

Smokey the Tapir: Traditional Fire Knowledge and Fire Prevention Campaigns in Lowland Bolivia

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Severe wildfires devastated the southeastern Bolivian lowlands during 1999–2001. In response, the Bolivian government instituted an education campaign to reduce rural burning. Working with Chiquitano Indians in the southeastern lowlands, we were interested in finding out (1) the level of knowledge of fire behavior and the ecological role of fire in shaping forest and savannah ecosystems, and (2) current attitudes in Lomerio toward fire as a land management tool. We conducted key informant interviews in the Chiquitano territory of Lomerio to document Chiquitano knowledge of and attitudes toward fire practices. Informants expressed knowledge of fire behavior and effects, recognizing the effects of wind, relative humidity, and fuel moisture on fire intensity, and the effects of fire intensity on soil fertility. Informants revealed a complex understanding of the role of fire in maintaining the structure and composition of savannahs and how fire interacts with changing cattle production, climatic, and demographic conditions.

Keywords Bolivia, indigenous fire knowledge, tropical savannah ecology

During a 1-month period in 1999, wildfires swept through more than 3.5 million hectares of forest and savannah land in the southeastern lowlands of Bolivia (SFN 2000) (Figure 1). Considered one of the worst disasters to hit Bolivia in decades, these wildfires destroyed hundreds of homes, forced evacuation of thousands of residents, consumed over 100,000 ha of agricultural land, and damaged more than 1 million hectares of forest land (SFN 2000). Smoke and haze became so

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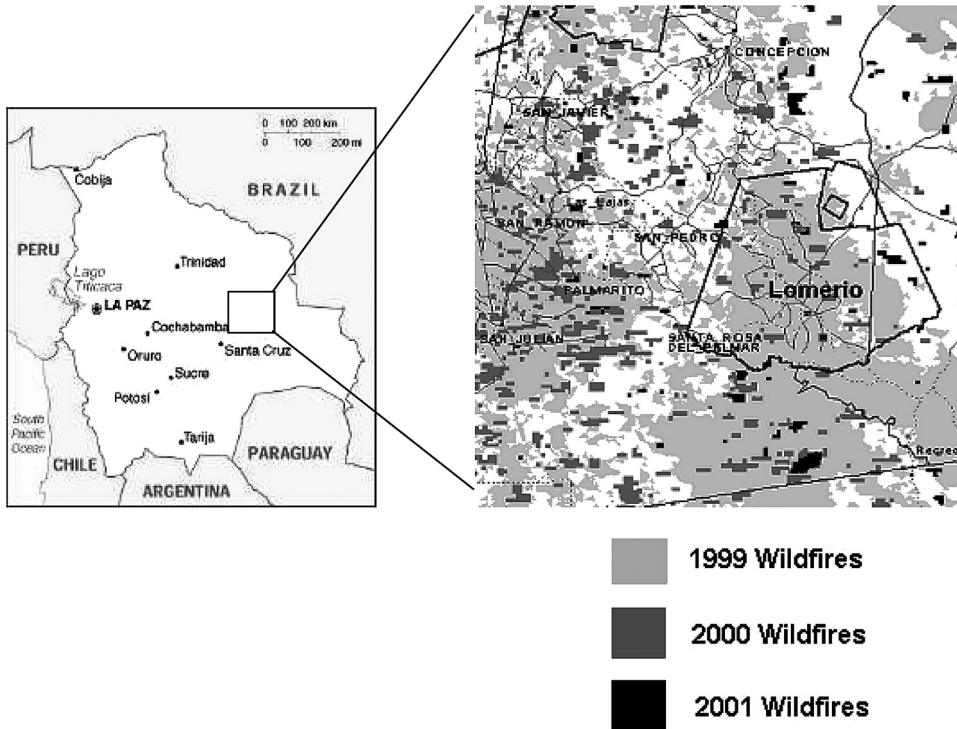


Figure 1. Distribution of wildfires in three different years (1999, 2000, 2001) in the Chiquitania region (with Lomerio outlined) of southeastern Bolivia. Map was generated by SATIF (Sistema de Alerta Temprana de Incendios Forestales) using satellite imagery (NOAA16).

thick in the regional capital of Santa Cruz de la Sierra that schools were closed and flights were canceled.

