J9.3 THE IMPACTS OF CLIMATE ON PRESCRIBED FIRE

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1. INTRODUCTION

All burn bosses in Federal agencies must create a prescription with weather and fire behavior parameters, and follow a "Go-No Go" checklist which determines whether or not they can light a prescribed fire. Climate, though an equally important factor, is not directly part of this checklist. Yet it is climate that influences fire behavior through its longer-term impacts such as an anomalous period of dry and warm conditions. In terms of fire behavior, climate may be thought of as an additive factor. For example, a few days of certain weather conditions may bring a proposed burn within prescription, but a longer period of drought prior to the burn could substantially increase the risk of the fire actually burning more intensely or escaping its controlled confines should a strong wind event occur. For fire management, there is much value in utilizing climate information for prescribed burning (Brown and Betancourt 1999; Brown 2003).

The overall goal of this project is to describe the impacts of climate on prescribed fire from both a physical climate perspective and the utilization of climate information by fire management. In part, it is necessary to understand management decision-making information needs and perceptions of climate. It is also necessary to distinguish climate impacts from related variables that affect prescribed fire, such as permitting and personnel acquisition issues. This paper describes the results of an initial query.

1.1 *History of Prescribed Fire*

"Prescribed burning has been defined as the judicious use of fire to achieve specific management objectives" (Rasmussen 1994), and as has been for many decades, continues to be a topic of debate in the United States (US). Many merits of controlled burning were utilized by both the early European settlers of the country and by many of the native tribes who used fire long before Europeans arrived. Natives used fire to clear agricultural lands and travel corridors, create open spaces for hunting and encourage berry production, to fell large trees, and to create fire breaks from naturally occurring forest and prairie fires. Early European-Americans used controlled burns for many of the same reasons, but due to the conflagration wildfires of the late 19th and early 20th centuries, and the establishment of suppression policy during the early years of the US Forest Service, the US government began to oppose the use of prescribed fire. The suppression policy quickly evolved in part due to European agricultural attitudes linked to the new Forest Service and a developing nation that saw a need in protecting communities and valued resources (Pyne 1997).

Prescribed fire advocates held a fairly even battle with the young USFS until the 1910 fires in the Northern Rockies. That summer, with the loss of 85 lives and millions of acres of timber, the Forest Service introduced aggressive suppression policies that would eventually come to rule the wildfire world. The early 1900s advocates of prescribed burning were primarily concentrated in northern California, where they promoted a let-burn policy in the backcountry and light burning in the front country. However, they were alone in their promotion of controlled burning practices as most foresters held the preconceived notion that the methodology would fail. The issue was highly political, as foresters tended to view the burning practices of the frontier folk as "wasteful and irrational" (Pyne 1997).

The 1928 McSweeney-McNary Act essentially ruled out fire use as an ecological management tool, and the combined front of World War II and the Smokey Bear campaign soon solidified the image of wildfire as the enemy in the public mindset. This perception ruled until the 1960s and 70s, when almost a decade of cooler, wetter and generally more favorable prescribed burning conditions prevailed, allowing managers to begin making the case for prescribed fire again. These same climate conditions also reduced the number

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of large wildfires, and helped provide focus on issues other than suppression. The 1963 Leopold Report and the 1964 Wilderness act both encouraged the National Park Service (NPS) to restore fire to its natural place in the wild. In 1967 and 1968, NPS released policy updates that favored the use of prescribed natural fire, essentially allowing lightning-caused fires to burn uncontrolled (Pyne 1997). During this decade, California once again took a leading role in prescribed fire use and research under University of California professor Harold Biswell, the infamous "Harry the Torch." Biswell set prescribed burns throughout northern California despite great opposition, and the result of his work is still evident today on many University-owned properties (Biswell 1989).

The Forest Service began to accept prescribed burning in the 1970s, and by the mid-1980s, federal agencies were burning millions of acres a year for a number of ecological management and restoration projects (Pyne 1997). The Bureau of Land Management (BLM) used fire extensively across its rangelands to promote forage production and improve big game habitat, and more than one study showed the economic advantage of prescribed burning and the ability to meet objectives over large areas (Frandsen 1985; Bunting et al. 1987). Prescribed fire, whether set naturally by lightning or by humans in a controlled setting, was beginning to be a new thinking paradigm.

