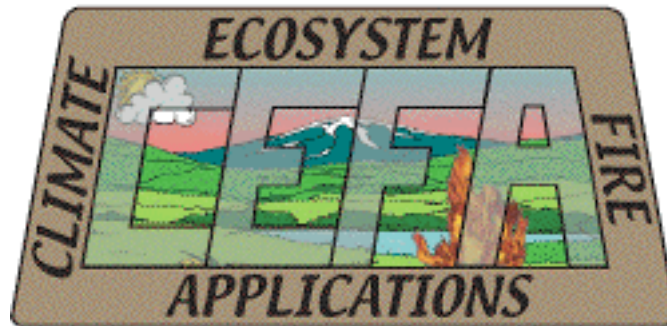


*Program for Climate, Ecosystem and Fire Applications*



# Using Climate information for Fuels Management

*Project Report*

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by

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## Foreword

In November 2000 an Assistance Agreement 1422RAA000002 was established between the Bureau of Land Management National Office of Fire and Aviation and the Desert Research Institute (DRI). One of the primary Task Orders begun under this agreement, and ending in September 2008 was Task Order 14 – Role of Climate in Prescribed Fire. The DRI program for Climate, Ecosystem and Fire Applications (CEFA) carried out the work done in this Task Order. This report describes the results of two surveys addressing the utilization of climate information by prescribed fire and wildland fire use managers. For further information regarding this report or the project described, please contact either:

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## EXECUTIVE SUMMARY

From 2003 to 2006, CEFA surveyed over 200 fire managers in the U.S. to assess how climate information affects their use of fire to meet resource objectives (i.e., prescribed burning and wildland fire use (WFU)). We conducted two very similar surveys, first with prescribed fire managers, then with WFU managers, and asked questions about climate perceptions, availability of climate information and obstacles to using climate information.

We found that while perceptions about the importance of climate are quite high in the fire use community, this does not necessarily translate into using climate information to make management decisions about fire use. Survey respondents indicated that the problem is two-fold: climate information targeted to fire use (as opposed to wildland fire suppression and management) is difficult to acquire, and even when climate information is available, the national structure for planning and implementing prescribed fire is not conducive to the interannual variability inherent in climate, and contains numerous obstacles to burning with regard to changing climatic conditions. The nature of WFU makes the use of climate information more feasible for WFU planning than for prescribed fire planning, but WFU managers face many of the same obstacles faced by prescribed fire managers to actually utilize WFU in the context of climate variability, with the political climate often dictating decisions about fire use.

The National Fire Plan of 2000 and the 2003 Healthy Forests Initiative both emphasize the role of fire use in reducing the threat of wildland fire to humans and resources, and indicate that more fuels reduction through fire use should be completed in the future to support that goal. Our findings indicate that unless climate information is incorporated into the national fire use programs (including appropriate management response (AMR)), and obstacles removed to using climatic windows of opportunity, the fire use programs will fail to accomplish the level of fire hazard reduction expected. Additionally, failure to utilize climate information will increase the inherent risks associated with fire use, such as escaped prescribed fires like the 2000 Cerro Grande fire. The wildfire hazard to human life and property will only continue to increase under climate change scenarios, and fire use as a successful mitigation measure to that hazard depends on understanding and utilizing fire-climate relationships.

## 1. Introduction

In May of 2000, the Cerro Grande Fire, a prescribed fire that had escaped control and burned into Los Alamos, New Mexico, took 435 homes while causing millions of dollars in damages. In the investigation that followed, one of the many contributing factors to the escape highlighted by investigators was related to climate:

*“Moderate drought existed in northern New Mexico and surrounding regions in the spring of 2000, having built since the fall of 1999. NPS did not adequately account for the effects of this drought in planning or implementing the Cerro Grande prescribed fire.” (DOI, 2000)*

The Cerro Grande Fire investigation report indicated that, in this case, climate information was not adequately or appropriately utilized to effectively mitigate the hazards of prescribed fire use (i.e., an escaped prescribed burn). It does not, however, indicate what types of climate information Bandelier National Monument fire management personnel should have used to adequately account for the drought, leading to some obvious questions: what types of climate information are available to prescribed fire managers that can allow them to adequately account for climate in management decisions? Is this information being effectively utilized? Are there climate information needs or knowledge gaps to be filled of importance to fire management?

Climate has come to the forefront of wildfire discussions in recent years as research contributes to the general understanding of how climate influences fuels availability to burn, the occurrence of severe fire weather conditions and other wildfire parameters. This understanding has crossed over into wildfire management applications through the creation of tools like climate forecasts for wildfire and drought indices, which are now widely used in wildfire suppression and mitigation planning. The overall question is how can climate information help fire managers meet management objectives?

Climate underlies weather. For example, a number of days could be generally wet, but that may occur in the context of a two-year overall drought. Knowing the baseline climate is not only critical to preventing escaped prescribed fires, but also how it may affect fire behavior, fire effects and whether or not fire managers will meet their fuels management objectives. Thus, for fire managers to use prescribed and WFU fire safely and effectively, and to minimize the number of escaped fires and conversions to suppression, they need to understand how current climate conditions will impact the use of fire. One example is the need to use prescribed fire under set “burn windows”. Since meteorological conditions vary considerably from year to year for a given day, fire managers will be more successful in utilizing burn windows effectively if they understand those climate thresholds conducive to an increased number of safe burn windows, and are able to predict and take advantage of those burn windows.

While climate and wildfire has been studied extensively, climate and fire use has not. The initial goal of this project was to assess how climate impacts prescribed fire

use in a more general sense. After a preliminary informal survey in the spring of 2003, we determined that 1) there is insufficient data (less than 10 years) to conduct empirical correlative studies similar to those of the relationships between climate and wildfire (e.g., Swetnam and Betancourt 1990), and 2) prescribed fire policy has many regulations that potentially inhibited the use of climate information for decision-making. It was also determined that because fire use *is* a human decision, it would be more informative to ask fire managers themselves how climate impacts fire use through their decision-making processes, and whether or not they use climate information for prescribed fire.

The first task for this project was to complete a regional survey of prescribed fire managers in California and Nevada. During the second phase of the project, additional prescribed fire managers were surveyed across the country. During the third year a second survey of WFU managers was completed. The goals of these inquiries were to determine:

- 1) If fire managers use climate information for fuels management;
- 2) The perspective fire managers have towards climate affecting fuels management;
- 3) Determine any obstacles that make it difficult to use climate information for fuels management; and
- 4) Determine climate information managers need to help them make better decisions for fire use.

## **2. Methods**

### *2.1 Prescribed fire survey methods*

In 2004, the prescribed fire survey was created and administered to 92 prescribed fire managers (i.e., fuels specialists, FMOs, AFMOs) in California and Nevada. We chose this region to begin the surveying in part because California federal land managers have had more escaped prescribed fires than any other state in the country (although this is largely attributed simply to the longevity of the burning programs at Yosemite and Sequoia-Kings Canyon National Parks).

The prescribed fire survey consisted of 34 closed-ended questions, and a section where we requested prescribed fire acreage from managers for their specific district (since there is no national database for this type of data). Questions were created based on the BLM Handbook for Prescribed Fire, and on the lead author's experience as a firefighter with the US Forest Service. Questions generally fell into four categories: experience and education, planning for prescribed burning, prescribed burning windows and characteristics, and climate impacts on prescribed burning. The survey in its entirety can be found in Appendix A.

In 2005, we expanded the prescribed fire survey to include the entire United States. Fire managers were selected to participate in the survey based on recommendations from other fire personnel, and whether or not they responded to our initial phone call inquiries. An additional 100 fire managers were surveyed in 2005, for a total of 192 total prescribed fire surveys completed. Respondents represented all five federal agencies and numerous state agencies (Figure 2.1) across the country, although only 16% of the respondents came from the eastern US (which we defined as the area covered by the eastern and southern Geographic Areas).

### *2.2 Wildland Fire Use survey methods*

In 2006, we initiated a second survey to assess how climate information is used in WFU decision-making. The survey questions were created based on our experience with the prescribed fire survey, and the Wildland Fire Use Planning and Implementation Guide (NIFC 2005). The WFU survey consisted of 27 questions, and was administered to 31 individuals in four federal agencies. Participants were selected based on recommendations from the national WFU coordinator from each of the five major federal land management agencies, and whether or not they responded to our initial phone call inquiries. The entirety of the survey can be found in Appendix B.



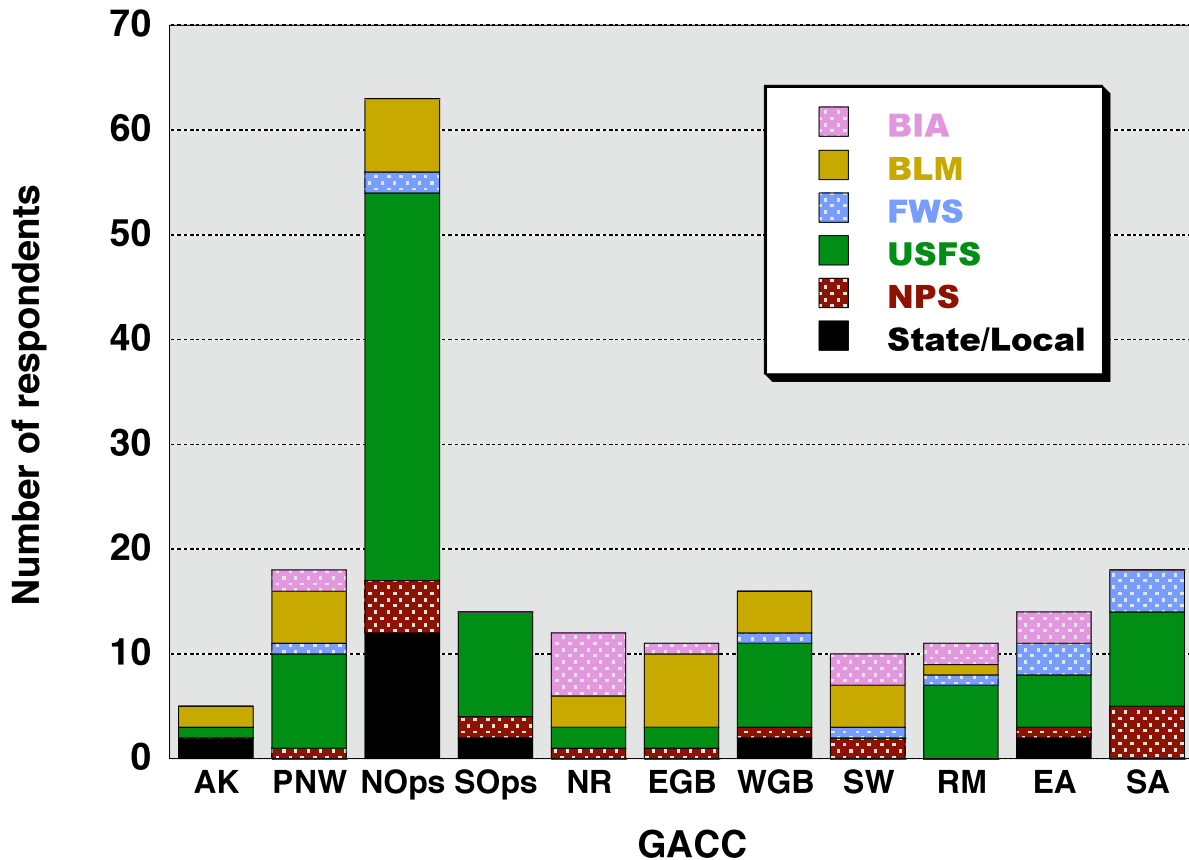


Figure 2.1. Prescribed fire survey respondents by agency and GACC.

### 3. Results of Prescribed Fire Survey

In brief summary, the results of the prescribed fire survey indicated that climate information is not widely used by prescribed fire managers for planning and/or implementing prescribed fires. Additionally, there are numerous obstacles associated with attempting to use climate information for prescribed fire planning and implementation, including a national prescribed fire program structure that does not recognize climate variability impacts on prescribed fire use.

#### 3.1 About the respondents and their prescribed fire programs

Of the 192 respondents surveyed, 32 managed prescribed fire programs in the eastern U.S., and 160 in the western U.S. Respondents represented all five federal land management agencies, seven state agencies and one municipal fire department. The average length of time that the respondent had been managing prescribed fire at their current location was 10 years, with a range of only a few months to just over 30 years. For 74% of the respondents, however, their current location was not the only place they had managed prescribed fire, and respondents indicated they have been trained across multiple regions and ecotypes for prescribed fire.

Respondents manage highly variable prescribed fire programs. When asked to estimate what percentage of their prescribed fire program acreage is attributable to broadcast and understory burns as opposed to pile burns or WFU, 15% of respondents indicated that their prescribed fire acres are solely broadcast, while only 3% of respondents have a prescribed fire program consisting entirely of pile burning. In contrast, 5% of managers have no broadcast burning, while 26% do not pile burn. WFU makes up only a small portion (average 6%) of fire use acres overall, with only 14% of respondents indicating that they have WFU capabilities. Based on estimates from managers, an average of 65% of their program acreage comes from broadcast burning, while 28% comes from pile burning, and 6% from WFU.

Timing of fire use is also highly variable across programs. Respondents were asked to estimate what percentage of their prescribed burning (not including WFU) occurs in each season, with the seasons loosely defined as winter (December – February), spring (March – May), summer (June – August) and fall (September – November). Based on respondent estimates, an average of 16% of prescribed fire acreage is completed in winter, 42% in spring, 6% in summer, and 36% in autumn. The distribution across seasons is not indicative, however, of how individual prescribed fire programs operate, as 73% of respondents do the majority (>50%) of their prescribed burning during a single season instead of spread out over the year as opportunities arise (Table 1).

*Table 1. Percentage of respondents by the portion of their prescribed burning they complete during each season. If respondents were able to burn year-round and take advantage of winter (particularly late autumn) and summer windows, a much higher percentage of respondents would complete 20-39% of their burning in each of the four seasons, and the spreads would be more balanced.*

% annual Rxfire	Autumn	Winter	Spring	Summer
<19	32	65	25	89
20-39	22	19	19	4
40-59	17	8	23	4
60-79	18	6	14	2
80-100	10	3	18	1

Overall, prescribed fire managers who completed the survey come from a wide variety of experience and highly variable prescribed fire programs, which is to be expected given the diversity between agencies and geographic locations.

### 3.2 Respondent use of climate information

Respondents answered four questions about their use of climate information for prescribed fire planning and implementation. The questions were designed to get at whether prescribed fire decisions are made based on the short term or the long term. First, they were asked about what factors impact their planning process; specifically,

how many acres they target for prescribed fire each year. Respondents ranked potential factors, including funding, permitting, public input, previous year accomplishments, and weather and climate information. The greatest impact on prescribed fire planning was funding, with 41% of respondents indicating it is the number one impact on their planning, and 77% indicating it is among the top three influences (Figure 3.1). Also impacting planning was the permitting process (16% top, 50% top three), weather information (10% top, 36% top three), and other free response answers (23% top, 42% top three) such as the availability of personnel resources and smoke management concerns. Climate information and proxies for climate influences (such as long-term forest health) only influenced 11% of respondents, with only two respondents saying it was the top factor.