The ignition sources of these wildfires came from two activities: burning of grasslands for cattle grazing, and burning fallows for agriculture by rural residents. In 2000 and 2001 these traditional burning activities combined with severe drought conditions caused by an El Niño/La Niña event to produce another series of devastating wildfires. In response to the 1999 wildfires, the Bolivian government instituted a national media campaign in 2000 to reduce the incidence of wildfire in rural areas. The campaign has adopted a tapir dressed as a forest ranger as a mascot, similar to Smokey Bear of the U.S. Forest Service fire prevention campaign. The Bolivian campaign, led by the national forestry agency (*Superintendencia Forestal*), uses posters, radio ads, and cartoon books to increase awareness of the negative effects of wildfires and promote safe burning practices.

One of the targeted audiences of this campaign is the Chiquitanos, the largest indigenous, or native, group in the Bolivian lowlands. The Chiquitanos live in an area of seasonally dry forests and savannas in the transition zone between the dry thorn-scrub of the Chaco and Amazonian humid forests. They have been using fire for traditional purposes for generations and continue to rely on fire as an agricultural tool today. We were interested in documenting traditional fire knowledge among the Chiquitanos, and our research focused on the following research questions:

1. What is the level of local knowledge of fire behavior and the ecological role of fire in shaping forest and savannah ecosystems?
2. What are the current attitudes among farmers and cattle owners in Lomerio toward using fire as a land management tool?

This is the first stage of a more comprehensive effort to document fire history in the region and to provide a comprehensive regional study of attitudes toward using fire as a land management tool. The long-term goal of the project is to develop strategies for incorporating local fire knowledge into regional and national fire management policies.

The Chiquitanos of Lomerio: Environmental and Social Context

Lomerio lies in the center of the former Jesuit mission region of the southeastern Bolivian lowlands, an area that extends from Santa Cruz east to the Brazilian border, between the tropical wetlands of the Llanos de Moxos to the north and the Gran Chaco desert of Paraguay to the south. The Chiquitanos of Lomerio are descendants of indigenous groups who lived in the Jesuit missions of the 1600s and 1700s. They are the largest group in the *Oriente*, or lowlands, with a population of around 72,500, 34% of the total for all indigenous people (INE Census 1992). There have been numerous population censuses conducted in Lomerio, with widely varying results, probably due to temporary labor migrations, but the most likely population estimate is between 5500 and 6000, spread out among 28 communities ranging in population from 12 to around 1200. They make a living primarily from farming, raising cattle, and hunting and collecting in the forest.

The landscape of Lomerio is characterized by undulating topography and distinct vegetation—a complex mosaic of natural savannah (pampa) and dry to sub-humid forest (*bosque*). The distribution of savannah and forest is primarily determined by soil depth, texture, fertility, and age (Killeen et al. 1990). While systematic studies have not been undertaken, it is likely to follow the distribution patterns of *cerrado* savannahs in Central Brazil, where forests occur on more fertile soils with higher levels of calcium and magnesium, while the *cerrado* soils are dystrophic with a high concentration of humic matter (Rattern 1992).

Today, fire is visibly important in determining the physiognomy of these savannas, which form a continuum from open grasslands to dense woodlands. Frequent burning favors the herbaceous as opposed to the woody component. Without fire, open savannas become denser and develop into *bosque bajo*, as has been documented in areas of *cerrado* in Brazil (Rattern 1992). Many of the tree species typical of the savannas have fire-adapted traits, such as thick, corky bark and high sprouting capacity. Many of the herbaceous species flower within weeks after a fire (personal observations).

Based on previous research in Lomerio, we knew that the Chiquitanos use fire as a tool in their subsistence round (McDaniel 2000; Kennard 2002). Like many places in the tropics, fire is used regularly to clear land and prepare agricultural fields, or *chacos* (Kennard 2002). Agriculture in Lomerio follows the swidden, or slash-and-burn, pattern, using ash as fertilizer. The agricultural cycle begins in June at the beginning of the dry season, when select forest understories are slashed with machetes and trees are felled by ax or chainsaw. Slash is allowed to dry for at least 2 months until the end of the dry season (August–September), when fields are

burned. This strong tradition of fire use related to agriculture and cattle production made Lomerio an ideal location for exploring knowledge of fire and its ecological impacts. We later describe the results of this investigation of traditional fire knowledge, but first we set the context by describing a national effort to educate rural residents on the effects of fire.

