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Heritage Resources and Fire Management: A Resource Management Crossroads

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Abstract.—Until the past few years Forest Service fire management had been characterized by a program of total wildfire suppression coupled with relatively small scale prescribed burning, having fuels reduction as the principle objective. As the organization moves toward "ecosystem management" the fire program is developing multiple, complex objectives employing a combination of wildfire suppression, prescribed natural fire, and both small and large scale prescribed burning. These changes raise some concerns with regard to heritage resource management and protection. However, fire managers and heritage resource specialists have a history of close working relationships in the Southwest, and through continued cooperation we are working to develop implementation strategies appropriate to changing land management objectives.

INTRODUCTION

An important human characteristic is our capacity for retrospection. We may look to the past out of historic, academic or even idle curiosity to gain a better perspective and understanding of some current phenomenon by examining its developmental sequence. Or we may look to the past for specific lessons that it can teach us. We can "revisit" events that occurred or decisions that were made in the past and view them in the light of what has come about over time as a consequence. If the results are largely consistent with our expectations, we may then either take no action or engage in some minor adjustments to a particular course of action. But if the results are not meeting our desires or expectations, we can take whatever steps are deemed appropriate. Lessons from the past will not necessarily tell us what is *the* correct course of action, but they will surely help us avoid repeating obvious mistakes and to alter a course that is not producing desired results.

The discussion that follows is retrospective on several levels. The main objective in the following discussion is to examine the current state of heritage, or cultural, resource management practices and objectives in light of what we have learned from 20 years of experience, but also in relation to developing trends in Forest Service fire management practices. What we have learned in the past 20 years can be directly applied in devising management strategies appropriate to changing methods and objectives. To accomplish this it is necessary to set the stage by first discussing the qualities and characteristics of heritage resources which are significant in determining the general parameters of heritage resources management. Then, relying upon historical accounts, fire management policy decisions of the past are examined as a means of providing an understanding of some current day management objectives and related challenges. Finally, a retrospective look at heritage resource management actions and decisions specifically associated with the La Mesa Fire of 1977 is used to suggest that these actions and decisions provided the foundation that has structured the cooperative relationship between fire management and heritage resource management that will take us into the future.

HERITAGE RESOURCE MANAGEMENT REQUIREMENTS

Based upon a proposition that policy and procedures for management of a particular resource

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ought to be determined on the basis of qualities and characteristics inherent in the resource itself, let's first focus upon the specific management requirements of heritage resources apart from other considerations. First and foremost there are two attributes of heritage resources that make requirements of management somewhat unique - heritage resources are fragile and they are non-renewable.

The range of what constitutes heritage resources is very broad, including individual artifacts, such as pottery, arrow points, spear points, knives, manos, metates, ornaments, and the like, but also including a variety of historic and prehistoric sites, such as pueblos, pit houses, cliff dwellings, water diversion structures, soil retention structures, garden plots, caves, rock shelters, log cabins, homesteads, mines, canals, acequias, trails, quarries, rock art panels, and a host of others. On yet another level entire districts of interrelated historic properties can be and have been treated as significant heritage resources, such as the CCC era National Historic District at Bandelier National Monument. But what actually is meant by the notion that heritage resources are fragile?

A central value placed upon heritage resources by archeologists is that they are a source from which we can obtain information important to our understanding of the events and general developments which occurred in both prehistoric and historic times. From our archeological, scientific study of the past we will one day understand how societies came to be as we know them today, why certain societies have failed and disappeared while others have prospered and grown, and perhaps we will be able to formulate general principles of cultural evolution and behavioral change on a par with those of biological evolutionary theory. While there is information to be gained from physical objects and materials, equally if not more important are the spatial relationships between artifacts and features of sites, both on the ground surface and beneath the surface. When an archeological site is excavated according to a preconceived plan, using careful and controlled techniques in conjunction with detailed note taking, mapping, and photography, spatial relationships are preserved through documentation. Objects and their spatial relationships provide the data from which archeologists make inferences and draw conclusions regarding sequences of events at a site and the life style of a site's inhabitants. Operation of a piece of heavy equipment within a site, or any of a number of other surface and subsurface disturbing activities, can crush artifacts and eradicate spatial relationships in an instant. Because it is so easy for human activities to destroy the information potentially obtainable from heritage resource site, heritage resources are regarded as fragile.