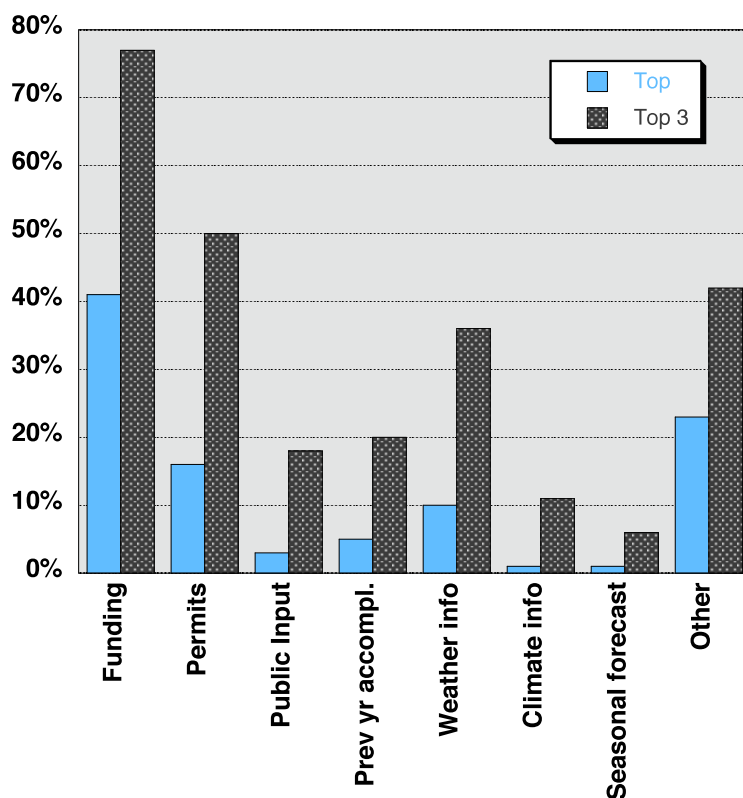


Figure 3.1. Percentage of respondents indicating the factor was the top (light blue) or among the top three (gray) influences on their prescribed fire long-term (annual or greater) planning.

The remaining four questions about using climate information pertain to specific types of data available. Respondents were asked to select all weather and climate sources of information that they use for planning and decision-making in relation to prescribed fire. While over 90% of respondents use Remote Automated Weather Station (RAWS) data, and forecasts and information from the National Weather Service (NWS), only one-quarter to one-half of managers use the information and indices that

track long-term climate conditions, such as drought indices, historical trend data and climate forecasts (Figure 3.2). We confirmed that RAWs data is not being used in a historical sense by asking respondents how much RAWs data they utilize prior to a prescribed burn. Over two-thirds of the respondents (70%) use less than one month of historical data (from RAWs or other weather stations) or none at all; not nearly a long enough period to look at conditions in a historical climate context. Only 19% percent of respondents use historical information of greater than one year, an indicator that prescribed fire decisions are based on short-term weather trends instead of long-term trends and departures from average (Figure 3.3).

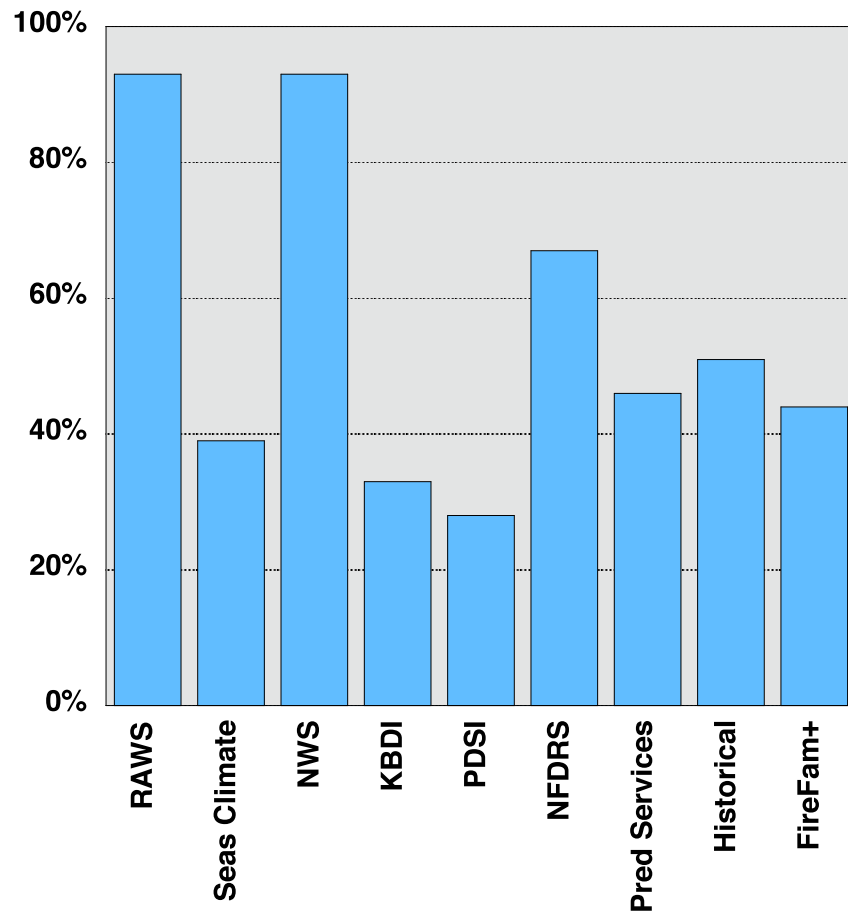


Figure 3.2. Percentage of respondents who utilize various indices and sources of information for prescribed fire planning and decision-making. Categories include Remote Automated Weather Stations (RAWs), seasonal climate forecasts, National Weather Service (NWS) products; Keetch-Byram Drought Index (KBDI); Palmer Drought Severity Index (PDSI); National Fire Danger Rating System (NFDRS); Predictive Services products; historical climate information; FireFamilyPlus (FireFam+).

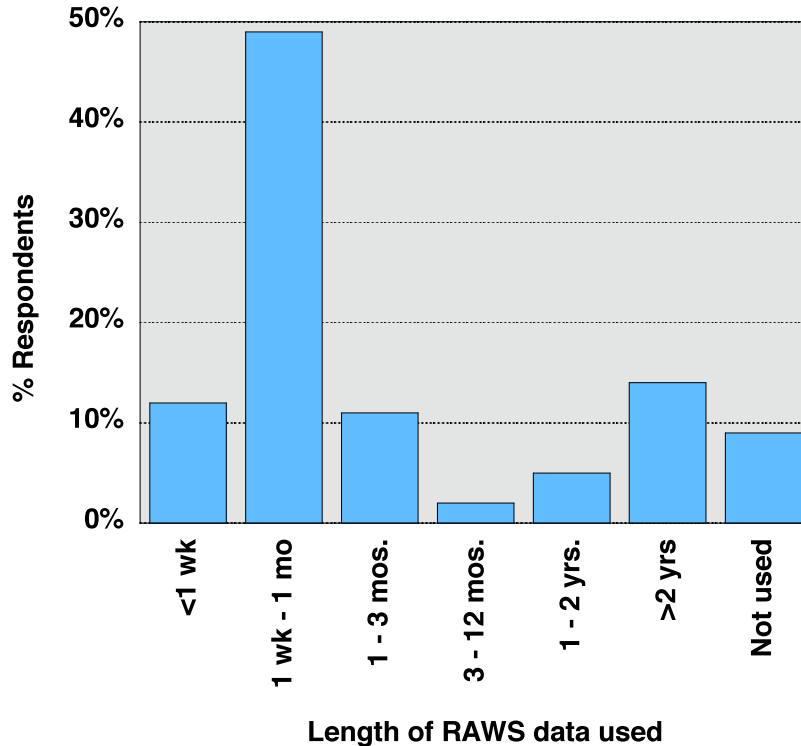
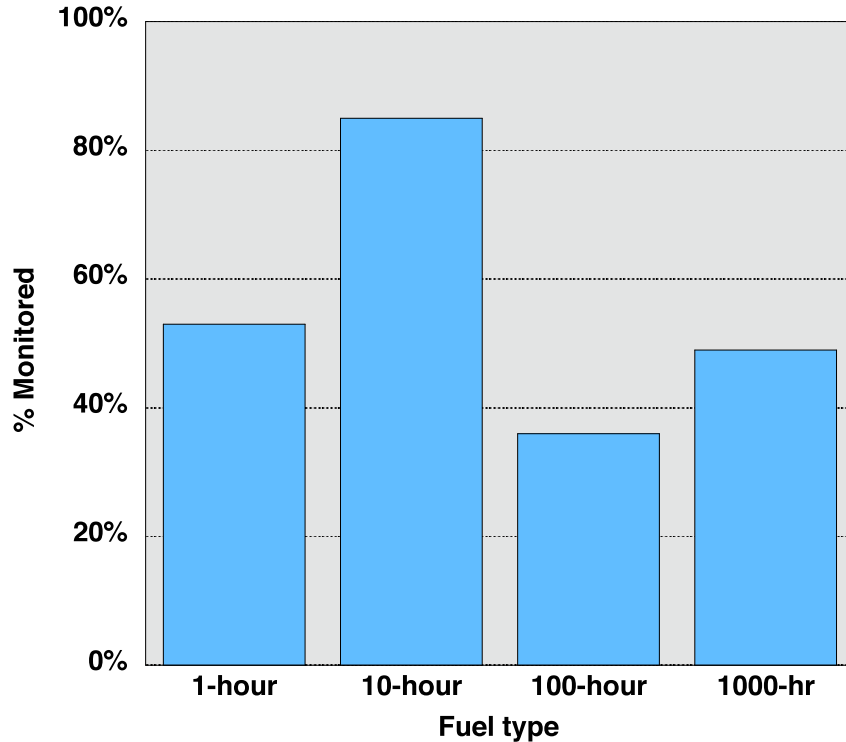


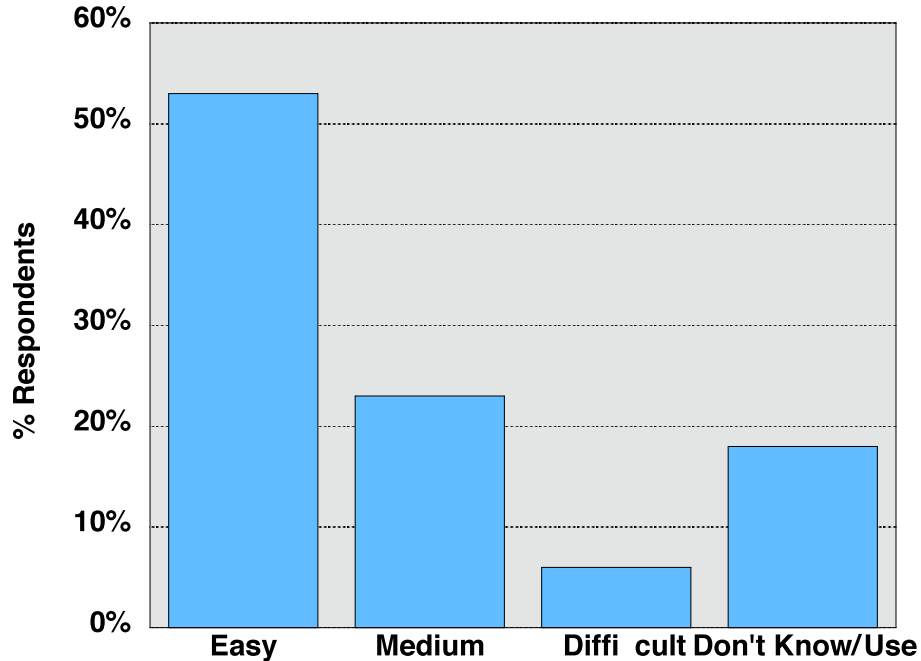
Figure 3.3. Percentage of respondents who use the indicated length of RAWS or historical weather data.

Another question asked of managers pertained to whether fuel moisture information is used in prescribed fire. Respondents were asked to indicate which fuel size classes they measured either before a burn or monitored regularly in their location. While over 80% of respondents indicated they monitor or measure 10-hour fuels (although many noted they utilize the fuel sticks on the RAWS for this), less than 50% of respondents who conduct prescribed burns in timber and brush (as opposed to fine-fuel dominated grasslands) measure fuel moisture levels in 100-hour and 1000-hour fuels (Figure 3.4). When respondents indicated that they did not monitor 1000-hour woody materials, we asked if they monitored or measured live woody or herbaceous vegetation, and counted an affirmative as a ‘yes’ for the appropriate size class. The results from this question indicate that large fuel conditions are not being measured and monitored. Since 1000-hour fuels and woody live fuels (i.e., trees and shrubs) are conditioned by long-term climate trends and not day-to-day weather, this is another piece of climate information that is not being widely utilized for prescribed fire management. While regional live fuel monitoring networks, such as the Great Basin Live Fuel Moisture Project, monitor 1000-hour and crown fuels intermittently during the wildfire season, they are limited by funding, record length (only a few years in most cases), and the inconsistency of methods and sampling periods when wildfire suppression becomes the priority.



*Figure 3.4. Percentage of respondents who measure or monitor fuel moisture levels for each fuel class size, where only those who conduct burns in large fuels were counted in the larger size classes. Responses include both dead fuels (the traditional fuel size class material), and live fuels in a follow up question.*

To ascertain whether climate information is even widely available to prescribed fire managers, or if part of the reason they do not use climate information is because it is not widely available, we asked respondents several questions about how they are trained and how they find data. If prescribed fire managers and burn bosses are not trained in the importance of climate effects on fuels, then they would have no reason to seek climate data to inform their decisions. Additionally, if they do seek data, but it is not available or easily accessed, then climate information will not be incorporated into their decisions. First, we asked respondents how difficult it is to get forecasts and data on long-term climate trends that affect their prescribed fire program (Figure 3.5). Over half of the respondents (53%) said it was fairly easy to get information, while an additional 23% said it was moderately difficult since it sometimes takes them a while to find what they are looking for. Only 6% of respondents said it was regularly difficult to find the information they sought, but 18% said they do not know how difficult it is because they do not use climate information in prescribed burn planning and decision-making.



*Figure 3.5. Percentage of respondents reporting how difficult it is to acquire climate information for prescribed fire planning and decision-making.*

Next we asked respondents about their training. About one-third (34%) of the respondents have taken some sort of coursework that dealt specifically with climatology, and 51% indicated they feel like they receive adequate climate education from their agency training courses, although 10% of respondents answered that they do not know if they receive enough training, and the remaining 39% do not feel like they receive enough training. Despite this training gap, 90% of respondents receive some sort of seasonal climate forecast or fire potential outlook from their agency.

Two of the primary potential sources for weather and climate information are the National Weather Service (NWS) and the Predictive Services (PS) units at the National Interagency Fire Center (NIFC) and in the 11 U.S. individual geographic areas. Respondents were asked to select the best description from a list for the data and services available from each of these entities. For Predictive Services, 70% of respondents said that the products were great or good enough to provide some useful information, while 19% said they were not familiar with Predictive Services and its available products (Figure 3.6), and most of these respondents were from state and municipal agencies that do not necessarily interface extensively with NIFC. Of the 11% of respondents who indicated that they know of but do not use PS products, four respondents indicated that the products generally do not reflect conditions in their location adequately, and seven respondents indicated that they get products that better reflect local conditions from somewhere else (such as NWS).

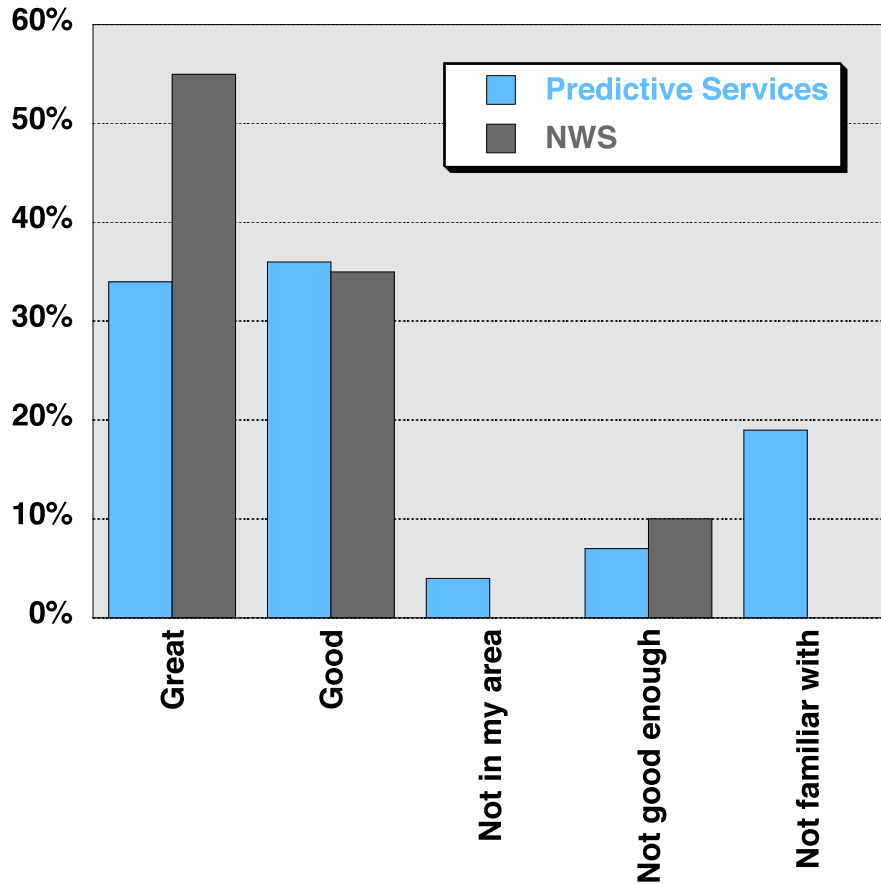


Figure 3.6. Percentage of respondents applying each descriptor to the products and information they obtain at Predictive Services (blue) and NWS (gray).

