Prescribed Burn Decision Support Tool (PB DST): An Essential Process to Support Your Decisionmaking

Brian Levine, Australian Capital Territory Parks and Conservation Service, Weston, Australian Capital Territory, Australia;

Simon Hemer, New South Wales National Parks and Wildlife Service, Toormina, New South Wales, Australia;

Tom Denman, New South Wales National Parks and Wildlife Service, Toormina, New South Wales, Australia;

and **Scott Farquhar**, Australian Capital Territory Parks and Conservation Service, Weston, Australian Capital Territory, Australia

Abstract—Prescribed burning is an essential tool for the management of fire. Burns can be complex and involve many variables that pose high levels of risk. Fire planners develop detailed plans to minimize risk, but risk will never be completely eliminated. Burn escapes and shrinking burn windows due to climate change have highlighted the need for a standardized tool to deal with the risks associated with prescribed burning. The Prescribed Burn Decision Support Tool (PB DST) is a risk assessment tool that assists practitioners in recognizing and documenting the risks associated with a prescribed burn and in identifying appropriate controls in a consistent, transparent, repeatable, and quantifiable manner. Based on the International Organisation for Standardization 31000: 2009, Risk Management – Principles and Guidelines, the PB DST facilitates fire planners in describing the burn context, identifying risks, and then determining the likelihood and consequence of potential escape and impacts from smoke. The tool, which has been validated in Australia, also provides fire managers with risk mitigation advice and assists agencies with succession planning by nurturing robust decisionmaking practices among developing staff. The strength of the PB DST has been the demonstrated ability to consistently document decisionmaking based on the best available information.

Keywords: prescribed fire, smoke management, risk management, fuel reduction, incident management

INTRODUCTION

In the review of the Margaret River Bushfire Inquiry (Ferguson 2010; Keelty 2012), the following point was made:

> Fire managers are being held more accountable. Greater accountability that brings with it higher expectations of fire manager performance and lower thresholds for failure. Bushfire management is often high profile, high risk and high consequence.

It is acknowledged that prescribed burning is an essential tool for the management of fire in the Australian landscape. Burns can be complex and involve many variables that pose high levels of risk, thus making it one of the more difficult activities conducted by fire managers. Fire planners write detailed plans to minimize risk, but risk can never be completely eliminated. Shrinking burn windows and high profile escaped prescribed burns such as Margaret River, Washington, in 2011 and Lancefield,

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Victoria, in 2015 (Independent Lancefield-Cobaw Fire Investigation Team, 2016), as well as numerous other escaped burns, have highlighted the need for a documented decision support tool that uses the ISO 31000: 2009 risk assessment process.

Various agencies in Australia and around the world have developed risk assessment tools and complexity analysis for prescribed burns. However, these have mainly been developed as planning tools and do not provide guidance or advice for operations while underway. In the United States, simplified matrices have been developed that advise incident commanders (ICs) on staffing requirements for mop-up and patrol procedures post ignition.

Often, ICs or divisional commanders (DCs) are questioned on their decisionmaking: Was it a suitable time to implement a prescribed burn? Why did implementation continue? Why did you leave a burn unattended? What are sufficient mop-up distances? How often should we patrol? Will the smoke have an adverse impact on the community?

Fire managers routinely work together to make these decisions, largely based on their past training and experiences. In Australia, these decisions, while documented in some internal fashion, are typically not done in a consistent, robust, or transparent manner. Additionally, as agencies work on succession planning, our industry lacks tools which nurture robust decisionmaking practices for trainee command staff.

What Is the Prescribed Burn Decision Support Tool (PB DST)?

The PB DST is a consistent, transparent, and semi-quantitative risk assessment tool that assists managers in recognizing and documenting the risks of escapes and impacts of smoke while identifying appropriate controls. The foundation utilizes ISO 31000: 2009, Risk Management – Principles and Guidelines and the tool links directly to the Australian Digital Forecast Database (ADFD) and Australian fire behavior models. The PB DST assists managers in identifying the burn context and determining the likelihood and consequence of potential escape and impacts from smoke, prior to lighting and while underway.

How Does the PB DST Work?

PB DST is applied to burn implementation in a complementary role to the burn plan. The tool is designed to be used in the days and hours prior to ignition, and to assess the relative risk of proceeding based on current and predicted weather. The tool can be re-run for each subsequent day of ignition and patrol. The tool includes automated 7-day ADFD grids and predicted fire behavior to support decisionmaking.

The PB DST is a six-step process. Step 1, identifying the burn context, allows the assessor to capture the context of the burn based on the current environment. Context can include all those factors that are not quantifiable but play a critical role in whether it is appropriate to implement the burn or not. An example is the political context.

