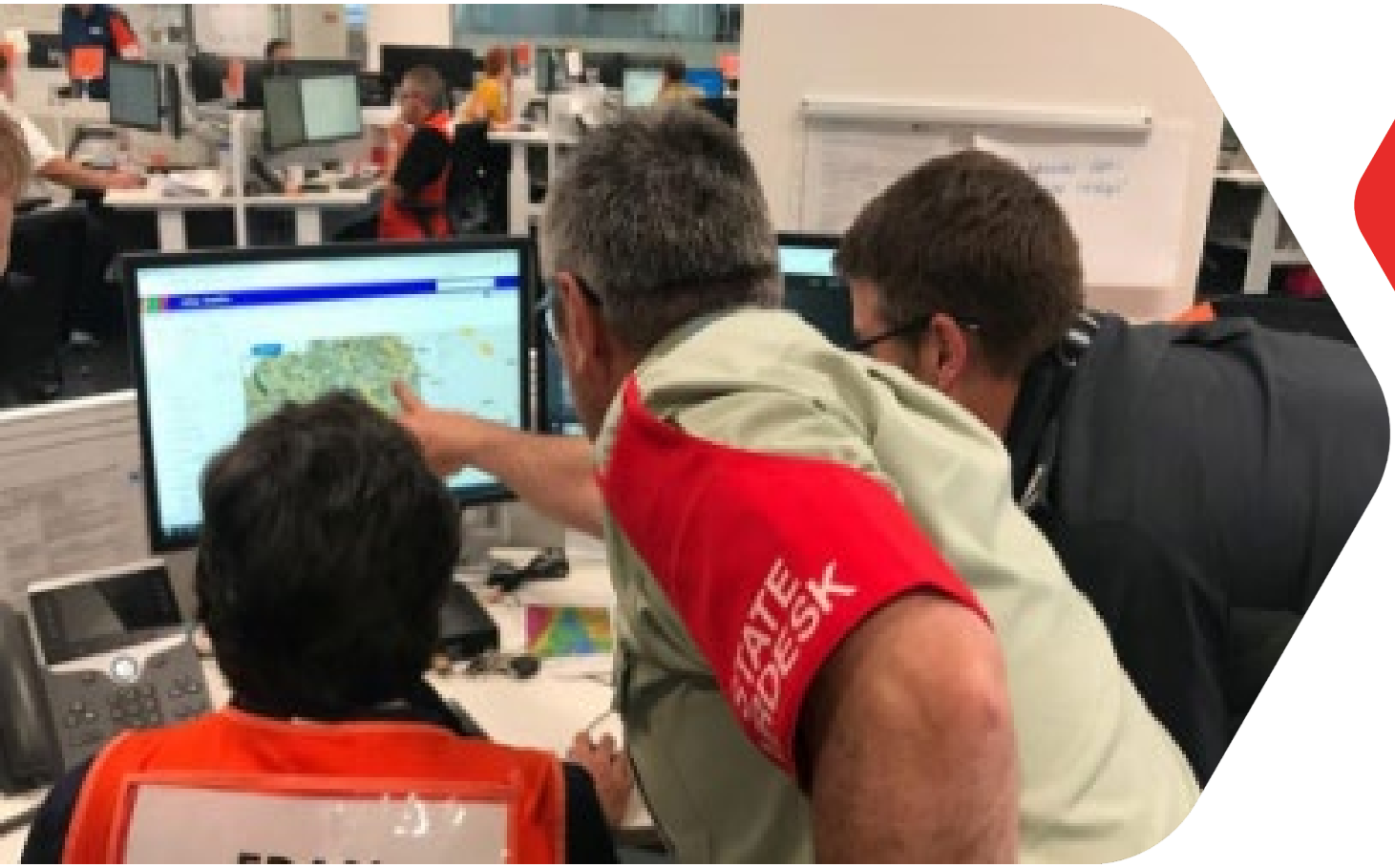
Natural Hazards Research Australia

Role and value of predictive service products

Predictions in public: understanding the design, communication and dissemination of predictive maps to the public

Timothy Neale[1] Gabrielle Miller[1] Chloe Begg[2] Paula Dootson[3] Erica Kuligowski[4] Amy Griffin[4] Graham Dwyer[5] and Angela Gardner[,2]

1. Deakin University, VIC 2. Country Fire Authority, VIC 3. Queensland University of Technology, Qld
4. RMIT University, VIC 5. Swinburne University of Technology, VIC



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We acknowledge the traditional custodians across all the lands on which we live and work, and we pay our respects to Elders both past, present and emerging. We recognise that these lands and waters have always been places of teaching, research and learning.

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Cover: FBANs and users interact in the Victorian State Control Centre, January 2020. Photo: Timothy Neale.

Table of contents

Executive summary

Bushfire simulation models and other predictive tools are increasingly used to inform operational and planning decisions, foremost through the production and use of predictive fire spread maps (FSMs). These maps show the predicted extent of a given fire over a given time period. Prior to the 2019-2020 bushfire season, such maps were occasionally shown to members of the public, however during that landmark season agencies in NSW and ACT produced, communicated, and disseminated select FSMs to the public. Subsequently, the *Predictions in public: understanding the design, communication and dissemination of predictive maps to the public* research project has been established to work with sector stakeholders and relevant communities to optimise predictive map design and dissemination. The ultimate aim of the project is to help ensure that any future predictive FSMs will support public protective action decision-making during a bushfire.

This report presents the results of Work Package 3 (WP3) of Phase 1 of the "Predictions in Public" project. WP3 seeks to help gain an overview of: the existing public information and warnings products; the potential role and value of additional predictive service products; and the views of sector experts with experience producing, communicating, and/or disseminating predictive FSMs. To this end, the project team conducted 44 interviews with identified sector experts, asking them about their experience of these issues and the anticipated benefits and risks of releasing predictive FSMs to the public in the future.

Participants asserted that the primary benefits would be increased public risk awareness, reduced bushfire impacts, increased access to hazard information, and increased agency credibility. The primary risks, in their view, were risks to the public from the misinterpretation or misuse of FSMs and risks to agencies from possible legal, reputational, or political consequences from publicly releasing or withholding FSMs. Overall, no participants were opposed to releasing predictive FSMs to the public in the future.

Asked about the barriers to releasing predictive FSMs to the public in the future, participants noted the persistent presence of risk aversion within agencies, the current lack of appropriate resourcing and training support, the current lack of public education regarding predictive FSMs, and the current lack of agreed processes, platforms, and formats.

On the matter of when and how predictive FSMs should be produced, communicated, and disseminated in the future, participants had a range of insights. Nonetheless, there was broad consensus that these products would be best reserved for impactful fires during extreme or catastrophic fire weather conditions and should be produced and designed as a specific product distinct from the FSMs currently generated for use by emergency management sector practitioners. In terms of communication, participants drew attention to the need for agencies to communicate predictive FSMs' assumptions and uncertainties and stated that predictive FSMs should be formatted consistently across jurisdictions and use a simple and clear visual hierarchy. Considering how these FSMs should be disseminated, the majority of participants supported broadcasting rather than narrowcasting these products, suggesting that agencies should use a range of digital dissemination platforms including agency apps and social media.