The answers selected to describe products and data from NWS were similar to those for PS, although a much higher percentage of respondents (90%) indicated that NWS products are great or good enough to be useful. No respondents indicated that they were unfamiliar with NWS products or that the products do not cover their area, but this is not surprising given that NWS spot forecasts are required for nearly all prescribed burns on state and federal lands, and there are over 130 NWS field offices. One notable result from this question is that of the 10% of respondents who indicated that they acquire better information from somewhere other than NWS, all 18 were located in northern California and utilize the Redding Fire Weather unit for most spot forecasts and fire business information.

Given the answers to the questions in this section, it is clear that prescribed fire managers are not utilizing much climate information in their planning and decision-making processes. It is also clear, however, that since nearly two-thirds of respondents have never had any coursework or training specifically in climatology, and nearly half either do not feel the agency training they receive is adequate or do not know what would be adequate, there is no impetus for managers to seek out climate information. If they do seek climate information from either PS or NWS, they may not find information



adequate for their needs. Many respondents commented that the PS unit at their regional Geographic Area Coordination Center (GACC) primarily produced forecasts and information for wildland fires during the summer wildfire season, but that these services are not geared towards prescribed fire needs, nor are they usually available during the non-wildfire months when most prescribed burning is completed. Several respondents noted that their interactions with NWS had been less than desirable as well, citing slow turnarounds and a lack of validation on spot forecasts. This was in contrast to a select few NWS offices, where local respondents noted that forecasters actively participated in making prescribed burning successful by requesting feedback on their spot forecasts and, on a few occasions, actually visiting the burn to assess their own spot forecasts and interface with burn bosses.

Overall, there is little to indicate that climate information is being integrated into prescribed fire planning and decision-making, and there has been no evident push within the fire agencies for prescribed fire managers to complete prescribed fire based on climatic conditions. As the next section will demonstrate, however, prescribed fire managers are aware of the importance of climate trends in a more abstract context, and there are numerous obstacles creating this gap between broad understanding of climate effects on prescribed fire and actually using climate information in prescribed fire.

### *3.3 Perceived climate impacts on prescribed fire*

Climate change and its impacts on wildfire have been brought to public attention by scientists and the media in recent years, so we wanted to ascertain whether this general public exposure to climate trends has transferred to how prescribed fire managers perceive climate impacts in their work. We asked a series of questions to ascertain whether respondents were aware of various climate impacts on their prescribed fire program and the extents of those impacts. Most directly, respondents were asked if long-term climate trends significantly affect their prescribed fire programs. Almost three-quarters of respondents (74%) indicated that, in their experience, climate trends have some sort of impact on their prescribed fire program, whether it be to determine when they are able to burn certain vegetation or dictate when piles can burn based on snowmelt, or for a variety of other reasons (Figure 3.7). Only 17% of respondents indicated that climate has no impacts on their prescribed fire program, and many of these commented that their burning days are heavily regulated according to calendar dates for endangered species or permits. An additional 9% of respondents were not sure if long-term climate has an impact on their prescribed fire program.

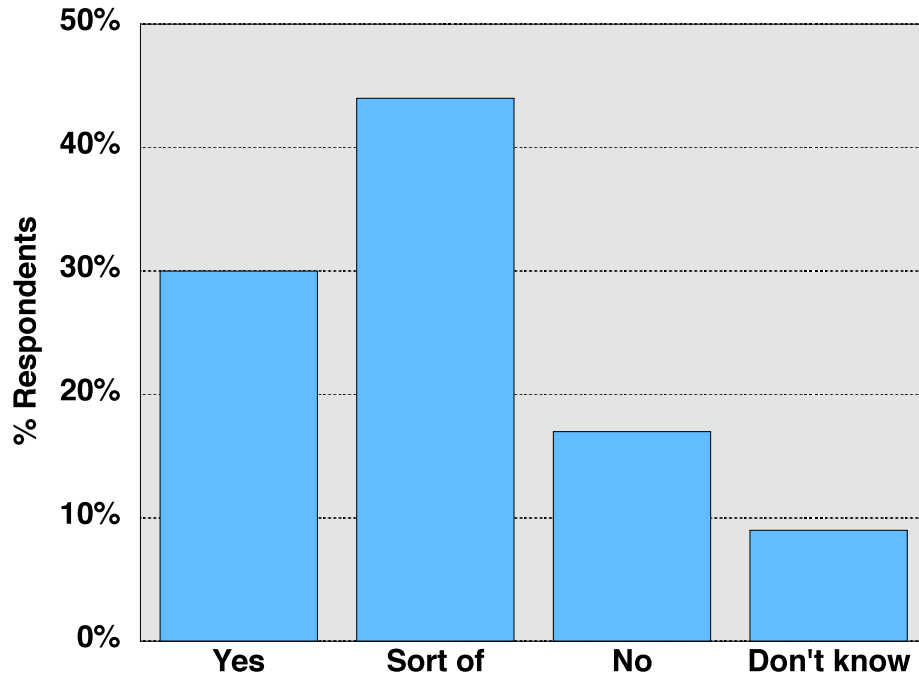
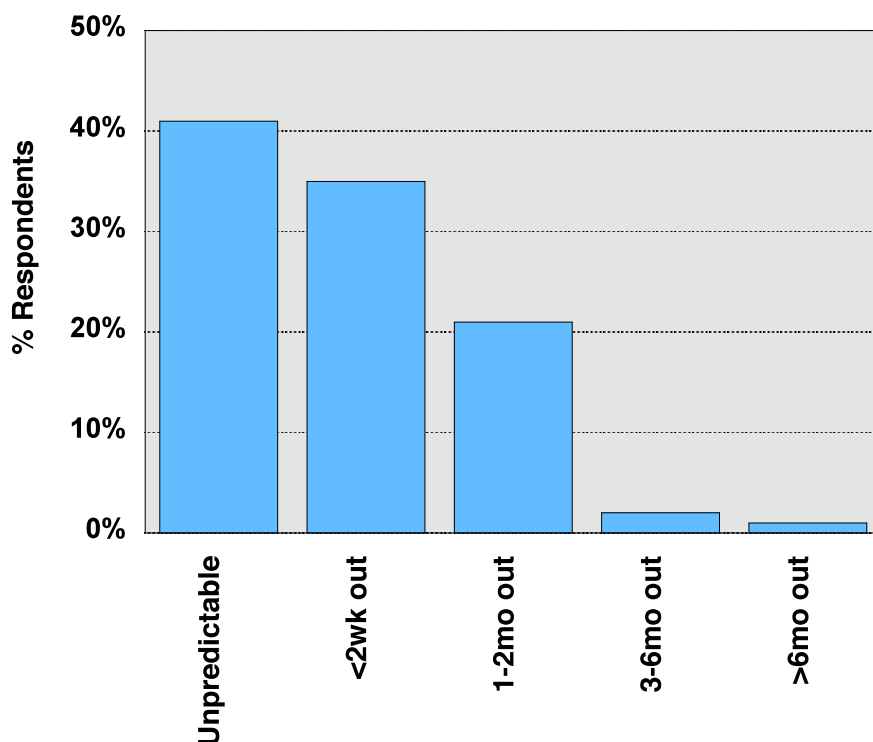


Figure 3.7. Respondent perceptions of whether climate trends have an impact on their prescribed fire program.

More indirectly, we asked respondents how far ahead of their main prescribed fire “season” they are able to ascertain whether the conditions will be favorable for burning. Over three-quarters of respondents indicated that either conditions are unpredictable at a seasonal level (41%) or are predictable only a couple of weeks out (35%). Given that nearly the same percent of respondents think that climate does impact their prescribed fire program (Figure 3.8), this inability to assess what kind of prescribed burning they will be able to complete is an indicator that they are looking at climate influence in retrospect, but that the link between long-term climate trends and the availability of potential burn windows at a seasonal level is not yet understood or has not been established through research. For example, if a climate teleconnection such as the El Niño Southern Oscillation (ENSO) hypothetically influences the number of “good” burn windows in an area for a given season, this relationship has not been established in the scientific literature or has not been translated into an information source that prescribed fire managers can easily access. Nearly a quarter of respondents (24%) said they are able to ascertain over a month out (with only 3% indicating they can predict over three months out) what kind of prescribed fire season they will have, indicating that in some regions these relationships have been established and managers are utilizing the appropriate information.



*Figure 3.8. Percent of respondents who can ascertain how favorable their prescribed fire season will be for the given period prior to the start of the season.*

Finally, we asked respondents what climate patterns they are aware of that have the greatest impact on their prescribed fire season. We did not directly ask how these patterns impacted prescribed burning, but this information was volunteered by many of the respondents and recorded. Over half of the respondents (51%) said drought was one of the major impacts (Figure 3.9), although this is not a great surprise given the number of drought indices available to fire management, and the prevalence of drought education in fire management programs and in the public media. The second highest impact cited by respondents was the dominance of a high-pressure ridge, or series of high-pressure ridges (46%), followed by precipitation departures (wet or dry) from average (42%). To further underscore that the link between climate teleconnections and their translated effects on conditions and seasonal weather patterns is poorly understood (i.e., ENSO is linked to precipitation departures from average in some regions), only 12% of respondents indicated that ENSO impacts their prescribed fire program, while PDO was cited by only 5%. Many respondents described how climate patterns impact their prescribed fire programs at the landscape level through fuels availability by noting that patterns like drought or departures from average would keep 1000-hour fuels sufficiently low to prohibit burning for weeks to months, or that above average snowpack would push the summer burn window later into the calendar year, potentially causing competition for resources during fire season.

Overall, responses to these questions and general comments from respondents were indicative of a general awareness that climate trends, and their associated impacts

on variability in weather and fuels are important for prescribed fire. However, the fine-scale links may not well understood by the respondents, nor do they have the resources and opportunities to assess these climate links for potential future benefit.

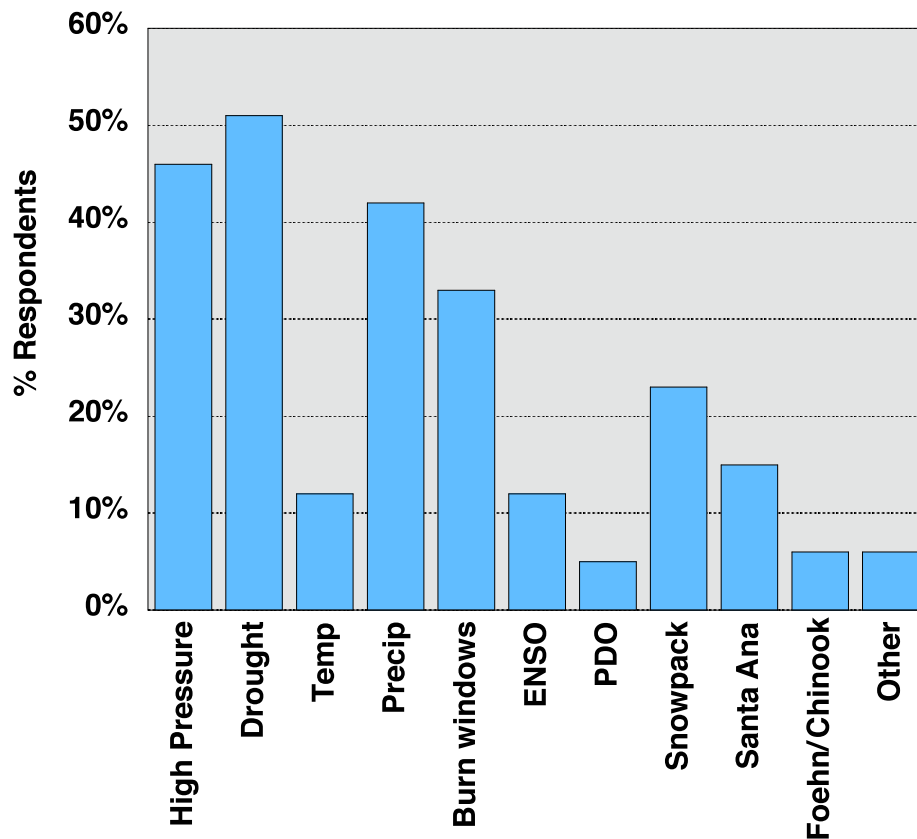


Figure 3.9. Percentage of respondents who indicated that each of the climate trends (high-pressure patterns, drought, temperature and precipitation departures from average, interannual variability of burn windows, ENSO, PDO, snowpack departures from average, and Santa Ana and other east winds) significantly impact their prescribed fire program.

### 3.4 Obstacles to using climate information

As described in the preceding sections, respondents indicated they are generally aware of the climate patterns that likely impact their prescribed fire planning and decision-making, and over three-quarters of them think that climate trends overall have a significant impact on their burning. They are not using much climate information in their prescribed burning program, however, and we asked a series of questions to determine those reasons. As previously described, the availability of climate information pertinent to prescribed fire appears to be somewhat limited, and if prescribed fire managers are not trained in locating and utilizing climate information, it is less likely they would be using it. But we also asked about obstacles to using climate information under the current structure of the national prescribed fire program, and

found that the current national structure is not conducive to utilizing climate information because it is inflexible to the interannual variability inherent in climate trends.

As previously described, we asked respondents what most influenced their prescribed fire planning, and their top answer was funding. Most respondents, particularly within the federal agencies, indicated that they receive a set amount of funding and a number of target acres each year, no matter what the climate conditions, and that they must attempt to spend all the funds and achieve the target acreage within the fiscal year. If targets are not met because of reduced burn window opportunities, the district is often punished by having to “return” the funding, and they receive less funding the following year. The other primary factors of prescribed fire planning were permits and resource availability, meaning that respondents were potentially unable to capitalize on burn window opportunities during a favorable year climatically because they were held up by permit acquisition or the inability to secure personnel and equipment for the burn (particularly prevalent during times when the wildfire activity and preparedness levels precluded resources from being available).

Respondents reiterated these types of obstacles when asked about the length of time between planning a prescribed fire and being able to complete it. On average, respondents have had to wait as long as 4.5 years to complete a planned burn, with many respondents indicating they have decades-old burns on the books that will likely never be completed due to restrictions. When asked why it takes so long to complete burns that have already gone through the planning process, one-third of respondents (33%) indicated that their prescription windows are so narrow that it is very difficult for them to find a burn window. While this answer is partially a result of climate variability, it is also indicative of how restricted prescribed burning has become, and that fire managers are severely limited by when they can burn based on perceptions of risk. An additional 15% of respondents noted that long-term droughts or pluvial periods (above-average water availability) reduced their ability to complete prescribed burns, but the remaining responses to this question (52% of respondents) consisted of obstacles to completing burns that were not related to climatic variability. Restrictions associated with the National Environmental Policy Act (NEPA) were cited by 11% of respondents, while 10% indicated that air quality concerns controlled burn opportunities. Other responses included endangered species concerns and calendar restrictions, external political pressures, and not being able to acquire appropriate resources for the burn. Of the 16% of respondents who answered “Other” and gave their own reasons, the majority of these free responses described internal politics within the agency that placed priorities on other programs before prescribed fire, and a general distrust or, in some cases, fully realized fear of prescribed fire use that prevented it from happening.