Fire Perceptions and the National Fire Education Programs

Since 2000, the *Superintendencia Forestal* has focused a public education campaign on indigenous communities, such as the Chiquitano communities of Lomerio, and other rural forest user groups. The *Superintendencia* has sponsored radio dramas on the theme of fire control and has sent staff out into rural communities to hold meetings and workshops. It has also distributed posters, brochures, and cartoon books (featuring a tapir as a forest ranger), directed at promoting safe burning practices and reducing yearly burning in the countryside (SFN 2000). The goals of the program are to (1) provide general environmental education regarding the benefits of ecosystems to rural resident farmers, (2) inform rural farmers of the damage inflicted by frequent fires on the potential for agricultural production, and (3) inform rural farmers of the proper uses of fire in the countryside (MDSP 2002).

The goal of the national fire education program is not to promote the idea that all fire is bad; in fact, many of the cartoon books are designed to educate rural residents on the proper techniques of controlled burns. However, it appears that the program has generated a degree of negative perceptions toward burning, based on informal discussions with the residents of Lomerio and the more focused informant interviews discussed here. In fact, the conversations with Lomerio residents regarding the education campaign are what spurred us to look at fire knowledge more closely. However, as we demonstrate in the results, traditions and knowledge of burning in Lomerio are well established. In the next section, we provide a brief overview of traditional fire knowledge worldwide, and also discuss how this knowledge has influenced land management in some areas.

Traditional Fire Knowledge and Land Management Policy

Fire is used as a land management tool by rural inhabitants worldwide. Research has documented the many reasons for burning, including clearing land for agriculture, promoting growth of pasture, creating habitat for game animals, eliminating pests, and providing protection from uncontrolled wildfires (Lewis and Ferguson 1988; Coutinho 1990; Goldhammer 1993; Mistry 1998; Boyd 1999; Laris 2002). Hough (1993) showed that rural people in savannah regions of northern Benin comprehend the positive and negative effects of fire on savannah ecosystems, and this knowledge corresponds closely with present scientific understanding. Mbow et al. (2000) also elicited knowledge of fire and its effects among inhabitants of the grasslands and savannahs of east-central Senegal. They showed that a complex set of fire use practices reflected a well-adapted production strategy for livestock grazing and agriculture. The timing, frequency, and intensity of set fires varied across the landscape according to a set of climatic variables and a gradient of forest and savannah environments.

Increasingly, these practices conflict with government policy regarding fire, and in some cases traditional fire uses have been banned (Brinkerhoff 1995). Policy

makers, forest management officials, and the general public often ascribe burning in rural areas to cultural backwardness and ignorance on the part of local people. In fact, most fire prevention campaigns in Africa are directed at educating rural peoples on the negative effects of burning (Fairhead and Leach 1995; Benjaminsen 2000).

However, there has been an increase in research showing that local bans on burning lack scientific basis, and need to distinguish among uncontrolled burning, burning for productive land use, and burning for wildfire prevention (Laris 2002). In many cases rural peoples, and especially indigenous groups with long ties to the land, have good reasons for setting fires and are knowledgeable about both the negative and positive effects of fire on landscapes and resources. For example, research in Australia has shown that landscapes in northern Australia have been shaped and maintained by prehistoric, historic, and contemporary burn practices by Aborigines (Russell-Smith et al. 1997; Hill and Baird 2003). One of the more exciting insights to come from this research is the recognition of the benefits of the “patch-mosaic” pattern of burning practiced by Aborigines. Aborigine burn regimes in northern Australia have been shown to maximize biodiversity through maintenance of ecological “edges” and habitat diversity.

Laris (2002) expanded on the Australian work through the use of Landsat images to provide a detailed illustration of the landscape level impacts of patch burning in the savannahs of southern Mali. The research in Mali shows that the annual burning regime prevents damaging late-dry-season fires, and increases the potential of the forests and savannahs for a variety of land uses, including hunting, gathering, and grazing. Laris (2002) argues that the public dialogue on African savannah burning overemphasizes the damaging aspects of fire while disregarding the beneficial ones. According to him, more often than not this leads to misguided policies that threaten rural people’s livelihoods and savannah ecosystems.

Indeed, understanding indigenous burning strategies and knowledge has provided insights into improved use of fire for land management in many parts of the world. As the costly experience of the past century has shown land managers in the United States, catastrophic wildfires invariably result when natural fires, as well as human burn regimes, are eliminated from some ecosystems (Pyne 1997). As this case study from Bolivia shows, knowledge of fire uses and of impacts on ecosystems is strong among many rural peoples. However, changing economic, demographic, and cultural contexts in rural areas often lead to burn practices that ignore the traditional knowledge of fire behavior and impacts.