In sum, the findings of WP3 suggest that sector practitioners are generally positive about the future public use of predictive FSMs, identifying a range of benefits that ultimately outweigh the risks to the public and agencies of developing this new product. Their insights will be of great value to a number of audiences, including the project team, who will investigate public awareness of predictive products and test and evaluate predictive FSMs in subsequent work packages.

End-user statement

Inspector Laurence McCoy, Manager of Predictive Services, NSW Rural Fire Service

In NSW, Fire Spread Prediction maps were a critical tool to support operational decisions during the 2019-20 fire season. For the first time in NSW, they also supported community decisions with the release of the product that became known as the “red map”.

A recent study by Whittaker et.al. (2021) relating to the release of these “red maps” found that 86% recalled seeing a fire spread prediction map for their area, 93% found it easy to understand, 77% sufficiently localised and 85% useful.

The research released in this report gives an important basis for understanding current firefighting agency perspectives and, more broadly, a snapshot of the maturity of the use of Predictive Services within the firefighting sector. It will prove very useful in future research, policy, and practice both in relation to Predictive Service and the sector more broadly.

I look forward to further research in this space to understand how predictive maps should be designed, communicated, and disseminated in the future.

Introduction

Bushfire simulation models and other predictive tools are increasingly used to inform operational and planning decisions, and trained fire behaviour analysts (FBANs) provide a range of operational decision-makers with expert guidance by validating and communicating their predictions.

FBAN products include predictive fire spread maps (FSMs) which show how fires might move through the landscape, including the worst-case scenario. These products are used in a variety of situations by a range of users including the planning and implementation of vegetation management, the presentation of intelligence and scenarios before first attack, as well as predictions of fire spread during an extended attack to inform the decisions of incident controllers and public warning officers.

The 2019-2020 bushfire season was the first time that NSW and ACT fire authorities disseminated fire spread prediction maps (or "red maps") to the public (Owens and O'Kane 2020). Other fire agencies have released similar maps previously, but only on an ad hoc basis, and Victorian fire agencies have sometimes released maps of potential impact zones (for example in East Gippsland during the 2019/2020 season). The novelty and popularity of these predictive products has prompted a growing interest in agencies across Australia, and thereby a need for the AFAC National Working Group for Public Information and Warnings (Warnings Group) and AFAC Predictive Services Group to better understand how the public received, interpreted, and acted on these maps, and where/when these maps would be useful in the future.

Research aims and rationale

The overall aim of this project is to optimise predictive map design and dissemination to ensure that these maps will support public protective action decision-making during a bushfire event.

The BNHCRC-funded Black Summer project, "Established and Emerging Users of Predictive Services in Victoria" found that there is much support amongst operations staff in Victoria for the dissemination of fire spread prediction maps to the public (Begg et al. 2021). Further, recent post-event inquiries have recommended greater use of fire spread predictions in public messaging (Neale and May 2018, 2020; SAIR 2020; Owens and O'Kane 2020). However, the translation of inquiry recommendations and internal support into action remains contentious, especially without evidence-based guidelines on, 1) how predictive maps should be designed and communicated, and 2) how and when they should be disseminated to the public. Therefore, this project aims to develop evidence-based guidelines and recommendations for how to design, communicate, and disseminate predictive maps to Australian communities exposed to bushfires.

Research in Australia has been conducted on the public's response to risk and warning communication (Dootson et al. 2019; 2021); nonetheless, less research effort has focused on maps exclusively and even less has focused on fire spread prediction maps. While some studies have focused on the public's response to general bushfire map design (Cheong et al. 2016; Cao et al., 2016, 2017), currently missing from the literature is a clear understanding of how community members use, comprehend, perceive, and act upon fire spread prediction maps. Foundational research has recently been conducted in NSW after the Black Summer Bushfires (Whittaker et al. 2021), however, data for other Australian jurisdictions is currently lacking.

Guidance about the design of bushfire maps in the AIDR Public Information and Warnings Handbook (AIDR 2018) is currently limited to the broad use of maps (e.g., location of hazard, route closures, prediction) and suggests the use of a legend and consistent symbols and colours. We believe

findings from this research will provide greater detail to how predictive maps should be designed, communicated, and disseminated under the new nationally standardised approach to public information and warnings required by the implementation of the Australian Warning System.

Research objectives

The overall aim of this project is to optimise predictive map design and dissemination to ensure that these maps will support public protective action decision-making during a bushfire event.

Objective 1: To understand how members of the fire and emergency services sector would prefer predictive maps to be distributed and used by members of the public.

Objective 2: To understand how members of the public use, comprehend, perceive, and take action in response to existing predictive map designs and other types of bushfire maps that are used by agencies across Australia.

Objective 3: To develop a set of evidence-based guidelines/principles for the design and dissemination of predictive maps to the public based on existing research on hazard mapping.

Objective 4: To develop guidance for communication and education for key community groups to improve their comprehension of predictive maps and empower them to identify appropriate preparedness and safety actions prior to receiving predictive maps during a bushfire event.

Objective 5: To develop a robust monitoring, evaluation, and learning framework that provides end users with a structured process for the continuous improvement of predictive map design and dissemination beyond the completion of this project.

The research is conducted using a mixed method design, beginning with:

- **Phase one**: Existing Agency Use and Public Awareness of Predictive Service Products in Public Information and Warnings

Planned future phases of the research project include:

- **Phase two**: Standardised Design, Dissemination, and Communication for Predictive Maps
- **Phase three**: Communication, Evaluation, and Learning Framework

This report forms part of **Phase one: Existing Agency Use and Public Awareness of Predictive Service Products in Public Information and Warnings.** The objectives of phase 1 are to:

1. advise the AFAC Working Group on Predictive Map Standardisation prior to the 2022/23 bushfire season, through participation in meetings held by this group.
2. inform the scope, content, and methods used in research conducted in phase 1 and refining the outcomes of the project (particularly phases 2 and 3) by conducting an online workshop with members of AFAC Predictive Services Group (PSG) and AFAC Warnings Group (WG).
3. gain an overview of the existing public information and warnings products across jurisdictions and the role as well as added value of additional predictive service products.
4. develop a preliminary set of evidence-based guidelines for predictive map design, dissemination, and communication based on existing evidence by reviewing the current state-of-the-art in hazard mapping and identify gaps in our understanding of the public's response to map-based public information warnings.

5. conduct post-season empirical research on public awareness and use of predictive services and other map-based products.
6. use the findings of phase 1 to inform the design of the empirical research conducted in phase 2 and the practical outcomes to be delivered in phase 3.

This report addresses objectives 2, 3 and 4, representing the views and perspectives of sector experts – including members of AFAC Predictive Services Group (PSG) and AFAC Warnings Group (WG) – regarding existing public information and warnings products and their use by the sector and members of the public.

Work Package 3

Phase 1 of the overall project has been split into five work packages.

This report presents the results of Work Package 3 (WP3), which seeks to:

- help gain an overview of the existing public information and warnings products across jurisdictions and the role as well as added value of additional predictive service products; and,
- help define the intentions and expectations of designers and disseminators of predictive maps in terms of the expected public response to the maps.

Sample and methodology

The research design of WP3 was cross-sectional and focused on subject-matter experts, where the research team interviewed an identified group of experts regarding their views of a subject directly related to their expertise. These experts are employed by emergency management agencies in Australian jurisdictions and were recommended as participants for this study by members of: 1) the Australasian Fire and Emergency Service Authorities Council (AFAC) Predictive Services Group; and 2) the AFAC Warnings Group.

