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The importance of traditional fire use and management practices for contemporary land managers in the American Southwest

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Abstract

Indigenous and traditional peoples worldwide have used fire to manipulate their environment for thousands of years. These long-standing practices still continue and have considerable relevance for today's land managers. This discussion explores the value of documenting and understanding historic and contemporary fire use attitudes and practices of the varied cultural/ethnic groups that interact with land managers concerning fire and fuels management in the American Southwest. Current research with historic records and present-day communities is reviewed.
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1. Introduction

From Australia to North America indigenous peoples have used fire as a tool to manage their environment for multiple reasons, from the religious to the utilitarian. In what is now the United States (US), anecdotal evidence strongly points toward the widespread "…occurrence of fire in the pre-European landscape…" (Stanturf, 2002, p. 2). Our natural environment is a result of all the forces of the past, including the use of fire by our ancestors. Many ancient fire-use practices have been passed down for generations, but increasing population, shrinking available open space, and modern environmental concerns often clash with these traditional fire uses (Langton, 1999; Stanturf, 2002). Harmonizing indigenous uses of fire with today's environmental rules and regulations, as well as with societal fears of wildfire, is a major challenge.

In this paper we discuss the value of examining and understanding historic and contemporary fire-use attitudes and practices of the varied cultural/ethnic groups that interact with land managers concerning fire and fuels management in the Southwestern area of the US. For purposes of this review, we focus on the states of Arizona and New Mexico, which correspond to the Southwestern Region of the United States Forest Service. This generally arid region of desert, high chaparral, and mountain ranges has an extremely long history of Native American occupation, extending back over 10,000 years. It was first colonized by the Spanish at the end of the 16th century and became part of the US with the close of the Mexican American War in 1848. For historical reasons, Spanish American (Hispano) and Native American traditions remain strong in the area. Thus, this type of research is particularly important in the Southwest owing to the large number of distinct cultural groups with long histories of fire use, which shape their present-day practices, attitudes, and interactions with land management agencies.

Many Native American groups, as well as Hispano and Anglo-American farmers and ranchers, have important bodies of traditional ecological knowledge regarding using fire to create desired ecosystem effects in their local areas (Boyd, 1999). These can be of considerable benefit to land managers. In addition, substantial amounts of land

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belonging to indigenous and traditional peoples[1] are located in proximity to lands controlled by the US federal government. Management practices on federal lands can affect those in non-federal ownership and vice versa. Large, landscape-scale management projects encompassing lands under a variety of ownerships are increasingly desirable as means of treating significant areas, such as watersheds. Implementing these multi-ownership projects often requires considerable cultural sensitivity and knowledge of the attitudes and fire-use practices of the distinct groups who own or manage the land. An absence of this understanding has led to conflict between land management agencies and adjacent communities, resulting in projects that are delayed or not completed (Raish et al., 1999).

For example, many indigenous and traditional peoples maintain special uses and sacred places on public forests and grasslands in the Southwest. Legal requirements and agency policies mandate that public land managers consult with indigenous and traditional groups to make sure their views concerning fire use and management on and near these sites are considered. Responding to social justice concerns in 1994, President Clinton signed Executive Order 12898, which requires federal agencies to understand the impacts of their projects and policies on different cultural groups to ensure that these groups do not bear the brunt of the possible negative impacts of proposed programs or actions. Despite these mandates, land managers may plan projects that do not adequately consider special use sites and sacred areas out of ignorance. This ignorance often stems from an inability to obtain the appropriate information, resulting in a lack of knowledge concerning the ways in which indigenous and traditional groups use fire and view the impacts of fire on special use areas. Ignorance of the information and how to collect it can lead to misunderstandings and conflict that harm agency-community relations and interfere with project implementation. Developing fair, realistic, and effective methods of consulting with Native American and traditional peoples is discussed in detail in Raish et al. (1999).

2. Status of research on fire use, management practices, and attitudes of indigenous and traditional peoples

2.1. General research on historical use of fire

There is a developing body of research concerning historical fire use and management practices of indigenous and traditional peoples around the world. This research can provide valuable information to contemporary land managers who are now working on these same lands. Additionally, these past practices influence the way groups view and use fire in the present. As presented here, ''fire use'' refers to specific uses of fire such as encouraging wild seed production or clearing agricultural fields. ''Fire management'' is used more generally to describe the ways different cultures deal with both wild and intentionally set fires at a broader, landscape level. For discussions of both of these topics, see the works of Langton (1999), Blaney (1999), and Andersen (1999) in Australia, and Stewart (1955a, b), Lewis (1973, 1985), Dobyns (1981), Pyne (1982, 1995), Anderson (1993), Kay (1994), and Williams (2000, 2002a, b) in North America. In an effort to encompass the full extent of literature reviews and syntheses on these topics, unpublished works are discussed. This is especially the case for the Southwest, where less research has been undertaken than in other areas. In some cases, unpublished information is listed in conjunction with a published paper because the unpublished information presents the full bibliography and source discussions.