To follow up on the long-term causes that inhibit prescribed fire use, we asked respondents what the primary cause would be for why a burn might be cancelled at the last minute. While the top response (39%) was that it was out of prescription (further reinforcing how narrow the burn window parameters have become), the second response (24%) pointed to air quality agencies deciding to shut down the burn. An additional 18% of respondents noted that winds in excess of what had been forecast

prompted cancellation of a burn. While the first and third response to this question are products of forecasting problems, the second response is problematic from the stand point that air quality agencies can cancel a burn last minute with no repercussions to their agency, but with serious repercussions to the prescribed burn program if considerable effort and financial resources have been spent to acquire the appropriate personnel and prepare for the burn. Many respondents, particularly in California, noted sometimes strained relationships with the air quality agencies that dictate when prescribed burns can occur, often from cities over a hundred miles away from where the burn is scheduled to happen.

While the questions about obstacles provided some insight into why prescribed fire targets are often unmet, the free response discussion with respondents was equally revealing, particularly when some of the regional and agency trends began to emerge. Among the agencies, there is a gradient of willingness to complete prescribed fire and the priority it takes within the agency. For example, the National Park Service (NPS) has the oldest prescribed fire program, and the attitude within the agency that prescribed fire for ecosystem health is a necessity and a priority is evident in responses about obstacles. NPS has made public education about prescribed fire a priority, and the obstacles to completing burns more often come from a lack of resources during a busy summer wildfire season and air quality issues. This latter obstacle is perhaps the greatest for NPS prescribed fire programs, as visibility is one of the primary draws for visitors to the national parks.

The air quality issue for NPS was highlighted when Sequoia-Kings Canyon National Park was fined \$25,000 in 2004 for ignoring a no-burn order from the San Joaquin Valley Air Pollution Control District in order to finish a critical prescribed burn. The NPS prescribed fire program is so critical to meeting conservation management objectives that in 2000, after the disastrous escaped prescribed fire at Bandelier National Monument near Los Alamos, New Mexico, the entire program was banned from prescribed burning until March 2001. However, only two years later the program reached new annual records for prescribed fire acres completed ([http://www.nifc.gov/fire\\_info/prescribed\\_fires.htm](http://www.nifc.gov/fire_info/prescribed_fires.htm)). Based on our discussions with respondents, this mentality is being adopted across the Department of the Interior (DOI) agencies, but in the USFS in the Department of Agriculture, competing multi-use interests and a different attitude towards prescribed fire have slowed this transition.

While NPS and the DOI agencies have recognized the critical role of fire in ecosystems across North America both nationally and at the local level, the USFS has faced challenges abandoning the fire suppression mentality long held by many within the fire management ranks. This was evident in respondent answers to a question that asked what the top two objectives of the prescribed burning program were. While 68% percent of NPS respondents and 52% of other DOI respondents (BIA, BLM, FWS) indicated that ecosystem restoration was one of their top two objectives, only 39% of USFS respondents indicated that answer. Meanwhile, 100% of USFS respondents indicated that hazardous fuels reduction was one of their top priorities, along with 98% of other DOI respondents, but fewer (74%) of NPS respondents. This is not surprising

given that NPS prescribed fire programs were founded in the 1960s and 1970 on concepts of ecosystem restoration, while USFS has embraced prescribed fire as a tool to reduce fire risk in the Wildland Urban Interface areas. These attitudes were further exemplified in free response comments from many of the USFS personnel that their line officers and fire management officers were somewhat reluctant to utilize prescribed fire use because of the potential risk for escaped prescribed fires and the drain on resources to support the burn.

The shift to a more complex strategy of some suppression and some fire use has apparently been difficult to accommodate in the twilight of their careers according to some respondents. Many current USFS fire management personnel spent the early part of their careers in the 1970s and 1980s being trained in the “10 a.m.” policy and the agency objectives of suppressing all fires. However, the latest modification of existing fire policies to utilize Appropriate Management Response (AMR) tactics is meant in part to address this very issue.

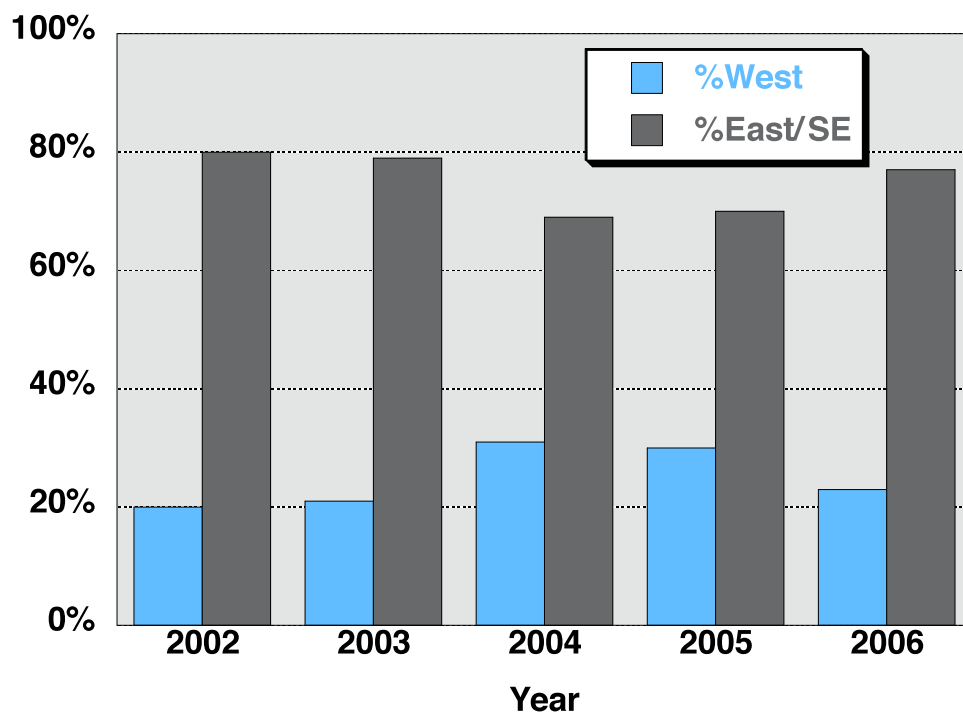
Regional differences also became apparent in both the results of the survey and the free discussion with respondents. While only 32 fire managers from the eastern portion of the U.S. (the Eastern and Southern GACC regions) were included in the survey, the differences in both management use of prescribed fire and public perceptions of fire use were evident in their responses. Those results are described in the next section.

### *3.5 East versus West*

Between 2002 and 2006, the amount of prescribed fire in the U.S. averaged just over one million hectares per year, but 75% of prescribed fire completed was attributed to the 33 southeastern and eastern GACC states (hereafter referred to as the Eastern U.S.). While these two regions hold only a fraction of federal land area managed in the 15 western states and Alaska, they are able to burn a substantial portion of the landscape each year (Figure 3.10). The majority of this prescribed burning takes places in the southeastern states, primarily in long-leaf pine forests and on prairie landscapes, with the northeastern prescribed fire efforts limited mostly to state and national historic parks (although our findings suggest that northeastern respondents had very similar answers to southeastern respondents, and all are best classified as East for purposes of our study). This is partially attributable to the efforts of Harold Weaver, Harold Biswell and other pioneers of prescribed fire in the longleaf pine forests of the southeast, where prescribed burning was recognized as a critical component of the ecosystem as early as the 1930s (Biswell 1989). These efforts have led to a public education campaign spanning multiple generations, and many of the respondents in these regions noted that the public is very accepting of prescribed fire on the landscape compared to the western U.S., often asking fire personnel how soon the burning will take place or requesting prescribed burns near their homes.

A comparison of survey responses between the two halves of the country revealed a few key differences between the regions that may help to explain why the

eastern U.S. completes the bulk of prescribed fire acreage each year. While 93% of prescribed fire acreage in the eastern U.S. is completed through broadcast and understory burns, only 59% in the western U.S. is broadcast burned, so a greater portion of time and available resources are devoted to pile burns over a smaller area in the West. There was little difference between the top prescribed fire objectives for each region (Figure 3.11a), but a key difference in what factors determine annual acreage targets in the planning process (Figure 3.11b). While most of the top factors were similar between the regions, only 3% of eastern respondents dealt with regulatory compliance issues, while 19% of western managers listed this as a top influence. This divergence was further observed in the primary cause for a late cancellation or postponement of a burn, as more western respondents cited not having enough resources or being shut down by air quality regulators, while more eastern respondents cited weather related phenomenon such as excess winds or being out of prescription (Figure 3.12).



*Figure 3.10. Percentage of prescribed fire treatment area completed by the Eastern and Southeastern GACC regions (gray columns) compared to the remaining nine GACC regions that comprise the western U.S. (blue columns) for the years 2002-2006.*



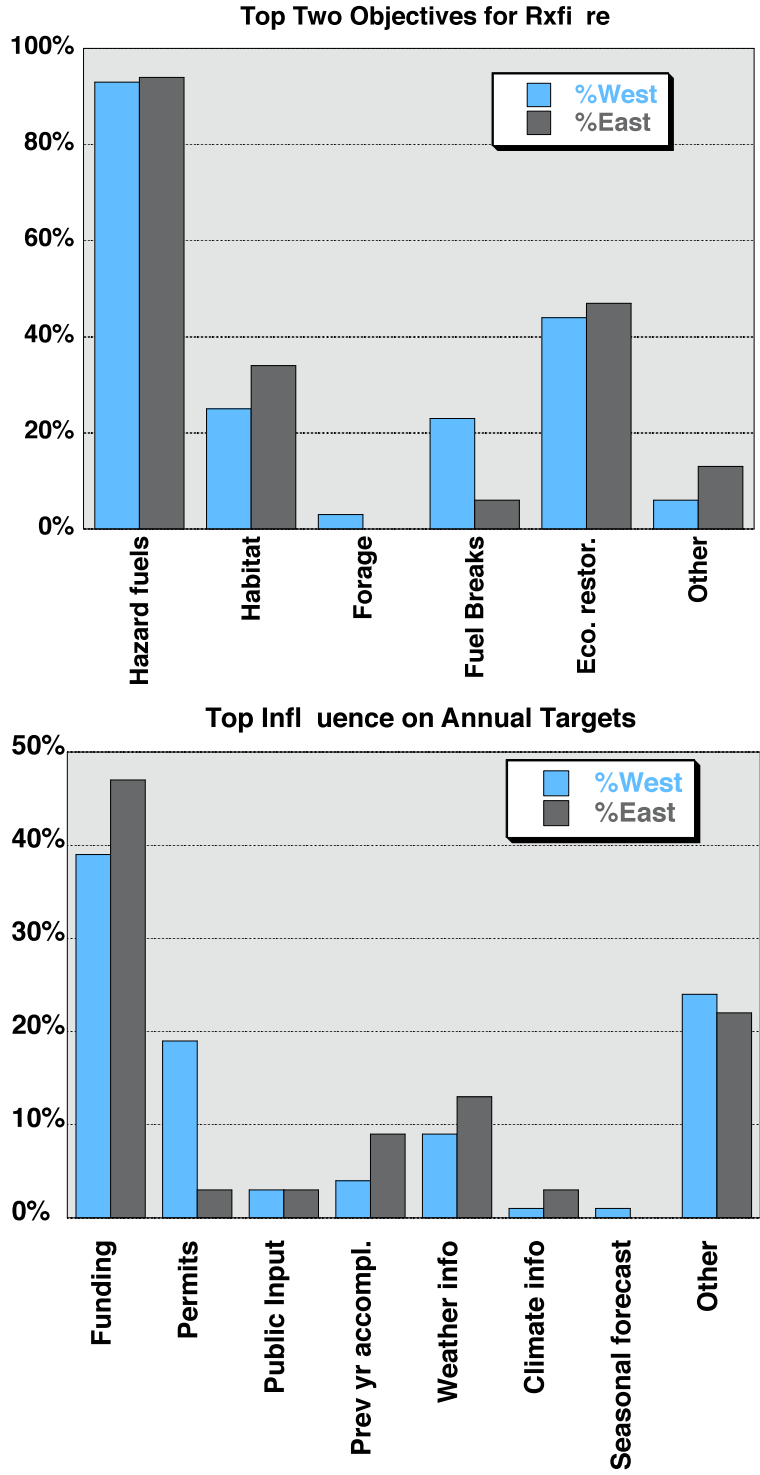


Figure 3.11. Percentage of respondents indicating whether an objective was one of their top two (top) and what the top influences on annual targets were (bottom) for both the western (blue columns) and eastern (gray columns) U.S.

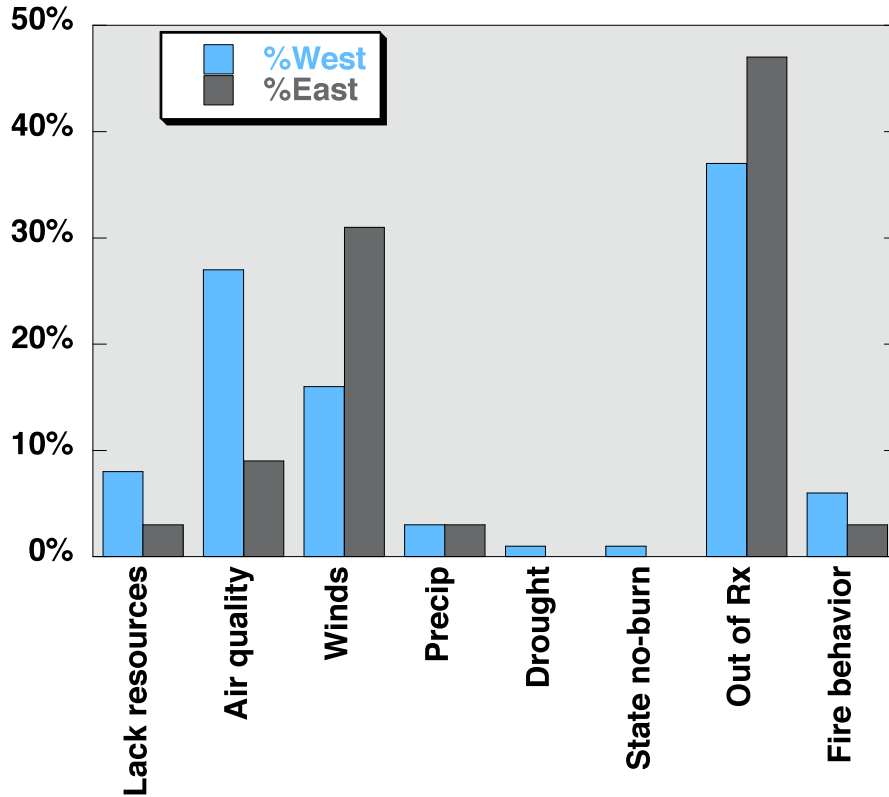


Figure 3.12. Percentage of respondents indicating the primary cause for having to cancel or postpone a burn at the last minute for the western (blue) and eastern (gray) regions.

Eastern respondents are not necessarily using climate information to get more burning done. Respondents in the eastern half of the country noted that they have far fewer information resources to support their prescribed fire efforts. Many noted that the forecast tools, fire models and fire danger rating systems are geared toward the western U.S., and that the primary source of information for prescribed fire is experience and NWS. The use rates of tools and climate information in prescribed fire planning and implementation are somewhat similar between the two regions (Figure 3.13), although there are several notable differences. These include the use of RAWs (96% West; 78% East), since eastern fire managers have considerably fewer RAWs available to them, and the use of Predictive Services products (49% West; 34% East). The disparate use of some climate indices was perhaps the most notable difference; seasonal climate forecasts (41% West; 25% East) and PDSI (31% West; 13% East) are more widely used in the West, while KBDI (24% West; 81% East) is overwhelmingly favored in the East. Overall, our results indicated a lower rate of climate information use among eastern respondents.