An initial list of over 100 possible interviewees was produced, with the research team then refining this list for suitability and representativeness. To ensure breadth in the sample, the research team sought to recruit participants from all jurisdictions (ACT, NSW, NT, Qld, SA, Vic, Tas, WA and the Commonwealth) and across a range of relevant domains of responsibility and expertise (public information and engagement, predictive services, incident control). Ultimately, the research team recruited 44 participants (see Table 1).

Table 1: WP3 participants, including jurisdictions and domains of responsibility and expertise

Jurisdiction	Total	Public information and engagement	Predictive services	Incident control
ACT	3	1	1	1
NSW	7	4	2	1
NT	3	2	N/A	1
Qld	4	1	2	1
SA	7	3	2	2
Tas	4	1	1	2
Vic	6	4	1	1
WA	6	3	1	2
Commonwealth (Cth)	4	3	1	N/A
Total	**44**	**22**	**11**	**11**

Each participant was invited to take part in an individual, semi-structured interview lasting 60-90 minutes. The interviews were audio recorded and then transcribed for analysis. Transcribed interviews were coded using the qualitative analysis software NVivo 10 according to common themes, structured by the questions (descriptive codes) and emergent themes (thematic codes) in order to identify points of consensus and disagreement between participants (Cope 2005). Themes identified across the three groups of public information and engagement, predictive services, and incident control participants were similar. Where significant differences were identified they are noted in the results where relevant.

This research received approval from Deakin University's Faculty of Arts & Education Human Ethics Advisory Group (approval: HAE-22-020) and was conducted in accord with the approved methods. Research data is stored securely at Deakin University in accordance with Human Ethics Advisory Group requirements and will be held for 5 years with access restricted to researchers named on the application.

Data collection and analysis

Interviews were conducted by Gabrielle Miller, Chloe Begg, and Timothy Neale between 25 July 2022 and 3 October 2022. Analysis of the interview data was led by Timothy Neale and Gabrielle Miller and occurred between 1 October 2022 and 20 October 2022.

Below we present the results of the analysis of the interview data, organized according to key emergent themes (thematic codes) relating to the project's first objective (to understand how members of the fire and emergency services sector would prefer predictive maps to be distributed and used by members of the public). Interviews were semi-structured, providing room for participants to guide the conversation, however key questions covered in the interviews included:

- How is predictive information currently communicated to the public during an emergency?
- What information should a predictive fire spread map contain to be able to effectively inform the decisions that you need the public to make during an incident?
- If predictive fire spread maps were to be sent to the public, do we need a common or standard approach?
- If predictive fire spread maps were to be sent to the public, who would you hope will use them?
- What do you think are the primary potential benefits of sending such maps to the public?
- What do you think are the primary potential obstacles to sending such maps to the public?

Quotes from participants have been attributed using a code to protect their anonymity, revealing the jurisdiction and specialisation of each participant only (e.g., "SA PI1" for South Australian public information and communication expert #1, "Vic PS1" for Victorian predictive services specialist #1, "WA IC1" for Western Australian incident control expert #1, etc.).

Results

1. What are the benefits of public predictions?

Public risk awareness and public safety

We asked participants about what they saw as the potential benefits of releasing predictive fire spread maps (FSMs) to the public during fire emergencies. Nearly all participants identified **increased public risk awareness** as the single most important potential benefit, with many noting that such increased awareness would or should lead to **reduced bushfire impacts** as members of the public take actions to mitigate risks to themselves and others. For example, participants spoke of how "the more information that we're giving them, probably the more educated they become and then the better the decisions they make become as well" (NSW PI2), or if "you're responsible for your safety, then I have to give you as much information as I can to allow you to be responsible for your safety" (SA IC1), so releasing predictions "arms them with knowledge and equips them with better knowledge around making an effective decision and a conscious decision" (Tas IC1). One spoke of an experience showing such maps to an at-risk community, recalling how "arming them with information and they can visually see 'oh my God, this is going to happen'… There's no doubt about that, that changed people's minds who would not have left" (Vic PI2). "It's sort of a line that I use in the media all the time, you know, to be able to make good decisions you need to know how to access good information" (Vic IC1), while others affirmed that: "Any information that can help people to make decisions to keep themselves safe, I think is worth sharing. So, if telling people, or if showing people, a predictive map is going to help them make better informed decisions, then I think we should absolutely do it" (WA PI1).

Accessibility of hazard information

Participants identified what they perceive to be several other potential benefits, including **increased access to hazard information**, as several believed that the visual form of maps "caters to different learning styles" (Vic PI4) and "could be shared quite easily because visually it's really easy to understand" (NSW PI1). "The huge benefit," one participant said, "is that people who are different to our target audience for our warnings products can start to make some well-informed decisions for themselves" (Qld PI1), while another noted that due to low literacy in some communities it is "even more important in our state to be able to display stuff, you know, easily digestible visual way" (Tas PI1). Related to this benefit, for some, was that releasing predictive fire spread maps would help meet **increased public demand** for information before and during emergencies. "The information age is well and truly here," to quote one, "I don't think it's an option. I think the Royal Commission had plenty to say about that when people were asking, you know, "What did you want?" "We wanted more maps" (Qld IC1). Others identified experiences during the 2019-2020 fire season that revealed much higher public interest in incident intelligence and analysis than previously imagined. "I mean like Black Summer [the public] were just drinking up everything that we could send out to them," one said (Cth PI1), while others stated that "it's what enough of the public wants" (WA PS1) and that "there's an opportunity to sort of grab attention and keep it" (Cth PI3) following the 2019-2020 fire season.

Agency credibility

A tangential potential benefit, identified by several participants, is that the release of predictive maps might lead to **increased agency credibility**. Such predictions would, one participant stated, lead to community members having "confidence in what they're being told and having them, then, have the confidence to act in the way that they're being asked to act" (Qld IC1). Others spoke of how such maps would mean "giving them more tools and that makes us more credible because we're taking more time to produce products for them to better interpret the situation and make decisions" (NSW PI4) or would "help people understand that they can rely on the fire agencies to give them really good science-based information, timely information. That increases trust, that increases the foot traffic to rely on the fire agencies and not going elsewhere" (WA PI3). "It's about transparency of information, so that we're completely transparent about what's occurring with the fire, with the situation, what's the worst-case scenario" (SA PI2), though another participant identified that such transparency comes with risk (see "Risks to agencies" below), noting: "building trust with the public is probably a good benefit or an outcome out of this. But that hinges on us getting it right more than we get it wrong" (Vic PS1).

Overall, **no participants were opposed to releasing predictive fire spread maps to the public** in the future, though several were careful to note they think these should be distinct in their content and design from the predictive fire spread maps currently used by sector practitioners within agencies.