Williams (2002a, b) and Pyne (1982, 1995) have reviewed extensively Native American use of fire and support the view that burning by indigenous groups has modified landscapes across the continent. Dobyns (1981), Kay (1994), Lewis (1973, 1985), and Stewart (1955a, b) also stress the importance of human-caused fires in altering pre-fire-suppression era ecosystems. In contrast, early European explorers and settlers often attributed the evidence of pre-contact fires to natural causes owing to the absence of written records. Many contemporary scientists studying pre-European-settlement fire evidence also tend to attribute most prehistoric fires to natural causes. Allen (2002) makes an especially strong case for the primary role of natural causation in the form of lightning ignitions in the upland Southwest; other useful treatments of this topic are presented by Fish (1996), Swetnam and Baisan (1996), and Touchan et al. (1996). The present discussion does not focus on the issue of natural versus human causation for historic-era, landscape-scale burning, but emphasizes a review of the available literature on known indigenous and traditional uses of fire in the Southwest, which has had considerably less review coverage than other geographic areas (Allen, 2002).

There are both primary and secondary accounts that describe purposeful burning by Native Americans in various parts of North America to promote diversity of habitats and resources, environmental stability, predictability, and maintenance of ecotones (Lewis, 1985; Williams, 2002a, b). These purposeful fires can differ from natural fires on the basis of seasonality (season of burning), frequency, and intensity. Groups burned in the late spring before new growth appeared and, in drier areas, in late summer or early fall prior to the main winter growth period (Lewis, 1985; Williams, 2000, 2002b).

In a 1973 study, Lewis (1973) listed 70 reasons for Native American burning of vegetation. Kay (1994), Russel (1983a, b), and Williams (2002b) have also compiled lists of the various reasons indigenous groups were using fire.

[1]For purposes of this discussion, the term ''indigenous'' is used to refer to Native American groups, while traditional groups are those continuing long-standing, generally non-commercial economic practices. Many Hispanos in northern New Mexico, who maintain small-scale farming and ranching operations, fall into this category.

From his extensive literature review of over 300 studies, Williams (2002b) summarized 11 major categories of fire use. They are the following: hunting, managing crops, improving growth and yields of wild plants, fireproofing areas around settlements, collecting insects, managing pests, waging war, extorting trade benefits from settlers and trappers by depriving them of easy access to big game (scorched earth policy), clearing travel routes, felling trees, and clearing riparian areas.

2.2. Research on historical use of fire in the southwest

The history of fire use in the Southwest is long, reaching well back into pre-European-contact times. Information from a recent review demonstrates that people were quite cognizant of the use of fire as a management tool and understood its ecological effects, intentionally employing it for specific purposes (Condie unpublished paper; Condie and Raish, 2003). These are listed in Table 1, with more detailed examples discussed in the following sections.

Native Americans and Hispanos in the region used fire to clear agricultural fields of tree growth, brush, and weeds, as well as to replenish soil nutrients (Cushing, 1920; Euler, 1954; Hill, 1982; Opler, 1971, 1973; Petersen, 1985; Petersen and Matthews, 1987). Farmers from Zia Pueblo, New Mexico, reported using wood ash to fertilize their fields, placing ash around the corn plants when they were 1.5 feet high (Euler, 1954). The Hispanos of northern New Mexico used fire as a means of clearing timbered farmland and land for pasture, with shepherds reporting the use of fire to enlarge pastures (Allen, 1984). Groups also managed natural vegetation with fire to clear land of woody species, encourage grass growth, and increase wild seed production. The Apaches of southeastern Arizona and southwestern New Mexico set fires to accomplish this purpose (Bahre, 1985), as did early Anglo-American and Hispano cattle and sheep ranchers. Ranchers were described as setting mountain meadows on fire at the end of the season to burn off dried grass and brush. These fires also killed young trees and encouraged new grass growth for the following season (Williams, 2002b).