At the “core” of the PB DST is a series of matrices (Steps 2 through 4) used by the assessor to determine the likelihood and consequence of the risk of escape as well as the potential impacts of smoke from the prescribed burn (fig. 1). In order to preserve the concept of a simple and effective tool, the factors chosen for each of the matrices represent the minimum levels that may contribute to an escape burn or adverse impact of smoke.

Steps 2 and Step 3 address the risk associated with prescribed burn escape; Step 2 assesses the likelihood and step 3 assess the consequence. The factors for determining likelihood have been grouped into five broad categories: burn day conditions, long-term conditions, fuels, control, and forecast conditions. The weather factors are the only factors that need to be updated for each day of subsequent ignition. The factors for consequence have been grouped into two broad categories: built and natural assets (external to burn area).

Step 4, smoke management, is a new module (released March 2018), which was added to support fire managers with dealing with one of the biggest challenges while implementing prescribed burns. Step 4 was designed to assist in quantifying the risk of smoke impacts and identifies mitigation actions for fire managers to consider prior to and during

		Factors	Low (1)	Mod (2)	High (3)	Very High (4)	Score
Weather factors (#4 & #5) to be completed prior to ignition and for each subsequent day of ignition.							
4	Burn Day Conditions	Max Wind	0-5km/h	6-10km/h	11-15km/h	>16km/h	4
		Min RH	>60%	59-41%	40-30%	≤29%	3
		Max FDI	0-3	4-9	10-15	≥16	2
5	Forecast Conditions from commencement	Max Wind (12hrs-24hrs)	≤9	10-15	16-20	>21	2
		Min RH (12hrs-24hrs)	>60%	50-59%	30-49%	≤29%	1
		Max FDI (12hrs-24hrs)	<12	13-20	21-25	>26	1
		Max Wind (24hrs-36hrs)	≤9km/h	10-15km/h	16-20km/h	>21km/h	4
		Min RH (24hrs-36hrs)	>60%	50-59%	30-49%	≤29%	3
		Max FDI (24hrs-36hrs)	<12	13-20	21-25	>26	2
		Max Wind (36hrs-72hrs)	≤9km/h	10-15km/h	16-20km/h	>21km/h	4
		Min RH (36hrs-72hrs)	>60%	50-59%	30-49%	≤29%	3
		Max FDI (36hrs-72hrs)	<12	13 to 20	21-25	>26	2

Figure 1—An example of the "core": Steps 2-4 of the PB DST. Each of the matrices consist of a list of factors divided into four categories that the assessor selects based on the prescribed burn assessed. The example above is the weather section of the likelihood (Step 2).

the implementation. Similar to the previous steps, a number of key factors that affect the amount and dispersal of smoke have been identified and grouped into different categories: weather, fuels, and topography. The consequence of smoke management consists of two factors within asset vulnerability: the proximity of smoke-vulnerable assets and the density of population and/or sensitivity to smoke.

The likelihood and consequence of weighted scores of both risk of escape and impact of smoke are then prepopulated into Step 5, risk matrix, to determine overall risk. Risk mitigation advice is then applied to the risk score. The final step, Step 6, is the approval form for the assessor and IC to document the preburn and post ignition decisionmaking process.

Multiple agencies in Victoria, Tasmania, NSW, South Australia and the Australian Capital Territory (ACT) have been trialing the PB DST, resulting in thousands of assessments over the last 3 years. The tool has been endorsed by Forest Fire Management Group and ideally the goal is to reach consensus on a consistent product for the Prescribed Burn National Toolbox. In the ACT, the value of the PB DST was evident following an escape on the Brandy Flat burn in 2016 where the ability to present a detailed summary of the decisionmaking prior to, during, and after the burn was invaluable when subject to political review.

CASE STUDIES: BRANDY FLAT AND POTTER'S HILL BURNS

Brandy Flat: The Context

In late autumn of 2016, The ACT commenced its annual burn program with five urban burns implemented over a 3-day period. The PB DST was completed for each burn to determine its suitability to implement. The late start to autumn burning was due to unseasonably warm conditions followed by frequent, small rain events. An extended period of burning appeared unlikely due to recent rain and the climatic outlook.

The rural burn program, which typically consists of larger, multi-day burns in remote and rugged country, commenced on 30 March. The ignition of two burns was planned over several days. On 1 April, these burns were nearing completion and implementation began on an additional two burns planned over a 2-3 day period. On 2 April, operations continued; objectives were being met, predominantly low-intensity backing fires with isolated patches of moderate intensity. Consumption of fuels was within acceptable ranges, which included removal of surface, near-surface, and elevated fuels while maintaining the mid- and over-story canopy. South and east facing slopes would not carry fire.