Table 2: Perceived benefits of production, communication, or dissemination of predictive fire spread maps

	Results	Representative quote from interviews
What are the benefits of public predictions?	Public risk awareness and public safety	*"It's going to give [the public] more time and space to make a decision on what action they take. And it will just provide… that visual appreciation of the actual impact of this, potential impact of what's going on"* Tas IC2
	Access to hazard information	*"I think in the arsenal of tools that one has to be able to use spatial information along with words to meet the multiple and diverse requirements of the multiple and diverse audiences that we have is really very useful"* Cth PI1
	Agency credibility and reputation	*"It gives much more authority or reputational credibility to an organisation, it means that, you know… - we can show we're not just there to put out a fire, we can actually be there to keep the community safe and to provide the tools that they need to know what's happening"* SA PI1

2. What are the risks of public predictions?

Risks to the public

We asked participants about the potential risks of releasing predictive FSMs to the public during fire emergencies. This produced a range of answers, relating to risks to the public and risks to agencies. In terms of **risks to the public**, several risks discussed by participants related to what might occur if

the production, communication, or dissemination of predictive maps failed in some way during an emergency. These possible failures are too various to list here (see Table 3), but either relate to technical errors (i.e., agency app failures leading to at-risk communities or individuals losing access to current information), user error (i.e., at-risk communities or individuals using information that is out of date), or misuse or malicious use (i.e., sharing misleading or edited versions with unofficial interpretations or messaging).

Many participants identified that, like existing incident warnings, new maps could be *misinterpreted by members of the public*, for example by viewing fire spread isochrones as completely accurate. "They don't have that comprehension that it's a rough guide," one participant stated (ACT PI1), while several others worried about "people trying to extrapolate either zooming down to my house and 'oh it's one side of the line or the other'" (SA PS1) and thereby concluding they are safe if they are just outside a predicted fire footprint (e.g., Tas PS1).

Additionally, some participants expressed concerns about potential risks to public safety should agencies release FSMs that are inaccurate; "We'll end up with people relying on information that's incorrect and then they could put themselves at risk" (QLD IC1) or communicated with messaging that is inconsistent with that of existing warnings and calls to action, noting that "we need to maintain confidence, and we need to have the situational lens to be able to release these… because if there's actions associated with the information released with it, and those actions aren't consistent with our fire management action, it could put the public in harm's way and cause safety issues" (NSW PS1).

Others raised concerns that members of the public might panic or "catastrophise" (SA PI1) after encountering a fire spread map during extreme conditions. However, most participants were either unconcerned about such risks or deemed them to be without factual basis, noting that clear communication and education about fire spread maps would significantly mitigate any potential for panic. "There's always a few clowns around, but I think most people would use it to make sensible decisions and not be within the incident footprint," one concluded (SA IC2). Another stated: "We shouldn't be worried about the malicious use of the information at all. What we should be doing is being honest and open and putting it out there to give people enough information to make informed judgements" (Cth PI3).

Risks to agencies

Participants also identified how releasing predictive FSMs might create **risks to agencies**. This is a topic discussed in previous research (Begg et al. 2021) and generally relates to the perceived consequences of releasing information that contains uncertainty to the public. For example, some participants were concerned about *legal consequences*, such as "a whole litigation around why didn't the fire behaviour analysts predict it" (NSW IC1) or that agencies "could get legal action taken using these [maps]" (NSW PI3), or "possible for litigation post [event] because we did this or didn't do this based on this map that you've sent me" (Vic PI3). Given the significant legal protections that emergency services have to release information about hazards (Eburn and Handmer 2012), including warning polygons, these risks may be more perceived than actual.

A second risk to agencies, identified by several participants, is that predictive FSMs could have *reputational consequences* for agencies because FSMs produced within emergency management often present worst-case (i.e., low probability but high consequence) scenarios, rather than the most likely predicted outcome. "I've seen some doozy predictive maps over the years that didn't even get close to happening," one participant said, suggesting that releasing such predictions "would just impact on the credibility of the predictive services, every time you put out a map that doesn't occur or it's out by enough that people start to question it" (SA IC2). Similarly, many

participants also noted that the potential benefits of increased trust in agencies came with potential risks of damaging trust in agencies. For example, several participants were concerned while releasing FSMs "can build trust but it can also break trust… that cry wolf stuff" (Tas PI1), "there's a real risk there [of] the boy who cried wolf" (ACT PS1), "because the minute you get it wrong people are going – you know, it's going to be even more than with the other types of warnings, people will go 'Oh well how can I trust you next time you show me one of these maps that shows half the State's going to burn?'" (Vic IC1). Others similarly noted "you don't want to develop mistrust," as perceived over-predictions "from a community perspective [agencies] could be seen as issuing inaccurate information" (WA PI1). Some participants noted that this is where having a set of triggers for production and release of FSMs could be important for agencies to mitigate the risk of decreased public trust or agency credibility. Alternately, multiple participants discussed how "fire is the most scrutinized of the hazards" (SA IC2) and therefore agencies face potential criticisms from inquiries and audits for not releasing intelligence such as FSMs to help inform at-risk communities' decision-making. One response is worth quoting at length:

> It's really interesting when people go 'oh, they mightn't use it or might not understand it.' No, no, we understand it, we need to show it in such a way that they'll understand. Because if it came down to it and we're sitting in front of the coroner and they said, 'why did you make this decision?' 'Oh, because the fire map said it was going to do this.' 'Well, did you communicate that with the public?' 'Oh, we tried to say in words and everything but' – well, why would we just not show them this product? We do this as though this is top secret [but] it's pretty hard to hide a 100-hectare fire. Why would we not show them the product? (NSW PI3)

Another risk to agencies frequently cited by participants, and also related to increasing the transparency of information provided to the public, was that of *increased workloads* within agencies as the public begins to expect more and more detailed information. As one participant noted; "I think, it would create more workload, just in the sense that it's another type of product that the community need to be aware about, that they need to understand how to decipher. So, that only gets done through more work" WA PI1. Some participants spoke about how, on the basis of their experience in other domains of emergency management, creating any new service to the public comes with ongoing responsibilities and therefore reputational risks to agencies if they are understood to not have fulfilled those responsibilities, particularly during emergency situations.

The third kind of risk identified by participants was that predictive FSMs could have *political consequences* for agencies. For many participants, emergency management can involve a significant amount of liaising and communicating with local, state, and federal political representatives. This requires time from practitioners but also leads to pressures on staff. Participants recalled experiences of "dealing with the political side… sometimes that became a bit more of a priority than the actual fire side of it, because there was so much interest and reach in" (ACT IC1), or "where, you know, you'll get ministers or local members or whatever start agitating that they feel you're not paying enough attention to parts of a community or… it's affecting their constituents" (WA IC1) or commercial sectors such as tourism (e.g., Tas IC1, Tas IC2, Vic PI1). For some "political pressure has always been at the edge of fires, it's never dictated what we have done, and it should and it won't" (NSW PI3), while others felt that "all those political risks are number – not number one, but they're – they're the first consideration we look at" during a major incident (WA IC2), meaning that there "may be political pressure to do something to manage the reputation of the government" (Vic PI1). These pressures could, many noted, shape agency decisions about when they choose to produce, communicate, and disseminate predictive FSMs. In summary, participants felt that the future release or non-release of predictive FSMs could prove to be of interest to political representatives, posing potential risks to agencies if they are seen to be uncooperative with those representatives.

