Fire in Indian Country

Two Case Studies in the Southwestern United States

Diane Austin & Barbara Wolf

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Foreword

As long-time residents of North America, Native Americans[1] have much experience with both climatic variation and strategies for coping with change. Native American tribes and tribal organizations are unique and important partners to those doing climate-related research and outreach, especially in the Southwest. Through the National Oceanic and Atmospheric Administration Climate Assessment for the Southwest (CLIMAS)[2] project, climate-related issues of concern to Native Americans are being addressed. An initial report, "Building Partnerships with Native Americans in Climate Related Research and Outreach" (Austin et al. 2000), established a framework for carrying out climate impacts research with tribes.

The research presented here documents institutional and organizational factors affecting fire management on tribal lands. Two case studies of fires occurring on tribal lands in Arizona provide insights into how these factors converged to influence the course of events. These case studies provide a foundation for considering more broadly the implications of climatic conditions and use (or potential use) of climate information for managing fire on tribal lands.

In this light, this study considers historic as well as current conditions and events because these affect whether or not people are receptive to information, to planning, and to working together. This report is intended for a broad audience, including tribal, federal, and local policy makers, natural resource managers, and climate information specialists. Though it focuses on decision making within tribes and agencies responsible for tribal lands, its findings are relevant for other locations as well.

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Introduction

The topic of fire has gained considerable attention, particularly following recent events that have caused significant environmental damage and loss of human life (e.g., Storm King Mountain, Colorado in 1994; Cerro Grande, New Mexico in 2000). In the year 2000, for example, 92,250 fires, affecting 7,393,493 acres, were reported to the National Interagency Fire Center (NIFC website; www.nifc.gov/fireinfo/nfnmap.html). Especially in the arid West, where water for extinguishing fires is often scarce, fire management requires careful planning. Factors that must be considered include biological and physical conditions such as vegetation cover or climate and weather patterns, and sociocultural and political conditions such as perceptions about the role of fire or jurisdiction. These require attention to land and resource management as well as to the fire itself. This report examines fire management in the context of two case studies of fire in Indian Country[3] in the southwestern United States. This focus provides an opportunity to explore the linkages among physical, sociocultural, and political factors and to offer recommendations for fire and resource managers and those who might provide climate information to them.

Links between climate and fire range from the obvious – fires burn hotter and drier during droughts – to the less direct – precipitation and temperature influence the type and density of vegetation, some of which acts as a particularly effective fuel. In the Southwest, the episodic occurrence of years with high fire activity has been correlated with El Niño and La Niña events[4] (Swetnam and Betancourt 1990). Conditions in the Southwest make this region "particularly prone to thunderstorms and lightning discharges" (Komarek 1969, p. 4). At the same time, recent increases in human population have resulted in more human-caused fires. For example, in 2000, of 25 large fires in Arizona, 13 were caused by humans and 15 by lightning (NIFC website; www.nifc.gov/fireinfo/firemap.html). Still, climatologists argue that the pattern of synchronous fire years, which are related to climate patterns, has occurred for at least the past 300 years and holds even in the latter half of the 20th century (Swetnam 2001). The relationships between climate and fire allow for some predictability; however, effective use of such information requires that appropriate management and planning tools and structures be in place. This study is an effort to explore management in the context of actual events and decisions.

The study takes a political ecology[5] approach that integrates ecology, political processes and policy analysis, historic physical and sociocultural conditions, and local and scientific knowledge and culture. This approach recognizes that, historically as well as in the present, not only local but also scientific knowledge reflects particular cultural assumptions; it is especially relevant for a study of fire and its role in ecosystems, about which dramatic shifts in scientific and policy perspectives have taken place. Research methods include site visits, document reviews, and in-depth interviews with people involved in resource management, the fires, and their aftermath. The study considers three periods: natural resource management *before* the fire, *during* the fire, and *after* the fire. Climate information was expected to be important before and after the fire and weather information to be critical during the fire. Still, those who respond to fire may be able to use climate information to help predict the type of fire season they might expect and the resources they will need to respond effectively. Therefore, this study looks at all three periods to identify potential information users and their needs. The study explores both the diversity and complexity of fire and resource management in Indian Country today and the origins of the present circumstances. Its components include:

- a review of documented historic tribal fire and resource management practices
- a review of land cover and use change since the reservations were established
- a review of federal and tribal policies and practices regarding fire management
- a close look at what led up to recent fires, the fires themselves, and activities after the fires.

The report is organized in four sections, beginning with an overview of the ecology and policy environment of southwestern tribal lands. The first section

also includes a discussion of historic and recent climate patterns and indigenous and scientific perspectives on fire in the Southwest. The second section is a case study of the summer 2000 fire on the Kaibab Paiute Reservation in northern Arizona, dubbed the "Moccasin Mountain Fire" (see Figure 1). That is followed by a case study of two fires on and near the Fort Mojave Reservation at the California-Arizona-Nevada border. The report concludes with a summary and recommendations for future management of fires on tribal lands and roles for those who generate and provide climate information.

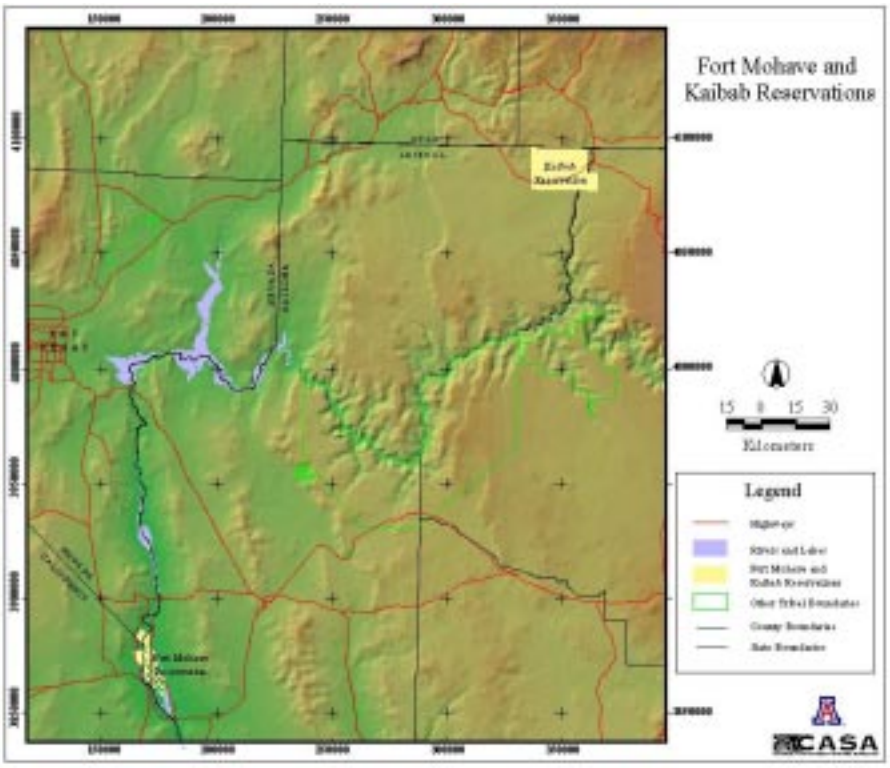

Figure 1. Location of Kaibab and Fort Mojave Indian Reservations
Source: Center for Applied Spatial Analysis, University of Arizona

Ecology and Policy: Fire on Southwestern Tribal Lands

Southwestern landscapes and ecosystems are very diverse, owing to topographic complexity, climatic variability, and numerous particular environmental histories (see Allen, Betancourt, and Swetnam 1998 for overview). For example, lightning fires over millennia created a diverse environment of plants and animals adapted to living with fire, "an ideal mechanism for regeneration and continuity" (Komarek 1969 p.7). In an environment defined by meager precipitation, however, the organisms were particularly susceptible to changes wrought by human activities. The following sections offer a brief review of human influences on southwestern ecosystems focusing on fire and fire management practices.

Ecological Change

There is increasing recognition that the idea of a pristine North American wilderness, untouched by humans prior to European settlement, is a false one (Boyd 1999; Farris 2000; Kay 1994; Komarek 1969). People lived on this continent and actively modified their environments in many ways—by cutting trees for fuel, structures, and manufacturing; gathering useful plants, and sometimes manipulating the environment to foster their growth; clearing land for gardens or agriculture; and hunting animals. Early explorers attributed the landscapes they saw to "natural" conditions, never conceiving, unless they happened to observe or hear first hand, that the native people were in part responsible for creating those landscapes (Boyd 1999).

In the Southwest, humans have been altering ecosystems for thousands of years. Yet, despite the long human history in which change has been a central feature, Europeans and Euroamericans dramatically accelerated the pace of that change. Most documented vegetation changes occurred after the arrival of Anglo-American settlers in the 1870s (Bahre 1995). Dams were built, forests were logged, and cattle, sheep and exotic plants were introduced. On a massive scale, manipulation of the region's rivers affected plant and animal communities and the interactions between Native

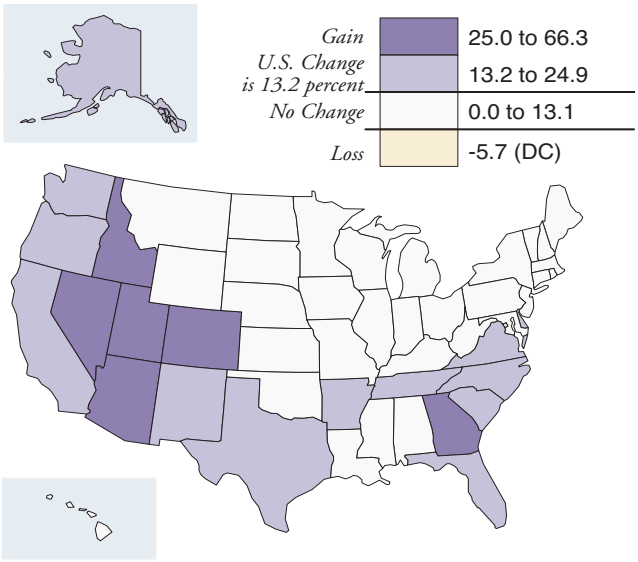

Figure 2. Percent Change in Resident Population, by State, 1990-2000
Source: U.S. Census Bureau

Americans and those communities. For example, prior to development, the Colorado River flowed unimpeded some 1,700 miles with a vertical elevation drop of more than 14,000 feet between the southern Rocky Mountains and the Gulf of California (Ohmart et al. 1988); today, four major dams control the volume and timing of water flowing in the river channel.

Though lightning fires have occurred in the Southwest for millennia and humans have started fires since they first came to the region, Anglo-American settlers caused dramatic changes to both the fire regime and the vegetation structure, especially impacting the grasslands and Ponderosa pine forests (Bahre 1995). Open forests have been replaced by dense forest and thicket structures, and suppression policies have reduced the number and increased the intensity of fires.

The links between human activities, climate patterns, and fire are less direct. The Southwest climate is complex and demonstrates high temporal and spatial variability, and links between human activities and climate are only beginning to be understood. For example, Southwestern temperatures have been climbing for at least the past thirty years (Sheppard et al. 1999), but the causes and effects of that change are widely debated.

Significantly, human migration to the Southwest continues at a rapid pace. In 2000, Nevada and Arizona were the fastest growing states in the United States (see Figure 2). The large influx of newcomers has implications for natural resource and fire managers everywhere, including those responsible for tribal lands.

Indigenous Fire Management

Fire was among the primary methods Native Americans used to alter their environments, although practices varied from tribe to tribe and according to local environmental characteristics. Native people observed the consequences of lightning-caused fires and used that knowledge for their own purposes. For instance, observing that grazing animals liked to browse the new green growth of burned over areas, Indians would set fires to attract game (Komarek 1969). Such activity also kept woody growth to a minimum and promoted the regeneration of native grasses.