Methodology

The research presented here is based on ethnographic research in the territory of Lomerio in June and July of 2003. We used in-depth semistructured interviews with 15 key informants from four different communities to gather information on local knowledge regarding fire use, behavior, and effects. Two of the authors had worked extensively in Lomerio since 1997 as an anthropologist and fire ecologist, respectively (McDaniel 2002; Kennard 2002), and we used established relationships with informants to gather the needed information.

We initiated the research with previous informants who were experts on fire and savannah ecosystems. We used snowball sampling, by asking initial informants to identify other experts in the territory familiar with specific forests and savannahs in different regions. We selected older male (12 informants, average age = 47 years)

and female informants (3 informants, average age = 53 years) who are widely considered to be experts in local agricultural systems, land management, and traditional ecological knowledge. Two of the informants are recognized as *curanderos*, or healers. All of the informants own cattle and have farmed in Lomerio their entire lives.

While these informants do not represent the general level of environmental knowledge possessed by Lomerio residents, they likely characterize the “state of the art” of fire knowledge found in Lomerio, and thus the depth of traditional knowledge regarding fire. While the knowledge held by experts is not representative of the population in general, these persons represent the *potential breadth and depth* of fire knowledge. We cross-checked information among informants and identified areas of agreement and consensus to maximize trustworthiness of interview data. Admittedly, this approach does influence the type of data that we were able to collect since it is restricted to the small group identified as experts. However, it allowed us to explore topics in depth, and will provide the basis for a more comprehensive broader assessment of regional fire knowledge. The interviews covered the relationship among fire and climate, fire and cattle production, impacts on savannah and forest ecosystems, fire behavior, and attitudes toward fire.

Results: Perceptions and Knowledge of Fire

In the following subsections we present analysis of interviews conducted regarding fire behavior, the impact of fire on savannah ecosystems, and the relationship between fire and cattle production.

Fire Behavior

Informants considered fire behavior as one of the controlling factors in the quality of crop production. According to informants, the people of Lomerio try to set *chaco* fires to burn against the wind. They say that they prefer small, slow-moving, hot fires that completely consume the fuels, turning groundcover to fertile ash. They also pay attention to soil moisture and humidity in the air. Informants said that the best time to burn is after the first rains of the rainy season. They wait until soil moisture reaches to about 10cm in the soil before setting *chaco* fires. This protects the soil from excessive heat, but also allows the fire to get hot enough to consume the fuels as completely as possible. Most said that they liked to burn at noon since this is when there was the least humidity in the air, which also promoted complete burns. However, they said that they would often burn in the morning or at night to adjust for excessive dryness in the fuels or in the soil.

Informants reported that containment is a major concern for *chaco* fires. Many *chacos* are close to communities and to the *chacos* of other community members. Any fires that escape could threaten homes, fields, crops, and fields in various stages of preparation. Informants said that farmers of Lomerio put firebreaks, or *callejones*, around *chacos* before they set the fire with all of the grass and dry vegetation removed. This prevents escapes, and it also prevents wildfires from elsewhere from entering the plot and ruining crops and months of hard work.

Impacts on Savannah Ecosystems

Informants are especially aware of the role of fire in maintaining the structure and composition of *pampa*, or savannahs, in terms of species shifts in the major grasses,

and the spatial mosaic of forests and *pampa* (described in detail later). Informants related these changes to a variety of changes in the Lomerio fire regime, including (1) a drought that has increased the negative effects of fire on the *pampa*, (2) a subsequent series of large, destructive wildfires that have affected the area, and (3) the increase in the construction of enclosed, planted pastures for livestock, which has reduced the need for maintaining healthy *pampa* grazing habitat.

Among informants, the consensus was that if you took fire out of the *pampa*, scrubby, undesirable forests began to take over. However, if you burned too often, or too hot, you damaged the soils and the same scrubby forests moved in. Informants observed that present drought conditions had increased the frequency of hot, destructive fires; as a result, the *pampa* was changing. The key to a healthy *pampa*, according to informants, was the right balance between precipitation levels and fire frequency. *Pampas* are burned, in the most ideal cases, when air, soil, and vegetative moisture are such that slow-moving fires with short flame heights burn relatively large areas. Informants said that timing is essential; fire has to be applied when the *pampa* is not too dry and not too wet. Most felt that the *pampa* system was out of balance at present, and the effects of the imbalance were being exacerbated by increased cattle grazing.