Table 3. Perceived risks of production, communication, or dissemination of predictive fire spread maps

	Results	Representative quote from interviews
Perceived potential risks to the public	Technical errors	*"A lot of our systems require connectivity, telecommunications, and obviously that's one of the first things to go in major emergencies, and I don't think that our redundancies of getting the information to communities are good enough"* VIC PI4.
	User errors	*"We have seen sort of a proliferation of third-party re-publishers of warning information… and they may or may not provide the level of education around what the product means as we do. They might display it in a different way. It might be out of context. You know, people may come to rely on that platform instead of ours and we've got no visibility of the reliability of those platforms…"* WA PI1. *"The main one I think is just around the uncertainty and people trying to extrapolate either zooming down to my house and oh it's one side of the line or the other - it's not that precise"* SA PS1.
	Undue public harm	*"There's a whole lot of issues - tourism providers and business owners they hate when we do things like this and rightly so. It's their business and livelihoods… So, there's the sensitivities about if we're doing large predictive maps telling people not to go to certain areas on a prediction of… that drives people away"* VIC-PI-1. *"I worry, actually, that it'll be all too much for the community, and we could really potentially be putting people in danger's way if we are making things more cluttered than they already are, because for some people, they're struggling to keep a tally on it all as it is"* QLD PI1.
	Malicious use	*"If we produce them beforehand, if somebody wants to do damage they're more informed in achieving their goal"* VIC PI3.
Perceived potential risks to agencies	Legal consequences	*"The risk of the prediction not coming to fruition within whatever threshold we think is reasonable because then the process loses its credibility, and then also there are elements out of our control, be it beyond the incident, things like grant funding and things like that. You know, if we use the tourism industry as an example, if we put out a predictive map, people left, industry loses money, and then the fire doesn't reach that extent, how does that interplay with grant funding and other mechanisms that governments use to support communities?"* NSW PI4.
	Reputational consequences	*"We saw that, in 2019-20, in [Whittaker et al.'s] study of publicly released predictions, there was significant trust placed in the fire agencies in releasing these predictions, and if we released them routinely, it would have - for us in New South Wales, in the way we prepare these predictions, it would have very significant resource implications for us, to make sure that we maintain that level of trust"* NSW PS1. *"There are risks as well in that people just become reliant on receiving prediction maps, so they start to forget or ignore everything else and then just say "I'll just wait*

		until I get one of these maps to tell me that my area's going to be affected tomorrow" or likely affected tomorrow" NSW PI4.
	Political consequences	*"We know there is risk, it's a different risk politically, telling 100,000 tourists to leave an area and that area's tourism sector [is] collapsing, there's going to be political implications from that which is why we need to have a robust formula to determine whether or not we use this particular tool at that particular time, and then that will have pre-armed us in not how to manage the political implications but how to manage the people and the industries that it affects which then starts to reduce many of the political risks because we're actually then going to the people most affected"* NSW PI4.

3. What are the barriers to public predictions today?

Presence of risk aversion

Having asked participants about the potential risks and benefits, we next asked about the key barriers and challenges that agencies face if they wish to or were required to publicly release predictive FSMs in the future. The most significant barrier participants spoke about is the **presence of risk aversion** within agencies. This is linked closely to the risks identified in the previous section. Institutionally, "it's a risk aversion that prevents us from providing that [predictive FSM]" (SA IC2), as participants feel "that risk aversion comes about I think by fire services being beaten up over many decades with respect to inquiries and royal commissions and the like" (Tas PS1). "Firies are held to a higher standard of accountability around decision-making than other hazards" (SA PI1) and "they've also been burnt a few times historically from inquiries and inquests" (SA PS2). Such issues are particularly acute, some participants said, for those in more senior decision-making roles such as Incident Controllers because they are often the individuals held responsible by such inquiries and reviews. Nonetheless, others felt that the aversion of agencies and specific staff to releasing more information publicly was sometimes unjustified. As one participant said, control and operations staff sometime have "a lack of belief in the public's ability to consume some of these products and really thinking that they won't understand it, or that they won't use them in the correct way and believing for some unknown reason that fires are top secret, and we shouldn't provide this kind of information. I think that that is the biggest [obstacle]" (NSW PI3).

Appropriate resourcing and training

Another leading barrier and challenge identified by participants was the **lack of appropriate resourcing and training support**. This was an issue identified consistently across jurisdictions. "The capability exists, it's really a funding question" (Cth PS1), many stated, meaning that "it's something that's achievable but it's just a matter of getting that resourcing" (NT IC1). While "resourcing is always an issue when you want to try and do something new" (Qld PS1), some participants from jurisdictions with smaller revenue bases noted that they are already financially constrained: "not [to be] a fire service crying poor but literally, we don't have any money" (SA IC1). Interviewees with predictive services roles often noted that they were already facing high demand for their services, asserting that "there's very low investment in our training and our preparedness" (WA PS1) and that "one of the biggest limiting factors at the moment is shortage of staff that have the skills and knowledge base to actually provide consistency" (Vic PS1). Those who had been involved in releasing predictive FSMs publicly in the 2019-2020 season also spoke about the difficulty of "being able to

resource the production of these maps. It was a huge effort, and we needed to gear up our resources ahead of that [sic] bad fire weather days" (NSW PS1). In short, to turn capability into capacity requires appropriate resourcing and training: "it's the funding, it's the resourcing, it's the right skillsets in the sector" (Vic PI4).

Lack of public education

The second significant barrier participants identified is the current **lack of public education** regarding predictive FSMs (see Conclusion for future research within this project). Those involved in public information and communication roles contributed strongly on this topic, noting examples of community members having limited comprehension of existing hazard information formats such as warnings and fire danger ratings. "The community doesn't understand our three levels of warnings. So, if we're adding more data in, is it going to, potentially, confuse the community, provide them with information which they – which could – which could create a more dangerous situation?" (WA IC2). "The community has a hard enough time dealing with the current fire danger rating system" (Tas PS1), many noted, some adding that they felt there was also inconsistent understanding of the relative purpose of certain forms of hazard information (e.g., fire danger index, fire danger ratings) within agencies. "I don't think, as a sector, we even truly understand [fire danger ratings] ourselves, so I don't know how the community understand it" (Vic PI4), meaning that further forms of information such as predictive FSMs "would need to be a pretty comprehensive education awareness raising campaign or strategy" (WA PI1) to "educate the public on what they are and how to read them and what they mean basically" (Tas IC2). "I think the one that makes me take a deep breath," were FSMs to be released publicly, "is actually the education piece of our own people" (SA IC1) one participant stated.

Lack of agreed processes, platforms and formats

Finally, it is worth noting that participants also identified many technical barriers and challenges relating to the current **lack of agreed processes, platforms, and formats** for publicly released predictive FSMs. These varied in their details between jurisdictions, given that each jurisdiction has different processes for producing, communicating and disseminating other hazard information, but can be thematically grouped into the following concerns: the appropriateness of existing workflows (e.g., FBAN function, warning approval processes) for releasing predictive FSMs; the current lack of agreed FSM formats and triggers; the need for national or interstate consistency in FSM formats and triggers; the appropriateness of current dissemination platforms (e.g., warning apps, social media) for predictive FSMs. We could find no examples of participants contending that such issues would present unresolvable challenges or barriers if agencies committed to produce predictive FSMs for public release. Nonetheless, several participants with experience trying to create national standards were cautious that the road to a national approach would not be straightforward. To quote one participant commenting on this matter: "Good luck figuring that out" (Cth PI2).

When should public predictions be produced?