Geographer Carl Sauer was the first to attribute major environmental characteristics to anthropogenic (human-created) use of fire; he has since been followed by other geographers, anthropologists, fire ecologists and other researchers (Boyd 1999; Farris 2000). It is now readily accepted that Indians well understood the effects of fire and used it intentionally, creating a significant impact on landscapes, although to what degree is controversial (Boyd 1999; Kay 1994; Komarek 1969). Some researchers credit the vast fertile grasslands that Europeans found on the American prairie to such burning (Boyd 1999; Komarek 1969; Pyne 1983; Williams 1994). In the West and Northwest, early explorers wrote of the "natural parklands" of tall trees widely spaced through open, grassy glades or "lawns," reminiscent of European parks. Researchers now recognize that these areas were "actively manipulated and managed, if not actually 'created,' by their Native inhabitants" (Boyd 1999; Pyne 1995).

Distinguishing between the effects of prehistorically lightning-caused and human-caused fires is indeed difficult, but a number of inferences have been made based on archaeological, dendrochronological (tree-ring), ethnographic, and ecological data (Farris 2000; Kay 1994). Large changes from forest to grassland may have resulted from the cumulative effect of fire and warm climate episodes, but these ecosystems were then maintained in grassland by burning even when the climate cooled (Pyne 1984). Patterns of Indian burning also changed the biological timing of fire. Natural (lightning-caused) fires came in the summer storm season, while Indian fires followed the grass life cycle and burned in early spring and late fall (Pyne 1984) when conditions were moist and produced low-intensity burns (Kay 1994).

Accounts of Indian burning indicate that practices ranged from careless and unintentional, such as failure to extinguish campfires and signal fires when people left an area (Lutz 1959; Pyne et al. 1996), to demonstration of a sophisticated understanding of the use of fire to modify the environment. Williams (1994) summarized eleven reasons for Indian burning:

- Hunting: burn large areas to drive game into smaller areas or to open up for browsers (deer, elk, bison); game birds such as geese and ducks were also attracted to fresh grass sprouts
- Wildlife habitat management: clear riparian areas to improve habitat for grasses, trees, and sprouts that would benefit game animals such as muskrat, beaver, moose and waterfowl
- Crop management: burn to harvest certain plants and grass seeds; clear for planting and preventing re-growth in abandoned fields; and facilitate acorn gathering
- Improved growth and yield: improve grass for grazers and encourage reproduction of camas[6], seed plants, berry plants, and tobacco
- Fire protection: clear areas around medicinal plants and settlements to protect from wildfire damage and to avoid encroachment by trees and shrubs on prairies
- Insect collection: use a "fire surround" in pine forests to collect and roast edible insects, and to drive away bees and collect honey from hives
- Pest management: reduce rodents and nuisance insects like mosquitoes and blackflies, and kill plant parasites such as mistletoe that threaten valuable trees like mesquite and oak
- Warfare: expose enemy hiding places in tall grass and underbrush, or use fire as an offensive weapon
- Economic extortion: "scorched earth policy" to prevent settlers or other tribes access to game resources and take advantage of middleman position
- Travel: clear trails through overgrown areas and provide better visibility in dense forest and brush
- Fell trees

Among other benefits, Indian burning added to the effects of natural fires to keep forest floors clear of fuel accumulation that could lead to catastrophic forest destruction; keep environments free of woody growth and foster lush growth of grasses that fed wild game and later domesticated livestock; foster the abundance of plants used by people for food, medicine and craft; and maintain and increase biodiversity along edges of burned areas. European-influenced forestry practices and emphasis on commercial forest values led to land management policies designed around fire suppression with unforeseen negative consequences, as discussed below.

Science in Fire Management

Non-indigenous perspectives on fire in the United States derived from a European perspective formed under conditions of extensive land cultivation and permanent settlements (NPS 1996). For most of the twentieth century, into the 1960s, control of fire was the overarching goal of land managers, and technologies for fire suppression improved to a point that few fires burned uncontrollably. With the advent of the science of ecology and attention to ecosystem dynamics came the scientific study of agents of change, including fire. As fires largely disappeared from many ecosystems, the effects of *absence* of fire were observed and stimulated greater study.

The negative economic consequences of habitats that were diminished by the lack of fire and the high costs of putting out all fires captured attention. Gradually, private and public managers began experimenting with reintroducing fire to the land, and fire suppression evolved to be only one aspect of fire management. As early examples:

> "The U.S. Forest Service began intentionally burning some southern forests in the 1940s to create new, even-age growth of greater commercial value. In the 1950s and 1960s, the National Park Service experimented with controlled burns in Everglades and Sequoia-Kings Canyon national parks, and by the late 1970s, a dozen national parks, including Yellowstone National Park, were allowing some fires to burn. In parks and forests preserved for their wilderness values, where the processes of wilderness are the only products, flames were no longer seen as good or bad but in the nature of change" (NPS 1996).

The vindication of indigenous fire management techniques has become a somewhat unusual example of the convergence of traditional and scientific knowledge and has led to further studies of indigenous fire practices. Also, political and social acceptance of fire's importance has opened up avenues for new scientific studies of the effects of fires on ecosystems. Questions being posed include the effect of burning on range productivity, groundwater recharge, large mammal movement and foraging patterns, and erosion and stream siltation. Yet, through both scientists and policymakers now recognize that fire is an important management tool, suppression remains the primary response to fire on many public and tribal lands (Arizona Strip Field Office 2000; personal communication, BLM Fuels Specialist, 2/8/01). As the following sections illustrate, translating knowledge into policy is a complex process.

U.S. and Tribal Policy: The Framework Within Which Decisions are Made

> "The Executive's environmental and natural resources policy under statutory law may emerge as the most critical policy area to tribes as they move into the twenty-first century, because it will substantially determine the future ecological viability of their separate native land base" (Wood 1995: 740).

The determined and rapid influx of European settlers onto the North American continent disrupted the lifeways and cultures of vast numbers of indigenous peoples (see, for example, Spicer 1962/1997, Kiple and Beck 1997). Native populations were decimated by disease, their access to resources was reduced or eliminated, and their movement was restricted by settlers, towns, and transportation corridors. Males were often forced to become laborers on farms and in mines. Policies of extermination and relocation removed many people from their homelands and sent others into hiding. Many groups were extinguished, but others became recognized as tribes and struggled to have their existence and rights respected. In all cases, opportunities for exercising active resource management diminished (see Austin, Gerlak, and Smith 2000).

Through treaties, Acts of Congress, executive orders, and other administrative actions, American Indian tribes achieved unique trust status that established the U.S. government as trustee for the tribes. Within the federal government, responsibility for federal interactions with tribes has rested with several different agencies. First, in 1775, the Continental Congress created a Committee on Indian Affairs (BIA 2000:www.doi.gov/bia/shorthist.html). In August 1786, the Secretary of War assumed responsibility for Indian affairs, and administration of Indian affairs remained within the War Department when that department was established in 1789. Though the Secretary of War created the Bureau of Indian Affairs (BIA) in 1824, Congress did not authorize that bureau until 1834. The BIA remained within the War Department until 1849 when it passed to civilian control under the newly-established Home Department of the Interior. During the 1800s, the BIA was organized with superintendents responsible for territories and agents concerned with the affairs of one or more tribes. Under civilian authority, its role changed to paying attention to specialized activities such as forestry, construction, employment, health, and education. Following WWII, the BIA was reorganized into a three-tier system composed of a Washington, D.C. office under an assistant secretary for land and water resources within the Department of the Interior, area offices, and agencies. In 1977, Indian concerns were elevated within the Department of the Interior with the creation of the office of Assistant Secretary for Indian Affairs.

Of the many laws and policies that have affected tribal governance (see Austin, Gerlak, and Smith 2000 for review), the 1975 Indian Self Determination and Education Assistance Act (Self-Determination Act, PL 93-638) has been particularly significant for redefining the roles of tribes and federal agencies in resource management on tribal trust land. The Act transferred authority and funding for many programs from the federal government to tribes while maintaining the U.S. government's legal and moral responsibility for those services. Similar in concept to block granting, this process, manifest as "638 compacting" or "638 contracting," enables tribes to tailor the federal programs and redistribute funds to meet their specific needs (Senate Committee on Indian Affairs 1999)[7]. Through the "638" processes authorized by the Act, tribes may assume responsibility for health, housing, education, and

natural resource management programs once operated by the BIA. As a result of that process and other requirements for interacting with tribes on a government-to-government basis, tribes interact directly with agencies under all branches of the federal government. Consequently, all federal agencies are expected to help the U.S. government fulfill its trust responsibility to tribes.

Interagency collaboration has become imperative for all parties engaged in resource management.[8] The BIA's role varies from tribe to tribe according to the extent to which the tribe has assumed responsibility for both tribal programs and participation in federal policymaking. This report will explore the relationships among tribes, the BIA, and other federal and state agencies by focusing on interactions between and among tribes, the BIA, the U.S. Forest Service, the Bureau of Land Management, and the U.S. Fish and Wildlife Service.

Integrated Resource, Forest, and Wildland Fire Management on Tribal Lands in the 21st Century

Land and natural resource management are significant concerns of both tribes and the BIA. Wildfire management has only recently been recognized as a separate management issue. Under federal policies and actions, resource management has been driven primarily by instrumental values and economic motives. For example, in the latter part of the 19th century, the BIA began addressing issues such as irrigation and forestry (BIA 2000: www.doi.gov/bia/shorthist.html). After nearly a century of fragmented, if any, environment management, attention was turned toward integrated resource management (IRM). According to the BIA:

> "Tribes have always pushed for the integrated management of Indian lands and have accomplished much in the way of ecosystem management long before the concept was recognized by the scientific community. The Bureau of Indian Affairs (BIA) views Integrated Resource Management Planning as the delivery mechanism for the expansion of ecosystem management to every reservation, village, rancheria, and individual Indian allotment throughout the United States. Native American ecosystem management is a proven tradition" (CNIE 1994).

Across the United States, resource management on tribal lands has been uneven. Early IRM efforts were unsuccessful, primarily because the BIA was (and still is) organized into separate programs according to function (e.g., timber, fish, wildlife, range, water) and funds were limited (CNIE 1994). The 1975 Indian Self-Determination and Education Assistance Act began the process of transferring authority and funding for tribal programs from the BIA to tribal governments, and tribes became eligible to receive, either directly or through contracts, resources for planning, cooperative agreements, or grants (25CFR163.10). By the mid-1990s, the federal government had revived IRM as a broad policy objective. IRM planning is called for in the National Indian Forest Resources Management Act (P.L. 101-630), and the American Indian Agricultural Resources Management Act (P.L. 103-177).

Yet, still today, few reservations have IRM plans. Where no such plan exists, tribes may have separate grazing or forest plans. Fire management is usually handled through a forest management plan, if one is in place. For the purposes of forest management, forest land is defined as an ecosystem at least one acre in size which is characterized by a more or less dense and extensive tree cover; contains, or once contained, at least ten percent tree crown cover, and is not developed or planned for exclusive non-forest resource use. Forest land management activities include: (a) program administration; (b) development, preparation and revision of forest inventory and management plans; (c) forest land development such as thinning and reforestation, (d) protection against losses from wildfire, including acquisition and maintenance of fire fighting equipment and fire detection systems, construction of fire breaks, hazard reduction, prescribed burning, and the development of cooperative wildfire management agreements; (e) protection against insects and disease; (f) assessment of damage caused by forest trespass, infestation or fire; (g) timber sale contracting; (h) support for the education of Indian and Native Alaskan foresters; (i) participation in the development and implementation of tribal integrated resource management plans; (j) improvement and maintenance of extended season primary and secondary Indian forest land road systems; and (k) research activities targeted at improving forest management (25CFR163.1). Where there is no forest management plan, a fire management plan must be developed as a separate document.