But the ideal burning conditions of the 1970's could not last. The tables turned in 1988 when Yellowstone National Park, the jewel of the Park Service, went up in flames. As a result, prescribed burning ceased almost entirely. Only after numerous studies examined the aftermath of the Yellowstone fires and the ecosystem regeneration did burning resume. NPS continued to use prescribed fire throughout the 1990s, but catastrophe struck again, and this time the consequences were more severe. In May 2000, Bandelier National Monument initiated a prescribed burning project outside of Los Alamos, New Mexico, despite a significant regional drought. The fire escaped, and the town of Los Alamos lost over 200 homes before the conflagration was brought under control. The threats to Los Alamos National Laboratory and billions of dollars of damage shut down all prescribed burning on federal lands for months. Prescribed fire as a tool was once again brought to trial (NPS 2001).

This time, however, prescribed fire was not thrown out as a failed tool of ecosystem management. The 2000 wildfire season was one of the largest on record in terms of area burned, required suppression resources and cost. Wildfire suppression costs exceeded $1 billion dollars for the first time for any season (http://www.nifc/gov/stats/wildlandfirestats.html). Congress and the White House recognized the need for prescribed burning to continue as a tool of hazardous fuels reduction and ecological restoration, and the new National Fire Plan provided funds to carry out increased treatments. As managers attempt to follow the mandates and regulations that often follow these disasters, they still find it exceedingly difficult to complete their objectives. Risk, regulations and climate variability are all significant inhibitors to burning. Prescribed fire in the US is at a turning point that will decide its future in ecosystem management.

2. BACKGROUND

The question of how climate affects prescribed fire has not yet been directly addressed in scientific literature. Prescribed fire is a well-researched topic, but most of the inquiries have been directed at prescribed fire effects on vegetation, landscape dynamics, and air quality. Countless authors have monitored and analyzed the use of prescribed fire as a management tool for biodiversity, floral regeneration and creating ecosystem mosaics. Prescribed fire planning was a widely published subject in the 1970s and 1980s, as managers sought to best utilize fire. For example, Great Basin land managers could turn to a number of resources in planning large or small-scale sagebrush burning projects. These guides give full prescriptions, time of year to burn, what species to target, what ecosystem shifts to expect, and a summary of the effects on flora and soil (Britton and Ralphs 1979; Klebenow and Bruner 1979; Wright et al. 1979; Bunting et al. 1987; Rasmussen 1994).

The use of prescribed fire to lower wildfire severity and reduce fuel loading is currently undergoing wide-scale investigation throughout the country. Van Wagtendonk (1996) used the FARSITE fire area simulator to show the reduction of potential wildfire severity in an area that was control burned, and others have followed up this work (Stephens 1998; Noonan 2002). Pollet and Omi (1999) quantified the direct effects of prescribed burning on wildfire severity by taking data immediately following a wildfire. Several studies are awaiting publication or are in progress that measure wildfire behavior change in areas

that have been burned under prescription (Fites, pers. comm.).

With the increased understanding of how fuels build-up in forests and rangelands leads to more severe wildfires, there is an increasing emphasis from scientists, from the public and even from the US President (White House 2001) to reduce the excess fuels by any and all means. Thinning and other mechanical treatments are widely used, but prescribed fire is gaining ground as an ecological management tool both for the increased area managers are able to treat and for the chance to restore fire to naturally fire-adapted ecosystems. To increase the area managers are able to burn and decrease the number of ideal burning windows missed, this project attempts to fill an information gap by studying how climate impacts prescribed fire, from both physical and human decision factors. In particular, it seeks to understand how the burn bosses and fire managers who conduct prescribed burns utilize climate information in their prescribed burn planning and implementation.

3. PRELIMINARY STUDY

In spring of 2003, a preliminary study was conducted to determine the need for and extent of a full formal study. Two objectives were addressed: 1) determine the main climate-related constraints on prescriptions; and 2) analyze means by which managers can overcome the climate-related barriers in their attempts to increase or even maintain prescribed fire use. An informal survey was developed and 22 fire managers (from the western half of the US) were casually contacted by telephone. The managers represented four federal agencies, three state agencies, and one private organization. In conversation, they were asked what kind of prescribed burning they perform, their primary objectives for burning, what environmental conditions they burn under, the type of climate and weather information they procure and where they procure it, and what types of events result in prescribed burn delays or cancellation. The results of this informal survey were compiled and analyzed for trends and content to assess the need for a formalized survey and the scope of the problem.

Five primary effects of climate on prescribed fire, and particularly controlled prescribed burning, were evident (Figure 1). Air quality, as dictated by mixing heights and frontal movement, is an overriding issue in the western states, particularly California. Drought cycles, and how well a manager understands the drought cycle for their region, contributes significantly to the amount of area and time of year a manager is able to burn. Plant phenology, and especially the associated fuel moistures, often determines when a spring burn window might open. Precipitation events, particularly heavy snow, often close a fall burn window. Finally, numerous respondents cited weather events that were not forecasted, particularly localized winds associated with fronts, as problematic.