The most recognized transformation that has occurred in the *pampas* is the disappearance of the grass species *saete* (*Trachypogon plumosus*), and its replacement by *paja carona* (*Elionurus muticus*). *Saete* has traditionally been an important resource for the people of Lomerio. It is the original grass used for the construction of roofs. The steady disappearance of *saete* has led to a shift to the palm *motacu* (*Scheelea princeps*) as a roofing material. One informant described it in this way:

Saete used to grow like rice about waist high for as far as you could see. *Pampa* such as this has disappeared though. There really hasn't been a quantity of *saete* in Lomerio for twenty years.

Informants said that *saete* has also been traditionally important for livestock. They said that cows prefer *saete* and will not eat *paja carona*. Customarily, livestock were allowed to range and graze over the *pampa*, and there were few enclosures dedicated to pasture production. However, over the past 10 years there has been a dramatic increase in the construction of enclosed, planted pastures, and most informants point to the disappearance of *saete* as a major stimulus for this change in production. Other informants argue that the shift to planted pastures was the cause, not the result, of the reduction in *saete*, since it reduced incentives to maintain the *pampa* through regular, controlled burns.

Informants told us that in the past, the *pampa* was burned intentionally almost every other year at a low intensity. Many reported that fire "cleaned up" the *pampa*. "Fire gets rid of snakes and other pests, and allows the grasses to grow back thick and tall," one informant stated. Specifically, fire stimulates the growth of perennial grasses such as *saete*, and without the periodic, low-level burns, it has disappeared. So, there is a classic chicken-or-the-egg scenario regarding the relationship between pasture and *saete*. It would be difficult to determine cause and effect without data on the abundance of both planted pasture and *saete* over the last several decades. However, the present relationship is clear. The *pampa* is not burning periodically at a low level, and this is resulting in an increase in occasional high-intensity, destructive wildfires, which informants believe have sped up the species shift from *saete* to

paja carona. At the same time, there has been a dramatic increase in the construction of planted pasture for grazing livestock; many informants believed that this has further reduced interest in the maintenance of *pampa* ecosystems through appropriate fire application.

Informants told us that previous generations had more knowledge of fire and its role in maintaining the *pampa*. The older informants told us that when they were younger there was much more *pampa* than forest, and they described it as *pampa raza* and *pampa bonita*, or clean and pretty savannah. They said that this preferred savannah had only a few trees spaced widely and luxuriant grasses, primarily *saete*. It also contained more game animals, including deer, armadillo, and agouti. Informants compared this to the new savannah landscape of Lomerio, which they described as *pampa arbusto*, or shrubby savannah. This is the savannah that proliferates around the villages of Lomerio, with short, scrubby trees that can best be described as thickets. Others referred to *pampa arbusto* as *monte basura*, or trash forest, being more direct about their negative assessments of its aesthetic qualities and usefulness.

While the lack of care through fire maintenance by present generations was cited by many informants as the reason for the transformations in the savannahs of Lomerio, others considered climatic factors. Informants pointed out that it was easier to maintain the savannahs when they were younger because it was wetter. If there is enough rain, the soils remain moist and the *pampa* can burn often. Without rain, fire is destructive to the savannah soils, and actually promotes the growth of the “scrubby trees that thrive in poor soils.” One informant put it this way: “The wild-fires kill the vitamins in the soil and make it where it is not productive for people. We are left with *monte basura* [trash forest].” According to many, the relative drought conditions of the past decade have made it very difficult to for the *pampa* to experience the slow burning, low intensity burns that were once common. The savannah is so dry that every fire has the potential to turn into a destructive wildfire. One informant told us that the savannah “burns like gasoline” now, and one match can start a wildfire that will burn for hundreds of miles.

Many informants lamented the loss of traditional uses for fire. However, with the increased use of planted pastures, *pampa* habitats were not as critical in the Lomerio economy. As mentioned earlier, the use of *saete* for roofing houses had been replaced by the use of *motacu* (*Athalea princes*), and all informants felt that this was an adequate replacement. Two of the informants were *curanderos*, or healers, and they said that medicinal plants were still as abundant as ever, and could be found in the forest as well as the *pampa*. On the other hand, the disappearing *pampa raza* was seen as richer game hunting habitat than the new *pampa*. Informants said that game abundance has reduced throughout all habitats in Lomerio, but this is seen as a result more of increased hunting pressure from growing populations in the communities of Lomerio than as a consequence of changing habitats.