Responsibility for fire management includes obtaining and maintaining facilities, equipment, and staff in "an adequate level of readiness to meet normal wildfire protection needs and extinguish forest or range fires on

Figure 3. Eastern Great Basin Fire Zones. Note that the Color Country Zone, managed out of the Cedar Dispatch Center, extends into northern Arizona.
Source: Eastern Great Basin Coordination Center

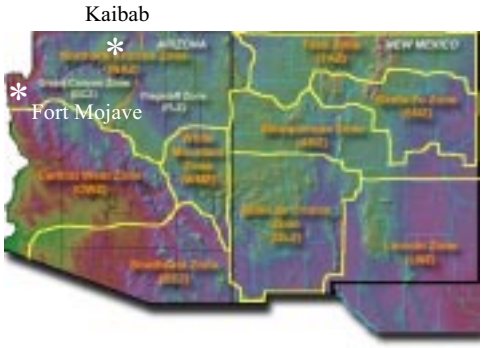

Figure 4. Southwest Fire Zones.
Source: Southwest Area Wildland Operations

Indian land" and on non-Indian land when "the fire threatens Indian land or… the expenses are incurred pursuant to an approved cooperative agreement with another protection agency" (25CFR163.28). It also covers wildfire prevention programs, emergency rehabilitation measures, and the use of fire as a management tool. The responsible party may enter into reciprocal agreements with any fire organization maintaining protection facilities in the vicinity of Indian land for mutual aid in wildfire protection.

In general, years of external decision making regarding resources and resource use, including long-term leases and agreements, have constrained the ready transfer of natural resource management responsibility from the BIA to the tribes. The transfer of authority to tribal governments has proceeded fairly rapidly in areas such as health and housing, but it is still in its infancy with respect to natural resource programs. For example, within the BIA's Western Region, only two tribes, the Salt River Pima Maricopa and the Shoshone-Paiute Tribes of the Duck Valley Reservation, compact out under the 638 process their fire management programs (personal communication, BIA Western Region official, 10/19/00). Two additional tribes, the Tohono O'odham Nation and the San Carlos Apache Tribe, have 638 contracts to provide support for fire management.

Consequently, for most tribes, forest and fire management responsibility rests with the Secretary of the Interior and is carried out by the BIA. That responsibility includes creating and carrying out an appropriate, and adaptive, forest management plan for all Indian forestlands. The BIA distinguishes forestlands, from which trees are harvested for sale, from woodlands and from areas with other vegetation types. Woodlands support trees that are not harvested, whatever their type. No special resource management planning process is required for woodlands. Beyond the forestlands, typically only grazing lands have received attention. Until recently, therefore, fire management on much reservation land was haphazard at best.

U.S. Wildland Fire Management in the 1990s

> "The challenge of managing wildland fire in the United States is increasing in complexity and magnitude. Catastrophic wildfire now threatens millions of wildland acres, particularly where vegetation patterns have been altered by past land-use practices and a century of fire suppression" (USDI and USDA 1995:1).

Wildland fire management is a complex and highly political process. U.S. fire management is carried out by a special interagency institutional and organizational structure that includes agencies within the U.S. Department of Interior (the Bureau of Land Management, Bureau of Indian Affairs, Fish and Wildlife Service, National Park Service), Department of Agriculture (U.S. Forest Service), the National Oceanic and Atmospheric Administration, the Office of Aircraft Services, and the National Association of State Foresters (see National Interagency Fire Center, www.nifc.gov). From a tribal perspective, this structure reflects pre-638 federal-tribal relations; tribes are represented only through the BIA.

Interagency fire management begins at the local level within Fire Zones (see Figures 3 and 4). Each zone is

managed by a unique configuration of personnel representing the agencies with jurisdiction within the zone. Within the zone, any dispatchers who receive word of a fire are expected to notify a central office from which an Incident Commander and other fire personnel are dispatched. The agencies within those fire zones are linked to Geographic Area Coordination Centers and then to the National Interagency Fire Center for assistance when fires exceed local capacities and resources (see http://www.nifc.gov/fireinfo/geomap.html).

During the 1990s, large fires and the consequent loss of human life called attention to the problems of past fire management practices. Spurred by the 1994 Storm King Fire in Colorado which claimed the lives of 14 firefighters (http://www.aip.org/inside_science/html/21.html) and by the increasing costs of fire suppression policies, the U.S. Secretaries of Agriculture and Interior chartered a Federal Wildland Fire Management Policy and Program Review (USDI and USDA 1995). In 1996, the Implementation Action Team Report was completed and required federal agencies to develop fire management plans for all areas subject to wildfires (Rosenkrance et al. 1996).

In 1997-1998, the BIA's Western Region began implementing the new wildland fire policy. Where no IRM plans or Forest Management plans existed, Fire Management planning began. Agency offices and field offices were assigned the responsibility for developing plans for the reservations under their jurisdictions. Each agency and field office decided whether to write a plan for each reservation or to write plans that covered two or more reservations. Offices without the internal capacity to write the plans contracted out the task. In a few cases, BIA staff worked with their counterparts at other federal agencies. Across agencies, though alternatives to fire management are discussed, written policies continue to privilege suppression.

Woodlands and other non-forestlands have presented a challenge to planners and resource managers. For these lands, fire management plans incorporate models based upon the dominant tree type, such as pinyon-juniper. However, areas such as the wetlands along the lower Colorado River that support willows, mesquites, and tamarisks (salt cedars) belong to no special category. Fire models for such vegetation types are rare (personal communication, fire manager, 2/02/01).

Summary

Contemporary responses to fire on tribal land are predicated on both the complex ideologies and policies about fire that have evolved over decades and perceptions about particular ecological consequences of prior actions. Fire has been perceived variously as a manifestation of evil, a sign of irresponsibility and carelessness, and a tool for environmental management. Manipulation has occurred through both starting and suppressing fires, and, because fire is an irregular—though certain—occurrence, it is difficult to separate natural from human impacts of fire. It is possible, however, to identify patterns that may assist fire managers, such as the co-occurrence of certain climate conditions and fire. The following two case studies examine recent fires in Indian Country to evaluate fire management there and identify if and when climate information has been or might be useful.

The Cases

The Moccasin Mountain Fire on the Kaibab Paiute Reservation

On July 21, 2000, a fire began on Moccasin Mountain on the Kaibab Paiute Indian Reservation in northern Arizona when a truck malfunction led to an engine fire that caused the gas tank to explode and spread to extremely dry roadside vegetation. That fire was finally extinguished after seven days during which it burned 1,618 acres of pinyon-juniper woodland. This case describes the reservation environment and history, traditional Kaibab Paiute fire practices, a century of woodland and resource management at Kaibab, the fire, and post-fire response.

The Kaibab Paiute Indian Reservation, located on 120,798 acres on the Colorado Plateau north of the Grand Canyon, is the remnant heritage land of the Kaivavits band of Southern Paiutes. It is spatially and jurisdictionally isolated on the Arizona Strip. Its northern boundary is defined by the Arizona-Utah border (Figure 5). In addition to four communities and a National Monument that are in direct contact with the Reservation, the Reservation lies within both Mohave (107,426 acres) and Coconino (13,300 acres) counties in Arizona and borders lands under the jurisdiction of the U.S. Forest Service and the Bureau of Land Management.

Anthropologists agree that Southern Paiute occupation of the Colorado Plateau extends back at least as far as 1150 AD (Euler 1964, Fowler, Madsen, and Hattori 1973), but Paiutes place themselves within these homelands from the beginning of time. The lands now defined as the Reservation range from a high point at Ed Lamb Point (7,058 feet) near the central northern reservation border to a low point (4,400 feet) on the southern reservation boundary. The reservation has many natural springs, and many of these continue to run off onto the land, forming tributaries flowing to intermittent streams that in turn converge and eventually feed into the Colorado River. The largest surface water source is Kanab Creek, which joins the Colorado River about 30 miles south of the reservation.

The Southern Paiutes practiced a transhumant lifestyle, moving seasonally among living and camping areas (Euler 1964, Stoffle and Evans 1976). Influenced by Ute and Navajo neighbors and Spanish explorers to the area, the Southern Paiutes nevertheless controlled the land and resources within their territory until the 1860s when Brigham Young sent members of the Church of Jesus Christ of Latter Day Saints (Mormons) to establish missions throughout the region. At that time, major changes began to occur in Kaibab Paiute territory (Kelly 1964, Stoffle and Evans 1976). Within two years of their arrival, Mormon settlers took control of all regularly flowing water sources in the territory. From the town of Kanab, the Mormons withdrew water from Kanab Creek for irrigation purposes and reduced the flow in the creek to a mere trickle. Then they established the town of Fredonia, several miles south of Kanab, to gain access to more land and water for farming. By 1865, they had claimed Pipe and Moccasin Springs, two major springs within Kaibab territory.

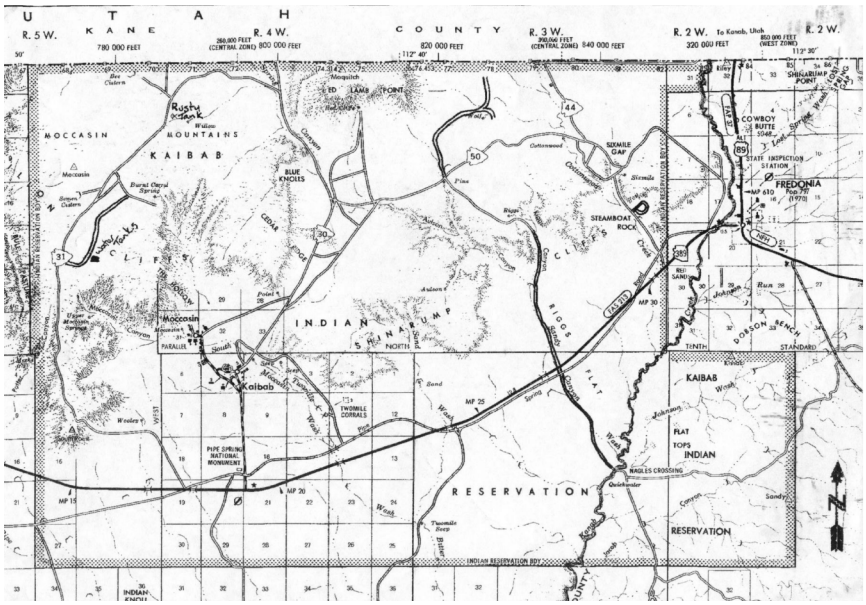

Figure 5. Kaibab Paiute Indian Reservation.
Source: Kaibab Band of Paiute Indians file

From the late 1860s until 1879, Pipe Spring and the nearby community of Moccasin were used by the Mormon Church as a base for cattle operations (Bleak 1928, Cook 1949). A Mormon Stake[9] was established at Moccasin Spring in 1875. In 1879, when the natural vegetation had become denuded and cattle ranching was not longer profitable, the church sold two-thirds of Moccasin Spring and all of Pipe Spring to a local stock-raising cooperative, the Mormon United Order.

The Mormon United Order recruited Paiutes to assist in farming the lands around Moccasin. The church "allowed" the Paiutes to receive water from Moccasin Spring for their own gardens as well. The Order was dissolved and the land at Moccasin was abandoned and split up among the five Heaton brothers who were working the ranch at the time. The Mormon Church "gave" one-third of Moccasin Spring flow to the Paiutes, which some argue was an attempt to lure the Paiutes away from the Mormon towns along Kanab Creek (Knack 1993).

The Paiutes continued to garden a few acres near Moccasin Spring and camped there during parts of the year. However, they became cut off from traditional hunting and gathering practices as lands in their territory were dedicated to ranching and forest preserves. The cattle industry flourished on the Arizona Strip in the late 1800s, but the Paiutes were not part of that economy and grew poorer. Historical records indicate that the Kaibab population living in the vicinity of the present-day reservation was at its lowest at the turn of the century.