Table 1
Uses of fire by American Indian, Hispano, and early Anglo-American settlers in the Southwest (Condie and Raish, 2003)

1. Clearing land for agricultural fields and pastures
2. Replenishing soil nutrients in agricultural fields
3. Killing woody species in rangelands
4. Encouraging grass growth
5. Increasing wild seed production
6. Stimulating shoot formation (producing straight shoots for basketry and production of other implements)
7. Improving growth of both wild and cultivated tobacco
8. Driving and hunting game
9. Waging war

Puebloan groups (such as the Zuni and Santa Ana of New Mexico), Apache, Navajo, Comanche, Ute, and Southern Paiute, as well as Hispanos, used fire in game drives and surrounds (Cooper, 1960; Curtis, 1926; Gifford, 1940; Hill, 1938; Hough, 1926; Jones, 1932; Kelly, 1964; Pratt and Scurlock, 1989; Stevenson, 1881; Stewart, 1942). Rabbit, deer, antelope, and other game were taken, as were insects such as cicadas, crickets, and grasshoppers. As described for the Apache, "…fire was used as an aid, a large segment of a circle being fired while a line of men closed off the unfired gap. Rabbits were killed with arrows or with yucca-stalk clubs about six feet long. One informant stated that a fire circle might be a mile in diameter; another had seen brush level areas one-half by one-quarter of a mile in size fired" (Buskirk, 1986, pp. 135–136). Clearly, these practices could have produced large-scale effects.

Using fire as a means of waging war is well documented in both pre-European-settlement and post-contact times. Kaib (1998) found that about 80% of historical references to intentional fires were in the context of warfare. Fire was used against enemies for purposes of escape, flushing out adversaries, and burning habitations, forage, and belongings. Archeological evidence of areas with significant numbers of severely burned sites is seen as the use of fire to burn out enemies in pre-contact times. In historic times, the Apache and Navajo used fire to drive away enemies, burn forested areas used by enemies, or escape from enemies in clouds of smoke (Scurlock and Parsons, 2001). The Comanche set fire to the grass to cover their trail from pursuing men and dogs, and Dobyns (1981) notes that the Hispanos set fires to burn out opposing warriors.

The research shows that Southwestern groups understood the ecological effects of fire and used it for specific, limited purposes. In certain times and places aboriginal and historic fire use had the potential to create landscape-scale environmental effects, but the role and effects of human-induced burning should not be automatically assumed. Much southwestern burning, especially in the ponderosa pine uplands, is apparently the result of the frequent lightning strikes in the area. Smaller scale, more limited environmental effects from human induced burning are probably the norm. Indeed, the most important human effect in pre-European-contact times may have been the absence of advanced fire suppression technology, which did not come to the fore until the 20th century.

2.3. General research on contemporary use of fire

As is the case with historical research, more contemporary research on indigenous and traditional groups has occurred at the national level than in the Southwest. This national information shows that some groups wish to continue traditional fire use and management regimes, such as the light burning practiced in prior years (discussed in de Buys et al., 1999). For instance, the conference "Traditional Use of Fire and the National Fire Plan" held by the

Confederated Tribes of Grande Ronde and the Confederated Tribes of Siletz Indians in Oregon in 2002 emphasized reintroducing the beneficial effects of traditional burning for improving grass growth and increasing wild seed production, as well as reducing the hazard of catastrophic wildfires.

In a study from the Northwest, Native American informants and researchers from botany and forestry discussed how traditional ecological knowledge of fire is used to create desired ecosystem effects (Boyd, 1999). Until very recent times annual burning was carried out by many groups. Elders remember these annual burning traditions and their benefits to the ecosystem. Boyd (1999, p. 1) describes an incident related to him concerning a visit with a group of Methow elders to one of their traditionally occupied valleys in Washington. Some of the Methow had not been there for 50 years. As they traveled through the valley, one woman began to cry and stated "When my people lived here, we took good care of all this land. We burned it over every fall to make it like a park. Now it is a jungle." Other tribal elders confirmed the regular burning program. The Dene Tha from northern Alberta also comment on the negative changes brought about by brush and tree encroachment and remember their tradition of annual spring burning (Lewis, 1982). Despite the fact that many peoples no longer engage in traditional burning practices, their effects are remembered and valued. (Anderson, 1993, 1996; Bonnicksen et al., 1999; Boyd, 1999; Johnson, 1994; Turner, 1999).