Following the completion of the PB DSTs on 2 April, it was determined that implementation would occur on a further four urban ecological burns and one new rural burn (Brandy Flat burn) on 3 April. The implementation of these burns was well within resource capabilities as the remaining burns were primarily aerial ignition requiring minimal resources. The Brandy Flat burn, a 3,000 ha ridgetop burn, consisted of a 9 km long ridgeline running north-south. The distance to the road on the western slope from the ridgeline was nearly 2 km in places. Based on the current and predicted fire behavior, it was determined that it would take a number of days to reach the road.

Likelihood and Consequence of the Brandy Flat Burn

The Brandy Flat burn rated as a moderate risk in the PB DST. There were no assets (built, natural, or cultural) inside or adjacent to the burn area and it was located outside the ACT's drinking water catchment. Benign fire weather was predicted, but the PB DST did highlight that Fire Danger Index (FDI) was predicted to increase to 12 and the relative humidity would decrease to the mid-20s on 6 April, 4 days out from the assessment. Both of these indices were within prescription.

To confirm the risk profile, the PB DST was updated each morning for all burns that had planned active ignition. On 3 April, there was no major change in the predicted weather for the Brandy Flat burn. The risk of escape remained moderate and, based on the current and predicted fire behavior, the IC approved implementation. Consideration was given to the increase in predicted fire weather for 6 April, but the burn would be backing down slope and into the predicted and predominant wind pattern. There was doubt as to whether the burn would back down far enough to reach the road.

The PB DST for the Brandy Flat burn on 4 April displayed only a slight increase in fire danger and operations continued as planned. However, the afternoon weather grids predicted a notable increase in the predicted fire weather for 6 April. The FDI was now approaching very high fire danger; minimum relative humidities were now forecasted to drop to 16 percent from 24 percent and the predicted winds had increased to 33 km/hr, up from 25 km/hr. The use of the PB DST focused the identification of pressure points for each burn, which then resulted in adjustments to strategies on 5 April. Aerial ignition was utilized to increase the area burned, thus strengthening those areas of concern. Additionally, another helicopter was ordered, other burns were consolidated, and crews were prepared for the predicted changes in weather. The PB DST allowed for the documentation of these decisions in a standardized, consistent, and repeatable-manner as the burn progressed.

For the Brandy Flat burn, the southwest corner of the burn was a pressure point. The control line was an ephemeral drainage that would be susceptible to pressure due to the predominant wind pattern (northwest). To mitigate this issue and strengthen the control line, prior to implementation, fuels were reduced and a hoselay was inserted that tied the road to the dry creek. When the PB DST was updated on the morning of 6 April, a further increase in the predicted fire danger was identified. The predicted FDIs were now approaching 28, with winds 35-40 km/hr.

The PB DST focused the Incident Management Team and a strong plan was outlined in the Incident Action Plan for 6 April. Resources were allocated in the right locations, which included moving crews out of potentially dangerous areas of the fire line and helicopters focused on areas of concerns. As the day progressed, the weather was tracking as predicted, but by early afternoon the winds started to exceed the predictions. Then, without warning the burn area began to experience local wind channeling with winds 50-70 km/hr. Fire behavior intensified significantly and helicopters were working to decrease fire intensity. A spot-over occurred adjacent to the ephemeral drainage along the southwest control line and made an uphill run.

The spot-over was eventually incorporated into our contingency plan, which met our future fuel reduction commitments in the area. No assets or damage occurred as a result of the escape due to the remote nature of the burn. In terms of weather, there was a stark difference between the information received on 3 April when the decision was made to commence lighting, compared to the actual day (fig. 2). The actual FDI recorded was over double the original forecast, 06/04/2016 Wednesday

