how it's classified with the PODs. We're undergoing forest plan*

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3   The Wildland Fire Decision Support System (WFDSS) is a system used by fire managers and analysis to document and share their decision-making process. Planning Areas are physical areas that include all the land a fire could burn during the life of the current incident; it includes the area used for analysis and planning to manage a fire. They are required for documenting a decision.

4   HVRAs are highly valued resources and assets.

Box 2. The Gurule Fire

OVERVIEW — The Gurule Fire on the Carson National Forest in New Mexico naturally ignited on June 7, 2019 and burned approximately 2,360 acres. The fire was managed for resource benefit, and interviewees spoke positively about the value of using PODs during the Gurule Fire. Interviewees said PODs were most useful to 1) validate decisions during fire response, 2) communicate with partners, and 3) structure the development of WFDSS Planning Areas.

VALIDATION — PODs did not drive decision making, but they aligned with and helped confirm managers' thinking. PODs also helped communicate rationale with agency leadership to manage the fire for resource benefit.

"We used [PODs] in conjunction with our rationale because when you do manage fire for resource benefit, you have to go through the many layers of approvals under the regional office, the Forest Supervisor, and such. We were able to say, [the fire] is in this POD, this is an area that needs treatment."

"It was [used] to validate [our] thought process… 'Let's go back and double check our thinking if we want to manage it for resource benefit and recall the discussion'."

COMMUNICATION — PODs were found to be valuable when communicating with neighboring land management agencies and partners. Forest-level personnel thought this would continue to be a useful aspect of PODs in the future.

"Introducing the concept and the classifications to cooperating agencies has been useful. We did have a meeting with some [local] area cooperators… about the strategic response classifications and how we anticipate managing fires in each POD. I think that's something that we'll be able to carry forward."

"It is easy to share with our partners, at least the state and county partners, they didn't really share the maps with other folks per se. I would imagine like next year…it could be really helpful to tell a story to cooperators, residents."

PLANNING — PODs were used an initial guide for drawing WFDSS planning areas.

"We found that the POD boundaries were useful for guiding and drawing plan areas. As in the operational delineation itself…there's been some ground-truthing to it. That POD boundary is a viable control line."

revision right now, and so [PODs] led into a deeper dive into the current forest plan to find exact verbiage of what it says has to do with fires, natural or planned ignition, to really wrap our heads around that [and] see if there are any other options" (57). The [key factors section](#) of this report explains some dynamics as to why using PODs to manage some fires for resource benefit was exclusive to the Carson and Santa Fe.

Finally, we compared interviewees' expected benefits and use of PODs from our pre-fire season research with the realized utility of PODs that interviewees highlighted in our post-fire interviews. [Table 2](#) below highlights these findings, which demonstrate general alignment between expected and actual use to date.

What were the key factors impacting PODs use during the fire season?

Most interviewees said the relatively less-active 2019 fire season and abnormal fire conditions were the main barriers inhibiting the use of PODs during incidents. Generally, PODs were not utilized as much as interviewees expected across all forests. It is important to clarify that there was not a lot of time between our Phase 1 and Phase 2 interviews, with minimal time for managers to integrate this new tool into planning. For example, our interviewees in Region 2 said the use of PODs was constrained because staff had recently developed PODs in the spring of 2019, so the approach was in a prototype phase. On the Tonto National Forest all interviewees

Pre-fire Season Expectations	Post-fire Season Reality
Increase coordination among multiple agency levels and partners about forest management and wildfire response.	Interviewees consistently reported PODs were useful for communicating and coordinating actions among several entities (e.g. line officers, incident operations staff, land management partners and the public).
Increase validation and credibility for decisions.	Interviewees said they did not change their response strategy based on PODs. PODs were referenced to validate thinking, evaluate risks and the probability of success, and draw planning areas.
Enhance efficiency during response by pre-planning.	Interviewees said the pre-season planning done to collaboratively develop PODs was particularly useful for building a shared understanding among staffs. Agreement and planning helped support safter and more effective decisions on-the-ground.
Increase opportunities to manage fire for resource benefit.	Findings were mixed on whether PODs yielded opportunities to manage fires for resource benefit. We heard on the Carson and Santa Fe enhanced coordination and rationale built from using PODs helped support opportunities to manage fire for resource benefit.
Support fuel and vegetation treatment planning.	As a planning tool, PODs were useful for proactively thinking about strategies, but they were not directly used for planning fuel and vegetation treatments this season. However, many interviewees still anticipated using PODs for planning treatments in future years.