Other information outlines the role of prescribed burning in maintaining and improving vegetation for groups as diverse as the Karuk of California and the Hopi of Arizona. Vegetation is managed both at the landscape level and at the level of specific plants for production of basketry materials, house construction materials, native grasses, berries, and mushrooms (Anderson, 1993; Boyd, 1999, Thakali and Lesko, unpublished paper). Many groups now work with the US Forest Service to assist in fire management projects on both tribal and federal land (Thakali and Lesko, unpublished paper).

2.4. Research on contemporary use of fire in the southwest

Projects to collect current fire use and management information are needed in the Southwest to provide land managers with region-specific data to assist them in working with local groups of indigenous forest users. To this end, work sponsored by Rocky Mountain Research Station, Forest Service, is currently underway to examine how attitudes and practices concerning fire use and management vary by cultural group, residence location, and past experience among contemporary Native American, Hispano, and Anglo-American communities. Preliminary information collected in interviews with several Puebloan and other Native American groups in New Mexico and Arizona show a high degree of knowledge concerning the positive effects of fire on ecosystems among the resource management professionals that were interviewed (Martin, Martin, and Bender, personal communication). Several have fuel management programs that include prescribed fire, mechanical thinning, and commercial logging on tribal forest lands and around communities to improve forest health and create defensible space.

Although groups often have concerns over damage to specific special use areas as mentioned previously, many also feel that plant use and management with fire can ensure plant abundance. As stated by Anderson (1993, p. 7) in a discussion of Native American cultures of the Sierra Nevada, "There is a common belief that in the absence of human harvesting, tending, and use the native plants are offended and consequently disappear." This view was echoed in an interview with Ron Trosper, from Native American Forestry at Northern Arizona University, when he stated that the notion that people should keep their hands off (the forest) is not an Indian view—people have a duty to take care of the land (Trosper, personal communication).

Other major management issues the tribal resource professionals discussed included a strong desire to manage their own burning programs for both economic benefits and to better protect special use areas, a need for better communication with federal agencies, and a desire for additional federal education programs concerning the benefits of prescribed fire that could be used in tribal education programs. However, concern over cultural resource sites and sacred areas remains a problem for both tribal and agency burning programs. For example, several resource managers expressed the view that thinning, as well as severe burning, makes sites more visible and more accessible to the public. As prior research has shown (Raish et al., 1999), prescribed or intentional burning over sensitive site areas can be a problem. Some groups consider that archeological sites are not only the home of ancestors but also living entities themselves. These issues serve as examples of concerns that must be taken into consideration by both tribal and federal land managers when planning prescribed burning programs.

Additional research on the role of culture and ethnicity in shaping attitudes towards fire and fire management is occurring in the area of economics. Although not located in the Southwest, these studies describe the types of questions that could profitably be addressed in the region owing to the large numbers of cultural groups and the prevalence of Spanish-speaking populations. A recent study by González-Cabán et al. (2003) compares survey response rates, protest responses, and willingness to pay for two types of fire prevention programs (prescribed burning and mechanical fuels reduction) for general residents of Montana and members of two Native American tribes in Montana (the Confederated Salish-Kootenai Tribe and the Blackfeet Tribe). The contingent valuation method (CVM) was used with a two-stage phone interview and a mailed booklet. In very brief summary, results indicated that support for prescribed burning was similar between general

Montana households and Native Americans. The Native American households actually supported the mechanical fuels reduction program at a higher level than other residents, while the overall results indicated there may be more across-the-board public support for prescribed burning than mechanical fuels reductions.

A similar CVM survey project examined a body of related questions concerning alternative wildfire fuel reduction techniques among English and Spanish-speaking households in Florida (Loomis et al., 2001, 2002). In general, the survey results showed that support for wildfire mitigation policies is not statistically significantly affected by ethnicity/language of the respondent. Although there are differences in respondents' attitude and knowledge by language, there is no indication this creates differences in support for wildfire mitigation policies (Loomis et al., 2001, 2002).

These studies were undertaken to include the opinions of minority groups and non-English-speakers in developing a body of information concerning forest management in the US. General fairness, as well as representative sampling, indicates that the many cultural groups of the nation be allowed to express their views. The studies also were designed to assess the effectiveness of the CVM survey technique when used with varying cultural groups and with non-English speakers. Including a survey in Spanish was desired because almost all CVM surveys have been conducted in English, despite the fact that some areas of the country have very large Spanish-speaking populations. Effectively omitting these households could lead to unrepresentative samples (Loomis et al., 2001, 2002).