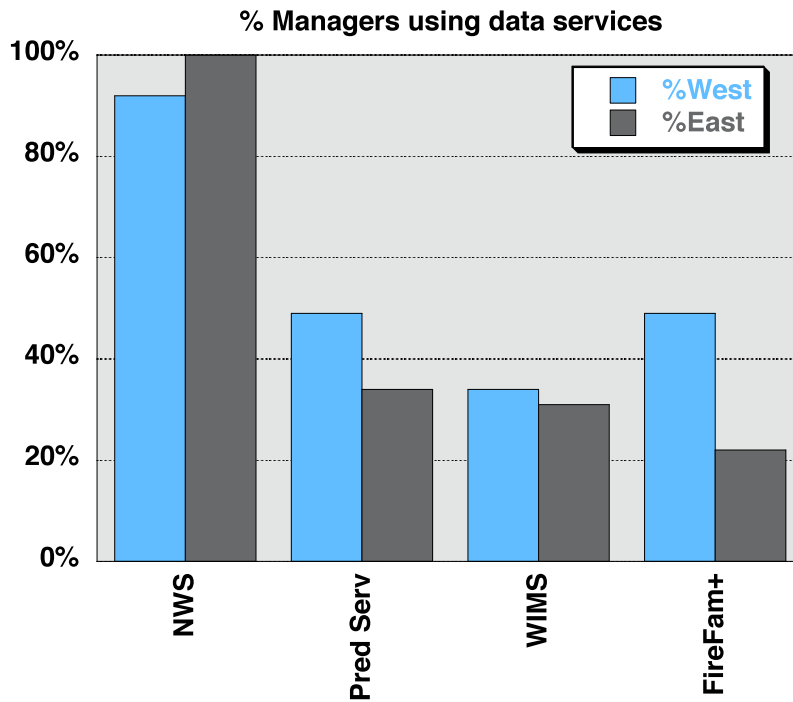
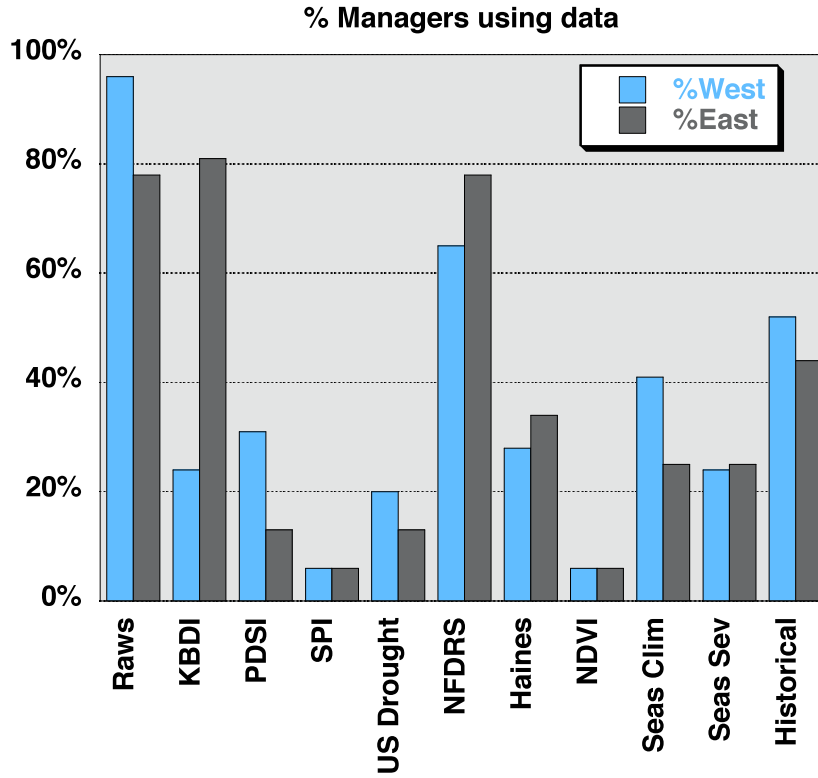


Figure 3.13. Percentage of respondents from the West (blue) and East (gray) using each type of data set (top) and information source (bottom).

Overall, the survey results do not paint a clear picture of the differences between western and eastern prescribed fire programs, and how each region is affected by climate. The ability of eastern fire managers to use prescribed fire extensively across the landscape was an oft-discussed topic during the free comment period of the interview, and as most western respondents had spent some time training with prescribed fire in the eastern U.S., common themes began to emerge from these discussions. As mentioned above, the public attitude towards prescribed fire in the East is far different from the West, but the agency attitude also appears to be more supportive of prescribed fire not just in the formal documentation, but in the day-to-day support via resources and cooperation between fire management and other personnel such as timber resources, wildlife, archeology, line officers and others. More important, however, were three critical factors that seem to favor prescribed fire completion in the East.

First, burn plans go through a more rapid approval process and have much broader windows that allow fire managers to burn during a greater number of days each year, and gives them the flexibility to consider a wider range of possible “good” conditions. Second, the western region essentially sees a near shutdown of prescribed fire during the summer wildfire season, based on public fear of fire and the push to make all fire resources available to fight wildfires instead of holding some in reserve for prescribed burning. Finally, support resources in the East are available year-round, while resource availability in the West is dependent upon hiring seasonal fire crews and having them trained but not yet assigned to wildfire suppression.

This issue of resource availability led to numerous respondents describing the trading system that occurs across the entire eastern U.S., where year-round crews travel throughout the region, and are shared across agencies and states such that if an optimal burning window occurs for a week or two in one area, prescribed fire crews are moved there *en masse* to complete the burning and then move on to the next area where a burn opportunity is occurring. This is in stark contrast to the western U.S., where respondents noted that sharing prescribed fire resources across agencies and state lines (much less across GACC boundaries) is rare, especially during wildfire season when resources are commandeered for wildfire suppression in different regions. Since wildfire Preparedness Levels rise as early as April in the Southwest and stay high as late as October and November in southern California, this means that the seasonal fire crews hired each spring in the West are unavailable while in training, unavailable as soon as PL levels begin to rise, and unavailable as soon as they are laid off at the end of the wildfire season in autumn. This does not allow national resource allocation priorities to support prescribed fire, and helps to explain why prescribed fire use will never play a major role in fuels treatment and ecosystem restoration in the West until the national support infrastructure is reexamined in the context of planned burning.

### *3.6 Requests and general discussion*

The results of the prescribed fire survey reveal several trends and opportunities for vastly improving the national prescribed fire infrastructure. While the original intent

of the survey was to determine how climate impacts prescribed fire use through the utilization of climate information in the planning and decision-making process, the results clearly indicate a much larger set of problems within the national prescribed fire program. To summarize:

- Prescribed fire managers receive inadequate training in climatology and its potential impacts on prescribed fire use
- Prescribed fire managers do not use much climate information to plan and implement prescribed burns
- Numerous obstacles make using climate information in prescribed burning irrelevant because regulations and restrictions preclude burning according to climatic variability
- Obstacles stem from both local fears of fire use and the potential repercussions of an escape to national lack of substantial support for prescribed fire programs
- Predictive Services does not provide enough prescribed fire support and information
- Eastern managers have more local and resource support than western managers, but have less climate information available to them because of a western focus in the national wildfire program

Respondents were asked what kinds of information they would like made available to support their prescribed fire programs. Many respondents described meteorological forecasts and tools, further indicating that attitudes towards prescribed fire use are based on short temporal scales and not the longer-term climatic scales. Many respondents, however, demonstrated an excellent understanding of how climate impacts prescribed fire use and fire behavior by requesting specific tools and information that would allow them to meet prescribed fire objectives within the parameters of climatic variability. The following points are a summary of these discussions and requests:

- NDVI is one of the most underutilized sources of data on fuels conditions and departures from average. Respondents noted that they perceive NDVI to be a valuable source of information about potential vegetation stress, and would like to have more decision-support tools to help them utilize NDVI. Only six percent of respondents utilize NDVI for prescribed fire planning and decision-making, however, even though the relative greenness (RG) index is a weekly product that can be compared over multiple years to assess departures from average. Respondents noted two major problems with these products. First, users cannot “zoom in” on their specific location or readily download data values for a specific location to better assess conditions. Second, since users cannot easily acquire the location-specific NDVI data, it is difficult to establish links between NDVI, RG, and successfully meeting prescribed burn objectives by looking at time series or historical trends in RG. Many respondents noted that NDVI might be useful for prescribed burns that depend on green-up or brown-down, but that they do not have the training or ability to fully utilize NDVI to its potential.

- While many respondents acknowledged that they see trends in burn window availability, they are unsure of how this is linked to climate, and how these linkages can be used to predict future burn windows, because this type of research has not been completed. CEFA is currently working on a prototype system that will allow prescribed fire managers to look at historical trends in burn windows and use a long-lead forecast to assess potential burn windows for the current burn season.
- Fuel moisture (both live and dead) is a critical input to fire behavior and fire effects during prescribed burns, but at the time of the surveys, there was no cohesive national strategy for monitoring fuel moisture levels and making that data available regionally or nationally in digital format. An effort is currently underway to do this, but has been slowed by lack of resources. Additionally, the effort is geared towards a national fuel moisture monitoring program to support wildfire prediction and suppression, and would only run for the months during the summer wildfire season. Numerous respondents asked for a comprehensive national fuels monitoring program that is supported year-round, and has an interactive component that would allow fire managers to access maps and data for their area of interest to determine when fuel conditions are appropriate for burning.
- Education was requested across the board. While fire managers undergo an extensive amount of training pertaining to wildland fire suppression, there are limited courses devoted to understanding not only the safety aspects of prescribed fire, but also how the climate and fuels relationship dictates the ability to meet prescribed fire objectives. Additionally, many respondents requested training on the products available from Predictive Services and how those products could be used for prescribed fire needs.
- Also related to products and Predictive Services, many respondents noted that there is no single website that they can turn to for prescribed fire resources and indices. For wildfire, the WFAS website and the Predictive Services pages contain the vast majority of information relating weather, climate and fuels conditions to wildfire suppression concerns. While these two sources of information are also useful to prescribed fire, they are primarily based on the worst-case scenario conditions, and less directly applicable to prescribed fire. There is no central location like this for prescribed fire, and many of the regional Predictive Services websites shut down during the winter and spring, precisely when prescribed fire managers need the information available on them.
- The Haines Index is another source of information that is poorly understood in terms of prescribed fire. Many respondents have observed trends in their prescribed burning related to the Haines Index, but like the NDVI and RG images on WFAS, the Haines Index data are only available as a non-zoomable image and are not readily available for download and analysis.

## 4. Results of Wildland Fire Use Survey

In 2005, we implemented the WFU Survey with the intent to understand whether WFU managers deal with some of the same issues as prescribed fire managers when it comes to making decisions about using fire to meet resource objectives. We found some similarities, but many striking differences between the two groups in terms of how climate information is utilized, and what the external obstacles and influences are when WFU can be utilized.

### 4.1 About the respondents

The 31 respondents to the WFU survey come from four federal agencies (USFS, NPS, FWS, and BLM) and 11 states. Only two of the respondents work in the eastern half of the U.S., which is no surprise given that the bulk of wilderness areas and national parks approved for WFU are in the western U.S. Alaska deserves some explanation, as the entire state is categorized into four fire suppression zones, and any fires occurring in the limited suppression areas are managed essentially as WFU events. Only one respondent was only qualified as a wildfire Incident Commander, while 43% of respondents were qualified as a Type 2 Fire Use Manager (FUM2), and over half (53%) were qualified as Type 1 Fire Use Managers (FUM1). Collectively, the respondents have an average of 25 years of wildland fire experience (range of 12-35 years), and an average of 12 years of WFU management experience. They have managed an average of 42 WFU events (range 1-150), with one-third (32%) having managed over 50 WFU events, and 19% having managed more than 100 WFU events. Only one-quarter (26%) of the respondents have received some sort of advanced training or coursework in climatology, but as their answers below indicate, this has not prevented most of them from self-educating on the links between fire and climate, and using that knowledge in their WFU management. The group of respondents, therefore, might be characterized as having a high level of expertise, but the expertise is attributed primarily to professional experience and longevity of the individuals in the WFU programs. It should be noted that over half of the respondents indicated they were originally trained in WFU management at one of the two long-running WFU programs in the Northern Rockies region: the Selway-Bitterroot Wilderness and the adjacent Frank Church/River of No Return Wilderness.

### 4.2 Pre-season planning for WFU and assessment of conditions

Seven questions were asked to determine how much pre-season planning occurs with regards to WFU. Almost all respondents (94%) indicated that they meet with their Fire Use Management Team, both locally and nationally where applicable, prior to the start of the fire season to discuss current conditions, and how those conditions may impact the potential to use WFU. Respondents indicated that the tools and products they utilize most to help them assess conditions include (Figure 4.1) seasonal assessment outlooks from Predictive Services (87%), the Keetch-Byram Drought Index (65%), the Palmer drought indices (74%), historical data (94%) and other tools from the Wildland Fire Assessment System (WFAS) website (65%). The

Standardized Precipitation Index (SPI) is used by just over one-third of respondents (36%), although this is a considerable increase over the mere 6% of prescribed fire respondents who utilize SPI. In addition, over one-third of respondents (36%) indicated an additional source of information or tool that they utilize extensively when looking at WFU potential, with indices such as Energy Release Component (ERC), relative greenness (RG), and the Canadian Forest Fire Danger Rating System (CFFDRS) used by multiple respondents. Respondents were also asked the relative importance of information on climatological trends such as the El Niño Southern Oscillation, drought, pluvial events, and anomalous conditions in the pre-season planning stages. Most respondents (74%) indicated that climate information was very important to them for assessing WFU potential, while 23 percent felt that it was somewhat important. Only one individual did not feel that climate information was important for WFU planning.

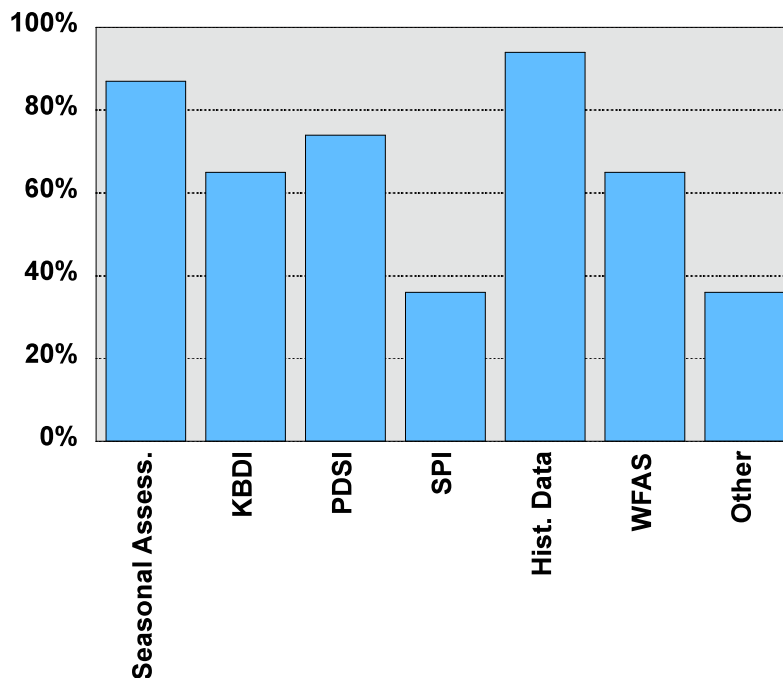


Figure 4.1 Percentage of respondents who utilize each type of climate information for pre-season assessments of WFU potential.

#### 4.3 Use of climate information during WFU event

Fourteen questions were asked relating to management of WFU fires with regards to utilization of climate and weather information at various stages of the event. During Strategic Fire Size-up, 90% of respondents consider the current climatic conditions to help them make decisions. Respondents were specifically asked about the importance of climate conditions in designating the Maximum Manageable Area (MMA), and 48% indicated that climate conditions are very important in designating the MMA, while 39% felt that climate conditions are slightly important, and the remaining



13% did not think information on climate conditions was important or should be utilized in designating the MMA.