It must also be recognized that virtually every site is unique. For example, if we suffer the loss of a 2,500 year old camp site where normally dispersed Archaic peoples occupying a specific territory just south of Grand Canyon once banded together to share food and other resources for the winter season, we will never have the information that this particular site could have provided. We cannot grow another such site, nor can we turn back the clock 2,500 years and ask these Archaic peoples to recreate the events that took place here. Thus heritage sites are regarded as non-renewable.

In addition to the scientific information potential of heritage resource sites, they are valued by others for different reasons. American Indians currently living in the Southwest are the descendants of the peoples who once inhabited many of the heritage resource sites located on federally managed lands here. To this day, Indian peoples often carry out religious observances not only at obvious sites but also at other sacred locations on federal lands generally known only to specific practitioners themselves. Many of these observances are viewed as essential in preserving the tribe or pueblo's traditional way of life while providing a sense of place in the cosmic scheme of things. But not all sites on federal lands pertain to American Indians. Modern day America truly is a diverse nation of peoples from a variety of places and different cultural backgrounds. Many of the ethnic groups who make up our population have been in this country long enough to have established their own "history" here. It is important that we respect these differences in heritage and manage our lands to preserve evidences of everyone's history. Additionally, the overall interest of the American public in the subjects of history and prehistory is phenomenal, as indicated by attendance records at parks and monuments dedicated to preservation and interpretation of history and prehistory.

Other significant attributes of heritage resources that should be considered, at least in the Southwest, are their complexity, their preservation in large numbers, their potential to occur in virtually any physiographic setting (although highly concentrated in woodlands and lower elevation forests), and their occurrence in high to very high densities in particular areas. Given the landforms and vegetative patterns prevalent in the Southwest,

heritage resources located here are also often readily visible and evident even to the untrained eye.

Finally, we must consider the legal aspects of heritage resource management. Congress has demonstrated time and time again, through passage of a series of laws dating back to the 1906 Antiquities Act, a concern for preservation and protection of our nation's heritage resources. These laws have authorized the promulgation of numerous implementing regulations that affect federal land management. The resulting requirements and procedures include various levels of external review and oversight that must be adhered to in the compliance process before implementing land management activities.

In summary, our policies and procedures for managing heritage resources must take into account all of the above attributes: they are fragile, non-renewable, complex, numerous, ubiquitous, valued by a wide range of individuals and ethnic groups for various reasons, and they are specifically protected under a number of federal laws. This is a daunting array of characteristics which need to be taken into account in our basic management strategy, leading some to view heritage resource concerns as one of the more significant constraints upon a program which seeks to use fire to attain a host of resource management objectives. Before we address this concern, let's look first at current day fire management from a historical perspective.

TOTAL FIRE SUPPRESSION POLICY

In retrospect it is now widely recognized and accepted among natural resource managers that a poor management decision was made in American forestry in the early 1900s when a policy was established to rapidly and completely suppress all fire which might occur in our woodlands and forests. With hindsight we now recognize that fire, both natural and man-caused, plays a critical role in perpetuating the structural integrity of ecosystems; periodic fire helps maintain a dynamic equilibrium among the various components of an ecosystem. Fire is essential to the health of many ecosystems.

Based on current day observations of lightning-caused fires, few would argue with the proposition that naturally occurring fire has been a component of terrestrial ecosystems for virtually as long as there have been terrestrial ecosystems. With the eventual arrival on the scene of humankind and ensuing cultural developments over the past few million years, an additional cause of fire was introduced into ecosystems when, at some unknown time in prehistory, humans appropriated fire from nature. Human-caused fires came to contribute importantly to the presence of fire in the ecosystem (Stewart 1956) and supplemented whatever role natural fire had heretofore played in ecosystem stability as well as change around the world. However, while humans were able to initiate fires which burned over large tracts of grasslands, woodlands, forests, and jungles, they were virtually helpless to control large fires, whatever their origin. But given a milieu of increasing social organizational complexity and technological sophistication in our recent history, man came increasingly to gain control over large fires, eventually arriving at an ability to consistently suppress fire so effectively as to interfere with "natural" processes.