During 1907, agents of the Federal Indian Service met with a delegation of Kaibab Paiutes and businessmen from the nearby towns of Fredonia, Arizona and Kanab, Utah to discuss the establishment of a reservation for the Paiutes. Though the people of Kanab advocated for another location, the Paiute preference for the Moccasin area prevailed. The Kaibab Paiute Reservation was established on October 16, 1907 by an order of the U.S. Department of the Interior. Southern Paiutes from the Kaibab, Kaiparowits, and Uinkarits territories settled on the Reservation. Persistent Mormon resistance to the Reservation led to the withdrawal of land on the eastern edge of the Reservation for the town of Fredonia, Arizona; in the center of the Reservation around Pipe Spring for the Pipe Spring National Monument, under the jurisdiction of the National Park Service; and in the center of the Reservation around Moccasin Spring for the community of Moccasin, Arizona. Once established, the reservation came under the trust responsibility of the U.S. government and its Bureau of Indian Affairs (BIA). However, lack of will and resources to protect Southern Paiute interests meant that Mormon ranchers continued to run their cattle on reservation lands into the middle of the 20th century (see Knack 1993)[10]. Tribal members moved on and off the reservation as necessary for survival.

Under the provision of the Indian Reorganization Act of 1934, in 1954 the Kaibab Paiutes organized a Tribal Council. The Council is composed of six individuals elected by tribal members over the age of twenty-one. In the 1950s and 1960s, the BIA became more active in working with the Southern Paiutes. The agency promoted activities designed to make the tribes economically self-sufficient. At Kaibab, cattle were introduced, a hay farm was started, and an orchard was planted.

More generally, the BIA began a pattern of short-term investments and reactive decision making that would persist until the end of the century. At the same time, the tribal government responded favorably to U.S. self-determination policies. For example, in 1976, the Tribe received a planning assistance grant from the U.S. Department of Housing and Urban Development to create a holistic plan for land and water use, housing, health delivery and employment (Turner 1985). In response to opportunities to establish special programs, during the 1980s and 1990s, the Tribal government expanded to include ten departments. Today, funding continues to come to programs associated with specific federal agencies, and this inhibits comprehensive resource management. Land and resource issues are managed by the Tribal Natural Resources Department, which consists of the Wildlife, Fisheries and Parks, Environmental, and Cultural Resources programs.

Ecological Change on the Arizona Strip

Early Euroamerican arrivals to the Arizona Strip were attracted by lush vegetation and tall grasses (Cook 1949, McKown 1960, Winsor 1959). As described above, they quickly took control of water sources for their settlements and livestock operations. They were unfamiliar with the native flora and fauna and took aggressive steps to shape the environment in ways familiar to them; they removed pinyon trees (*Pinus sp.*), grazed cattle in fields of rice grass (*Orozopsis hymenoides*), and tried to eliminate rabbits and prairie dogs, all important food sources for the Paiutes.

Settlers also found marshy areas dominated by willows (*Salix sp.*); Kanab Creek, the major surface water

source in the area derives its name from the Paiute word for willow, *kanav*. Would-be farmers set about to dig channels through these areas to drain them and plant crops. During heavy rains, their canals eroded quickly until they cut down to bedrock (Webb, Smith, and McCord 1982).

The activities of the newcomers dramatically changed the local ecology and topography. Within twenty years of settlement, marshes had been replaced by deep gullies, pinyon pines and other trees had been removed, and large cattle herds had transformed grasslands to barren landscapes characterized by sagebrush and cacti (Fox 1994, Stoffle and Evans 1976, Webb, Smith, and McCord 1992). By the time the Kaibab Paiute Reservation was established, its land and resources were vastly different from pre-contact days.

Kaibab Fire Management

In the Southern Paiute worldview, elements of the environment, such as plants, animals, and natural phenomena, are perceived more as kinsmen than as "resources." The following, for example, summarizes the Paiute view of water:

> "The protection of water sources is assured in Paiute society when humans acknowledge that water is alive and that our relationship with water is governed by respect of that life and of its power to give and take human life. In Paiute tradition, the environment is not perceived as a resource to be turned to profit. The natural setting of the people is valued because it sustains life, and humans are only one element in a harmonious complex of living things" (Austin and Jake 1998: 3).

All land on the Kaibab Paiute Reservation is owned by the entire tribe and held in trust for tribal members by the U.S. government. Cattlemen are allotted pastures, and families return to favorite areas to hunt and gather firewood. Though the BIA holds responsibility for land and resource management on the Reservation, tribal members continue to prune vegetation, cut dead trees for wood, burn their gardens to prepare for planting, and clear and maintain reservation springs. Much of the activity occurs in and around the villages where their homes are clustered.

Prior to the arrival of the Mormons, Kaibab Paiutes moved seasonally among the mountains, plateaus, and Colorado River canyons. Vegetation management included planting gardens and small farms around springs and water sources, pruning plants such as willow to ensure continued growth, and scattering rice grass seeds to encourage growth. As early as 1776, Paiutes were observed using fire to control vegetation on the North Rim of what was to be named the Grand Canyon (Warner 1976). In discussions related to this and previous studies of traditional fire practices, Paiute elders described using fires to clear undergrowth on Moccasin Mountain within the reservation boundaries.

By the time the Reservation was established, Paiute lifestyles had altered in response to changes in their environment. As more people moved into their territory, settled on and around the best water sources and destroyed major food sources, the Paiutes were forced to occupy marginal lands. Hunting and gathering areas were designated as national parks and monuments, and access to and use of these lands was restricted. For example, the Grand Canyon Forest Reserve was created in 1893, followed by the Grand Canyon National Monument in 1908, and the Grand Canyon National Park in 1919. With each successive designation, Southern Paiute use of the area was restricted (Stoffle, Halmo, Evans, and Austin 1994). Many Paiute males took work as wage laborers for ranches and mines on the Arizona Strip.

Despite the changes, Paiutes retained some of their early practices, such as small-scale farming in the lowlands and hunting and gathering firewood and pine nuts in the mountains and nearby forests. They adapted to government initiatives such as the introduction of hay farming, fruit orchards, and cattle ranching.

Once established, the Tribal Council became officially responsible for all decisions, but actual decision making continued to be carried out in traditional fashion, based on achieving consensus first within and then among families (Turner 1985). As the Tribe began to take greater responsibility for administering programs, it established separate offices staffed by one or two employees. The first tribal natural resources program was a Wildlife Department, established in 1994. That program was created to manage the tribal hunt and wildlife concerns.

An early concern of the Wildlife Department was the dense growth of sage in the pinyon-juniper woodland on Moccasin Mountain that had blocked the growth of new grasses and other foliage. The Tribe began discussions with the BIA about how to address this prob-

lem. In 1997, when a new tribal Wildlife Director took office, this issue was placed high on his agenda. At that time, hunters complained that the sagebrush within the forest had become so thick that it impeded walking and prevented them from spotting deer. Several members of the Tribe's hunting task force (renamed the wildlife committee) had begun to talk about using prescribed burning to thin some of the old sagebrush from the woodland. The Wildlife Director worked with hunters to identify areas to be burned. The Tribal Council supported the idea but wanted a careful plan prepared.

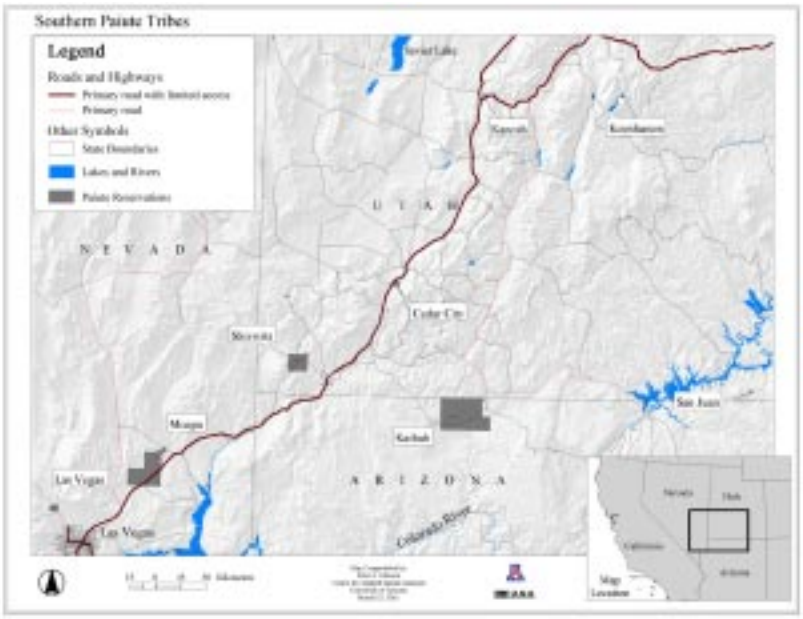

Figure 6. Location of Southern Paiute Tribal Lands .
Source: Center for Applied Spatial Analysis, University of Arizona

In 1998, faculty and students from Northern Arizona University's (NAU) Forestry Department were implementing a restoration burn on Mount Trumbull, south of the Reservation. Because Mount Trumball lies within the traditional lands of the Kaibab Paiutes, Bureau of Land Management officials responsible for the project made a presentation to the Tribe about the project. At the time the Tribal Council requested that they be kept apprised of the activity on the mountain.

Also that year, the BIA-Western Regional Office funded a Woodlands Inventory Project on the Kaibab Indian Reservation. The purpose of the study was to count the trees on the reservation to provide data for future management decisions. The Tribe sought to hire a team leader from the Fort Apache Tribe's forestry division, but the Fort Apache crew was too busy to release anyone to undertake the project. Remembering NAU's role in the Mount Trumbull project, tribal officials contacted the Forestry Department and requested assistance with the woodlands inventory. NAU faculty provided technical assistance to the project, and the Tribe hired an NAU student as project leader. This initial interaction between the Tribe and the NAU forestry department led to discussions about using fire as a management tool on the reservation. Because the Tribe had not assumed authority for fire management under the Self-Determination Act, any burns had to be planned, approved, and implemented by the BIA.

BIA Fire Management

The BIA Southern Paiute Field Office is responsible for five federally recognized Southern Paiute tribes, one of which is a composite tribe of five bands with lands spread across southwestern Utah (see Figure 6). The federal government failed to recognize the Southern Paiutes until nearly half a century after their homelands were taken by Mormons and their population decimated by disease (Stoffle, Jones, and Dobyns 1995). Tribal members were living in small clusters and refused, on several occasions, federal efforts to relocate them to reservations with other tribes. Of the 15 Southern Paiute bands recorded by an anthropologist in the early 1930s (Kelly 1934, 1964), nine are federally recognized today, and they are spread across four states. The other six bands either persist as state-recognized tribes or have been split up and their members absorbed into neighboring bands.

Despite the large area over which Southern Paiute reservations are located, their populations are relatively small, so the Field Office has responsibility for all of them within the states of Arizona, Utah, and Nevada. The Field Office has eight full-time employees, one of which, the natural resource specialist, is responsible for range management and other natural resource management concerns. In 2000, the individual assigned to that position was also assigned collateral duty as the Fire Management Officer (FMO). The Southern Paiute tribal lands under the Field Office's jurisdiction are located within five Fire Zones (see Figure 4 for zones.) Annual Operating Plans for each zone are approved at yearly meetings, and the BIA FMO attends all five meetings.

Interagency agreements exist within some of the zones to facilitate management and response to fires. The Field Office is party to the Richfield Interagency Fire Agreement, the Color Country Interagency Fire Protection Agreement, the Interagency Agreement between the BIA-Western Regional Office and the BLM-Nevada State Office, and the Interagency Agreement for the Northern Arizona Zone. The Kaibab Paiute Reservation lies within the Color Country Zone and the Northern Arizona Zone (see Figures 3 and 4) but is governed under the Color Country Agreement. According to that agreement, any dispatchers who receive notice of a fire are to notify the Cedar City, Utah Dispatch Center, and the BLM-Arizona Strip office out of St. George will dispatch an Incident Commander to the scene of the fire. Fires within the Northern Arizona Zone are handled out of Williams, Arizona.