Table 2. Expected and Actual Utility of PODs

explained challenges that arose with using PODs in the Sonoran Desert ecosystem where above-average precipitation in the spring led to high grass levels that could more easily carry fire. The staff plans to re-evaluate PODs to be more useful in abnormal conditions for future years. One interviewee from the Tonto explained, *"This season, we had an unprecedented and continuous grass problem, especially in the Sonoran Desert landscape…it carried the fire, and it could carry fire. Any start that we would have would travel fast through that. It was one of those years where you were not going to make the same decisions as a normal year…. To manage fire in those conditions is difficult. PODs still play a role in informing those decisions, but we're not going to rely on it quite as much as in a normal year."*

Within the Forest Service, leadership risk tolerance and the resulting agency culture affect how PODs have been adopted and the ability to employ the approach to its fullest potential. Interviewees attributed varying levels of risk tolerance to different elements of the unit. Several interviewees said the leadership and culture within Region 3 generally supports more risk tolerance than

currently exists in other regions. For example, one interviewee said, *"There's a reason that Arizona, which also had a pretty mild year, had a ton more burned acres than Colorado did. And it's all just acceptance of having fire on the landscape. There's not really that same acceptance in Region 2 as there is in Region 3… In Region 2, we have a tremendously difficult time not fully suppressing every single fire in low-end conditions."*

Agency risk tolerance and fire management culture is also influenced by key individuals at the forest level. Many interviewees said line officers and FMOs make a big difference in the ability to consider different management strategies, namely managing fire for resource benefit. Overall, leadership support was a central dynamic that influenced the use of PODs, according to interviewees.

> *"We're lucky to have some pretty good FMOs who're really supportive of confine/contain or going indirect on fires under the right conditions. But again, you could switch any one of those people out at the district FMO level for someone who doesn't see the value in it or is risk averse to it, and they could basically shut it down."*

What are PODs users' recommendations for improvement?

The most common recommendation to improve PODs was to focus more efforts on involving forest-level leadership, external land management partners, and other USFS specialists during the development process. This finding is consistent with what interviewees said during our pre-season interviews. Interviewees had several reasons for why including a broader scope of stakeholders and partners would be helpful. First, getting broader participation would be useful for gauging comfort level and priorities among land management agencies and stakeholders upfront. Range permittees were specifically identified as a key partner the USFS plans to involve more. Second, many interviewees suggested that involving resource specialists beyond fire management staff could strengthen working relationships and help provide a more comprehensive evaluation of the values at risk. Interviewees said:

> *"Internally we need to do a little bit better job of bringing our resource specialists into the fold. Building some understanding with them and them also giving them the opportunity to provide input into refining some of the nuances of these PODs… there's a lot of stuff out here that our local resource specialists know and would want to protect or even have fire in that maybe hasn't been captured at the scale and pace that this thing rolled out. As we get into off-season work with them, it's about building understanding and having them provide input [for the] decision" (52).*

> *"We need to make this cross-boundary and make sure that we're bringing in other partners…how do we take that information and make it more transparent, more available to the other land management agencies and to some of the non-fire folks in a landscape and use the information that they have to further help design and shape the PODs?" (60).*

Most interviewees said agency commitment to the approach was necessary to sustain PODs longevity. Particularly, interviewees said that as ecological conditions change PODs cannot remain static and will require dedicated upkeep to maintain relevancy. As one person said, *"It is an evolving map. It's a living document. It's something that you have to revisit every year" (55).* Interviewees explained PODs must be adaptable and dynamic for use during different times of the year and different weather conditions. said, *"We need to make them more responsive to seasonal effects. Also, they need to be looked at probably on a yearly basis and updated for most of the fires…because it will change basically on a yearly basis" (54).* Some interviewees expressed confusion over using the Suppression Difficulty Index (SDI) and Potential Control Locations (PCL)[5] under specific percentile weather conditions and suggested creating sets of PODs tailored to different percentiles. Interviewees felt agency commitment to using PODs in addition to additional financial and staffing capacities were needed to both develop the approach, emphasize its importance, and maintain its upkeep from year to year. These recommendations were consistent with our pre-fire season interviews.

Other suggestions that were less common among interviewees included adding post-fire considerations and formally integrating PODs with existing tools. Specifically, a couple interviewees said integrating post-fire effects, like run off and erosion after wildfires, are important elements to consider when designating response zones and could be emphasized more when developing PODs. Also, a few interviewees discussed accessibility concerns for agencies and partner organizations outside of the Forest Service. To help address this concern, some staffs are beginning to integrate PODs into more accessible mapping and documentation tools like Avenza and WFDSS.

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5   The Suppression Difficulty Index (SDI) and Potential Control Locations (PCL) are spatial tools used to help develop PODs. For more information on these analytics see O'Connor et al., 2016.

What are the general perceptions of PODs going forward?

Because our work was done shortly after forests created PODs and before extensive use of them during incidents, we continued to collect additional information about interviewees' general future outlooks on PODs. Broadly, interviewees anticipated that, as PODs continues to progress, the approach will be most valuable for communication, enhancing strategic decision making during fire events, planning fuel treatments and potentially impacted by the local fire management culture. We discuss these elements further below.

Almost all interviewees said several ways that they anticipate PODs will continue to be valuable for enhancing communication among actors and across jurisdictions. Interviewees value the collaborative PODs pre-season planning process as a method to better coordinate personnel and build trust and a shared understanding of fire management objectives prior to the fire season. During fire events, interviewees expected that PODs would ultimately function as a communication tool among responders from multiple agencies and line officers and anticipate it will be used more in future years when relaying information to the local community.