According to one historian, as America moved into the 20th century, natural and man-caused fires had burned, and were continuing to burn, vast expanses of forested lands, while at the same time lumber men were rapidly and wastefully logging away, based on the belief that it was foolhardy to attempt to husband timber since it seemed inevitable to everyone that it would one day be lost to fire (Steen 1976:174). There were some, however, who realized that with rampant, uncontrolled logging and the associated increase in enormous forest fires, the industry would one day, perhaps in the not too distant future, be faced with shortages. Steen (1976: 174) notes that a real "wake up" call came in 1902 when the Yacolt Burn in Washington burned over 400,000 acres of timber and caused great financial losses. Realizing that individual companies were quite vulnerable to similar disastrous loss due to threat of fire, the industry began to band together and lobby for legislation that would lead to creation of a state fire warden's office. After a few spectacular infernos in 1910 in Idaho and Montana on national forest lands, the Forest Service turned its attention toward developing better means of fire-fighting, through actions such as increased patrolling in conjunction with more road and trail construction and improved fire fighting technologies including aerial surveys, smoke-jumpers, the Osborne firefinder, portable pumps, enhanced radio and telephone communications and the like.

While these developments were in progress, there were concurrent complex and somewhat Machiavellian political struggles occurring in the early decades of the 1900s (Steen 1976). What eventually came to be legislated as standard operating proce-

dure for federal forest management, in close cooperation with state and private forestry, was a policy under which all fire was to be rapidly and thoroughly extinguished; the only thorny issue was whether there would be federal or state control and regulation. History thus informs us that the development of the total suppression policy was largely based upon business and financial considerations, rather than, if not contrary to, sound principles of ecology and forestry. Suppression of all fire even became policy in our National Parks, despite their mission to maintain "natural" conditions.

Although it would come back to haunt us, this fire suppression policy was effective for decades. Baker, Dethloff, Maxwell and Treat (1988) note, for example, in the Southwestern Region that the fire situation on the Apache-Sitgreaves National Forest was clearly in control in the year of 1937 and that fire losses over the preceding decade had been extremely minimal, while post-World War II fire prevention on the Kaibab National Forest had been so effective that managers were starting to notice that the absence of fire was having an effect upon the appearance as well as the equilibrium of the forests. The missionary zeal with which the Forest Service implemented the policy is exemplified in events noted by S.J. Pyne (1982:163):

> "During 1927 in Lincoln County, New Mexico, the scene of bitter frontier range wars in the nineteenth century, incendiary fires were constantly being set around a certain ranch ... When firefighters were indeed met with rifle shots, the sheriff and local forest supervisor set out after the unrepentant incendiarist. In the ensuing shootout an innocent Forest Service clerk, commandeered as a driver, was killed along with the rancher".

THE CONSEQUENCES

Over hundreds of millions of years fire had come to be an essential component of many ecosystems, helping to maintain the dynamic equilibrium that ensured the degree of stability necessary for continuity. Total fire suppression constituted, in effect, removal of one essential component from an ensemble of systemically interconnected phenomena, precipitating accommodative changes in various other components. After a number of years of total fire suppression policy, there began to emerge the recognition that such policy was generating marked physical changes in the character and appearance of wooded and forested areas and was having very undesirable effects with regard to ecosystem health. For example, consider ponderosa pine forests of the Southwest that experienced low intensity, high frequency fires for millennia. These fire-dependent forests exhibited open stands of large trees, with vigorous grass understories, giving a park-like appearance. Total fire suppression, in conjunction with heavy grazing and logging activities, have changed these forests so that many stands of young trees are crowded together in thickets beneath the few remaining old, large trees, accompanied by heavy accumulations of fuels on forest floors and marked reductions in herbaceous understories (Covington and Moore 1994: 39). Such conditions have led to declines in biodiversity and are conducive to widespread outbreaks of insects and disease problems, with the threat of disastrous, unnaturally intense wildfires ever-present. Indeed, this is the scenario that led to the 1977 La Mesa Fire (Foxx and Potter 1984).

Recognition of the deleterious effects of removing fire from the picture was not an overnight discovery, although as many as 70 years ago some individuals in the Forest Service were well aware of the increased potential for disastrous conflagrations fostered by a build up of fuels (Leopold 1924).