At the time of this study, the Field Office's FMO was not in a position to gather and bring new information to the fire management meetings. She relied on the decisions made by the others within each group. The Field Office had contracted in 1998 with a private firm to create a single Fire Management Plan to cover all reservation lands under its jurisdiction. The Fire Management Plan was to address prescribed burns to minimize the risk of large wildfires (personal communication, fire manager, 11/28/00). The Plan was not finished at the time of this study.

After coming to an agreement on the use of fire on the Kaibab Indian Reservation, the Tribe's Wildlife Director and NAU faculty began discussions with BIA representatives about implementing a program of prescribed burning on the Reservation and the process through which they could gain approval for the project. After several attempts, the Tribe, NAU and BIA participants came to agree on a plan for a restoration burn. Some delay occurred because their work preceded development of the Fire Management Plan.

In the summer of 1999, the NAU-Kaibab team began conducting the woodlands inventory by counting the trees on Moccasin Mountain and calculating density and fuel load. The BIA representative sought and received funding for the Prescribed Burn Plan. However, the process was stalled because no one at the Field Office or within the Tribe was qualified to write the official Burn Plan. The Field Office's FMO sought assistance from the BIA Regional Office and, when none was available, from outside the Bureau.

The Moccasin Mountain Fire

In the summer of 2000, while still awaiting the Burn plan, students from NAU returned to the reservation to cut trees in one of the areas targeted for burning. Conditions across the Reservation and the Arizona Strip were dry (see PDSI, Figure 7). Figure 8 shows monthly rainfall for 1998-2000 when compared with a ten year average. Because they would be using chain saws that emit sparks, the students and Wildlife Director agreed that they needed water at the work site. The Director arranged to drive the Tribe's water truck up the mountain to the site. Due to dry conditions, the access road to the mountain was in poor shape. Thick sand was particularly troublesome where the road crossed dry washes and climbed hills. The Tribe receives BIA funds for road maintenance but has never paved or otherwise improved the road; the intent is to discourage unauthorized people from entering the reservation and driving onto the mountain.

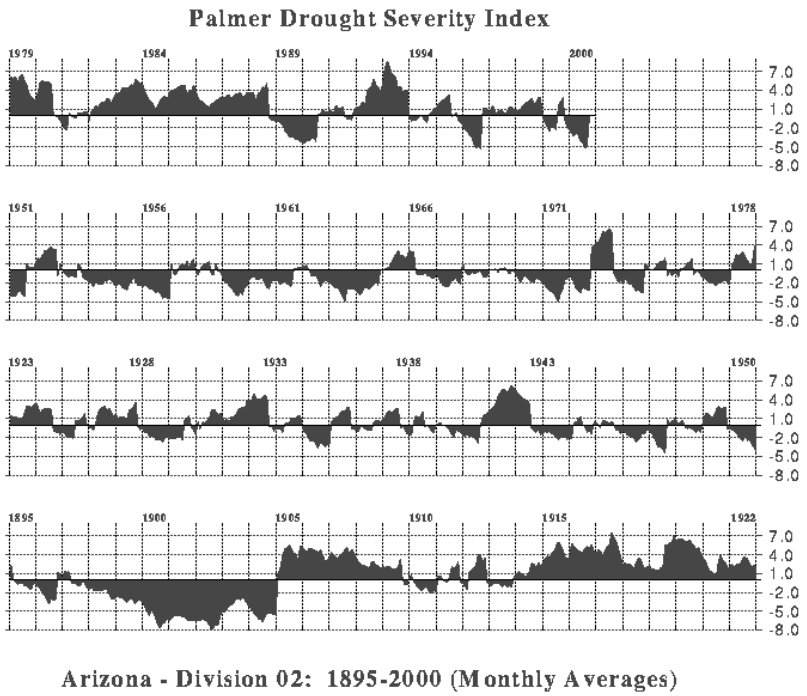

Figure 7. Palmer Drought Severity Index for Arizona Division 2, which includes the Kaibab Paiute Reservation.
Source: National Oceanic and Atmospheric Administration

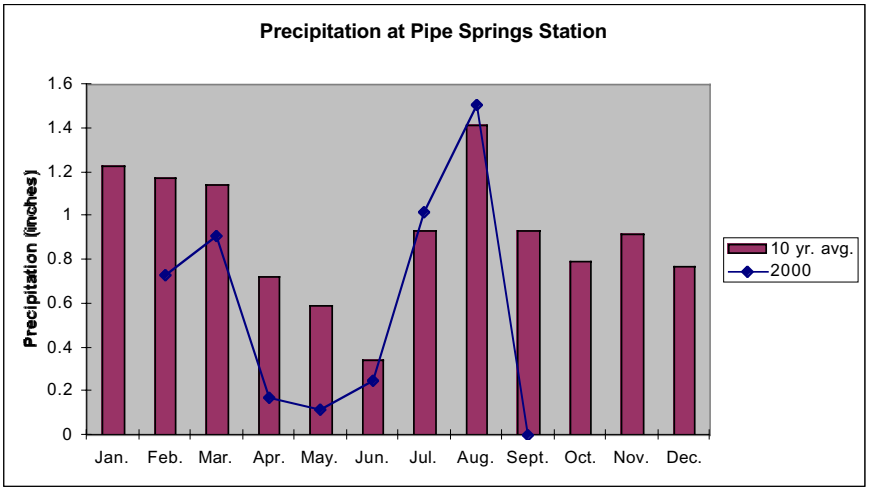

Figure 8. Precipitation at Pipe Springs Station.
Source: based on data from the Western Regional Climate Center; http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?azpipe

Struggling to get up the road, the Tribe's water truck overheated and caught fire. The fire reached the gas tank, caused the tank to explode, and quickly spread to vegetation bordering the road. The Wildlife Director radioed the tribal office for assistance. Two members of the tribe's firefighting crew met at the Tribe's fire station and drove the brush truck to the scene of the fire. The brush truck was equipped with radios that allow communication with the tribal office.

The tribal secretary contacted the dispatch office. Engines from the neighboring Colorado City Fire Department and BLM Office in Kanab, Utah responded as soon as they saw smoke coming from the mountain. The Colorado City fire fighters were unaware of the extent of the fire until they arrived, and they lacked the necessary equipment for wildland fire fighting. The BLM truck drove across dirt roads to reach the north gate onto the Reservation and stopped there to get permission from the BIA to cut the lock on the gate, resulting in a delay of more than an hour. The BIA Fire Management Officer was contacted at the Southern Paiute Field Office. She left immediately to get her equipment and travel the 75 miles to Moccasin Mountain.

Several people from nearby towns arrived hoping to help, but they lacked training in fighting wildland fires, so the Wildlife Director contacted the BIA Law Enforcement Officer to close the road to everyone except fire crews. A fire marshall with the Utah State Forester saw the smoke and responded. He was given command of the fire until the BIA representative arrived. He contacted the dispatcher in Cedar City.

On the mountain, because they came from opposite directions and were unable to use the road, the group was split. Lack of communication hampered firefighting efforts. Technical problems with the BIA radios prevented their operation when helicopters or planes were overhead. Incompatibility among the tribal, Colorado City, and Forest Service radios further exacerbated the communication problems.

By the time the BIA FMO arrived on the scene, it was clear that the fire was too big for her to handle. She transferred authority back to the Utah State Forester's Fire Marshall. He later transferred Incident Command to the National Forest Service officer from the Northern Arizona Zone, who was dispatched from Williams, Arizona.

Progress in fighting the fire was hampered by the dry, sandy roads. There was no source of water near the location of the fire, so attempts were made to bring water up the roads. The Tribe operates two water catchments on Moccasin Mountain for wildlife and cattle. Because of the drought, there was little water available, and what was there was inadequate for fighting the fire. Water was obtained from a private contractor in Kanab, but heavy equipment had damaged both roads and culverts and exacerbated the situation. The fire fighters were unable to get a water tender up the roads, so they relied upon a temporary reservoir that was set up north of the reservation boundary on Utah state park lands and supplied by the private contractor. Helicopters flew in and out with water from the reservoir.

The fire was contained four days after it began and completely extinguished three days later. According to estimates drawn from aerial photos, 1,618 acres were burned. It was one of several thousand fires that burned on tribal trust land in 2000.

After the Fire

Several weeks after the fire was put out, a Burned Area Emergency Rehabilitation (BAER) team was assembled to plan for restoration and reseeding on Moccasin Mountain. The team sent the Tribe a list of seeds

Figure 9. After the Moccasin Mountain Fire.

they intended to drop from a helicopter, but none of the tribal officials who saw the list had the expertise necessary for evaluating the efficacy of the mix. Dry conditions continued, and several people both inside and outside of the tribe expressed concern that seeds would not germinate. Several tribal members suggested sending people over the burned area in small off-road vehicles to disperse the seed and stir up the ground enough to ensure the seed would not blow or wash away. The BIA opted to fly over with a helicopter and scatter the seeds from the air. No special measures were taken to prevent erosion from the site.

The BIA contracted with a private firm for an archaeological survey of the burned area. The Tribe received the BIA contract to build a fence around the burned area to keep cattle out of it. Delays from both the BIA and the Tribe meant that the fence was not yet begun six months after the fire. By the summer of 2001, the reseeding had had only limited success and the team from NAU and the Tribe was establishing experimental plots to test whether adding microbes to the soil with the seeds would enhance growth and erosion protection.

The BIA reimbursed the Tribe for damages to the fence, roads, and culverts that occurred during the fire suppression efforts. The Tribe's grader was repaired. The Roads Department purchased new culverts to replace those broken by fire trucks in their attempt to navigate the dry, sandy roads.

As a result of the fire, the Field Office's FMO organized a meeting with the Western Region FMO, the FMO of the Truxton Canyon Agency, tribal representatives, and the BLM's FMO in St. George to discuss ways to improve fire management capability. The Western Region approved the creation of a position for a full time FMO at the Field Office, but that position has not been filled. High fire activity and federal monies that have allowed agencies to increase their personnel have resulted in a shortage of qualified fire management personnel and given those with the necessary qualifications many options. The collateral duty FMO has left the Field Office for a position elsewhere in the BIA.

Factors Influencing Fire Management

Drought conditions on the Arizona Strip affect the condition of the vegetation and can increase the speed and severity of fires there. In addition, they negatively impact unpaved roads and the availability of water needed to respond effectively to fires. When coupled with a lack of active woodlands management and the extensive overgrowth of sagebrush, these conditions create a major fire hazard. Human inhabitants increase the potential for fires to become disasters.

Fire fighters from federal, state, local, and tribal agencies responded to the Moccasin Mountain fire. The interagency fire structure that establishes Fire Zones was designed to improve organization and fire management, and within that structure is the potential for the incorporation of data, including climate information. However, tribes are represented in that structure only by the BIA. The location of the Kaibab Indian Reservation led to confusion about the Fire Zone in which the Reservation is located, and this uncertainty persisted even after the fire was over. On the Arizona Strip, the Northern Arizona Zone includes the Kaibab National Forest, which borders the eastern end of the reservation. Kaibab tribal leaders have positive working relationships with the personnel at the Ranger Station in Fredonia, and both tribal and Forest Service employees expressed the belief that it was the Forest Service's responsibility to respond to fires on the Reservation. Upon close examination, however, the participation of the Southern Paiute Field Office in the Northern Arizona Zone is on behalf of the San Juan Southern Paiute Tribe rather than the Kaibab Band of Paiute Indians. The Kaibab Indian Reservation is included within the Color Country Zone which includes the BLM and the Dixie National Forest, but not the Kaibab National Forest.