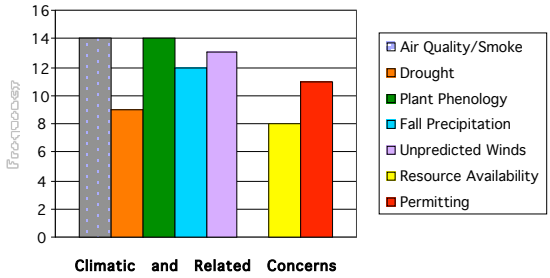

Fig. 1. Frequency of responses indicating climate and decision effects on prescribed fire.

Two issues that affect burn bosses and are indirectly related to climate are the permitting process and resource availability. The number of permits required for a controlled burn varies locally, but most permits require burn bosses to notify officials and the public of the intent to burn, often several days in advance. Several respondents noted that this often negates an opportunity to complete a prescribed burn under ideal climatic conditions, essentially in a good window. Additionally, regional climate patterns often dictate the opening of a burning window simultaneously across several states. Since primarily local crews complete prescribed burns, this leads to a resource shortage.

It is apparent that the effects of climate on prescribed fire follow regional tendencies. Regional drought, flooding, late winter snows, and early spring growth all tend to fall into areas defined by the geography of the country. These areas are difficult to precisely define given a small sample, but appear to have some geographic homogeneity. The geographic areas shown in Figure 2 indicate general locations of survey respondents, but also represent areas of common priority climate factors. For example, California and Oregon emphasized smoke and air quality, the Southwest long-term drought, and Alaska fuel moisture. A more formal study will help refine these preliminary findings.

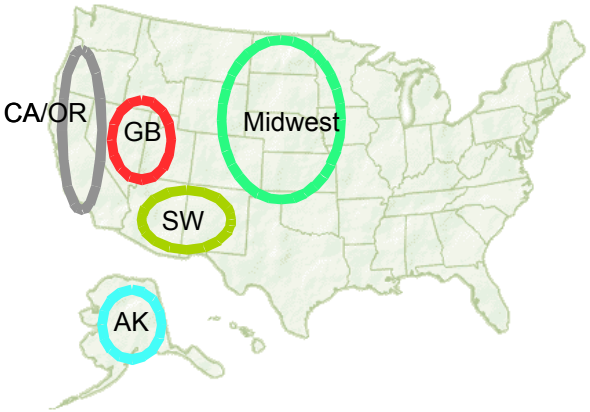

Fig. 2. Geographic areas of survey respondents.

Finally, managers universally feel in order to make effective decisions, a certain range of accuracy and reliability is required in fire weather and spot forecasts for prescribed fires. For some, it was felt that highly accurate forecasts were available, and cited excellent working relations and understanding with National Weather Service (NWS) forecasters. But for others, it was felt that NWS relations were poor, and therefore, the forecasts were less reliable and perceived as inaccurate. It is widely known that climate forecasts have less prediction skill than short-term daily weather forecasts. For those managers that embrace forecast information, the utilization of forecasts with even minimal skill will have some value. But for those that find daily forecasts as unacceptable will surely reject monthly and seasonal forecasts, despite the fact this information represents the best available science for decision making accountability.

4. CONCLUSION

Understanding how climate affects prescribed fire is not often on the list of concerns fire managers have. Resource acquisition can be difficult, the permitting process is often a nightmare, and other duties often interrupt the process of tracking burn window openings and closings. But climate factors and weather forecasts heavily impact the ability of managers to plan and complete their prescribed burns, so it is imperative that they fully understand how climate affects their burning patterns and what types of information and historic data are available to them. Our informal survey revealed that there is a wide range of understanding how to acquire and interpret climate data and weather forecasts among fire managers, and that their decisions are often made without the best information available. Much of this can be attributed to the lack of a national infrastructure to support prescribed fire in the manner that wildfire suppression is supported.

The results of this preliminary study point to the need for a full survey with increased respondents and a more formal questionnaire. This query is anticipated to take place in spring of 2004. The full project will summarize how climate impacts prescribed fire, both in terms of physical factors and human decision. It will analyze the current system by which climate data and weather forecasts are utilized in planning and implementing prescribed burns. It will also analyze the climate record against annual prescribed fire area burned totals, and against past escaped prescribed fire incidents to assess potential patterns. The final result of this project will be a better understanding of climate's role in prescribed fire, a set of recommendations for both fire managers and fire weather forecasters at a local and national level, and an Escaped RxBurn Index to predict the potential for prescription burns to become wildland fires.

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