Our discussions of the possible future public release of predictive FSMs naturally led our conversations to the practical aspects of doing so. Many participants were careful to stipulate that they did not think predictive FSMs should be released under all circumstances, noting the uncertainties of predictive FSMs, the workload created by predictive FSMs, the potential for "warning fatigue" amongst community members, and the existence of other spatially explicit hazard information such as warning polygons.

High impact events in extreme conditions

Overall, participants often sought to understand when predictive FSMs should be produced for the public in the context of the existing warnings system, arguing that existing measures such as warning polygons are beneficial and predictive FSMs should "complement" and not "compete" with the use of polygons. The overwhelming opinion of participants was that predictive FSMs should be produced for the public for **single or multiple fires during extreme or catastrophic fire weather conditions.** Participants spoke about how predictive FSMs were most appropriate for "any incident that is going to go for probably more than a single shift or to us that's a 24-hour day" (ACT IC1) or "typically extreme to catastrophic days when fire was predicted to impact large communities" (NSW PI4). Many others indicated that some mix of fire danger and potential impact should act as triggers for releasing predictive FSMs to the public: "where you have a significant impact or significant fire activity in the landscape, coupled with a high level of impact that we know that it's going to be a really bad day" (ACT PS1); "it comes down to population, geography and how fast the fire is expected to spread" (NSW IC1); "probably only tier 2 fires and above that would get predictive maps" (NT PI1); "only look to release them on those days where we think our firefighting won't be effective" (SA IC1); "the scale of the fire and the potential impact" (SA PI2); "it needs to tie into the fire danger rating system" (Tas IC1), AFDRS and warning level (Tas PI1); "those situations where it's a level 3 fire and it's going to have serious impacts" (Vic PI2); or "it would be communities that have limited egress and there's high population according to the danger they are in" (WA PI3). One of the most cautious participants put their view in these terms, suggesting predictive FSMs are for "extreme to catastrophic fire danger… This is for the out of scale events, this is for the unprecedented events. This is not just a routine product" (NSW PI1). Another was wary of having formal triggers (e.g., fire danger rating, anticipated length of incident or scale of impact) as "every incident is a little bit different," instead favouring the discretion of decision-makers: "there's so many factors that it's probably a when – when the decision makers feel it will complement the public information" (Qld PI1).

If the release of predictive FSMs was reserved for impactful fires during extreme or catastrophic conditions, participants suggested, this would help mitigate warning fatigue and ensure these maps caught the attention of community members. As one participant put it, "I see the benefit as we release it on days that are really bad, we release it on the equivalent of [the 2015] Pinery fire and the message from my perspective is 'we're not mucking around'" (SA IC1).

5. How should public predictions be produced?

Designed for purpose

Participants largely agreed that if agencies are to release predictive FSMs to the public during emergencies, then these maps and their production will need to be **designed specifically for these purposes**. Many were uncertain about the merits of releasing the kinds of fire spread maps that FBANs regularly produce for use within incident management. As participants stated, "there's probably a benefit for the community to see some [of] those blob maps, but the maps that are in IMTs, not so much" (NSW IC1), suggesting "we might not show [predictions] in their raw format out of PHOENIX - but why can we not have a public consumable product" (NSW PI3). Instead, like the 'Red Maps' produced in NSW and the ACT during the 2019-2020 season, future predictive FSMs released to the public would need to have a distinct production process and design.

Production pathway

In terms of process, participants were largely in agreement that predictive services units should generate the relevant predictions (e.g., NSW PI4, Cth PS1, ACT PS1), however opinions varied on who should manage the production of the predictive FSM product. A large number felt that public information staff are better positioned to understand the needs of community members, and so "it should always be led by the public information stream with inputs from the various functional areas" (ACT PI1) or "something that the warnings officers would develop and release in conjunction with predictive services" (Qld PI1). "I don't think it should sit with FBANs," one Incident Controller remarked, "because I love you guys but you're thinking about different things than the rest of us" (SA IC1). Alternatively, a minority suggested that the process should be collaborative between predictive services and public information staff, potentially with nominated leads from each section (e.g., Tas PI1, Vic PI3, NT PI2). Whatever the process of production, interviewees were broadly in agreement that the responsibility for authorising the release of predictive FSMs should sit with Incident Controllers or their statewide equivalents (e.g., State Response Controller): "any map should go through the Incident Controller" (ACT PS1); "the public information or alerts and warnings are a statutory responsibility of the Incident Controller in our state so ultimately it is their decision" (NSW PI3); "ultimately that comes from our Incident Controller, they are the ones that authorise that release" (Qld PS2).

6. How should public predictions be communicated?

Given the views presented above, it is perhaps unsurprising that participants had a range of views about how predictive FSMs should be communicated as they move from incident management teams out to the public. Organising these views thematically, we found that the following were shared by a sufficient minority (i.e., >20%) of participants: agencies should communicate predictive FSMs' assumptions and uncertainties; agencies should consistently format predictive FSMs across jurisdictions; agencies should communicate FSMs with a simple and clear visual hierarchy.

Communicate assumptions and uncertainties

A challenge for communicating predictive FSMs to the public is that, while it is not desirable to include the lists of analytical assumptions and uncertainties that are included with predictive FSMs for incident management (e.g., that predictive FSMs typically assume no fire suppression), these nonetheless need to be communicated in some way to the public. Practitioners were concerned that "a whole raft of stakeholders and the public could misuse [predictive FSMs] if it's not really clearly stipulated about their limitations and what their purpose is" (Tas PI1), and therefore "it would be good to have some standards about - what do you call it, you know, riders or qualifiers to say this - this projection was produced with the best available information at the time" (WA IC1). Three possible strategies to **communicate predictive FSMs assumptions and uncertainties** suggested by participants were:

1. include a generic disclaimer conveying the most important analytical assumptions (e.g., that fire suppression is ineffective on the given incident);
2. include a textual indicator of overall probability (e.g., 50% or 50-70%) similar to that used by meteorologists for rainfall;
3. include visual indicators of levels of temporal and spatial uncertainty associated with potential impacts (e.g., colour gradients).

Notably, in relation to this last point, a number of interviewees spoke about their concerns that existing predictive FSMs create a "perception of accuracy" (Qld PS2) or "falsely implied accuracy" (Cth PI1) due to their designs. These designs are based on simulation outputs, one predictive services participant noted, "which kind of shows too much detail and looks too much like a fire and doesn't look enough like a kind of a warning… it sort of starts to communicate to people that this is exactly where the fire will be because this is exactly how a fire looks basically" (NSW PS2). Participants were concerned that such a high level of detail "gives a false sense of precision" (SA PS1) to those unfamiliar with their unpinning uncertainties, and so participants discussed how these uncertainties might be communicated in map design. One idea as to how this might be done, suggested by several interviewees, is to ensure fires are represented in FSMs with a "smooth" or "blob" shape to mitigate perceptions of their spatial accuracy (e.g., NSW IC1, NT PI2, SA PS2, Tas PS1, Vic PI3). A second idea, again suggested by multiple participants, is to borrow elements from the cyclone prediction maps developed by the Bureau of Meteorology: "I sort of would be an advocate for something like the cyclone map, which kind of shows that, you know, as time goes on the kind of prediction gets less and less certain" (NSW PS2). Others were similarly enthusiastic about this solution, suggesting FSMs might show "this is the path, and these are the definite areas of impact, and these could be the areas of impact" (Tas PS1, also WA PI2). Cyclone predictions "communicate a range," one predictive services practitioner stated, "We have to communicate the uncertainty and the problem we have in the technology at the moment is we've got deterministic simulators" for fire prediction (WA PS1). Currently, it is not standard practice in any jurisdiction for predictive FSMs used within emergency management to include any quantitative measures of prediction uncertainty.