From a tribal perspective, a major flaw in the existing structure is that tribal interests are represented by BIA personnel rather than people working directly for the involved tribes. As a consequence, on only a few isolated occasions have tribal representatives been invited to and attended meetings to develop the Annual Oper-

ating Plans. This structure allows confusion to persist and makes it difficult for the people who will have to work together to plan for and respond to fires to come to know and trust one another. Even if climate information were incorporated into the planning process, until the tribes are more active participants in the process they are likely to see little benefit.

Within the BIA, there is recognition that inadequate resources and personnel have hindered natural resource management planning, and particularly fire management. Ironically, widespread public attention to and federal financial support for fire management have improved options for trained personnel and exacerbated the difficulties that offices such as the Southern Paiute Field Office face in finding the staff they need.

During the study, the firefighters and decision makers at all agencies participating in this study expressed a desire for better communication and coordination. Efforts to coordinate radio communication and provide adequate radios to all parties are sorely needed. In addition, participants reported that interaction among federal agencies and between the agencies and the fire fighters is lacking. Cooperation among federal agencies will make it possible for improved interaction with local units and is likely to facilitate the use of climate information by all involved.

The Tribe has begun working with NAU's Forestry Department to improve ecosystem management on the reservation. As that process develops, climate information may be need for decision making on the reservation.

Fires on the Fort Mojave Indian Reservation

Two recent fires are described here. The first, the Ice House Fire, was started by arson in the Havasu Wildlife Refuge in May 1995. It spread onto tribal, Bureau of Land Management (BLM), and Fish and Wildlife Service (FWS) land. The second, Walters Burn, began in 1999 on land leased from the tribe on the California side of the Fort Mojave Reservation. This fire escaped and moved onto tribal land before it was extinguished.

The Fort Mojave Indian Reservation is located on both sides of the Colorado River, comprising land in California (12,633 acres), Nevada (5,582 acres), and Arizona (23,669 acres). Reservation land borders towns, wildlife refuges, and other federal and private land, and lies within the larger region of Mojave ancestral lands. The checkerboard pattern illustrates how private and tribal land are interspersed.

The Mojave people call themselves Pipa Ahamakav (People by the River). Their ancestral lands stretch along the Colorado River from Black Canyon near present-day Hoover Dam, to an area south of Blythe, California. The core area extended twenty to fifty miles east and west of the Colorado River, but Mojaves also had a presence in the east to within 50 miles of present day Phoenix. They also frequented transportation corridors west of the core area to southern and northern California, Baja, and Guaymas on the Sea of Cortez, and east as far as Zuni in New Mexico.

Spirit Mountain, northwest of the present reservation, overlooks these ancestral lands. The Mojave consider the mountain to be the site of their earthly origins. According to their origin story, the Great Spirit Matavilya, born from the union of Earth and sky, was killed before he could teach his people all they needed to know of their world. His son, Mastamho, then took upon himself the responsibility of shaping the land and teaching the people how to cultivate it. Mastamho created for his people AviKwame (Spirit Mountain), the spiritual center of Mojave life. He drove a willow stick into the Earth and drew out the Colorado River, which he gave to his people along with all that grew alongside it. The river was thus at the heart of Mojave civilization (Fort Mojave Indian Tribe, 1993).

According to some anthropological accounts, ancestors of the modern Mojave originally settled in the Mohave Valley in the 12th century (Sturtevant 1978); the Mojave themselves consider this date incorrect and trace their presence in the homeland to tens of thousands of years earlier (personal communication, Ahamakav Cultural Society, 2/28/01). Under all accounts, the Mojave have a demonstrably long history of occupancy and land use in their present location and deep cultural and economic links to the land through time (Klasky 1997). Such dominion and cultural ties to the land are considered the criteria for defining aboriginal territory and rights to land.

Mojaves were successful agriculturalists, depending on the silt deposits of the yearly Colorado River floods to fertilize the land. Floodplains were planted with maize, tepary beans, pumpkins and melons; fish and game

supplemented the crops; and mesquite beans were gathered in the wild. If floods did not occur, the Mojave could rely on mesquite beans and beaver (Dutton 1976). The Mojave traditionally visited people at great distances (Kroeber 1951); their prosperity allowed them to travel as far as the Pacific Coast in trade networks with other tribes (Fort Mojave Indian Tribe 1993).

Prior to Euroamerican contact, Mojave society was a patrilineal society comprising at least three bands—northern, central and southern divisions (Stewart 1983), and 22 clans (now 18) (http://www.nps.gov/moja/mojahtm2.htm). Families lived in sprawling settlements and people moved freely through Mojave territory. Leadership was assumed by individuals recognized for their moral strength rather than through a formal political process (Economic Development Administration 2000, www.doc.gov/eda/html/lg3_4_indianres.htm). By the 16th century, the Mojave had the largest concentration of people per square mile in the Southwest United States (Sherer 1994). The Spanish expedition of Juan de Oñate encountered them in 1604 (Stewart 1983). The arrival of trappers and settlers in the 1820s threatened their flourishing civilization. The United States annexed territory including Arizona in 1850, and sent expeditions out along the Colorado River to find a site for a fort. The U.S. government learned of the Tribe's existence through encounters with the Mojaves at that time.

Later expeditions surveyed for wagon routes and railroads, and soon settlers and steamboats made their way into Mojave country. The railroad and the people it brought reduced game and food plants available for Mojave use. Conflict ensued between the tribe and newcomers. In 1859 the U.S. War Department built a fort outside present day Needles, California to protect the river crossing. That same year the soldiers with their rifle power overwhelmed the Mojaves in battle (Sherer 1994) and ended their military resistance (Stewart 1983).

Mojave chieftains sued for peace. In 1859, some Mojaves were induced to migrate south to the Colorado River Valley (Sturtevant 1978). They were joined by others in 1865 when the U.S. government created the Colorado River Indian Tribe Reservation. The incentive to migrate included 75,000 acres of land and promises of farming and irrigation projects. The migration brought about the two groups that comprise the present tribes: the Fort Mojaves and the Colorado River Mojaves. A former Great Chief resumed his leadership of the conservative group of Mojaves who remained in their ancestral homeland in the Mohave Valley.

Disease and poverty decimated Mojave population from 1870 to 1890 when a Department of War general order first established the Fort Mojave Reservation. A boarding school was established in the old fort and Mojave children were forced to attend and learn English language and American culture, and to reject their own. Older Mojaves were taught Euroamerican farming methods, but most turned to wage work for railroads and mining operations (Klasky 1997). Nonetheless, Mojaves continued floodwater farming well into the twentieth century until dams along the Colorado River dictated the change to irrigated agriculture.

In 1911, half a century after the Colorado River Reservation was established, an executive order confirmed the reservation for the Mojaves in Mohave Valley. The Fort Mojave Indian Reservation eventually came to encompass more than 41,000 acres, including the old military outpost, reserves on the California and Nevada side of the Colorado, and checkerboarded[11] farmland on the Arizona side. The distance between the two groups of the Mojave did not prevent a large amount of visiting and intermarriage; travel between the two reservations became essential to preserving Mojave culture.

The construction of major dams in the twentieth century wrought dramatic changes to the landscape and all the peoples along the lower Colorado (see Table 1). Beginning with Hoover (originally Boulder) Dam in 1936, followed in 1938 by Parker Dam and Davis Dam in 1953, management of the river occurred outside the Tribe. Decisions affecting water use were taken out of the hands of local users, and regulations were established to ensure that the water would reach users along its entire length. The regulated river forced changes or abandonment of the traditional livelihoods that had depended on the river's natural course and periodic flooding. The Colorado River Compact of 1922 had established allocations of river water among the states and Mexico; the dams began the era of fulfilling those commitments.

Their long occupancy along the Colorado River, however, gives the Fort Mojave Indian Tribe senior priority on water allocation, a right finally won in the 1963 U.S. Supreme Court case of Arizona v. California[12]. The case asserted, among other things, the reserved rights of the

Table 1. Dams along the Lower Colorado

Dam/Location	Year	Primary Purpose	Impoundment	Areas Served
Hoover (Boulder) Dam/ Black Canyon between Nevada and Arizona	1936	Flood control; river regulation; water storage for reclamation " and other beneficial uses;" hydroelectric power	Lake Mead	Arizona, California, Nevada
Parker Dam/ Parker, AZ	1938	Reservoir storage for Colorado River and Central Arizona Projects	Lake Havasu	Arizona, California
Davis Dam/ Bullhead City, AZ	1953	Re-regulate Hoover Dam releases for downstream needs; hydroelectricity	Lake Mohave	Arizona, Mexico

Fort Mojave, Cocopah, Yuma, Chemehuevi, and Colorado River Indian Tribes (Checchio and Colby 1993).

The Fort Mojave Tribal Constitution was approved in 1957. The Fort Mojave tribal government consists of a Tribal Council with five members, a chair, and a vice chair, who are elected into office by the community (Fort Mojave Indian Tribe 1993). There are no individual allotments of land in the Fort Mojave Reservation. Rather, the seven-member Council controls the allocation and use of tribal resources on the reservation. The tribal government has grown to include 48 departments. The Physical Resources Department is responsible for all land and resource management. In 1997, the population of enrolled tribal members was estimated to be just over 1,000; of these, 890 resided on the reservation in 1998. (Arizona Department of Commerce: 1999).

Leases of reservation land to large-scale farming operations, issued by the BIA on behalf of the Tribe, began in 1974. Over a period of several years, 16,000 acres of the Fort Mojave Indian Reservation were leased, and a majority of tribal income was derived from those leases. The 25-year leases have begun to expire, and by 2001 the Tribe had regained control of 9,000 acres. The Tribe operates a commercial farm on this acreage, producing crops of hay and cotton. An additional 20,544 acres of reservation land that are currently fallow could be irrigated with Colorado River water (personal communication, tribal employee, 5/9/01; Economic Development Administration 2000, www.doc.gov/eda/html/lg3_4_indianres.htm).

The tribe owns and operates two casinos, an RV park and its own telephone, electricity, and water and sewer utilities. The tribal water and sewer plant is expanding to provide services to customers both off and on the reservation (personal communication, tribal employee, 2/2/01). A new natural gas-fired power plant that came on line in early 2001 was built on land leased from the Tribe, which also supplies its water. Although the tribe has an increasingly diverse business and economic base, agriculture is still an important source of revenue. The casinos alone provide more jobs than there are tribal members to fill them; firefighting, with its physically demanding, irregular and risky nature, is not an appealing job option for tribal members (personal communication, tribal leader, 2/5/01).

Ecological Change along the Lower Colorado River

The Colorado River has always been regarded as an integral part of Mojave life. The Mojaves believe that they have been in this territory since "time immemorial;" consequently, their environment plays a key role in mythology, folklore, and traditional subsistence activities. According to Mojave mythic stories, the land surrounding the Colorado River was given to them by the deity, Masthamo, and, as result, that land is their responsibility and their right.

Before Euroamerican settlement and development, the lower Colorado River formed an alluvial delta containing vast marshes, riparian forests and backwaters. The riparian belt extended away from the river for up to several miles where the water table remained relatively shallow. Cane (probably *Phragmites sp*.), arrowweed (*Tesseria sericea*), cottonwood (*Populus fremontii*), and willow (*Salix gooddingii*) grew in the river bottoms. Behind them in less marshy areas were mesquite (*Prosopis* spp.) stands, and beyond those grew only xerophytic desert vegetation (Stewart 1983).

Figure 10. Entrance to Fort Mojave Tribal Farm.

Figure 11. Tamarisk (and arrowweed) in Havasu Wildlife Refuge.

Figure 12. Mesquite regrowth.

Mesquite was—and remains—a most important plant in Mojave culture. Mesquite beans were a food source in earlier times, and mesquite wood was required for use in funeral ceremonies, a practice which continues today. Reduction in numbers of mesquite trees and damage to mesquite habitat is thus of considerable concern to the Tribe.