Date	Time	Temp	RH	Dir	Speed	FDI	FMC
6/Apr/2016	12:00 AM	14.5	60.6	NW	8.5	2.1	9.9
6/Apr/2016	1:00 AM	13.5	63.8	NW	8.7	1.8	10.4
6/Apr/2016	2:00 AM	13.1	65.1	WNW	8.7	1.7	15.2
6/Apr/2016	3:00 AM	12.7	66.4	WNW	8.7	1.6	15.8
6/Apr/2016	4:00 AM	12.2	67.7	WNW	8.5	1.5	16.1
6/Apr/2016	5:00 AM	11.6	69.4	WNW	8.9	1.4	16.3
6/Apr/2016	6:00 AM	11.6	69	WNW	9.3	1.5	16.6
6/Apr/2016	7:00 AM	12.6	65.6	WNW	9.8	1.7	17.0
6/Apr/2016	8:00 AM	15	58.2	NW	12	2.5	16.9
6/Apr/2016	9:00 AM	18.2	49.5	NNW	14.4	4.1	16.3
6/Apr/2016	10:00 AM	21.3	41.9	NNW	16.8	6.2	14.8
6/Apr/2016	11:00 AM	23.4	36.3	NNW	18.5	8.5	12.9
6/Apr/2016	12:00 PM	24.6	32.4	NW	20.4	10.5	11.2
6/Apr/2016	1:00 PM	25.3	29.7	NW	22	12.3	10.0
6/Apr/2016	2:00 PM	25.7	28.1	NW	19.3	12.4	6.1
6/Apr/2016	3:00 PM	25.4	27.9	WNW	16.7	11.6	5.2
6/Apr/2016	4:00 PM	24.2	30	W	14.1	9.7	5.0
6/Apr/2016	5:00 PM	22	34.8	WNW	13.3	7.5	5.5
6/Apr/2016	6:00 PM	19.4	42.3	NW	12.6	5.2	5.9
6/Apr/2016	7:00 PM	17.2	51.4	NW	11.9	3.5	6.8
6/Apr/2016	8:00 PM	16	59	NW	10.4	2.5	8.1
6/Apr/2016	9:00 PM	15.6	63.9	W	8.9	2.0	9.5
6/Apr/2016	10:00 PM	15.1	67.8	WSW	7.4	1.7	10.5
6/Apr/2016	11:00 PM	14.6	69.6	WSW	7.8	1.6	11.1

06/04/2016 Wednesday

Date	Time	Temp	RH	Dir	Speed	FDI	FMC
6/Apr/2016	12:00 AM						
6/Apr/2016	1:00 AM						
6/Apr/2016	2:00 AM						
6/Apr/2016	3:00 AM						
6/Apr/2016	4:00 AM	13.6	47	NW	21.3	4.3	
6/Apr/2016	5:00 AM	12.9	46.8	NW	29.5	5.1	
6/Apr/2016	6:00 AM	12.5	46	NW	36.7	6.1	13.9
6/Apr/2016	7:00 AM	13.2	41.6	NW	37.9	7.5	14.1
6/Apr/2016	8:00 AM	15.1	37.3	NW	33.4	8.5	14.1
6/Apr/2016	9:00 AM	18	31.7	NW	28.6	10.2	13.4
6/Apr/2016	10:00 AM	20.8	25.4	NW	28.9	14.2	12.4
6/Apr/2016	11:00 AM	23.1	20.1	NW	29.8	18.8	11.0
6/Apr/2016	12:00 PM	24.7	17.1	NW	37.2	26.2	5.0
6/Apr/2016	1:00 PM	25.7	15.7	NW	36.3	27.8	4.4
6/Apr/2016	2:00 PM	26.1	15.9	NW	34	26.5	4.1
6/Apr/2016	3:00 PM	25.9	16.8	WNW	33.3	25.1	4.0
6/Apr/2016	4:00 PM	24.8	23	WNW	30.8	18.4	4.0
6/Apr/2016	5:00 PM	22.9	26.2	WNW	22.7	12.8	4.1
6/Apr/2016	6:00 PM	20.6	30.8	WNW	14.3	8.3	4.6
6/Apr/2016	7:00 PM	18.5	39.6	W	9.7	5.1	5.0
6/Apr/2016	8:00 PM	17.2	46.1	W	10.2	4.0	6.6
6/Apr/2016	9:00 PM	16.4	48.8	W	10.9	3.6	8.0
6/Apr/2016	10:00 PM	15.9	50.7	W	11.3	3.3	8.9
6/Apr/2016	11:00 PM	15.3	55.6	WSW	12	2.8	9.3

Figure 2—Comparison of ADFD gridded weather forecasts for Brandy Flat burn that highlights the FDI; 03/04/16 at 05:15 hrs (left) and 06/04/16 at 04:47 hrs (right).

and the relative humidity was nearly 15 percent less. The day ended up being one of the warmest days in April recorded in the ACT for the past 30 years.