The Federal Wildland and Prescribed Fire Management Policy Guide states that once a WFU event has progressed to Stage III (long-term planning), a Wildland Fire Relative Risk Assessment must be completed. Three specific components of this Risk Assessment address climatic influences on fuel conditions and resulting fire risk. WFU managers must determine Probability Levels for Time of Season (whether the incident is occurring in the early, middle or late part of the fire season), Probability Levels for Seasonal Severity (whether severity conditions are low, high or extreme), and the type of drought that is currently being experienced (this is a component of the Probability Levels for Seasonal Severity). For each of these three components, respondents were asked what information sources they find most useful or utilize most frequently to complete these sections of the Risk Assessment.

To determine Probability Levels for Time of Season, respondents reported that they utilize a variety of information sources (Figure 4.2), with most frequent answers including local knowledge (52%), historical data (48%), and ERC (39%). ERC (65%) is also the most utilized information source for determining Probability Levels for Seasonal Severity, followed by historical data (29%) and the Burning Index (BI) (29%). PDSI (45%) is the most utilized resource for determining the type of drought currently being experienced, followed by KBDI (42%), Predictive Services forecasts (23%) and BI (23%).

Respondents were also asked about specific resources that are widely used in fire management and available to them to help with assessing current conditions. First, we asked respondents if they collect fuel moisture samples on WFU fires; 1-, 10- and 100-hour fuels are regularly collected by 52%, 55% and 45% of respondents, respectively, and 1000-hour fuels are collected by 77% of respondents. Live herbaceous fuel moistures are collected by 74% percent of respondents, while 65% collect live woody fuel moistures as well (Figure 4.3). Second, we asked fire managers if they use a variety of resources to assist them with making decisions about and management of WFU incidents. Several resources have a 100% use-rate among respondents (RAWS data, seasonal climate forecasts, National Weather Service forecasts, Predictive Services forecasts, historical weather data, FireFamilyPlus, and local knowledge), while seven additional resources had high (>70%) rates of use. These included (Figure 4.4) NFDRS indices (97%), seasonal severity maps (87%), the Haines Index (84%), PDSI (77%), the US Drought Monitor (74%), and KBDI (71%).

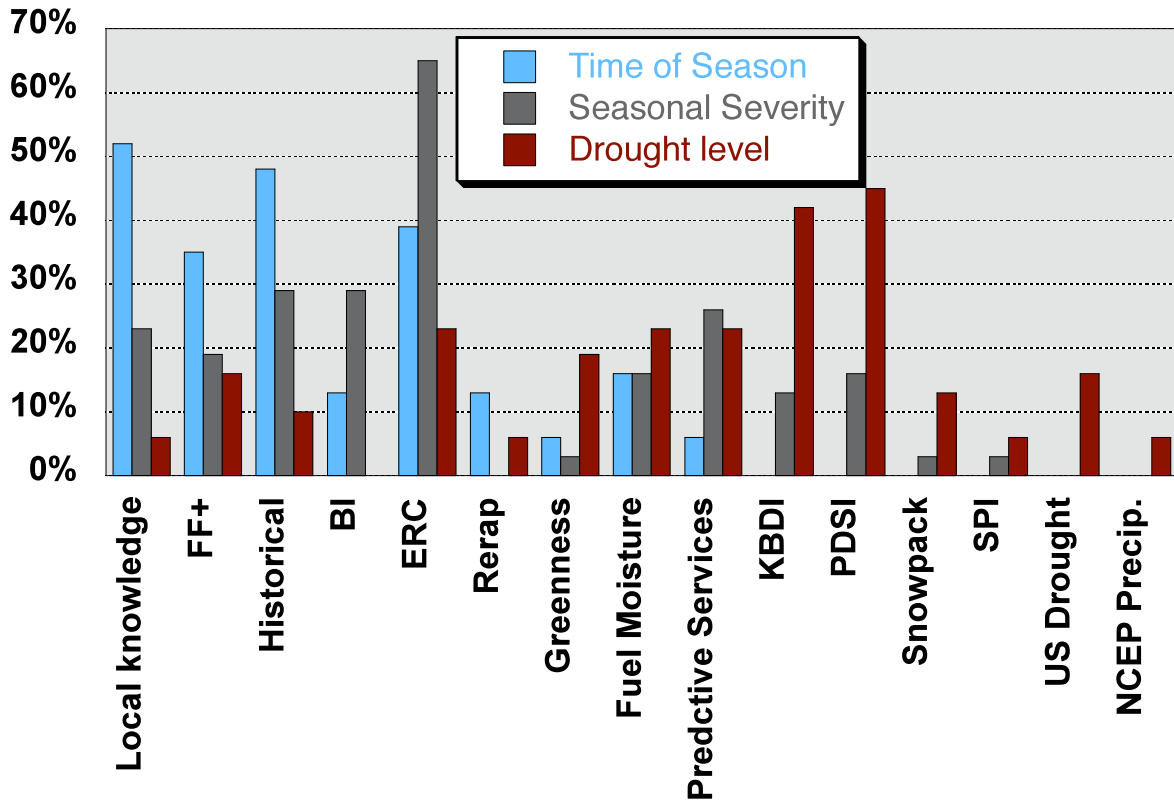


Figure 4.2. Percentage of respondents who utilize each source of information to determine Time of Season (blue), seasonal severity (gray), and drought level or seasonal severity (red) for Stage III of the WFIP.

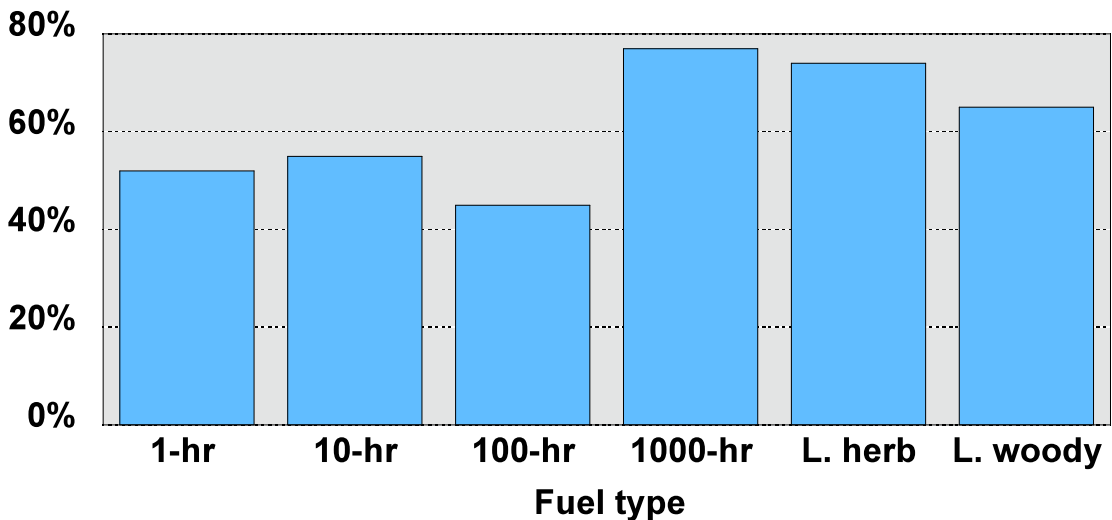


Figure 4.3. Percentage of respondents who collect and/or utilize fuel moisture measurements for each fuel moisture type to assess conditions for a WFU event.

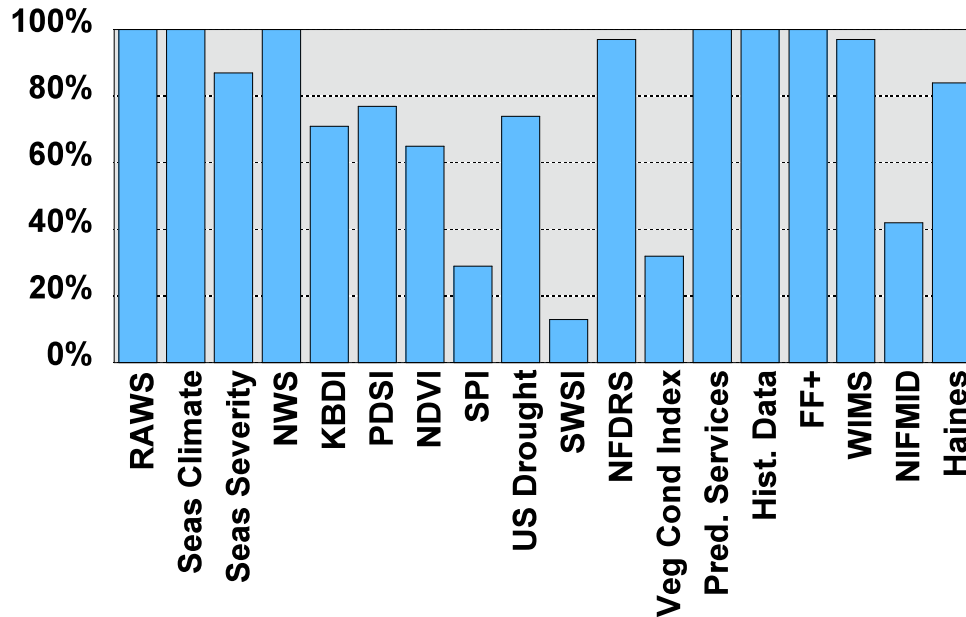


Figure 4.4. Percentage of respondents who use each type of information source for WFU incident decision-making and management.

#### 4.4 Obstacles to using climate information in WFU

Respondents were asked two questions about a wider range of external influences that impact WFU decision-making. First, they were asked to rank the top influences on WFU decision-making, particularly with reference to the MMA designation and management actions taken. Over half (52%) of the respondents indicated that public inputs and the general political climate locally (both within the agency and in the locality) have the greatest impact on management of WFU (Figure 4.5). The second most cited influence on WFU management was the location of the ignition and the time of year (35%). Several respondents noted this influence as a reference to both physical conditions (i.e., spatial location, climatic conditions, seasonality) and political conditions (i.e., impacts to communities, whether there are multiple WFU events or suppression wildfires already going and resources are unavailable). An additional 13% indicated that WFU management actions and decisions are primarily based upon how comfortable the local line officer is with WFU.

Second, respondents were asked about reasons why a WFU event converts to a suppression incident. The primary reason cited by respondents was that the fire exceeded the MMA (58%), although 19% of respondents answered that they had not yet converted a WFU event to a full suppression incident. These two questions are good indicators of how important climate is in the management of WFU, particularly with regards to decisions about when to convert to full suppression. For the first question, impacts on WFU management, public input and political climates may be indirectly affected by climatic conditions because of a drought situation, or a locally intense and high profile wildfire season driven by climate may influence opinion negatively towards

allowing fires to burn unsuppressed on the landscape. Personnel availability, line officer comfort levels and staffing are also impacted by the wildfire situation. Respondents answering that time of year influences their decisions raises an interesting question about whether a mental “cut off” date is adjusted for perceived climatic conditions. If, for example, they would not normally allow a WFU event in early July, but the current year is abnormally cool and wet, do they adjust their tolerance for the less risky conditions? This survey did not ask this specific of a question, but our results and discussions seem to indicate that this is exactly the reason WFU personnel utilize climate information - so they can assess the current situation in the context of climate, and not simply go by a calendar.

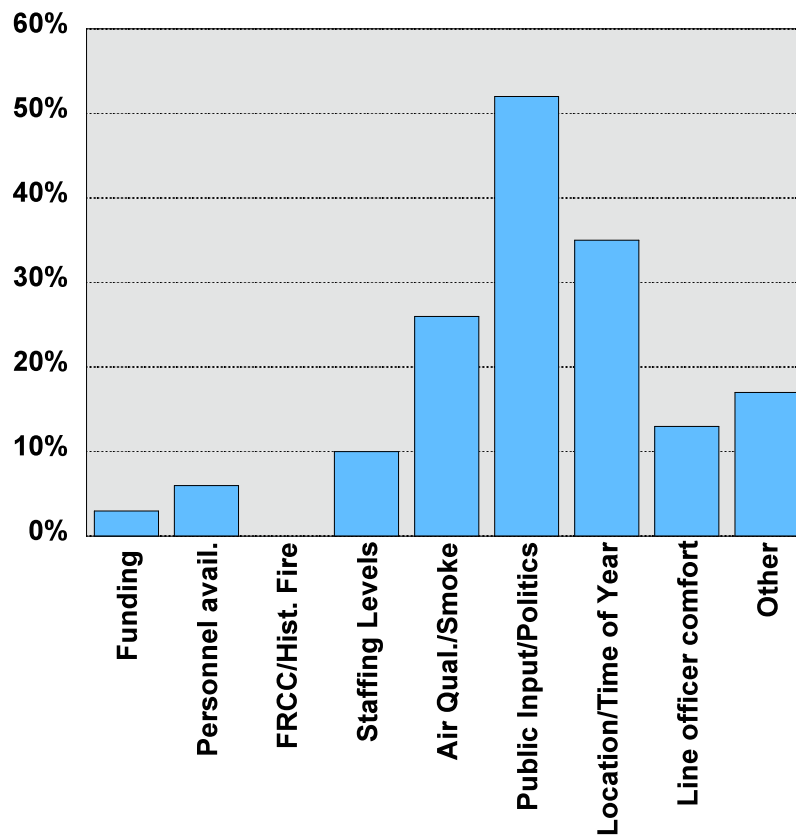


Figure 4.5. Percentage of respondents for whom each factor was the top influence on WFU decision-making and management.

The second question about reasons for conversion to full suppression brings up an interesting point regarding setting MMA boundaries. There are two approaches to determine an MMA. One is to use a rigid boundary or polygon size for an area that depends on topographic or political features to determine the boundaries. The other, more flexible approach is to assess the current conditions (i.e. climate, public support, resource availability), and determine how large you are willing to let the WFU fire get so that it does not escape control or fail to meet resource benefit objectives. In a previous

question, we determined that 87% of respondents think that climate information on trends and teleconnections is very important for setting MMA size (the second approach), while 13% said that climate information is not and/or should not be used to set the MMA (the first approach). This means that most of the respondents take the second approach, and utilize climate information to MMA size based on expected fire behavior under current climate conditions. For example, drought conditions may influence the MMA size through one of two avenues: 1) either the MMA is set smaller to reflect that the resources available can only manage a smaller area of potentially more extreme fire behavior; or 2) the MMA is set larger to reflect that a wildfire will naturally burn across a greater area when conditions are conducive to greater fire spread and consumption.

If 58% of respondents indicate that their WFU fires are converting to suppression fires due to exceedance of the MMA, we suggest that this means one of two outcomes. One, the managers set the MMA exactly the right size using the best climate and weather information available to predict fire behavior and effects perfectly leading to a successful WFU that intentionally converts to suppression when the MMA area has been burned. Two, the managers miscalculated the MMA size based on inadequate information or model, and consequently the WFU was unsuccessful because it was not supposed to exceed the MMA, but did. For either of these outcomes, we suggest that climate information is a critical role in both setting the correct MMA size for conditions, and ensuring that the WFU is successful within the MMA, whatever the resource objective may be.

In comparison to the results of the Prescribed Fire Survey discussed earlier, WFU fire managers are able to better utilize climate information for planning and decision-making on WFU incidents. This stems from their vastly greater experience in managing WFU fires, and fewer political obstacles to using WFU as compared to using Prescribed Fire. WFU managers have a better overall understanding of climate impacts on WFU, and the majority expressed a desire to have even more tools available to them for assessing climatic situations and the potential for WFU. This desire for more tools is partly due to the lack of standardized tools targeted specifically to WFU management, but also based on their own acknowledgement of the role that apprenticeship and the oral tradition has played in the training of WFU managers. A few respondents actually noted that they regularly consult the retired personnel that founded the early WFU programs, and they will lose an immense resource in the near future when these personnel are gone.