The twentieth century dams that altered the river flow volume and seasonal flooding patterns affected the riparian communities downstream, particularly the cottonwood and willow that depended on the floods to re-establish themselves. Ecologists now characterize the lower Colorado River ecosystem as "highly perturbed" (Busch 1992). In addition, the Colorado River waters have become more saline due to the many impoundments and run-off from the associated agricultural activity (DOI 1995).

Tamarisk (*Tamarix ramosissima*), or salt cedar, appeared along the main stem of the Colorado River in the 1920s (http://www.lc.usbr.gov/~g2000/assess/chapter3.htm#E3E4); the Mojaves began to notice this change in the mid 1930s, shortly after damming began (personal communication, tribal leader, 2/5/01). These salt-tolerant and fire-adapted trees were introduced by the Bureau of Reclamation for erosion control and as windbreaks (personal communication, tribal leader 7/13/01) but rapidly spread in riparian areas, crowding out native vegetation, contributing to the desiccation of watercourses, and increasing the frequency of disturbance from fire (Busch 1992, DOI 1995). Fire appears to have been relatively infrequent in riparian ecosystems prior to tamarisk invasion and to have played a relatively minor role in structuring plant communities dominated by cottonwood, willow, and mesquite. Tamarisk, with its propensity for episodic burning, has thus produced a novel distribution in low-elevation southwestern floodplain ecosystems such as those that occur along the lower Colorado River (Busch 1992). Culturally important mesquite now struggles for a foothold in the shade of salt cedar (Figure 12).

During the 20 years from 1963 to 1983, while the Colorado River filled Lake Powell behind Glen Canyon Dam, only enough water was released to meet downstream requirements. This dropped the water table, and wetlands began to dry out. After Lake Powell was filled in 1983, high snowmelt, a result of that year's El Niño event, raised the water level in the lake to the point where the dam was threatened. Large releases to save the dam resulted in flooding downstream. (A building on the Fort Mojave reservation was seriously damaged in this flood.) When the flood period was over and releases returned to pre-flood levels, the river bottom had been scoured to a depth of about five feet. The river's volume was returned to what it had been prior to the flooding, but the deeper channel further reduced the extent of remaining wetlands (personal communication, tribal employee, 2/2/01).

Mojave Fire Management

According to a Mojave tribal leader (personal communication, 2/5/01), the Mojave people used fire primarily for agricultural purposes. Each spring they would clear land for planting along the Colorado River, cutting down the native vegetation and piling it in the middle of the cleared field prior to burning to minimize the risk of the fire jumping to surrounding areas. Such "old methods" ceased by the 1940s; the Davis Dam regulated the flow of water and led to final abandonment of traditional floodwater farming methods as the Mojave adopted irrigated agriculture (personal communication, tribal elder, 2/5/01). Today, both Mojave and non-Indian farmers burn the stubble left in fields after harvest in late June and early July, and burn off Bermuda grass during the winter dormant period (personal communication, tribal employee, 2/2/01). For these long-time farmers, the damming of the Colorado River caused significant changes, with consequences for fire management. Construction of farm roads and irrigation canals on the reservation (Figure 13) also affected both the occurrence and management of fire.

The Mojave also have always used fire in their mortuary practices. Upon death, a person was burned in his house and the site permanently abandoned (personal communication, tribal elder, 2/5/01; Kroeber 1925). Today, cremation with a fire of mesquite wood, which occurs in a public space, remains an important practice in Mojave religion and culture. Such cultural practices must be recognized as factors in tribal natural resources management and planning processes.

Mojaves remain concerned about appropriate land use in their traditional territory as well as on reservation land itself. For example, in the 1990s, the Tribe participated in opposing the siting of a nuclear waste dump in Ward Valley, California, for which a transport route would have passed directly through Fort Mojave and the traditional tribal homeland. The Tribe's resource management options will continue to be affected by external decisions such as those governing the flow of the Colorado River, as well as by activities on the lands bordering their reservation. As noted in the first section, tribes such as Fort Mojave that do not opt under PL-638 to assume responsibility for fire management leave that responsibility to the BIA, and the extent of their participation in meetings and policy processes varies. When, as in Fort Mojave's case, reservation land does not contain forests for which there are management plants, the roles and interactions can become quite complex.

Figure 13. Road through Mojave Tribal farmland with portion of Walters Burn area in foreground.

BIA Fire Management

The Fort Mojave Reservation is one of three reservations under the jurisdiction of the BIA's Colorado River Agency. That agency is responsible for the Colorado River Indian Tribe and Fort Mojave reservations, as well as Chemehuevi, the southernmost Southern Paiute tribe. When a new superintendent arrived at the Colorado River Agency in 1993, he was surprised and dismayed to learn there was no fire organization there. The three tribes were in two different Fire Zones in Arizona (see Figure 4) and one in California. The superintendent was concerned about the lack of training and resources to fight wildland fires in his agency area; with a fire management budget of only $15,000, he was responsible for all three reservations. Fire incidence, fortunately, was not high, but occurrences had rarely been reported. Because federal fire management funding is based on a formula that allocates money in accordance with the number of incidents reported, the superintendent faced a considerable challenge.

Fortunately, "[t]he River was ripe for cooperation" (personal communication, BIA official, 2/2/01), and the BIA superintendent could look beyond his agency for assistance. There were no large fire operations in the lower Colorado River area encompassing two BIA agencies, five wildlife refuges, and two BLM field offices. The recent deaths of 14 firefighters in the Storm King fire in Colorado had raised awareness of safety issues throughout the western United States; this stimulated the organizations along the River to pool their efforts. Working together, economies of scale could justify a larger and more effective fire organization than any one unit could afford alone.

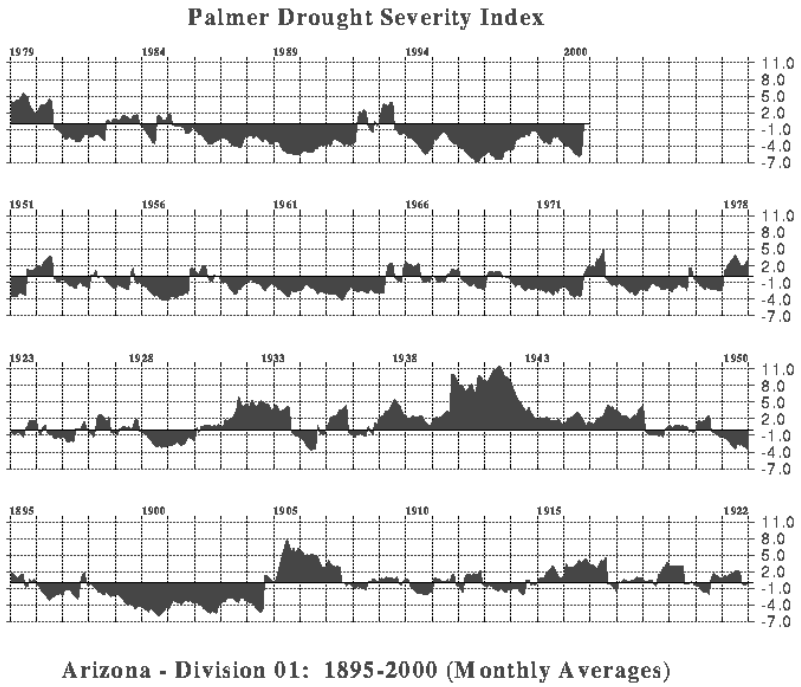

Figure 14. Palmer Drought Severity Index for Arizona Division 1, which includes the Fort Mojave Indian Reservation.
Source: National Oceanic and Atmospheric Administration

The effort to create such a cooperative venture was underway when the Ice House Fire occurred in 1995. The following sections describe that fire and the resulting fire management reorganization.

The Ice House Fire

In the early stages of development of the Interagency Agreement, on May 2, 1995, two young boys started a fire in the Havasu Wildlife Refuge along the Colorado River. Conditions were dry (see Figure 14), and the fire spread quickly. The Mohave Valley Fire Department responded to the fire and notified the FWS and the BLM. When the fire spread onto the Fort Mojave Reservation, the BIA was contacted and authorized other area fire fighters to enter tribal land. The BIA superintendent contacted the tribal chairperson and requested a representative from the Tribe be dispatched to the fire camp being set up near the fire. On May 3, the BLM's FMO, who had assumed responsibility for the fire, arrived from Yuma and requested a Type II fire team. Fort Mojave was at that time within the Grand Canyon Zone (a subunit of the Northern Arizona Zone; see Figure 4), so a U.S. Forest Service Type II team was dispatched out of its Williams, Arizona office. The Type II team deployed heavy equipment including bulldozers and helicopter tankers, which scooped water directly out of the Colorado. The team included a micrometeorologist and burn specialists in addition to firefighters. At the peak of the effort, 225 firefighters from both federal and local agencies were present (DOI 1995).

Fort Mojave's Physical Resources Director was designated to represent the Tribe at the fire camp and authorized by the Tribal Chair to provide whatever tribal resources the effort required, such as access to water in their irrigation ditches. Irrigation pumps on the reservation took water from the Colorado River and out of Topock Marsh. Fish and Wildlife Service pumps in the refuge were also converted for firefighting.

The Ice House Fire burned 3,407 acres of land. It was brought under control on May 7, and declared out on May 22 (DOI 1995). Subsequent investigation determined the fire had been deliberately set by the boys, using a "childproof" lighter. The fire burned 1,661 acres of tribal land, including 360 acres of prime mesquite habitat (of particular concern to the Tribe because of mesquite's cultural significance); 1,235 acres of BLM land; 236 U.S. Forest Service acres; and 255 acres on state and private land (DOI 1995). The north end of the Havasu Wildlife Refuge burned to its border with cropland, and the fire threatened a residential development. Although all structures were saved and no one was injured (personal communication, fire manager, 2/2/01), the fire had an impact on fire management policy along the Colorado, stimulating the development of the Interagency Agreement.

Reorganization

The Ice House Fire caused authorities to recognize that they needed a stronger fire management program and consequently affected funding and staffing patterns. It eventually led to reorganizing and establishing a field station on the Fort Mojave Reservation. The BIA and the BLM signed the "Interagency Plan of Operation for Fire Management on the Lower Colorado by the BLM and BIA" on October 17, 1996 (personal communication, BIA official, 4/2/01). The Fish and Wildlife Service (FWS) signed on in January 1999 after yet another fire (South Dike in 1998) burned FWS and BLM land and threatened tribal land. The geographic area covered by the Plan includes the Lower Colorado

River from the Fort Mojave Indian Reservation and Needles, California, south to the Mexican border, in a corridor that extends approximately 10 miles on each side of the river. Its farthest reach is to about 40 miles east of the river, to cover the Kofa Game Refuge at the south end (personal communication, fire manager, 4/2/01). All units within the area encompassed by the agreement now operate within the Central West Fire Zone; the BLM supplies the FMO, and the FWS and BIA provide assistant FMOs. Consolidation within a single Fire Zone has facilitated BIA participation in management and the development of the Annual Operating Plan. As elsewhere, the tribes are represented by the BIA in the planning process; the location of the field station on its reservation has facilitated communication with the Fort Mojave Indian Tribe.

The Walters Burn

On New Year's Eve at the close of 1999, after the Interagency Agreement was in place, a fire started by an individual burning trash on leased reservation land accidentally spread, eventually burning 500 acres of salt cedar and mesquite habitat on the Fort Mojave Reservation. The fire was reported to the local Mohave Valley Fire Department, which responded. The local firefighters were joined by a task force from the San Bernardino County Fire Department in Yucca Valley. Authority was turned over to the Yuma BLM, as per the Interagency Agreement, when the FMO arrived. No permission was sought or needed for the firefighters to enter tribal land.