PB DST as a Documentation Tool

The first major escape from a prescribed burn within the ACT occurred in 2015. Afterward, fire managers received considerable questioning and some criticism from both inside and outside the organization about how the escape occurred. Following the escape from the Brandy Flat burn in 2016 (fig. 3), new questions and additional scrutiny were received about having lost two burns in recent years. The first being, surely "you" knew about the predicted fire weather for 6 April. This time around when the questioning occurred, fire managers were able to produce the daily PB DST assessments undertaken leading up to and during the period of lighting. Documents displayed the changes in predicted weather and how tactics were adjusted midway through the burn as the fire weather started to deteriorate. The Executive Management team was provided a clear and well documented picture that this situation was beyond our control and fire managers acted using best practices. What became quite clear is that a consistently applied risk-based decision support tool for prescribed burning is essential.

Figure 3—Spot-over from Brandy Flat burn as it made an uphill run. (Photo courtesy of Steve Forbes.)

Potter's Hill: Decisionmaking Based on the Best Available Information

The strength of the PB DST has been the ability to consistently document decisionmaking based on the best available information. In March 2018 the ACT was implementing a number of large, rural prescribed burns. A decision was to be made as to whether it was appropriate to implement another large burn as two other burns were winding toward completion. The Potter's Hill burn was chosen due to its solid control lines and relatively standard ignition patterns. The forecasted weather was very favorable (fig. 4) with the next 7 days all well within prescription. Additionally, the fuel moisture, which is sampled regularly, was also within acceptable range (10-hour fuels ranged between 10-16 percent). Based on the best available information, the PB DST was completed and there was a low risk of escape and moderate impact of smoke.

The decision was made to begin implementation on March 10, 2018. Over the course of the burn the weather fluctuated greatly, which resulted in limiting active ignition when the FDI was outside of prescription (fig. 5). The standardized forms allowed the IMT to capture their decisions. The PB DST proved invaluable again as this information changed almost daily, which then affected the decisionmaking of the IMT, all captured in the PB DST. Through the course of the burn, 18 March was highlighted by the PB DST as a "day of concern." The initial forecast for the 18th (made on March 12) predicted an FDI of 16, which is slightly out of prescription and not too much of a concern (fig. 4). The following day the prediction decreased and then it slowly started to increase as March 18 became closer. Strategic decisions were made by the IMT to strengthen the weaker control lines prior to March 18, but ignition options were limited by unfavorable weather on March 15.