Fire and Cattle Production

The primary function of the *pampa* in the eyes of informants in Lomerio is as grazing habitat for livestock. Besides the relationship among precipitation and fire frequency and intensity, informants felt that cattle had also impacted the savannahs. They said that there had been an increase in the number of cows in Lomerio in recent years, and the impact of these cows had increased the negative impacts caused by the

drought and the changing fire regime. They said that ideally, the *pampas* should burn after the first rains. This allows moisture to prevent damage to the soil and prevents the fire from becoming too hot. Informants said that the rains also promote rapid regrowth that provides the soil with groundcover. However, the same informants pointed out that with the present fire regime, the high-intensity fires leave the soil exposed, and the drought conditions impede the growth of groundcover. Under these conditions, cattle grazing can damage the soil permanently, and also lead to expansion of scrubby forests adapted to poor soils.

Informants also said that the impact of cattle on the savannahs has also been augmented by a change in the breed of cattle raised in Lomerio. In the mid-1960s, the *cebuino* breed of cattle was introduced to Lomerio as part of a government program to increase cattle production. These cows replaced an older breed of cow, which informants referred to as *mestizos* and *nativos*, which were smaller and more adapted to living in the forests and *pampa* of Lomerio. Informants said that the *cebuino* cows were much larger, harder on the soils, and consumed much more of the native grasses. Some informants told us that the disappearance of *saete* began in the 1970s and 1980s as the number of *cebuino* cows began to increase in Lomerio. They also said that the process picked up speed in the 1990s as the number of cows increased rapidly along with the growing population. When we asked informants how the grass *saete* could be restored on the *pampas*, they referred to changes in precipitation and fire frequency, but they also said that you would have to enclose areas for restoration in order to keep cattle from completely consuming *saete*, or more cattle in Lomerio would have to be moved permanently into enclosed pastures. Most agree that there are too many cattle on the *pampas* of Lomerio and that the vegetation shifts will continue until those numbers are reduced.

Fire Prevention Media Campaigns

In many instances, when we initiated discussions and interviews with informants regarding fire, they expressed disapproval of burning practices. Many even referred to stories from the radio dramas as evidence of the negative aspects of burning. They also did not attribute burning in Lomerio to the residents and farmers themselves. Informants stated that the people who burn the *pampa* are not from their community—*gente de afuera*, kids playing, or even bus passengers riding through Lomerio who throw out a cigarette.

However, these negative views of burning are not a deep-seated belief. When questioned further, informants began to discuss in detail the benefits of burning. Once the informants realized that we also recognized the benefits of burning, they admitted to burning regularly. The contradiction expressed by informants suggests that the media campaign has affected informant attitudes on a superficial level, but the knowledge of fire benefits remains. The informants recognized that burning is seen negatively by the larger Bolivian society, and clearly wanted to demonstrate to the authors their familiarity with opinions of “outside experts.”

Conclusions

There is a common sentiment in Bolivia, among foresters and scientists, that rural residents use fire arbitrarily, with no regard to effects on the landscapes and to communities. There is certainly a high level of irresponsible and uninformed fire use

occurring in the region; however, this study also shows that there exists a pool of traditional knowledge regarding the beneficial uses of fire. Many Chiquitanos have very good reasons for burning, and know the time and the technique for proper burns. The challenge is to determine what aspects of Chiquitano traditional knowledge have broad application across the region, and which aspects can be used to strengthen public education efforts to expand the pool of traditional fire experts.

The limited number of informants interviewed does not allow for broad generalizations to be made regarding fire knowledge by Chiquitanos as a group or on the subject of regional or national fire policy. However, the depth of knowledge and the consensus existing among informants regarding fire effects on the *pampas* of Lomerio suggest a potential for incorporating traditional fire knowledge into fire and land management policy. At the very least, the study results indicate that blanket policies of fire suppression, such as the one undertaken in the United States in the 20th century, are unwarranted. Going further, the results suggest that local and regional fire policies could be strengthened with consideration of local knowledge of fire practices (timing and intensity of burns) on native grasses. The results also show that the relationship between fire practices and production systems, such as livestock and pasture, is complex, and any fire management policy must be sensitive to local economic and cultural motivations in trying to influence land management practices.

This study suggests that there are many challenges to integrating traditional fire knowledge into land management, including changing demographic and production systems. However, the results also indicate that there are a number of individuals in Lomerio with the experience and expertise to develop locally relevant land management systems that recognized the role of fire. With minimal guidance, local leaders and experts could establish fire and land management policies based on local understanding of ecosystem dynamics and the yearly subsistence round. Given training, institutional authority, and research support, areas such as Lomerio could quickly become models and laboratories for effective local fire policy.

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