Burning fast and hot enough to melt glass, the fire charred tamarisk, mesquite and all other available fuels down to the bare soil (personal communication, fire manager, 2/2/01). The fire burned for one day. No structures were threatened or damaged and the fire's spread was limited by roads and the river. The Tribe's Physical Resources Director was out of town during the fire. The Tribe's involvement was limited to acknowledging that the firefighters were on the scene and putting out the fire.

After the Fires

Located within riparian habitat that had become dominated by tamarisk, the major impact of the two fires was to increase the success of tamarisk over native vegetation. Within the burned areas, the tamarisk began a quick recovery, soon shading out the mesquite that started sprouting from the roots of burned trees. After the Walter's Burn, the Tribe and BIA were slow to develop a restoration plan, and conditions worsened. In early 2001, the Director of Physical Resources

Figure 15. Site where the Walters fire consumed a large haystack and charred the soil beneath it.

began an experimental restoration project with a small grant from the U.S. Environmental Protection Agency. Burned tamarisk will be mechanically removed, young mesquite pruned and planted, and cottonwood and willow propagated, in an effort to restore the experimental plot to its native composition. This is the first such effort at restoration attempted on Fort Mojave land; the Physical Resources Director and the Tribe are enthusiastic about it as a project that addresses both the ecological and cultural integrity of tribal land.

Participants in the Interagency Agreement also face unique challenges. Lightning-caused wildfires are relatively infrequent in the Mohave Desert environment. Humans cause the vast majority of fires (personal communication, fire manager, 2/2/01). The Colorado River Agency's jurisdiction includes both urban and agricultural interfaces, but fire management models exist only for urban interface situations. Neither are there fire models for the desert scrub or salt cedar and cane (*Phragmites*) that dominate the riparian vegetation zone. A Mohave Valley fire captain noted that California scrub responds to fire differently than do the grass and timber for which his crews are trained. Fires in this ecosystem also exhibit unique characteristics, such as burning into the wind and under humid conditions. The most active period for fire along the lower Colorado, from May through August, comprises both dry and humid months, but "it burns all year round along the river" (personal communication, fire manager, 2/2/01). This proves critical for managers because, outside the regular fire season during which many seasonal

Figure 16. Walters burn restoration site.

firefighters are employed, qualified firefighting personnel and resources are in short supply. Mohave Valley firefighters are cross-trained for both structure and wildland fire, but once a fire reaches Type II severity, they call in the specialized expertise of federal wildland firefighting crews.

Factors Influencing Fire Management

The signatories to the Lower Colorado agreement recognize that there is still much that can be done to improve their program. As of the time of this study, for example, separate fire management plans were being developed for the BIA, FWS, and BLM. The goal is to consolidate these plans and develop one budget and master plan for all entities involved in the Interagency Agreement. In addition, fire managers expressed the need for shifting from reactive fire management to incorporating fire into overall resource management and planning.

In contrast to the situation at Kaibab and on the Arizona Strip, fire has exacerbated disturbance of native riparian vegetation; the invasive tamarisk benefits from fire and burns regardless of climatic conditions, perpetuating its own dominance. Nevertheless, dry conditions contributed to rapid spread of the 1995 Ice House Fire. Given the tremendous care with which restoration efforts including burning tamarisk will have to proceed, climate information will be an important aspect of management decisions.

At the time of this study, the Fire Management Officer responsible for implementing the Interagency Agreement utilized climate data provided by weather stations, the National Interagency Fire Center in Boise, Idaho, and federal resources such as NOAA and the National Weather Service. He had the capacity to process data for use in creating Annual Operating Plans and for other resource management purposes.

Within the Tribe, Fort Mojave's Physical Resources Director expressed interest in receiving climate information that could be used in agricultural decision-making. This need will increase if the Tribe further expands its agricultural program. At this time, the Tribe uses the University of Arizona Extension Service, local weather station data (there is an Arizona Meteorological Service recording station on the reservation), and Internet resources. Drought is not a concern because all agriculture is irrigated; the Tribe's senior right to Colorado River water guarantees a dependable supply from that source. Instead, it is excess rather than lack of water that can cause problems. Rain at the wrong time can discolor hay and bring down the price, delay cotton harvests, result in lower quality produce, or germinate seed too early. Too much water disrupts the irrigation regime that is in place. In addition, Fort Mojave's location in a valley below the 4,500 foot Black Mountains, in a rocky watershed, raises concerns about flooding; serious rains in the mountains could lead to problems because the runoff has nowhere to go but across the reservation. Consequently, rain and flooding are far greater concerns for the Tribe than is either wildland fire or drought. However, the Tribe has no access to information from the Black Mountains.

Summary and Recommendations

This study set out to investigate institutional factors influencing fire management on southwestern Indian reservations and evaluate when and where climate information could be useful to those responsible for reservation lands and resources. By examining case studies of recent fires on two reservations, the study moves beyond the hypothetical discussion of what might occur to identify actual decision processes and whether and where information could be incorporated. In addition, it reviews historic fire and ecological practices and past decision processes to identify beliefs and experiences that might generate reluctance to use fire or climate information in resource management.

In both cases reviewed, there is documented and oral evidence of historic as well as current tribal practices involving fire. Though neither tribe considered their lands and the natural elements on them as resources to be exploited, they have both used fire to effect changes in vegetation. However, both tribes occupy lands on which dramatic ecosystem changes have been caused by non-Indian decisions and practices. Their members and leaders recognize that they can benefit from partnerships with others who can help them restore their lands to support the plants and animals that are important to tribal members.

Resource Management and Information for Planning

As this study demonstrates, the resources and capacities of individual tribes and BIA offices vary significantly. Therefore, each reservation situation must be individually investigated and evaluated to determine when and how reservation management decisions are made, if and how climate information could be used, and the best form for delivery.

In both cases, fire management on tribal land is officially the responsibility of the BIA. The BIA participates in the federal interagency fire structure that begins locally with Fire Zones and culminates in the National Interagency Fire Center. The BIA's Southern Paiute Field Office is responsible for Southern Paiute lands in three states and within five Fire Zones. Recent restructuring within the Colorado River Agency has left that BIA office responsible for three tribes, all of which have been brought within a single Fire Zone. Direct tribal participation in planning meetings and other activities within the Fire Zones is minimal to nonexistent. This arrangement has created problems for the Southern Paiute tribes, especially because the BIA personnel are spread so thin, but it has met the needs of the Fort Mojave Indian Tribe.

At Kaibab, the Tribe and reservation will benefit most from resource management planning and greater involvement in fire resource decisions made by the agencies that are responsible for responding to fires on the reservation. The evolving partnership with NAU provides one potential mechanism through which better resource management might occur and climate information might be funneled.

At Fort Mojave, the Tribe benefits indirectly from fire management and the climate information used by the Fire Management Officer responsible for implementing the Interagency Agreement that includes the Bureau of Land Management, Fish and Wildlife Service, and Bureau of Indian Affairs on behalf of the Tribe. The Tribe's leaders believe that the interests of the Tribe are well served by the relatively new arrangement and do not seek changes in fire management practices. The Tribal Physical Resources Director could benefit directly from climate information related to agricultural issues, such as heat units and evapotranspiration. His need for climate data is therefore different from that which the FMO needs for fire management and planning.

Those dedicated to improving regional capacity to respond appropriately and effectively to climatic events and climate changes face critical decisions about how to achieve their objectives in the face of obstacles like those described in this study. Parallel to efforts to improve understanding of climate and how to represent climate information to the public must be efforts to identify the institutional structures that are best able to use information. In addition, those charged with providing such information must continue to refine ways to help tribes, local governments, and even federal agencies develop mechanisms that will allow them to incorporate climate information into their decision processes. Otherwise, they risk privileging only those who, because of historical conditions or potential in-

fluence, have the resources and capacity to utilize the information.

Broader Implications

In addition to what this study has revealed about the nature of fire management and the potential for incorporating climate information in decision-making, its findings have broader implications for land and resource management in Indian Country in the 21st century.

Tribes have faced significant changes; the period during which reservations were established was one of major disruption and change. Rapid non-Indian population growth occurring throughout the West threatens to cascade into another period of vast disruption and change, especially for those tribes that previously were at least somewhat buffered by public lands around their reservations.

Tribes have undergone significant changes in self-government. Each tribe will continue to determine for itself the appropriate degree to which it will assume authority for functions once provided by (or at least assigned to) the federal government. Tribal-agency and interagency agreements can benefit all partners when they are developed and implemented in a collaborative process to meet the needs of all partners.

Though regional partnerships, meetings, and interagency decision processes consume large amounts of time, much of what affects the reservation environment occurs beyond the reservation boundaries and is decided by private and governmental entities. Each tribe and tribal coalition will continue to face decisions about which of those processes are most pertinent to the issues facing its members and lands and how best to participate in them.

Endnotes

[1] The people whose tribes are indigenous to the United States are referred to in this paper as Native Americans, American Indians, and Indians. The term Indian is inaccurate but has been used in this paper because it is used in federal policies and other writing on native peoples and also is the one many natives use when talking about themselves. The failure of non-Indian people to differentiate among tribes is the cause of much misunderstanding. Tribes represent distinct sociocultural groups, many of which have as little in common with one another as they do with Europeans. U.S. law, however, has generally treated tribes as members of a single group. The word "tribe" can also be subject to misunderstanding; anthropologists define tribe to mean an autonomous political unit comprising a group of people who share a common heritage, speak a distinct language, and identify with a known (but not necessarily rigidly bounded) territory. Tribes can also be understood as nations within a nation-state (such as the United States).

[2] CLIMAS was established in 1998 with funding from the National Oceanic and Atmospheric Administration (NOAA) to enhance U.S. capacity to assess climate variability and longer-term climate change with regard to the impacts on human and natural systems in the Southwest. The project aims to foster participatory, iterative research involving researchers, decision makers, resource users, educators, and others who need more and better information about climate and its impacts.

[3] Lands held in trust by the U.S. government for Indian tribes and individuals are collectively referred to as Indian Country. The definition of Indian Country has evolved beyond restriction to geographical boundaries and also represents the political relationship of the United States to tribes (Deloria and Lytle 1983).

[4] El Niño years often bring above-normal precipitation to the region, while La Niña years—which often follow El Niño years—tend to be dry. Fire activity historically is greatest when wet El Niño episodes, which play a role by contributing to a rapid buildup of herbaceous understory vegetation, are followed by one or more unusually dry (usually La Niña) years.

[5] Political ecology expands ecological concepts to include cultural and political activity within an analysis of ecosystems that are significantly but not always entirely socially constructed (Greenberg and Park 1994).

[6] *Camassia esculenta*, a blue-flowering plant with a bulbous root. It was dug and eaten raw or cooked by the Native Americans of the Northwest Plateau, for whom it was a major food source (Encyclopedia Britannica Online, http://search.eb.com/bol/topic?eu=127685&sctn=4#s_top)

[7] Amendments to the Act, in 1988, 1991, and 1994, attempted to expedite the transition away from federal domination of Indian programs and authorize tribal self-governance.

[8] In July 1998, for example, 11 bureaus and agencies within the Departments of the Interior, Agriculture, and Defense signed a Memorandum of Understanding for the Southwest Strategy addressing natural resource management and conservation and community issues. The BIA was among the signers.

[9] A Stake is a division of the Mormon Church.

[10] The continued occurrence of problems beyond reservation establishment is not unique to this case. See, for example, Perry (1993).

[11] The checkerboard sections resulted from 19th century awards of alternating square mile sections of federal land to the railroads, to encourage their expansion; when the reservation was established, the federal government assigned to the tribal reservation those sections which had remained in federal ownership.

[12] 373 U.S. 546 (1963), decreed in final form, 376 U.S. 340 (1964), decree amended, 383 U.S. 268 (1966), supplemental decree entered, 439 U.S. 419 (1979), supplemental opinion, 460 U.S. 605 (1983), second supplemental decree entered, 466 U.S. 144 (1984).

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