In general, the projects showed that the CVM survey format worked well for Native Americans in Montana both on and off the reservations. There was a difference in the follow up survey rate (the second of the set of phone interviews), however, with the Native Americans having a significantly lower response rate that reduced the ability to generalize from the sample to the general Native American population. The authors suggest that future surveys should explore attempts to increase the response rate, such as including a letter from tribal officials in the mailed booklet (González-Cabán et al., 2003). In the Florida survey the response rates of English and Spanish speakers to the entire survey process were very similar (Loomis et al., 2001, 2002).

3. Recommended future research

Although there is a growing body of national information on fire and related topics, additional Southwestern research is still needed for a clearer understanding of traditional and contemporary fire attitudes and uses among Native American and Hispano groups. Specific questions on fire use and management require clarification. As far as fire use is concerned, questions center around the contemporary role of fire in indigenous and traditional communities. For example, is fire still a tool for improving soil productivity, increasing wild seed production, killing woody species in rangeland pastures, and encouraging grass growth, given increasing populations and changing patterns of land ownership? Is fire still used in ceremonial activities, or is it now mainly a tool for wildfire hazard reduction and vegetation management?

Fire management questions of interest concern public land managers as well as tribal and community managers. For example, is reintroduction of fire in the ecosystem compatible with current tribal and community land use patterns and are the managers of these lands willing to support the fire management objectives of the public agencies? On the other side of the coin, are public land managers becoming more knowledgeable concerning the historical uses of fire by indigenous and traditional peoples? Are the public agencies using this information to better manage resources, special use areas, and sacred places of concern to these groups? These are but a few of the questions that could help us better understand the interface between fire and culturally varied land management.

A wider range of studies and research methods than are currently practiced are needed to obtain the data required to answer these questions. As discussed previously, we need to gather information from regional land managers concerning the extent of their understanding of Native American and Hispano fire use practices and attitudes, as well as the extent to which this information is used in land and resource management planning. What techniques are needed to help public agencies collect and use the appropriate information?

Interviews with additional Native American groups and traditional Hispano communities are needed to gather information on contemporary or desired burning and other vegetation management practices that groups would like to implement, as well as on attitudinal information concerning prescribed fire as a vegetation restoration and management tool. Data on problems, issues, and concerns related to burning or to working with public agencies on burning and vegetation management projects also need to be examined. Gathering additional information on traditional practices for land managers could be accomplished at this time. This type of information could help public and private land managers reduce conflict levels among different groups by understanding better the rationale behind the use of fire by traditional groups.

The importance of collecting data not only from a variety of groups but also from a variety of people within a group must be considered. In addition to tribal resource managers, for example, religious leaders and general tribal members can provide valuable information and possibly different perspectives. These people should be sought out when possible. Collecting oral history information on traditional practices from the elders is particularly critical. As the older generation ages, opportunities to work with this group become more restricted. In many cases, these people have detailed, first-hand knowledge of traditional

practices learned when they were young. This body of data can be helpful to managers attempting to implement traditional practices to manage resources of concern to indigenous and traditional groups. This same type of information collection program can also be undertaken with Hispano communities. Conversations with forest and grassland users from these communities, such as grazing permittees and recreationists, as well as with land grant members can provide valuable discussions concerning contemporary and traditional resource management techniques.

In addition to interview data, broad-scale survey information is needed from a variety of cultural/ethnic groups across the region. Willingness to pay and preferences for the various types of fuel treatments can be collected across ethnic/cultural groups and across regions. Benefit-cost analysis studies can be used to determine the positive and negative economic impacts on different groups of fuel reduction programs, and address social justice concerns. Where appropriate, the survey materials and surveys themselves could be in the language of the respondents. Spanish-language work, as previously described for the Florida study, is certainly appropriate for the Southwest. The need for using other languages besides Spanish would require further study and should be determined on a case-by-case basis. Using native speakers as research partners in project choice, design, and implementation is very important and has proved successful in tribal archeology programs in the Southwest. This type of program might be beneficial in fire research as well.

A program designed to gather regional economic survey information using the CVM or other nonmarket valuation technique format in combination with other demographic data could provide an important comparative base for data from other parts of the country. Differences within groups residing in different areas could provide valuable insight into regional variations in cultural traditions, attitudes, and experiences with fire. Longitudinal studies will help track changes in attitudes and behavior towards fuel treatment practices both from the Native American point of view and also from contemporary, non-Native American communities.