Consistent format across jurisdictions

Another view held by a significant number of participants is that **agencies should consistently format predictive FSMs across jurisdictions**, including by developing shared design guidelines. To date, the predictive services function and predictive FSMs have been developed through interstate coordination and collaboration, but without consistent processes and formats. This is less of a challenge within incident management, as practitioners tend to work within a single jurisdiction, however many participants identified lack of consistency in communications with the public as a significant risk. "[If] it's confusing, it's difficult to understand, it places people in danger," whereas "consistency makes it easier as well for people to interpret and make decisions" (Cth PS1) because "if you can have consistency with that, that will reduce both confusion for the public and frustration for emergency services" (Qld PS1). "Everyone has their unique way of doing [predictive FSMs], everyone thinks that they're doing a little bit better," as one public information practitioner stated, "But we need to put that aside and go 'no, no, no, what can the community understand?'" (NSW PI3). Several participants noted that there were potential operational benefits to creating standardised formats, namely that it would increase capacity and ease of deploying personnel interstate; meaning that "when you deploy to interstate it's not a 'we do it this way here'. I think standardisation is good" (TAS-IC-1).

Simple and clear visual hierarchy

Finally, many participants recommended that **agencies should communicate predictive FSMs with a simple and clear visual hierarchy**. Some were concerned about potentially having "polygons over polygons" (Vic PI1), recalling incidents where "it can get a little bit confusing having multiple polygons on top of each other" (WA PI1), whereas others were concerned about the inclusion of too much temporal or textual detail. For example, the predictive FSMs used within incident

management tend to represent predicted fire progression in hourly isochrones, using distinct colours for each isochrone. Alternatively, many participants felt that predictive FSMs for public audiences should contain only one to two isochrones representing much longer timesteps in "one simple easy to digest diagram" (Cth PI3). To give some examples, predictive services practitioners suggested "it probably needs to be a little broad brushed in terms of hourly spread rates, that might be four-hour increments or larger" (Qld PS2) or "the potential area of spread within say zero to 12 hours or something I think is a better way of doing it" (SA PS2). Several participants suggested that such isochrones might be usefully colour-coded to align with the three-tiered Australian Warning System (AWS), which uses yellow (Advice), orange (Watch and Act) and red (Emergency Warning) to communicate hazard information and actions (e.g., SA PI1, SA PI2, WA IC1, WA PI2). Whether this is in fact possible or worthwhile, it aligns with participants' common view that all forms of public information during emergencies - whether warnings of predictive FSMs - should be easily understood and prescribe appropriate actions.

7. How should public predictions be disseminated?

Over a number of decades, Australia's emergency management agencies have developed a range of techniques and infrastructures for disseminating information about emergencies to members of the public. This includes, for example: radio broadcasts of fire weather warnings created by the Bureau of Meteorology since the mid-1950s; the national text-messaging Emergency Alert System begun in 2009; a range of specific phone-based apps (e.g., Fires Near Me) used since 2010; and posts on official agency pages and on social media platforms (e.g., Facebook). Asked about the appropriate strategy and channel for disseminating predictive FSMs to the public, our participants expressed a range of views about the merits and challenges of these diverse dissemination channels.

Broadcast approach

Regarding the strategy for dissemination, most participants supported **broadcasting rather than narrowcasting predictive FSMs** to members of the public. There was a diversity of views about whether such predictive FSMs should have different versions, meaning agencies should produce "one predictive map for all audiences" (NT IC1) or rather "we need to use all channels and provide the information in different formats for different audiences" (Cth PI1). Some participants spoke about the merits of having previously shown predictive FSMs to community members in meetings during emergency incidents (e.g., ACT PS1, SA PI1, SA PS2), though it is not clear why this could not occur alongside broadcasting. Further, some noted, broadcasting would help ensure that predictive FSMs reached individuals who may be in an area during bushfire season but not connected to local social networks (e.g., tourists) and would also act as a prompt for individuals outside affected areas to "check-in" with individuals within affected areas (e.g., ACT PI1, NSW PI3, WA PI3).

Digital dissemination and future channels

Regarding the appropriate channels for dissemination, two participants expressed concerns about the **risks of disseminating predictive FSMs digitally**, for example via apps, email, or social media. Once placed within these platforms, they suggested (e.g., Qld PS1, SA PI2), predictive FSMs could be graphically altered or shared with incorrect information, leading to negative outcomes. However, the vast majority of participants felt that the benefits of digital dissemination far outweighed these risks, suggesting digital dissemination **increased the reach and accessibility of hazard information** potentially including predictive FSMs. Some participants who had been involved in the release of "Red Map" predictive FSMs during the 2019-2020 fire season spoke positively about the significant

speed and reach of such platforms, recalling that "the first one we released, we got three-and-a-half thousand reactions, four thousand comments and 27 thousand shares" (NSW PS1) or that "within six minutes it was being used on news media websites, it was being shared throughout social media" (NSW PI1). "If it's a little light graphical product like that," another summarises, "it can kind of go everywhere and really hopefully try and cut through a lot of different channels I suppose" (NSW PS2).

Reflecting on the future potential of predictive FSMs, a few participants discussed the need to develop capabilities in new digital platforms, suggesting that agencies might need to develop "personalised notifications, video notifications, trying to get to that Tik Tok generation" (Cth PI2). Another expressed concern that "we are falling behind [because] no one listens to local radio anymore to get that incident as they are driving home," and that agencies needed to access popular media platforms such as Spotify and Netflix (ACT PI1). Alternately, a handful of participants also expressed concerns that the development of digital dissemination channels should be pursued alongside the development and maintenance of low-tech redundancies (e.g., phone trees, community noticeboards), which can function if areas lose power or internet supply during an incident (e.g., ACT PI1, NSW IC1, Tas IC1).

Finally, a significant proportion of participants (>20%) felt that an important feature of disseminating predictive FSMs via digital platforms such as apps would be the ability for members of the public to self-locate within the map (e.g., WA PI2, Qld PS1). With geolocation, participants said: "they can find that they're in the red area and that they're going to have to do something" (WA PI2); "[they] see what's coming, and what risk they have, and that sort of thing" (Vic PI4); "see where their house is, is it on that side of the line or that side?" (Tas PS1); and "If I grab up my Google map and drop the pin on where I am… [you have] enough detail that people can identify at a glance where it is, where the fire is" (SA IC1). Interestingly, these proposals would seem to be in tension with other participants' concerns about the potential for maladaptive protective actions if predictive FSMs are provided with too much spatial and temporal specificity or are interpreted with too much confidence by the public (see "risks to the public").

Table 5. Perceived barriers to predictive fire spread maps and key views on the appropriate production, communication, or dissemination of predictive fire spread maps in the future

	Results	Representative quote from interviews
What are the barriers to public predictions today?	Appropriate resourcing and training	*"At the moment with not having as many fire behaviour analysts within our organisation we probably don't have that particular skill set, it'd need a fair bit of training for us to be able to do that"* SA PI3.
	Lack of public education	*"It's peoples' interpretation of that information [that] needs greater work… there's a really narrow window that you've got to educate"* SA PI1.
	Presence of risk aversion	*"It's a risk aversion that prevents us from providing that information… Risk aversion by the hierarchy I think… they would be concerned that they're not accurate and robust enough and that by sending them out they will be held to account when it doesn't pan out that way"* SA IC2.