Some foresters, such as Aldo Leopold and C.K. Collins, began to recognize the contribution of fire in the maintenance of grass and pine forest in the Southwest and were aware of the positive results of the burning habits of the Indians, which had contributed to the evolution of the high quality forests that the Anglo-Americans found. (Baker et al. 1988: 115).

> Collins and others had discovered that the great achievements in fire suppression since the 1930's had begun to make the national forests a veritable tinderbox. (Baker et al. 1988: 116)

As these changes came to be recognized and their causes came to be understood, Forest Service fire policy began to change in the late 1960s and 1970s. Baker et al. (1988: 116) regard 1967 as a "watershed" in the fire policy of the Southwestern Region when they note that:

> Fire suppression began to be replaced by fire control as a major policy objective. The change from the view of fire being only an enemy to fire being both an enemy (wildfire) and a friend (prescribed fire) was slow to take hold within the Forest Service and within the

Southwestern region. The shift took place slowly, perhaps only over the last 20 to 30 years.

STANDING AT THE CROSSROADS

Having recognized various deleterious effects resulting from total fire suppression policy, many are now espousing an urgent need to reintroduce fire into ecosystems through prescribed burning and prescribed natural fire. The use of prescribed fire to reduce accumulating fuel loads has been steadily increasing in the Forest Service since the recognition of its beneficial effects. Over the past 15 to 20 years the prescribed fire program has been characterized by relatively cool burns of sufficiently small scope that any given project was contained within an area having general uniformity of terrain, vegetation type and fuel loading. Individual burn units have typically been small enough that they could be burned during a given work day.

Some managers are understandably eager to return grassland, woodland, and forest ecosystems to healthy conditions immediately and stand poised to rapidly adopt prescribed fire programs designed to accomplish a whole range of resource management objectives including fuels reduction, slash disposal, wildlife habitat improvement, stand replacement, type conversion, and general restoration of ecosystem health. Some of these objectives necessitate very hot fires, while others require large scale burning of project areas containing tens of thousands of acres with a wide range of variability in terrain, vegetation types and fuel loadings. The range of fire behaviors one might anticipate in such extensive projects is likewise relatively wide, which suggests increased complexity of fire control considerations. We are also in the process of instituting prescribed natural fire plans that cover, in some cases, hundreds of thousands of acres.

Thus, we have arrived at a crossroads. Various avenues of management options lie before us, and although we have looked to the past and seen the undesirable consequences of a flawed policy, we cannot simply return to the past. While we are eager to return our environment to a healthy condition, the potential beneficial effects of fire must be weighed against other resource management considerations. The prevailing conditions of today's ecosystems are not the conditions which existed in the days before total suppression - we are operating under a set of changed parameters. We do not have open, park-like stands of large, mature trees with grass understories. Many forested areas are now characterized by excessively thick growth of small and medium-sized trees underlain with heavy leaf, needle and branch debris. Many woodland areas are now characterized by the virtual absence of ground cover that might act as a carrier for surface fires, forcing us to seek means of burning such areas that are markedly different from the burning of pre-suppression days. Rather than "reintroducing" fire, what we are actually considering is initiating fire into areas and situations that have come to be as they are because of the absence of fire. It also appears that we are moving rather hastily toward fire management projects that fall somewhere between the controlled, prescribed burning of the past, with the primary objective of fuels reduction, and a new range of projects more closely approximating wildfire with a host of resource management objectives. This being the case, there are various resource concerns that will function to constrain and help guide fire management projects, such as heritage resources, soils, air quality, wildlife habitat, and watershed protection.

WILDFIRE IMPACT STUDIES

In the 15–20 years that federal land-managing agencies have been in the business of heritage resource management, we have learned a great deal about potential impacts to the resource from a host of different kinds of undertakings, including fire management. A considerable amount of very useful data have been gathered from several studies conducted following wildfires here in the Southwest. One of the earliest studies, although rather informal, was carried out in connection with the Little Moccasin Canyon Fire in Mesa Verde National Park in 1972. Following a 1,080 acre fire in pinyon, juniper and oak brush, Switzer (1974) documented a number of impacts to heritage resources after a cursory inspection of several burned over sites.