#### *4.5 Requests and general discussion*

As with the prescribed fire survey, a free response and comment section was made available to respondents, and each respondent was asked what types of information resources they would like to see made available for WFU planning and management. Similar to the prescribed fire managers who took the survey, many WFU respondents indicated that a tool kit of resources specifically geared towards WFU

would be the most helpful. While the WFU respondents generally used more climate information than their prescribed fire colleagues, they also acknowledged that much of their decision-making is based on experience and the oral tradition of their particular program. They also requested more in the way of new products, and better support to share information both with the public and with their peers as an education process. For example, two requests that came from multiple users and were focused on education were: 1) having webcams on WFU events to chronicle the event, and make that story available to the public and other agencies; and 2) having a seasonal assessment workshop specific to WFU (much along the lines of the National Seasonal Assessment Workshop for wildfire).

Overall, the requests made by WFU respondents were reflective of the sentiments held by prescribed fire respondents as well that the current tools and information sources available for assessing fire-climate conditions that are geared towards wildfire and not as useful for fire use programs. This is because wildfire assessment tools (such as the risk maps found on the WFAS website) are built for the worst-case scenario, but for decision-making on fire use events, a range of possibilities, not just worst-case scenario, is desired. Other, more specific requests from users included:

- Trends and analysis of time series for Haines Index. Respondents suggested observed links between Haines index values and both potential and realized fire growth, but Haines images are not currently archived as a dataset for research.
- Several respondents suggested soil moisture information as a potentially good indicator for WFU fire.
- Having better communication with Predictive Services outside of the “traditional” fire season is a request from numerous respondents. Even during fire season, Predictive Services is often focused heavily on suppression and not available for WFU.
- Need better fuel moisture information. They need more localized information than the coarse national maps, either through local sampling or map derived from remote sensing and validated locally. Expanding the Great Basin fuel moisture monitoring network and making it pertinent to WFU would be helpful.
- NFDRS threshold maps specific for WFU requirements would be useful, since most of the respondents use NFDRS, and ERC in particular, for WFU decision-making.
- Better smoke forecasts (i.e. inversions, dispersion and trajectory of impacts), to minimize negative impacts to communities and places where air quality is high priority (such as scenic national parks).

## 5. Summary and Conclusions

The two surveys of prescribed fire and WFU managers were originally meant to ascertain whether climate impacts fire use through the integration of climate information into planning and decision-making prior to and during fire use events. Our reasoning was that climate has an effect on fire use through two primary paths. First, if climate information is not used, interannual variability and climate trends will determine how much fire use is completed based on rigid standards for fire use (such as weather parameters, burn windows and NFDRS thresholds). Second, if climate information is used, fire use patterns will be adjusted by fire managers both spatially and temporally based on fuel conditions. Since there is a temporally limited data set for both prescribed fire and WFU area burned, we determined that it would be difficult to quantify and disaggregate climate impacts on area burned under fire use, and initiated the survey to determine use levels of climate information, essentially answering the climate impacts question from a social science perspective.

Resulting from these surveys was much more than a simple determination of whether or not climate information is used. We found that there is a distinct difference between prescribed fire management and WFU management in terms of whether climate impacts on fire use are understood, the utilization of actual climate tracking tools (Figure 5.1) and the constraints on using climate information based on the national support of the fire use programs. Overall, climate information is severely underutilized in prescribed fire planning and implementation, but this is a result primarily of how prescribed fire programs are funded on an annual basis, and restricted by staffing, air quality and regulatory issues. The reality for most prescribed fire managers is that they must try and burn as much as they possibly can each year within a wide range of restrictions, and do not have the flexibility to burn conservatively if it is a bad year climatically, or burn extensively if it is a good year climatically.

At the national level, fire use has been touted as the “natural” and cost-effective way to treat millions of acres considered hazardous. However, while the national level of prescribed fire use has increased from just over a million acres each year in 2000 to a projected three million acres more recently, the majority of this increase is attributed to the southeastern GACC. There has been little increase in prescribed fire in the western U.S. where most of the hazardous fuels dollars and publicity have been targeted. This is demonstrated particularly well in the interannual variability total area burned in the U.S. under prescribed fire, which runs parallel to the interannual variability in the southeastern GACC accomplishments (Figure 5.2). Annual trends in area burned per fire also reveal no increase in the number of acres burned per fire, despite considerable efforts to complete more acreage targets (Figure 5.3).

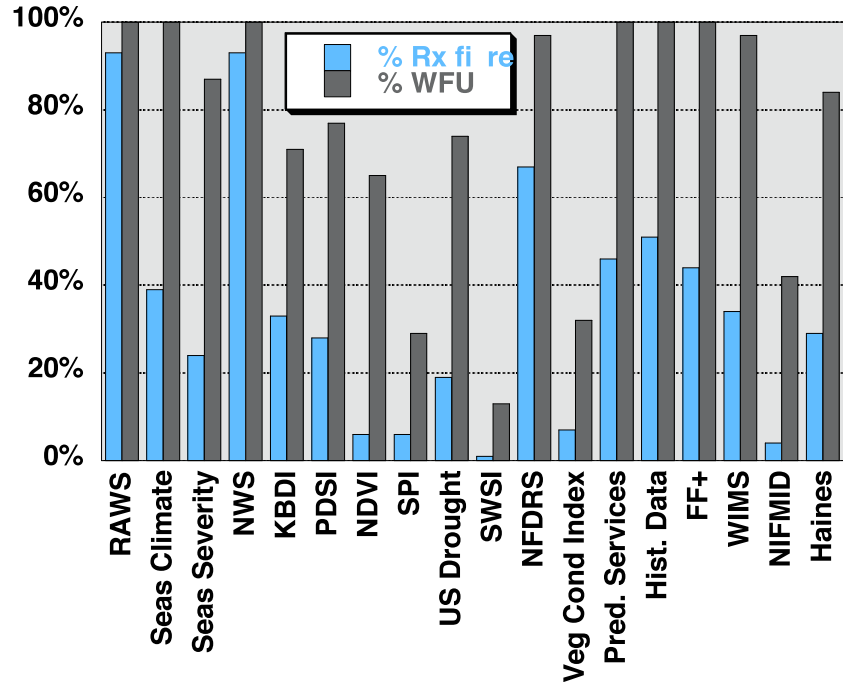


Figure 5.1. Use levels for a variety of indices and tools for both prescribed fire (blue) and WFU (gray) respondents indicates much greater use rates in WFU, particularly for long-term climate trend trackers.

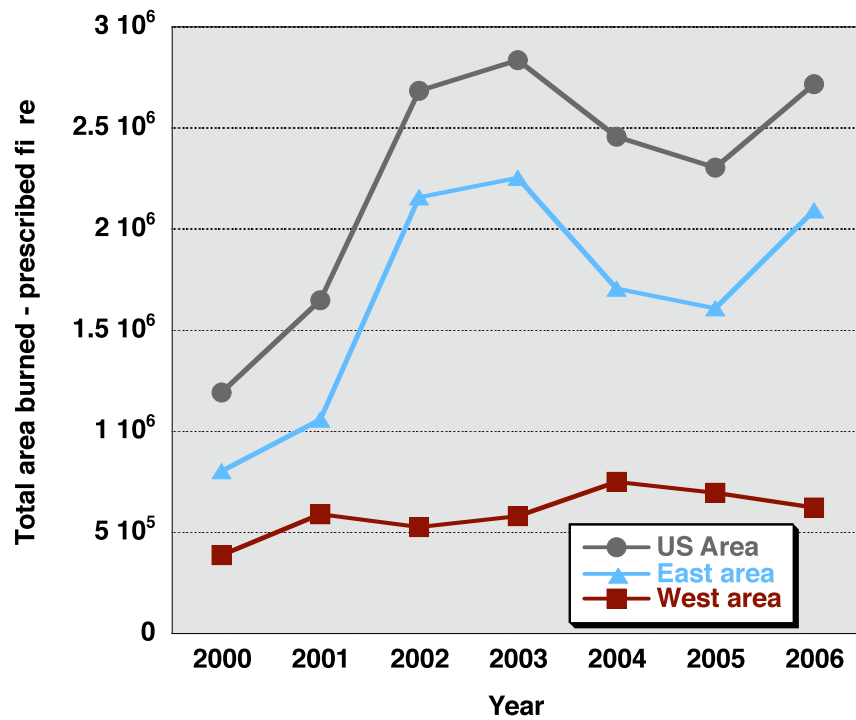


Figure 5.2. Trends in prescribed fire for the total area burned between 2000 and 2006 in the entire (gray circles), eastern (blue triangles) and western (red squares) U.S.



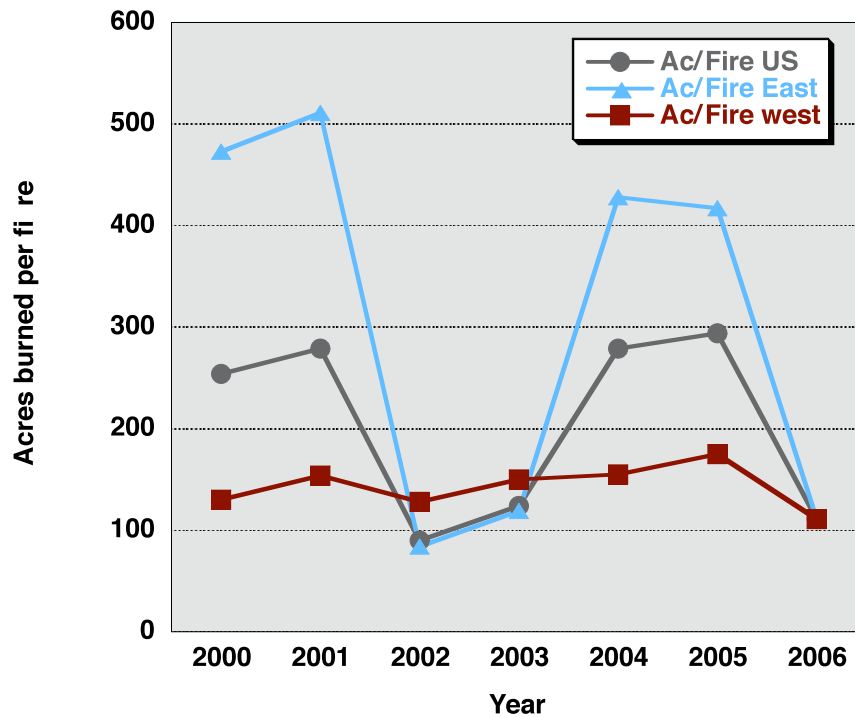


Figure 5.3. Trends in prescribed fire for area burned per prescribed fire between 2000 and 2006 in the entire (gray circles), eastern (blue triangles) and western (red squares) U.S.

These results indicate that while there has been considerable progress, there is still much work ahead in order to fully realize the potential of prescribed fire and WFU. At the national level, increasingly higher targets are being set for managed fire, partially based on its past successes. But the reality of climate change, and how it will impact opportunities as well as risk management for prescribed fire and WFU, bring to light the need to continue exploring opportunities to integrate climate information into planning and implementation of these fires. Incorporating climate information allows fire managers to better predict windows when risk is low and the chance for success is high, but efforts must be supported at the national level by policy, and the local level through training and operational support. Agencies need to continue to emphasize climate impacts and the importance of using climate information in order to use the managed fire “tool” to its fullest and most powerful capabilities.

Fire managers are having difficulty in meeting desired annual targets and management objectives, especially for prescribed burning in the West. There are several human factors for this related to funding, permits and public input, but climate is also playing an important role. There are physical climate impacts that affect outcomes from shifting burn windows to anomalous dry or wet conditions that inhibit operations. Climate can allow for effective burning to take place, but it can also increase the risk of an escaped burn or exceeding MMA boundaries. Not using climate information in the planning process omits an important component of fire management given fire’s relation

to climate. We offer below some recommendations in no particular order for improved utilization of climate information in managed fire:

- Climate must be recognized as an important component of management fire, from the local level up through federal fire policy.
- There should be a climate element in the prescribed fire planning process and the Go-No Go checklists.
- Climate training should be offered in several fire management training courses, especially those that are related to management fires. Topical climate training courses for Fire Behavior Analysts, Long-Term Analysts and prescribed burn bosses should also be developed.
- Predictive Services and collaborators have done some applications work in improving the understanding of climate and prediction for the Geographic Areas, but this effort should be increased and nationally supported.
- A process should be established to deliver the science from the recent increase in the number of fire-climate studies to fire managers.
- Consideration should be given to how climate change might impact the management objective of a managed fire.
- National policy should be more flexible allowing prescribed burning to be more opportunistic given the interannual variability in environmental conditions associated with climate.

## **6. Acknowledgements**

We wish to thank all of the participants who participated in this survey and freely gave their time and thoughtful insight on fire use programs and situations that, for many, have been both their passion and a source of great frustration to them over the years. Every single individual who was asked to participate in the surveys during the initial cold phone call agreed to do so, and many provided additional information such as burn plans and examples of local solutions to the issues they face. A participation rate of 50% is considered phenomenal for surveys, and we had nearly 100% participation from a group of people who evidently care very much about the landscapes they manage. We also thank Paul Schlobohm for his continued support of this project and helpful review of this manuscript. This work was done under BLM Task Order 14 supported by the National Interagency Fuels Coordination Group.

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## APPENDIX A: Prescribed Fire Survey Questions

### PRESCRIBED FIRE SURVEY PROGRAM FOR CLIMATE, ECOSYSTEM, AND FIRE APPLICATIONS DESERT RESEARCH INSTITUTE, RENO, NEVADA

Please answer all questions as completely as possible. Your answers will remain anonymous, therefore, I ask you to be honest. If a question does not apply to you or you don't know, please answer "Don't know" or "Not Applicable".

Agency: \_\_\_\_\_

National Forest/National Park/BLM district/etc.: \_\_\_\_\_

#### Part I. *Information about your position.*

1. How many years have you been involved in the prescribed fire program at this location? \_\_\_\_\_
2. Have you been involved in the prescribed fire program at another location? \_\_\_\_\_  
 If so, what GACC region? \_\_\_\_\_

#### Part II. *Information about your prescribed fire program.*

**By "prescribed burning," I mean fires that are planned and intentionally set, including broadcast burns, pile burns, etc.**

**By "WFU," I mean Wildland Fire Use, previously known as Prescribed Natural Fire (PNF).**

3. Over the last few years, approx. what percentage of **acres** was burned by each type of prescribed fire at your current location? (Please make sure percentages total 100%.)  
 Broadcast/underburning \_\_\_\_\_  
 Pile burning \_\_\_\_\_  
 Wildland Fire Use \_\_\_\_\_

**The remaining questions in this survey apply only to prescribed burns. If 100% of prescribed fire acreage comes from Wildland Fire Use, please stop here.**

4. What percentage of your prescribed burning is performed in each season? (Please make sure percentages total 100%.)

- Fall (September - November) \_\_\_\_\_
- Winter (December - February) \_\_\_\_\_
- Spring (March - May) \_\_\_\_\_
- Summer (June - August) \_\_\_\_\_

5. What are the **TWO** most common objectives of the burns your program performs? (Check one or two answers)

- Hazardous fuels/vegetation reduction
- Habitat improvement
- Increase forage production for livestock
- Creation of fuel breaks (such as greenstrips, shaded fuel breaks, DFPZs, etc.)
- Ecosystem restoration (including mimicking natural processes)
- Other \_\_\_\_\_
- Don't know/ Not applicable \_\_\_\_\_

### Part III. *Planning Prescribed burns*

6. What factors have the most influence on the amount of acres or burns you *target* for burning each year? Please **RANK** (1 through x) all of the factors that affect your planned acreage.

- \_\_\_ Funding
- \_\_\_ Permits (NEPA, air quality, EIS approval, city/state approval)
- \_\_\_ Public input
- \_\_\_ Number of acres/burns completed the previous year
- \_\_\_ Weather information
- \_\_\_ Climate information
- \_\_\_ Seasonal climate forecasts
- \_\_\_ Other \_\_\_\_\_
- Don't know/ not applicable

7. For your location, what is the *minimum* amount of time that must elapse between initial completion of a Prescribed Fire Plan and the completion of a burn (due to approval or NEPA process)?