	Lack of agreed processes, platforms, and formats	*"That's where the core issues lies there, lack of… training, standards, consistency in terms of delivering a standard product"* Vic PS1.
When should public predictions be produced?	High impact events and extreme conditions	*"[In 2019-2020] we were only going to use them for days of, kind of, extreme to catastrophic fire danger and the reason for that was we didn't want to over-warn or overuse them and then, they would lose their appeal and usefulness"* NSW PI1.
How should public predictions be produced?	Designed for purpose	*"I think, that would be my key caveat on all of this, is it must be driven by what the public wants. Otherwise, it won't be effective, and it'll just be something that ticks boxes for us and makes us feel good, but is not useful for them"* NSW PI1.
	Production pathway	*"[They] should be something that the warnings officers would develop and release in conjunction with predictive services"* Qld PI1.
How should public predictions be communicated?	Communicate assumptions and uncertainties	*"Probably the key one is the assumption that no suppression has taken place and that's a hard one to communicate. When you are creating those maps it is normally a worst-case scenario"* Qld PS2.
	Consistent format	*"I think some high-level design principles would be really useful whether it's colour or capacity or pattern or just some way that the community can recognise… I've seen this before. I kind of understand what this and what this means to me"* WA PI1.
	Simple and clear visual hierarchy	*"Community don't need all of the level of information and intelligence that we, as agencies, receive, so I think it's keeping it as simple as possible, identifiable, and yeah, really just relatable"* Vic PI4.
How should public predictions be disseminated?	Broadcast approach	*"I think they need to be broadcast to everybody. There's no value in having a restricted audience for them and it's really difficult to define a restricted audience in a major event"* Cth PS1.
	Digital dissemination and future channels	*"Another way of engaging, again digital on social media. We're just getting such an audience, it's a whole new world out there"* Vic PI2.

Conclusions

This report gives new insight into the views of a range of practitioners engaged in the production and use of predictive fire spread maps (FSMs) in Australian emergency management. It also gives new insight into the potential future production, communication, and dissemination of predictive FSMs to the public. Drawing on 44 interviews with identified sector experts, this report synthesises the most common themes and understandings that emerged from these conversations, while also drawing attention to contrasting views expressed by select interviewees. We are very grateful to the participants for the depth of their engagement with the project team, though the nature of such research is that not all ideas and experiences can ultimately be represented in this report.

Overall, participants contended that predictive FSMs should be developed for use as a warning product for single or multiple fires during extreme or catastrophic fire weather conditions. This product should be developed, in their view, because it will increase public risk awareness, reduce bushfire impacts, increase public access to hazard information, and increase agency credibility.

More specifically, WP3 found:

- **BENEFITS:** for participants, the primary benefits of producing, communicating, and disseminating select FSMs to the public during the fire season would be increased public risk awareness, reduced bushfire impacts, increased public access to hazard information, and increased agency credibility.
- **RISKS:** the primary risks of publicly releasing FSMs, participants said, were risks to the public from the misinterpretation or misuse of FSMs and risks to agencies from possible legal, reputational, or political consequences from publicly releasing or withholding FSMs. Overall, no participants were opposed to releasing predictive FSMs to the public in the future.
- **BARRIERS:** participants noted the persistent presence of risk aversion within agencies, the current lack of appropriate resourcing and training support, the current lack of public education regarding predictive FSMs, and the current lack of agreed processes, platforms, and formats as the primary barriers to publicly releasing predictive FSMs.
- **WHEN:** there was broad consensus amongst participants that public-facing predictive FSMs would be best reserved for impactful fires during extreme or catastrophic fire weather conditions. Some participants were opposed to releasing predictive FSMs outside these contexts.
- **HOW:** participants felt these predictive FSMs and should be produced and designed as a specific product distinct from the FSMs currently generated for use by emergency management sector practitioners. Agencies, they felt, should communicate predictive FSMs' assumptions and uncertainties prior to their use and during their use, and these FSMs should be formatted consistently across jurisdictions and use a simple and clear visual hierarchy. Considering how these FSMs should be disseminated, most participants supported broadcasting rather than narrowcasting these products, suggesting that agencies should use a range of digital dissemination platforms including agency apps and social media.

Work Package 2 (WP2) of the overall research project identified 24 evidence-based principles for bushfire map design, communication, dissemination, and education.[1] The findings of WP3 broadly accord with all of these principles, however it is worth elaborating on the alignment of certain principles with these findings and the overall project:

- **Principle 2: Ensuring that map readers can understand their location in relation to the risk; and, Principle 18: Personalising risk.** Many participants noted the importance of members of the public

[1] A report of the findings of Work Package 2 is available by request from research@naturalhazards.com.au.

being able to identify their current location and the location of their homes within any map-based warning, including predictive FSMs, to better communicate their level of risk. However, some participants were also concerned that individuals might place too much faith in the spatial bounds of a warning or prediction, believing themselves "safe" if they are just outside of a given polygon or FSM. Designs that help people understand their location relative to risk locations on predictive fire spread maps will be explored in phase 2 of the overall project.

- *Principle 13: Including maps in warnings by default*; and, *Principle 20: Maintaining clear triggers for map dissemination*. Most participants asserted that predictive FSMs should be reserved for impactful fires during extreme or catastrophic fire weather conditions, meaning that they believe these particular products should not be included by default for most fires. The definition of triggers for dissemination of predictive FSMs will be explored further in phase 2 of the overall project.
- Principle 23: Educating and collaborating with the public. A significant number of participants were cautious about the creation of a new product for the public (e.g., predictive FSMs) because they felt it will need to be preceded, accompanied, and followed by public education programs to support public understanding. This said, participants were also optimistic that this could be achieved, given the successful development and use of a range of other predictive products (e.g., warning polygons, thunderstorm risk maps, cyclone prediction maps). The overall project will explore opportunities to engage with and educate the Australian public about public-facing predictive fire spread maps so that the benefits outlined in this principle are achieved. Recommendations for how to engage with and educate members of the community could be provided in the proposed practical outcome of a communications framework as part of Phase 3 of the project.

In sum, the findings of WP3 suggest that sector practitioners are generally positive about the future public use of predictive FSMs, identifying a range of benefits that ultimately outweigh the risks to the public and agencies of developing this new product. Their insights will be of great value to a number of audiences, including the project team, who will investigate public awareness of predictive products and test and evaluate predictive FSMs in subsequent work packages.

Team members

WP3 research team

- Timothy Neale, Deakin University
- Gabrielle Miller, Deakin University
- Chloe Begg, Country Fire Authority

Project principal researchers

- Erica Kuligowski, RMIT University
- Amy Griffin, RMIT University
- Paula Dootson, Queensland University of Technology
- Timothy Neale, Deakin University
- Graham Dwyer, Swinburne University

Project management committee

- Chair: Chloe Begg, Country Fire Authority
- Angela Gardner, Country Fire Authority
- Blythe McLennan, Natural Hazards Research Australia

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