The landmark study which has set the standard for subsequent studies of impacts on heritage resources is *The 1977 La Mesa Fire Study* (Traylor, Hubbell, Wood and Fiedler 1990). The La Mesa Fire burned out of control for seven days over about 15,000 acres on Bandelier National Monument, Santa Fe National Forest and Department of Energy lands. A combination of years of fuel accumulation on the ground, forest structural change, critically low moisture, and high winds created a wildfire situation that necessitated complex, intense,

closely coordinated fire suppression activity involving hand crews, bulldozers, slurry bombers, water tankers, and helicopters. By the time the fire was contained, miles of hand and cat line had been constructed along with clearings for a number of helispots. One of the decisions made in combatting the La Mesa Fire which has since become standard procedure was the deployment of archeologists, about 30 in all, to work along side fire line construction crews and to monitor mop-up activities; this was a "first" in combatting such fires. Following the fire, archeologists conducted surveys and inspections of all construction disturbance areas to assess the impacts to heritage resources. From site surface inspection data, damage was assessed at 58 sites which had been burned over. Three of these sites were excavated, and a fourth tested to determine the extent to which heat had penetrated beneath the surface and to assess whether archeological materials below the surface had been affected.

The La Mesa Fire study is notable for its exceptional documentation of a full range of fire-related impacts to heritage resources through implementation of systematic data gathering and detailed analyses of a host of related cultural and natural phenomena. Although the study was not formally published until 1990, the manuscript had been readily available for a number of years previously and served as the basic body of data in the Southwest, if not the nation, on the effects of fire on heritage resources. The National Park Service deserves much credit for undertaking this pioneering effort. There have been subsequent heritage resource impact studies following wildfires, including the 4,600 acres Radio Fire on the Coconino National Forest in 1977 (Pilles 1984), as yet unpublished work on the Yellowstone fires of 1988, the 3,000 acre Long Mesa Fire in Mesa Verde National Park in 1989 (Eininger 1990), and the 800 acre Henry Fire on the Santa Fe National Forest in 1991 (Lent, Gaunt and Willmer: In press). These studies have incorporated a few new considerations, such as complete survey of burn areas, but most have added little to the initial findings from the La Mesa Fire study.

The Henry Fire study did break some new ground in that it attempted to go beyond basic post-fire documentation. Because the fire occurred in an area that had been previously surveyed, some pre-fire baseline data were available for comparison. Most significant, however, was the involvement of fire behavior specialists in the research design, post-fire survey, and analysis. Fire behavior characteristics were estimated for each site, and an attempt was made to correlate those characteristics with the nature and severity of site damage as determined from field observations and analyses of surface and excavated cultural materials.

What have we learned from these studies? Following past authors (Lissoway and Propper 1990) I find it useful to view fire effects on heritage resources in two broad categories: one includes the impacts resulting from fire itself, and the other involves impacts resulting from fire suppression, mop up and rehabilitation activities. It is useful to further subdivide these categories into direct and indirect effects.

As regards direct effects of fire we know from the La Mesa fire and subsequent studies that the nature and severity of damage depends upon fire intensity, duration of heat (residence time), and heat penetration into the soil. These three conditions, in turn, are directly related to the density and size of fuels on and adjacent to a site. Depending upon the exact nature of the above conditions, wooden objects, bone, plant remains, plant pollen - any combustible material - can be consumed partially or completely by fire. Stones used in building and food grinding/processing can become discolored, cracked, spalled or even disintegrated. Cracking, spalling, and discoloration can also occur to chert and obsidian lithic materials used for tool making, while obsidian, a volcanic glass, can be melted. Pottery sherds, the source for a wealth of archeological information, can become spalled, split into pieces and/or discolored, sometimes having surface designs burned completely away or clay paste characteristics altered. Rock faces containing pictographs and petroglyphs can be scorched and spalled. The potential to derive dates from pottery, obsidian, tree-rings, charcoal and/or fire hearths can be destroyed if such materials are on or near the ground surface.