Finally, providing the resulting attitudinal and behavioral information concerning cultural variations in fire and fuels management views and practices to the land managers responsible for fuels reduction projects is important. This will allow managers to design their projects taking into consideration the cultural, attitudinal, and behavioral concerns of the indigenous and traditional people of the area creating, therefore, projects that are less contentious and more likely to succeed. The costs of implementing projects would be reduced and the probability of court litigation would be minimized. Training sessions, databases, and publications geared to the targeted audience should be developed. Funding for this type of technology transfer is critical and often seems to be overlooked. There is little practical utility in gathering a valuable body of data if those charged with on-the-ground application are unaware of its existence. Both historical and contemporary research is needed on cultural/ethnic variations and traditional practices concerning fire use and management. Gathering and disseminating these data are challenges for current and future southwestern fire research.

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References

Allen, C.D., 1984. Montane Grassland in the Landscape of the Jemez Mountains. MS thesis, University of Wisconsin.

Allen, C.D., 2002. Lots of lightning and plenty of people: an ecological history of fire in the upland Southwest. In: Vale, T.R. (Ed.), Western Wilderness: Fire, Native Peoples, and the Natural Landscape. Island Press, Covelo, CA, pp. 143–193.

Andersen, A., 1999. Cross cultural conflicts in fire management in northern Australia: not so black and white. Conservation Ecology 3 (1), 6 [on line] URL: http://www.consecol.org/vol13/iss1/art6.

Anderson, M.K., 1993. Indian fire-based management in the sequoia-mixed conifer forests of the central and southern Sierra Nevada. Yosemite Research Center, Yosemite National Park. Cooperative Agreement Order Number 8027-2-002. Manuscript on file, Yosemite Research Center.

Anderson, M.K., 1996. Tending the wilderness. Restoration and Management Notes 14 (2), 154–166.

Bahre, C.J., 1985. Wildfire in southeastern Arizona between 1859 and 1890. Desert Plants 7 (4), 190–194.

Blaney, G., 1999. How fire shaped a continent: Australian experiences of fire since 1788. In: National Academies Forum, Proceedings of the 1999 Seminar Fire! The Australian Experience; 30 September 1999–1 October 1999; University of Adelaide, Australia, National Academies Forum, Canberra, Australia, pp. 33–38.

Bonnicksen, T.M., Anderson, M.K., Lewis, H.T., Kay, C.E., Knudson, R., 1999. Native American influences on the development of forest ecosystems. In: Szaro, R., Johnson, N.C., Sexton, W.T., Malk, A.J. (Eds.), Ecological Stewardship: A Common Reference for Ecosystem Management, vol. II. Elsevier, Oxford, England, pp. 439–470.

Boyd, R., 1999. Indians, Fire and the Land in the Pacific Northwest. Oregon State University Press, Corvallis, OR 313pp.

Buskirk, W., 1986. The Western Apache: Living with the Land Before 1950. University of Oklahoma Press, Norman, OK 273pp.

Condie, C.J. [Unpublished paper]. Documented uses of fire in prehistoric New Mexico. Unpublished paper on file at: US Department of Agriculture, Forest Service, Rocky Mountain Research Station, Albuquerque Laboratory, Albuquerque, NM.

Condie, C.J., Raish, C., 2003. Indigenous and traditional use of fire in southwestern grassland, woodland and forest ecosystems. In: Jakes, P.J., (Ed.), Proceedings from Human Dimensions Research and the National Fire Plan, Ninth International Symposium on Society and Resource Management, 2–5 June 2002, Bloomington. US Department of Agriculture, Forest Service, North Central Research Station, Gen. Tech. Rep. St. Paul, MN

Cooper, C.F., 1960. Changes in vegetation, structure and growth of Southwestern pine forests since white settlement. Ecological Monographs 30 (2), 129–164.

Curtis, E.S., 1926. The North American Indian 17, the Tewa, the Zuni. The Plimpton Press, Norwood, MA [Reprinted 1978, Johnson Reprint Corp.], pp. 580–615.

Cushing, F.H., 1920. Zuni Breadstuff. Indian Notes and Monographs 8. Museum of the American Indian, Heye Foundation, New York, NY [Reprinted 1974], 673pp.

de Buys, W., Crespi, M., Lees, S.H., Meredith, D., Strong, T., 1999. Cultural and social diversity and resource use. In: Johnson, N.C., Malk, A.J., Sexton, W.T., Szaro, R. (Eds.), Ecological Stewardship: A Common Reference for Ecosystem Management, vol. III. Elsevier, Oxford, England, pp. 189–208.

Dobyns, H.F., 1981. From Fire to Flood. Ballena Press Anthropological Papers 20. Ballena Press, Socorro, NM.