Many interviewees anticipated that as PODs continue to develop, the enhanced communication and pre-season planning will increase safe and strategic decision making as well as opportunities to get more "good fire" on the ground. Interviewees anticipated that evaluating values at risk and the probability of success prior to fire events will lead to more informed and safe fire response. Interviewees further anticipated that PODs may leverage more support to manage fires for resource benefit objectives based on pre-season dialogue and assessment of conditions and values at risk.

Interviewees continued to say that they are interested in integrating PODs with fuel and vegetation treatment plans in future years. According to our interviewees, PODs have not been directly used for treatment plans (e.g. prescribed burning or thinning). However, several interviewees in both research phases expressed interest in using PODs to inform treatment areas, prepare and improve control lines, or prioritize future projects as they get more familiar with the approach. For example, one interviewee said, *"It really began to click with one of our FMO's as they were laying out the design for a landscaped scale prescribed fire project...As the burn units are prepped and made ready to burn, they could easily be incorporated in as PODs" (46).* Another agreed, *"We could easily be prioritizing stuff based on the PODs, prioritizing fuels treatments and restoration. The PODs are showing us where the problems are" (37).*

Most interviewees thought the local stakeholder and community outlook toward fire management could still influence how PODs are utilized but did not impact use during the 2019 fire season. Interviewees explained that local perceptions about fire management from external land management partners and the surrounding community not be overlooked. As one person said, *"If you don't have the public buy-in and have the right conversations with them and you start running around and trying to implement this PODs process it's not going to go very well" (55).* Interviewees anticipated community acceptance towards prescribed burning or managing fires for resource benefit influence could shape the differences in how PODs are utilized. These ideas were also brought up in our first round of PODs interviewees, particularly in places where stakeholders and partners have less agreement about the value of fire or different levels of tolerance for fire and smoke, although no interviewees reported public perceptions as a factor that impacted PODs use during 2019. Some interviewees anticipated that future years where more fires cross neighboring jurisdictions with conflicting mandates and objectives would prove challenging. For example, one interviewee thought:

> *"I'm anticipating the first time we have to go onto a different land ownership... even if we've worked with them, there's going to be some level of surprise there.... [If] we used PODs and it says 'don't hurt your firefighters and pull out to this more defendable area', and we burned up a timber sale that's been marked or sold, I think we're going to have some issues there" (47).*

Conclusions

Our findings from investigating PODs before and after the 2019 fire season reveal emerging benefits of the approach as well as some areas for improvement. Below we summarize four key findings central to using PODs.

- Using PODs can contribute to stronger communication and coordination among multiple entities during fire events, validate operational decisions, and help enhance opportunities to manage fire for resource benefit.

- Leadership commitment continues to be a central factor for utilizing PODs to its fullest potential. Both phases of our interviewees emphasized USFS organizational commitment from leadership and dedication of resources are key to maximizing the potential of PODs.

- It remains valuable for the agency to encourage and support deliberate involvement of land management partners and a variety of USFS staff areas to foster a more holistic and collaborative approach. This finding was consistent in both pre and post-fire interviews.

- It remains to be seen how PODs are utilized when fires cross jurisdictional boundaries. Interviewees expected local social and political dynamics (e.g. smoke tolerance, conflicting fire mandates, media portrayal, existing community support for fire) would likely impact the use of PODs and might be observed during seasons with larger and more cross-boundary fires. There was limited reliance on PODs during active fires in 2019 due to the slow fire season and abnormal weather conditions.

Finally, we found that our interviewees both valued and used PODs as a tangible product to share information. As a physical document, PODs can add a level of legitimacy because they capture

scientific expertise and were developed intentionally through a planned process, investing time, resources, and managers' local knowledge. In this way PODs function as an output of boundary work, which focuses on knowledge sharing between different communities combining knowledge from both science and practice. Research suggests this type of boundary work can support the production of products that are perceived by multiple groups as credible, legitimate, and salient (see Graham and Mitchell, 2016). Thus, PODs add to communication and may create a stronger level of trust in management decisions among a variety of actors. Also, given the challenges of focusing on long-term risks during fire incidents, PODs offer an opportunity to consider risks over time outside the emergency management context when short-term risks are often prioritized (Schultz et al., 2019). In light of this opportunity to align the strategic thinking of multiple responders, build agreement among partners and stakeholders, and the potential to inform fuels treatment planning, PODs appear to be an important emerging tool for improving fire management planning and response.

The 2020 fire season will pose unusual circumstances due to COVID-19. The short- and long-term potential impacts on different parts of the PODs workshop, planning, and implementation process remain to be seen. Some researchers have reported on COVID implications for firefighting operations and community behaviors (Edgeley & Burnett, 2020; Thompson et al., 2020a). Understanding the value of PODs under different circumstances will likely require tracking PODs development and use over multiple years.

The intention of this work is to build upon other early findings of PODs implementation (e.g., Caggiano et al., 2020). Our reports can be used to track the progress of PODs as it continues to develop, such as outcomes of the recently developed POD Atlas (Thompson et al., 2020b) Particularly, tracking the agency's investment in PODs, their use and impact on fuel treatment planning, and use during future fire seasons will be needed to understand the efficacy and adaptability of the approach going forward.

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