For a number of years, fire effects studies described the points at which damage starts to occur in terms of temperature, a measure not very usable in fire behavior analysis. The results of the Henry Fire study were encouraging because they indicate that thresholds where damage begins might be identifiable for particular classes of cultural materials for fairly specific fire behavior characteristics, such as fire line intensities. Indirect effects of fire on heritage resources include erosion and eventual uprooting of fire-killed trees that can damage site features and displace artifacts.

Studies have also documented that the most severe impacts to heritage resources result not from fire itself but from fire suppression, mop up and

rehabilitation activity. These activities have a direct potential to damage or destroy artifacts, architecture, and other site features, and to obliterate information-rich spatial relationships among materials both above and below the surface. Such suppression-related activities include hand line construction, cat line construction, road and helispot construction, general vehicular traffic in a burn area, laying out and moving hoses, retardant dropping, digging of burning roots and stumps, snag felling, water bar construction, berm leveling, use of heavy equipment for seeding or site prep prior to planting, salvage logging, and fuelwood collecting. Indirectly, heritage resources are put at risk because their locations become known to large numbers of people working in an area where site visibility is greatly enhanced due to the absence of vegetation. The more widely known the location of a site, the greater the chances that surface collecting and illegal excavation will occur.

Fortunately, a number of factors have helped reduce the impact of suppression and related activities on heritage resources. Archaeologists are now routinely included on most suppression and rehab teams when heritage resources are present. Modules on the effects of fire on heritage resources have been added to agency fire management training programs. And discussions of heritage resource values are frequently included in fire management conferences and publications, all contributing to increased awareness and sensitivity. A recent bibliography on fire effects on cultural resources, published by the Bureau of Land Management (Knight 1994), attests to the amount of attention this topic has received, particularly over the past ten years. On the Henry Fire, for example, heritage sites were a major consideration in the suppression effort, and damage due to fire suppression and mop up activities was minimal. However, because this is not uniformly the case, continued emphasis in this area is essential.

IMPLICATIONS FOR PRESCRIBED FIRE

The above findings are based on conclusions drawn from wildfire studies, and one might well ask how the findings pertain to prescribed fire. It should be apparent that any of the listed ground-disturbing activities, many of which also occur in the conduct of prescribed burn projects, have the same potential to affect heritage resources. We also know from wildfire-related studies that the nature and extent of damage to archeological materials is directly related to fire intensity, duration, and heat penetration into the soil. But in prescribed burning we can exercise a certain degree of control over these parameters of fire behavior. This improved control, in conjunction with reductions in ground-disturbing activity, present prescribed fire managers with at least the potential for reducing risks to heritage resources, with corresponding reductions in the amount of pre-burn survey and site protection or mitigation measures. This is reflected in some of the management strategies currently followed in the Forest Service.

Not all kinds of sites are equally at risk from fire at lower intensities nor do all areas of the forest have equal potential for the presence of sites. There are certain steps short of complete survey that can be taken to assess the likelihood of historic sites in an area, such as checking results of previous surveys in the area, consulting historical maps and records, examining aerial photographs, and directing personnel who are involved in fuels inventories and other pre-burn activities to be especially watchful for historic sites with combustible materials. In some cases where the presence of sites with combustible materials can be reasonably ruled out, we have burned certain high elevation areas and steep slope areas with low intensity fires with minimal or no survey in concurrence with State Historic Preservation Office review. Prescribed burning has also proceeded with reduced survey in project areas located at lower elevations or on gentler slopes if fire line intensities are going to be kept low and less fragile sites are the only kinds of sites known or expected to be in the area. However, in certain instances, such as when fire intensities are likely to be high and fire-sensitive sites are likely to be present, burn areas receive complete survey and most sites are recommended for protection or mitigation. This certainly does not mean the project cannot proceed; it does mean that extra caution and care are required. In such cases sites can be protected through various means, such as briefing all burn personnel on identification and required protection for sites, eliminating a portion of the area from burning, wet lining or black lining around sites to exclude fire, and removal or reduction of fuels from in and around sites. Using these and other practices, prescribed burning projects can proceed while heritage resource sites receive appropriate protection.