Euler, R.C., 1954. Environmental adaptation at Sia Pueblo. Human Organization 12 (4), 27–30.

Fish, S.K., 1996. Modeling human impacts to the Borderlands from a fire ecology perspective. In: Ffolliot, P.F., et al., (Ed.), Effects of fire on Madrean Province ecosystems: A Symposium Proceedings. Gen. Tech. Rep. RM-GTR-289. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO, pp. 125–134.

González-Cabán, A., Loomis, J.B., Hesseln, H., 2003. Do cultural differences affect support for alternative wildland fire mitigation strategies: Native Americans in Montana, USA. In: Proceedings, third International Wildland Fire Conference and Exhibition; 3–6 October 2003, Sydney, Australia. ISBN:1-877040-15-0.

Gifford, E.W., 1940. Culture element distributions, XII: Apache-Pueblo. University of California Anthropological Records 4 (1), 0 Berkely, CA: University of California. 207pp.

Hill, W.W., 1938. The Agricultural and Hunting Methods of the Navaho Indians. Yale University Publications in Anthropology 18. Yale University, New Haven, CT 194pp.

Hill, W.W., 1982. An ethnography of Santa Clara Pueblo, New Mexico. University of New Mexico Press, Albuquerque, NM, 400pp.

Hough, W., 1926. Fire as an Agent in Human Culture. United States National Museum Bulletins 139. United States National Museum, Washington, DC, 270pp.

Johnson, L.M., 1994. Aboriginal burning for vegetation management in northwest British Columbia. Human Ecology 22 (2), 171–188.

Jones, H., 1932. Use of wood by the Spanish colonists in New Mexico. New Mexico Historical Review 7 (3), 273–291.

Kaib, J.M., 1998. Fire History in the Riparian Canyon Pine-Oak Forests and the Intervening Desert Grasslands of the Southwest Borderlands: a Dendroecological, Historical, and Cultural Inquiry. MS thesis, University of Arizona, Tucson, AZ, 234pp.

Kay, C.E., 1994. Aboriginal overkill and Native burning: implications for modern ecosystem management. Western Journal of Applied Forestry 10 (4), 121–126.

Kelly, I.T., 1964. Southern Paiute ethnography. University of Utah Anthropological Papers 69, Glen Canyon Series 21. Salt Lake City, UT: University of UT, 253pp.

Langton, M., 1999. The fire at the center of each family: Aboriginal traditional fire regimes and the challenges for producing ancient fire management in the protected areas of northern Australia. In: National Academies Forum, Proceedings of the 1999 Seminar Fire! The Australian Experience; 30 September 1999–1 October 1999; University of Adelaide, Australia, National Academies Forum, Canberra, Australia, pp. 3–32.

Lewis, H.T., 1973. Patterns of Indian Burning in California: Ecology and Ethnohistory. Ballena Anthropological Papers. Ballena Press, Ramona, CA.

Lewis, H.T., 1982. Fire technology and resource management in aboriginal North America and Australia. In: Hunn, E., Williams, N. (Eds.), The Regulation of Environmental Resources in Food Collecting Societies. American Association for the Advancement of Science Selected Symposium Series No. 67. Westview Press, Boulder, CO, pp. 45–67.

Lewis, H.T., 1985. Why Indians burned: specific versus general reasons. In: Proceedings—Symposium and Workshop on Wilderness Fire; 15–18 November 1983; Missoula, MT, tech. coords. Lotan, J.E. et al., Gen. Tech. Rep. INT-GTR-182.: US Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT, pp. 75–80.

Loomis, J.B., Bair, L.S., González-Cabán, A., 2001. Prescribed fire and public support: knowledge gained, attitudes changed in Florida. Journal of Forestry 99 (11), 18–22.

Loomis, J.B., Bair, L.S., González-Cabán, A., 2002. Language related differences in a contingent valuation study: english versus Spanish. American Journal of Agricultural Economics 84 (4), 1091–1102.

Opler, M.E., 1971. Jicarilla Apache territory, economy, and society in 1850. Southwestern Journal of Anthropology 27 (4), 309–329.

Opler, M.E., 1973. Grenville Goodwin among the Western Apache: Letters From the Field. University of Arizona Press, Tucson, AZ, 104pp.

Petersen, K.L., 1985. The history of Sagehen Flats: the pollen record. In: Petersen, K.L., et al. (Eds.), Dolores Archaeological Program: Studies in Environmental Archaeology. US Department of the Interior, Bureau of Reclamation, Denver, CO, pp. 229–238.