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8. For your location, what is the *maximum* amount of time that you have seen elapse between planning and completion of a burn (if your answer is more than 10 years, please answer 10 years)?

---

9. What is the primary factor that lengthens this lapse period? (Check only one)

- NEPA
- Air quality concerns
- Environmental concerns (species issues, lawsuits, etc.)
- Political pressure (politicians actively preventing burn plan approval or completion)
- Very strict prescription parameters- it's hard to get a burn window
- Long-term drought or wet period
- Inability to acquire resources for burn
- Other

---

Don't know/ Not applicable

10. What resources do you use when planning prescribed burns, from the initial planning process right up until the burn day (Check all that apply)

- RAWS data
- Seasonal Climate Forecasts
- Seasonal severity maps
- National Weather Service Forecast
- Keetch-Byram Drought Index (KBDI)
- Palmer Drought Severity Index or Palmer-Z (PDSI)
- NDVI
- Standard Precipitation Index (SPI)
- US Drought Monitor
- Surface Water Supply Index
- NFDRS output (i.e. ERC, BI, SC)
- Vegetation Condition Index
- ECPC Forecast
- Predictive Services (if so, what GACC location(s)?

\_\_\_\_\_)

- Historical Weather data
- FireFamilyPlus
- WIMS
- NIFMID
- Haines Index
- Other

---

Don't know/ Not applicable

11. If you utilize RAWs data or historical weather data, how much data did you use on your most recent prescribed burn? (Check only one. Example: if your burn was on October 31, 2003 and you used RAWs data from October 15<sup>th</sup> to burn day, you would answer "1 week to 1 month prior to burn")

- less than 1 week's worth of weather data prior to burn
- 1 week to 1 month prior to burn
- 1 to 3 months prior to burn
- 3 to 12 months prior to burn
- 1-2 years prior to the burn
- more than 2 years prior to burn
- I don't generally use RAWs data or historic weather data
- Don't know/ Not applicable

12. How would you describe the information and products available at your GACC's Predictive Services? (Check only one)

- It provides great forecasts, data, etc.; my data needs are met
- It provides some information for us
- I don't use the products much because the products don't work for my area
- I don't use the products much because I get better products from somewhere else
- I don't use Predictive Services because I'm not aware of what products are available
- Don't know/ Not applicable

13. How would you describe the information and products available at your NWS office (check only one), which is (please fill in the blank)

- \_\_\_\_\_?
- It provides great forecasts, data, etc.; my data needs are met
  - It provides some information for us
  - I don't use the products much because the products don't work for my area
  - I don't use the products much because I get better products from somewhere else
  - I don't use NWS because I'm not aware of what products are available
  - Don't know/ Not applicable

14. Which phrase **BEST** describes how you determine when your **primary** prescribed burning season begins? (Check only one)

- Our prescribed burning season is usually year-round
- Our prescribed burning season is usually any time outside of fire season
- Our prescribed burning season usually begins as soon as the snow melts
- Our prescribed burning season usually begins right after green-up
- Our prescribed burning season usually begins at the end of fire season
- Our prescribed burning season usually begins after the first big rainfall/snowfall
- Our prescribed burning season is determined by permits from local, county, or state agencies (including air quality compliance restrictions)
- Our prescribed burning season is determined by wildlife or endangered species issues (such as breeding or nesting periods)
- Our prescribed burning season usually begins when a burn window opens
- Our prescribed burning season usually occurs about the same time every year (for example, the first two weeks of April or around the beginning of November), and that time is (please fill in the blank) \_\_\_\_\_
- Other \_\_\_\_\_
- Don't know/ Not applicable

15. What tools/resources do you use to monitor when your burn season begins? (check all that apply)

- RAWs station or manual weather data
- Fuel moisture sticks or samples
- Visual observation of snowmelt, green-up, precipitation, etc.
- NDVI or other remotely sensed data
- Other \_\_\_\_\_
- Don't know/ Not applicable

*Part IV. Burn implementation. Questions 16-19 apply to your most recent completed prescribed burn.*

16. Did you measure onsite 1-hour fuel moistures before your last burn?

- Yes                       No                       Don't know/Not applicable

17. Did you measure onsite 10-hr fuel moistures before your last burn?

- Yes                       No                       Don't know/Not applicable

18. Did you measure onsite 100-hr fuel moistures before your last burn?

- Yes                       No                       Don't know/Not applicable

19. Did you measure 1000-hr fuel moistures before your last burn?

- Yes                       No                       Don't know/Not applicable



20. What is the **primary** cause for last-minute postponement or cancellation of a prescribed burn for you?

- Not enough resources on-hand
  - Air quality issues
  - Winds
  - Precipitation
  - Drought conditions
  - State or county no-go decision
  - Out-of-prescription
  - Unsatisfactory fire behavior conditions (test fire behavior, lightning in area, etc.)
  - Other
- 
- Don't know/ Not applicable

#### Part V. *Burn Windows.*

I would like examples of prescribed burn windows for various ecotypes and regions. This information will be used to study the predictability of optimal burning conditions. I would appreciate copies of any recent burn plans you are able to send (even if it is only one or two); the information contained in them will remain confidential. The information I plan to use is:

- Parameters of the burn window (min, max, and ideal values for temperature, RH, 1-hr fuel moistures, wind speed, wind direction, how long window must hold for, etc.)
- Severity of planned burn
- Location of the burn
- Vegetation burned or targeted for burning
- Time of year the burn was planned for (if applicable)

Please use the envelope provided to send burn plans. Any unnecessary information (such as who prepared the plan, appendices, BEHAVE runs, etc.) may be removed at your discretion.

21. What is the minimum number of *hours* of "good" weather you need to commence burning for a given day? \_\_\_\_\_

22. What is the minimum number of *days* of "good" weather you need to commence burning? \_\_\_\_\_

23. On average, about how long is your burn season? \_\_\_\_\_

Part VI. *Climate.*

24. Based on your experience, how far ahead can you usually tell how favorable the conditions are for your prescribed burning season?

- Conditions are unpredictable at a seasonal level
- Less than 2 weeks before the season begins
- Usually within one or two months before the season begins
- Usually within three to six months before the season begins
- Longer than 6 months before the season begins
- Don't know/ Not applicable

25. Based on your experience, which of the following weather components is the hardest to predict/most variable for trying to come into/stay in prescription at your location? (check all that apply)

- Relative humidity
- When precipitation will occur
- How much precipitation will fall
- Wind speed
- Wind direction
- Temperature
- 1-hr or 10-hr fuel moisture
- Mixing height/transport wind/ventilation
- Other \_\_\_\_\_
- Don't know/ Not applicable

26. Based on your experience, which of the following climate patterns have the greatest impact on prescribed burning in your location? (check all that apply)

- High pressure ridges
- Drought
- Temperature departures from average
- Precipitation departures from average
- Variability of burn windows
- El Niño Southern Oscillation (ENSO) or La Niña
- Pacific Decadal Oscillation cycles
- Snowpack
- Santa Ana winds
- Foehn or Chinook winds
- Southwest Monsoon
- Other \_\_\_\_\_
- Don't know/ Not applicable

27. In your experience, do long-term climate trends significantly affect your prescribed burning program?

- Yes, they have a major impact on our prescribed burning program
- Sort of, they have some impact on our prescribed burning program
- No, they really don't have any impact on our prescribed burning program
- I'm not sure
- Not applicable

28. How difficult is it to get forecasts or data on the long-term climate trends affecting your fuels and/or your prescribed burns?

- Easy. I can get them with minimal effort, or someone else gets them for me.
- Medium. Sometimes it takes me a while to find what I am looking for.
- Difficult. It takes a lot of effort and time.
- Climate data is not used in fuels assessment and burn decisions.
- Don't know/ Not applicable

29. Have you taken any college-level or agency-provided training courses in climatology?

- Yes
- No

30. Do you feel like you receive adequate climate education in agency training courses (such as the skills training series)?

- Yes
- No
- Don't know/ Not applicable

31. Does your agency provide you with seasonal climate forecasts or seasonal fire potential outlooks?

- Yes
- No
- Don't know/ Not applicable

#### Part VII. *Escaped prescribed burns.*

32. Have you observed or know of an escaped prescribed burn on your district in the last 15 years?

- Yes
- No
- Don't know/ Not applicable

33. If yes, what was the primary cause of the escape (check only one)?

- Unexpected wind gusts or cold front
- Inadequate personnel for fire
- Drier 1-hr or flashy fuels than expected
- Drier large or 1000-hr fuels than expected
- Outside of prescription from start
- Unexpected extreme fire behavior
- Can't remember
- Other \_\_\_\_\_
- Don't know/ Not applicable

34. If you have any additional comments pertaining to this survey, please indicate them here. I am trying to determine how climate impacts prescribed fire use, and how available climate information is to the people who need it most in their planning and execution of burns. Your input is very important to me.

## APPENDIX B: WFU Survey Questions

### WILDLAND FIRE USE (WFU) SURVEY PROGRAM FOR CLIMATE, ECOSYSTEM, AND FIRE APPLICATIONS DESERT RESEARCH INSTITUTE, RENO, NEVADA

Please answer all questions as completely as possible. Your answers will remain anonymous, therefore, I ask you to be honest. If a question does not apply to you or you don't know, please answer "Don't know / Not Applicable".

#### Part I. *Information about your position.*

1. How many years have you been involved in wildland fire suppression or management? \_\_\_\_\_
  
2. How many years have you been involved with Wildland Fire Use (WFU) through local planning or size-ups, or served on a fire use management team (FUMT)? \_\_\_\_\_
  
3. Approximately how many WFU fires have you managed/assisted in managing as part of a team?
  - 0-5
  - 5-10
  - 10-20
  - More than 20
  - Don't know/ Not Applicable
  
4. What is your highest qualification level with regards to WFU?
  - ICT Type 4
  - FUM2
  - FUM1
  - Don't know/ Not Applicable
  
5. Have you taken a collegiate-level course on climatology or received climatology training from your agency beyond S-491 Intermediate NFDRS or Advanced NFDRS?
  - Yes
  - No
  - Don't Know/ Not Applicable

**Part II. Information about pre-season planning.**

6. Do you meet with your local fire management team or your FUMT before the fire season?
- Yes
  - No
  - Don't know/ Not applicable
7. If so, do you discuss potential areas for increased WFU fire activity as part of this meeting?
- Yes
  - No
  - Don't know/ Not applicable
8. If so, do you discuss climatological conditions as part of this meeting?
- Yes
  - No
  - Don't know/ Not applicable
9. If so, what resources do you utilize to assess the potential for WFU fires in the upcoming season?
- Seasonal Assessment Outlooks from Predictive Services
  - Keetch-Byram Drought Index (KBDI)
  - Palmer Drought Severity Index or Palmer-Z (PDSI)
  - Standardized Precipitation Index
  - Historical Data analyzed in FireFamilyPlus
  - Other tools available from the Wildland Fire Assessment System (WFAS) site
  - Other \_\_\_\_\_
  - Don't know/ Not applicable
10. To the best of your knowledge, are local fire managers briefed on seasonal potential for WFU fires based on current conditions?
- Yes
  - No
  - Don't know/ Not applicable
11. To the best of your knowledge, are local fire managers briefed on seasonal potential for WFU fires based on predicted conditions?
- Yes
  - No
  - Don't know/ Not applicable

12. In your opinion, how important is information on climate phenomenon such as El Niño, drought conditions, wet conditions, historic fire danger levels, etc. in pre-season planning for WFU?

- Very important; has major impacts on planning
- Slightly important; has some impacts on planning
- Not really important; considered, but doesn't have much impact
- Not important at all/ not considered
- Don't know/ Not applicable

### **Part III. WFIP and Management of WFU Fires**

13. Are current climatic conditions (such as drought conditions, temperature departures from average, etc.) considered during the Strategic Fire Size Up?

- Yes
- No
- Don't Know/ Not Applicable

14. In your opinion, how important is information on climate phenomenon such as El Niño, drought conditions, wet conditions, historic fire danger levels, etc. in the determination of the MMA for a WFU fire?

- Very important; has major impacts on MMA size
- Slightly important; has some impacts on MMA size
- Not really important; considered, but doesn't have much impact
- Not important at all/ not considered
- Don't know/ Not applicable

15. In the Wildland Fire Relative Risk Assessment, what information sources are most frequently used/provide the most useful information to determine Probability Levels for Time of Season (whether the time is in the early, middle, or late part of the fire season)?

(Example answers may include, but are not limited to: local knowledge, RAWs data, seasonal forecasts, forecasts from Predictive Services, NFDRS, NWS, KBDI, PDSI, NDVI, SPI, Drought Monitor, FireFamily Plus, Haines Index, etc.)

16. In the Wildland Fire Relative Risk Assessment, what information sources are most frequently used/provide the most useful information to determine Probability Levels for Seasonal Severity (whether severity is Low, High, or Extreme)?

17. In the Wildland Fire Relative Risk Assessment, what information sources are most frequently used/provide the most useful information to assess the type of drought currently being experienced to determine the Probability Level for Seasonal Severity?

18. What resources do you use for any part of WFU Fire Management (Check all that apply):

- RAWS data
- Seasonal climate outlooks
- Seasonal severity maps
- National Weather Service forecasts
- Keetch-Byram Drought Index (KBDI)
- Palmer Drought Severity Index or Palmer-Z (PDSI)
- NDVI
- Standardized Precipitation Index (SPI)
- US Drought Monitor
- Surface Water Supply Index
- NFDRS outputs (i.e. ERC, BI, SC)
- Vegetation Condition Index
- ECPC forecasts
- Predictive Services/GACC Resources
- Historical weather data
- FireFamily Plus
- WIMS
- NIFMID
- Haines Index
- Local knowledge
- Other \_\_\_\_\_
- Don't Know/ Not Applicable

For each of the following fuel types, please indicate whether you collect fuel moisture samples on WFU fires to help with decision-making:

<b>Fuel Type Applicable</b>	<b>Yes</b>	<b>No</b>	<b>Don't Know/ Not</b>
19. 1-hr	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. 10-hr	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21. 100-hr	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22. 1000-hr	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23. Live fine fuels	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24. Live heavy/tree (cookies or moisture probe)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



25. Please rank the importance of each of the following influences on WFU management, particularly the MMA and management actions (#1 is the most influential; not all influences need to be ranked):

- Expense/ Funding availability
- Availability of personnel, equipment, or Fire Use Modules
- Historic Fire Regime/ FRCC/ time since last burned
- National Fire Situation/ Staffing Levels
- Air quality/ smoke considerations
- Public input/ political climate
- Other \_\_\_\_\_
- Don't Know/ Not Applicable

26. Please rank the following reasons why a WFU fire converts from WFU to full suppression by frequency (#1 is the most frequent reason why a WFU fire must be suppressed; not all reasons need to be ranked):

- Excessive Costs/ Lack of funding to continue as WFU
- Lack of WFU personnel or equipment resources (such as a Fire Use Module)
- No longer providing resource benefits
- Air quality/ smoke concerns
- Extreme fire behavior
- Exceeds MMA
- Concerns from the public/ political climate (such as proximity to a road or increased wildfire activity in the region)
- Other \_\_\_\_\_
- Don't Know / Not Applicable

#### **Part IV. Reporting WFU Fires**

27. When completing the reporting process to NIFC, what *general* (DOI) or *statistical* (USFS) cause do you report for WFU fires?

- Lightning
- Fire Use/ Resource Management Fire
- Miscellaneous
- Other \_\_\_\_\_
- Don't Know/ Not Applicable

28. When describing the type of fire in the reporting process, how do you describe a WFU fire (these descriptions later show up in FireFamilyPlus, etc.)?

- Wildland Fire
- Prescribed Fire w/in prescription
- Prescribed Natural Fire w/in prescription
- Other \_\_\_\_\_
- Don't Know/ Not Applicable

29. If you have any additional comments pertaining to this survey, please indicate them now. I am trying to determine how climate impacts WFU fires, and how available climate information is to the people who need it most during WFU fires. Your input is very important to me.