CURRENT RESEARCH

In developing the appropriate strategy for heritage resource management in particular prescribed

fire projects, we generally opt for a conservative or cautious approach. Although we know from wildfire studies that low fire intensities are not a threat to certain kinds of heritage resource sites, we do not currently know the thresholds at which fire damage starts to occur to various archeological materials. Building from the Henry Fire study (Lent et al.: In press), the Forest Service's Rocky Mountain Forest and Range Experiment Station, in partnership with the Santa Fe National Forest, New Mexico BLM, and the NPS Southwest Region, established a cooperative agreement with the Museum of New Mexico to conduct research aimed at determining these thresholds. Much of the field work is taking place on the Santa Fe National Forest. The basic approach to research consists of experimental burning across both actual and artificial sites under different fuel loadings within different fuel models to try to establish these thresholds. Although fire managers can potentially burn under any one of 12 fuel models, the research is focused upon the six most commonly burned in the Southwest. Burning is initially conducted under conditions of both light and moderate fuel loading, with an option to also test under heavy fuel loadings if appropriate. At both actual and artificially created sites a variety of specific provenience locations (e.g., on top of the duff layer, on the ground surface but beneath the duff layer, five centimeters below the ground surface, etc.) are "salted" with artifacts. The physical condition of these artifacts is thoroughly analyzed and documented prior to placement. Archeologists work closely with fire personnel in determining which sites are to be burned, which fuel models are represented, what fuel loadings are present, and when the burn should occur. The actual controlled burning is carried out completely by fire personnel, preferably in conjunction with an already planned prescribed fire project. Following the burn, archeologists recover all materials and once more analyze them to determine fire effects and assess whether or not effects are significant in terms of loss of integrity, research potential, or other factors. The results of this research will provided some badly needed data to help us devise management strategies appropriate to the various circumstances and conditions under which we conduct prescribed burning today and in the future.

CONCLUSIONS

Although the research outlined above is still in progress, preliminary indications are that fire damage to heritage resource sites and materials occurs where slash from logging and thinning has accumulated on the surface beyond what might occur naturally, leading to a very hot fire with relatively long residence time. Many areas of the forests and some woodland areas contain these unnatural accumulations of slash. Such areas are commonly the location of prescribed burning projects in the Forest Service. This underscores the need to proceed with caution as we move to undertake vastly larger burn projects with complex objectives. Variability in terrain, vegetation types and fuel loading over large areas makes it more difficult to accurately predict fire behavior at any specific locality. If fire behaves in a manner significantly different from pre-burn predictions, we may be faced with conditions that approximate those of wildfire in certain portions of large burns. Experience has shown that we simply must be able to first predict then control fire intensity and duration on or adjacent to heritage resource sites if we are to prevent damage or loss. For example, in a recent large prescribed fire on the Santa Fe National Forest, fire entered six sites having combustible materials present where we had taken what we felt were adequate precautions to see that fire was excluded. The sites were damaged to various degrees. This indicates that it may be necessary to exclude certain portions of large projects and burn them under more tightly controlled conditions. Additionally, in large complex burns the chances of fire getting out of control are multiplied. If controlled fire escapes and becomes wildfire, the likelihood of damage to not just heritage resources but to a host of resources including timber, fuelwood, range, soils, wildlife and wildlife habitat, as well as water quality, are greatly increased. Thus burning of large areas with complex patterns of terrain, vegetation, and fuel loadings should be approached with considerably more caution than burning of small areas where conditions are generally much more uniform.

However, I believe that as we move toward management of multiple resources from an ecosystems perspective, we need to direct management efforts in our fire program, as well as in other functional areas, to those projects which will result in the greatest benefit to the greatest number of resources considered together. When we become too narrowly focused upon a single management objective, then any of the various other resource objectives tend to be viewed as constraints or limitations upon our focal objective. Working closely with fire managers, beginning essentially with the La Mesa Fire, archeologists have learned a great deal about

the potential for fire and fire management activities to effect heritage resources. Prior to the La Mesa Fire many would likely have scoffed at the notion of archeologists accompanying fire fighting crews. In retrospect this was an excellent management decision and the practice has now become standard operating procedure in many places. Archeologists are now routinely "red-carded" and frequently participate in various aspects of fire management. Working closely with fire managers, as in the research project cited above, has given archeologists the necessary understanding to devise strategies for protection of heritage resources that call for greater care and vigilance in our burn projects, but ultimately do not unduly restrain attainment of fire management objectives.

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