Petersen, K.L., Matthews, M.H., 1987. Man's impact on the landscape: a prehistoric example from the Dolores River Anasazi, southwestern Colorado. Journal of the West 26 (3), 4–16.

Pratt, B.C., Scurlock, D., 1989. Llano, River, and Mountains: the Southeast New Mexico Regional Overview l: Historic Overview. Historic Preservation Division, Santa Fe, NM.

Pyne, S.J., 1982. Fire in America: A Cultural History of Wildland and Rural Fire. Princeton University Press, Princeton, NJ.

Pyne, S.J., 1995. World Fire: The Culture of Fire on Earth. Henry Holt, New York, NY.

Raish, C., Engdahl, L., Anderson, W., Carpenter, D., Crespi, M., Johnson, P., McConnell, L., Neller, E., 1999. Resource management strategies for working with cultural and social diversity. In: Johnson, N.C., Malk, A.J., Sexton, W.T., Szaro, R. (Eds.), Ecological Stewardship: A Common Reference for Ecosystem Management, vol. III. Elsevier, Oxford, England, pp. 209–225.

Russel, E.W.B., 1983a. Indian-set fires in the forests of the northeastern United States. Ecology 64 (1), 78–88.

Russel, E.W.B., 1983b. Indian-set fires in northeastern forests. Bioscience 33 (7), 462.

Scurlock, D., Parsons, H.R., 2001. Valley, Plains and Sky: An Environmental History of the Middle Pecos, vol. 1. Along the East Bank of the Pecos: A Tale of Four Fort Sumners and Beyond. Friends of Fort Sumner's Heritage, Fort Sumner, NM.

Stanturf, J., 2002. SFRA Chapter 25 (background paper FIRE)—Fire in southern forest landscapes. Final Tech. Rep. Asheville, NC: US Department of Agriculture, Forest Service, Southern Research Station and Southern Region, URL: http://www.srs.fs.fed.us/sustain/report/fire/fire-06.htm. 52pp.

Stevenson, J.J., 1881. Report upon geological examinations in southern Colorado and northern New Mexico, during years 1878 and 1879. US Geographical Surveys West of the 100th Meridian, vol. 3 (Supp.). Government Printing Office, Washington, DC, 420pp.

Stewart, O.C., 1942. Culture element distributions, XVIII: Ute-Southern Paiute. University of California Anthropological Records 6 (4), 231–355 Berkely, CA: University of California.

Stewart, O.C., 1955a. Why were the prairies treeless? Southwestern Lore 20 (4), 59–64.

Stewart, O.C., 1955b. Forest and grass burning in the Mountain West. Southwestern Lore 21 (1), 5–9.

Swetnam, T.W., Baisan, C.H., 1996. Historical fire regime patterns in the southwestern United States since AD 1700. In: Allen, C.D. (Ed.), Fire Effects in Southwestern Forests: Proceedings of the Second La Mesa fire Symposium; 1994 March 29–31. Los Alamos, NM, tech. Gen.

Tech. Rep. RM-GTR-286. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO, pp. 11–32.

Thakali, R., Lesko, L. [Unpublished paper]. Wisdom of the ages: traditional knowledge and forest ecosystems. Unpublished paper on file at: US Department of Agriculture, Forest Service, Kaibab National Forest, Williams, AZ.

Touchan, R., Allen, C.D., Swetnam, T.W., 1996. Fire history and climatic patterns in ponderosa pine and mixedc forests of the Jemez Mountains, northern New Mexico. In: Allen, C.D. (tech. Ed.), Fire Effects in Southwestern Forests: Proceedings of the Second La Mesa Fire Symposium, 29–31 March 1994, Los Alamos, NM.

Turner, N.J., 1999. Time to Burn: traditional use of fire to enhance resource production by aboriginal peoples in British Columbia. In: Boyd, R. (Ed.), Indians, Fire, and the Land in the Pacific Northwest. Oregon State University Press, Corvallis, OR, pp. 185–218.

Williams, G.W., 2000. Introduction to aboriginal fire use in North America. Fire Management Today 60 (3), 8–12.

Williams, G.W., 2002a. Aboriginal use of Fire: Are there any ''Natural'' Communities? US Department of Agriculture Forest Service, Washington, DC.

Williams, G.W., 2002b. References on the American Indian use of Fire in Ecosystems. US Department of Agriculture Forest Service, Washington, DC.