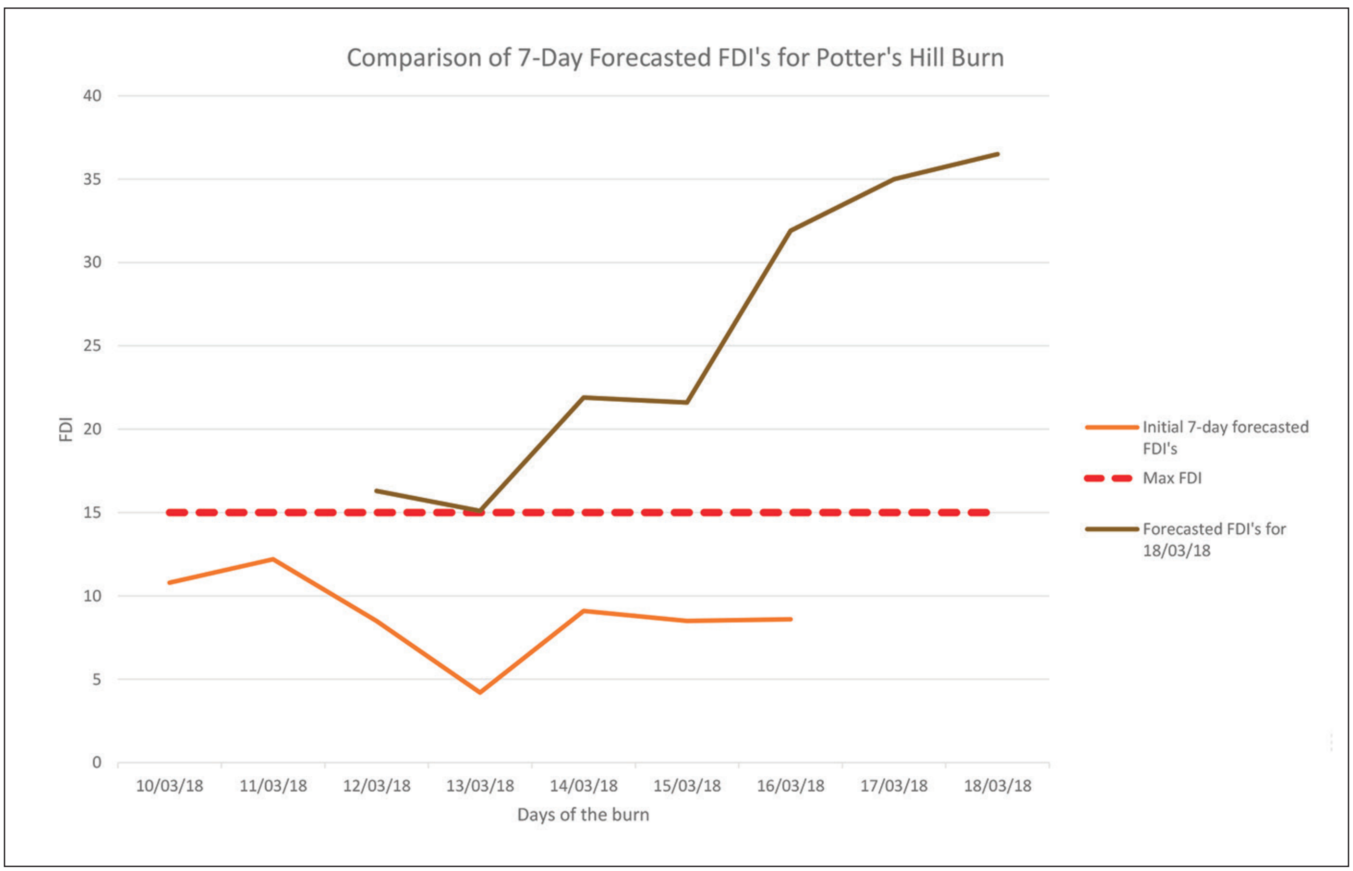

Figure 4—Forecasted FDI for the Potter's Hill burn: the initial 7-day forecasted FDI (orange) prior to implementation and the escalating forecasted FDI for March 18 (brown).

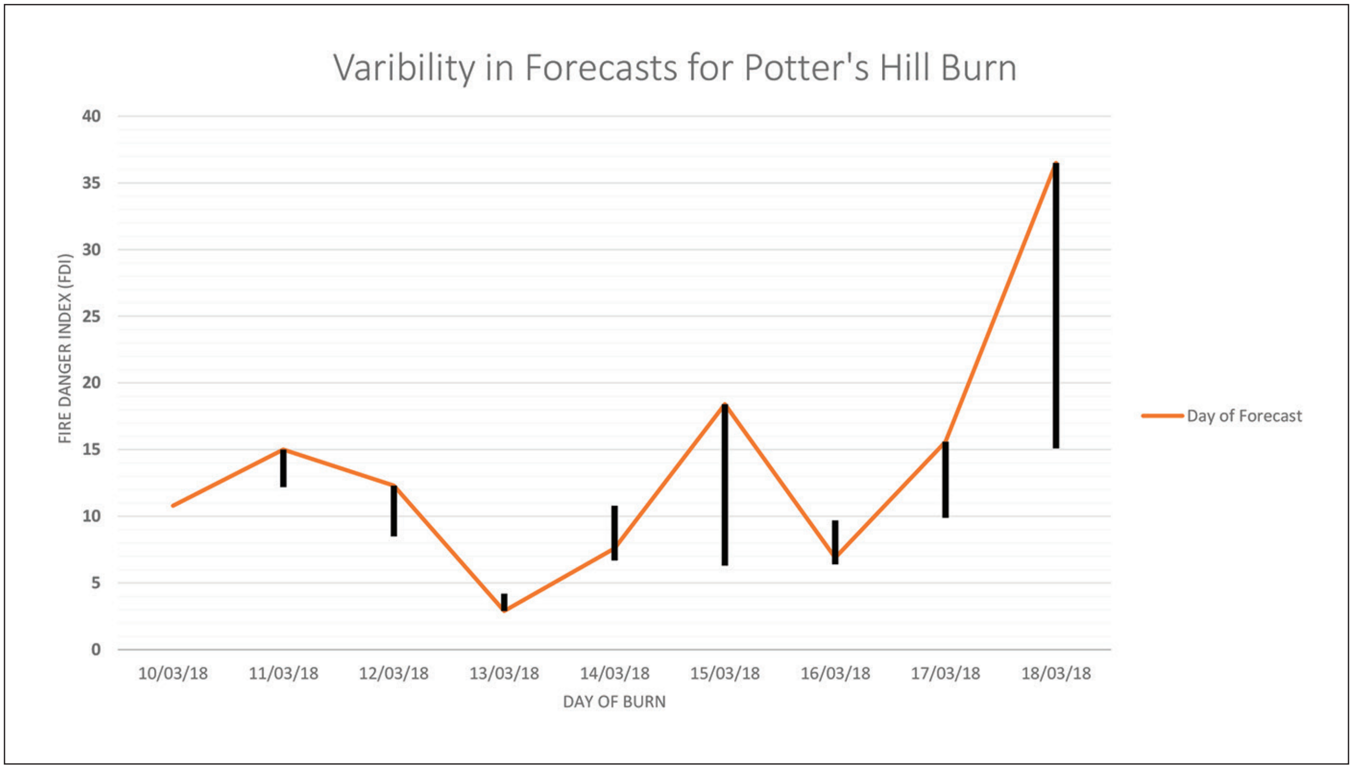

Figure 5—The range (black) of forecasted FDI for the Potter's Hill burn, highlighted by predicted forecast on each given day (orange).

On March 16, the predicted FDI had nearly doubled and it was clear that March 18 could be a problem day. March 18 was ultimately declared a Total Fire Ban for the ACT and a preemptive IMT was established at the State Control Centre. Regardless of the best attempts to shore up control lines, the observed weather was too difficult to overcome as all aircraft were shut down due to strong winds. A spot-over occurred and the fire made a run (fig. 6). Long-range spotting of 6-10 km occurred; however, with the quick work of crews and aircraft—when they were able to fly the fire—was held to 200 ha.

It is important for fire managers to utilize the best information that is available at the time of decisionmaking. This is done at all times but was highlighted on the Potter's Hill burn and documented on the PB DST. The weather and fuel moisture were well within prescription; crews were ready and available and the burn had strong containment lines. But ultimately after the decision was made, the information changed and an escape occurred. The "low" risk rating on the initial PB DST was attributed to the benign predicted fire weather and the lack of "high level" assets. The risk was deemed acceptable. This places fire managers in precarious situations, as in Australia where we implement 5-8 million hectares a year of prescribed burns. It is not in our best interest to begin second guessing the Bureau of Meteorology (BoM), for example, otherwise we will find ourselves with little or no burn windows. But with the advent of the PB DST we can now document in a clear and transparent way how we utilized the available information before and during implementation.

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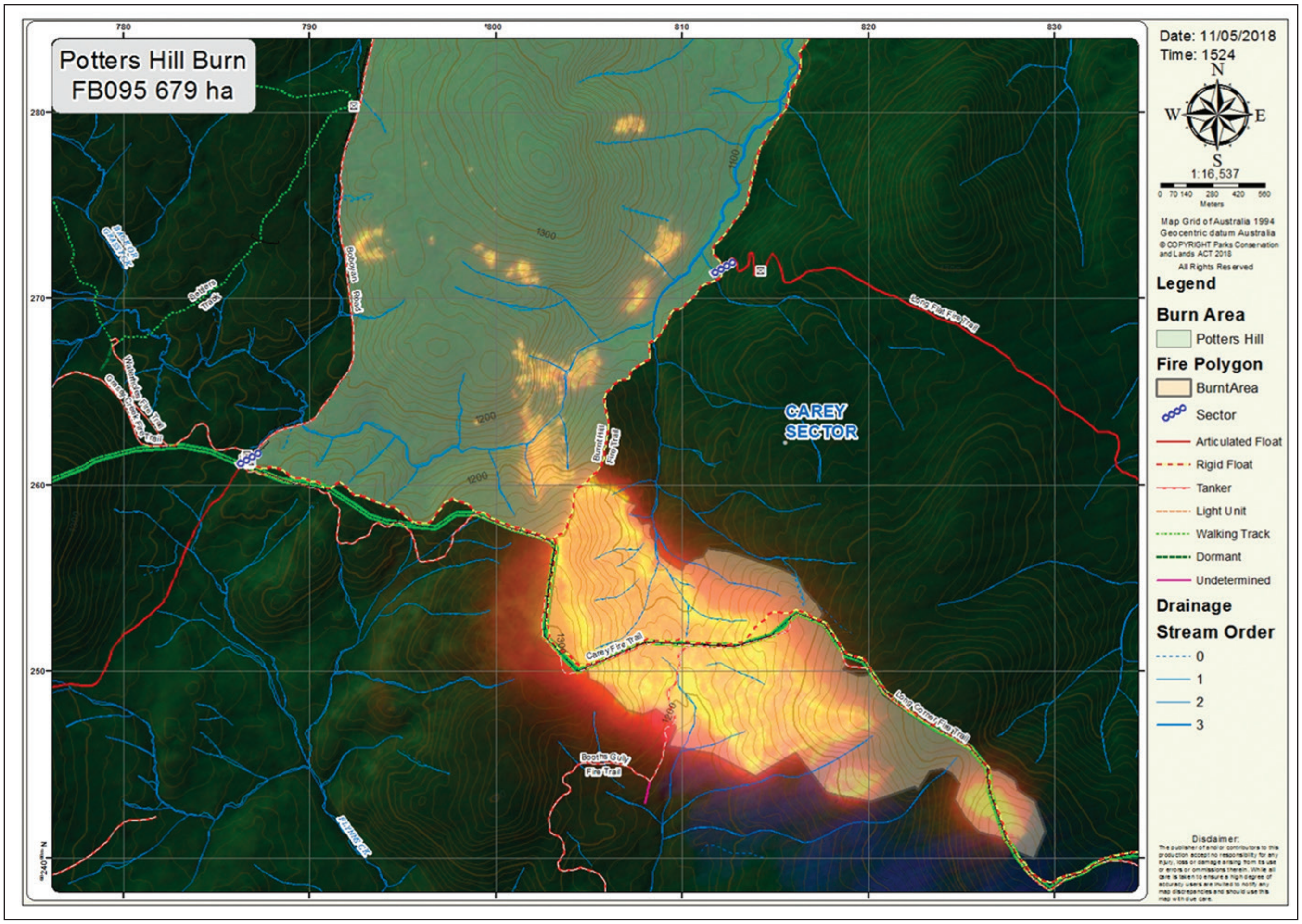

Figure 6—Map of the line scan for the Potter's Hill escaped burn.

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ADDRESSING THE CHALLENGE OF SMOKE MANAGEMENT

For decisionmakers and fire managers, the two most important questions regarding prescribed burns can be summarized as: Will the burn behave and will the smoke impact stakeholders? The latter question has a direct impact to communities and industry and is one of the biggest challenges for our industry. There are a number of factors that contribute to smoke management; despite recent developments, there has not been a consistent method to document and demonstrate how fire managers have considered this information and the decisions made as a result.

In Australia, steps have been taken to assist with predicting the effects of smoke and smoke forecasting. Three years ago, a smoke plume model was developed by the New South Wales Rural Fire Service that provides information on smoke dispersal from a single prescribed burn. More recently, a new experimental smoke forecasting system (AQFx), which takes a landscape approach to air quality, has been developed and hosted by the BoM. Prior to the PB DST smoke module, there had not been a consistent tool or process to document the information from these smoke forecasting tools.

Fire planners are now able to gather data from the smoke plume model or AQFx along with other factors that contribute to smoke and then consider the potential consequences in a transparent and systematic manner. This has facilitated the ability to determine whether it is suitable or not to proceed. Smoke management is complex and a range of variables can affect smoke dispersal on any given day.

A number of lessons have been learned since the inclusion of this module. Consistent feedback emphasized additional public engagement by the IMT, resulting in better communication and signage with the public. In the documentation of numerous assessments, it was determined that the impact of smoke would be minimal based on predicted wind direction; this seemed to give the IMT confidence to proceed with the best information available at the time. In some cases, the burn assessor documented that regardless of predicted winds there would be an impact to the community; however, the risk benefit outweighed the short-term impact to the public. This scenario is often debated: Is smoke from a prescribed burn better than from a bushfire? Lastly, there are occasions where the result of the assessment was determined to be a "Very High" risk of smoke. In these situations, context played a large role. This situation occurred on recent pile burns that were not in proximity to the public. The ventilation index was poor due to light winds, but the wind direction would disperse the smoke away from assets. Utilizing the PB DST, assessors were able to clearly document why they believed it was still suitable despite the risk rating.

CONCLUSION

Prescribed burns are becoming more difficult to implement due to a range of factors, including decreased opportunities, increased scrutiny, and increasing expectations resulting in higher accountability. These factors contributed to the development of the Prescribed Burn Decision Support Tool, a tool designed by fire managers to be utilized by fire managers. This tool supports fire managers by providing a consistent, transparent, repeatable, and robust system that documents the decisionmaking process before, during, and after the operation.

REFERENCES

Ferguson, E. 2010. A review of the ability of the Department of Environment and Conservation, Western Australia, to manage major fires. Perth, WA: Department of Environment and Conservation. 6 p.

Independent Lancefield-Cobaw Fire Investigation Team. 2016. Independent investigation of the Lancefield-Cobaw Fire, Department of Environment, Land, Water and Planning. Available at: https://www.ffm.vic.gov.au/__data/assets/pdf_file/0002/20000/Independent-investigation-into-Lancefield-Cobaw-fire.pdf.

Keelty, M.J. 2012. Appreciating the risk: report of the special inquiry into the November 2011 Margaret River bushfire. Perth, WA: Government of WA.