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The Mesquite Economy in the Mexican-American Borderlands

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Abstract

Scrubby mesquite trees infest large regions of the Mexican-American borderland. In this same area, demand for mesquite wood and charcoal places pressure on mature trees. This paper examines consumption of this biomass fuel on both sides of the Sonora-Arizona border and the demands that consumption places on the environment in Northern Sonora. In Sonora multi-stemmed trees provide wood for heating homes and cooking stoves upon which coffee pots bubble and large, flat tortillas cook to perfection. At the opposite extreme, large, mature trees fall to the chainsaw and charcoal pits to provide North American restaurants and backyard cooks with a chic and flavorful grilling fuel. This research in northern Sonora reveals details of this hidden industry. This study provides important information and discussion about biomass use in a dry region. Studies like this, which consider direct use of biomass resources, are important, especially in light of present and future industrial, population, and urban growth along the border, which all place additional pressure on natural resources.

Keywords: *Sonora, charcoal, mesquite, ejido*

Resumen

Maleza, en forma de árboles de mesquite, plaga regiones extensas de las tierras fronterizas entre México y Los Estados Unidos. En esta misma área la demanda para leña y carbón pone presión sobre árboles grandes y bien establecidos. Este manuscrito examina el consumo de este combustible en Sonora y Arizona y los resultados que tiene esta utilización en el ambiente en el norte de Sonora. En Sonora los árboles de multi-tallo proveen leña para la calefacción de casas y para estufas de leña donde las ollas de café hierven y tortillas grandes se tuestan a la perfección. Al otro extremo, los árboles grandes y viejos declinan ante la motosierra y los talleres de carbón, para suministrar a los restaurantes y cocineros de barbacoa en los Estados Unidos, un combustible muy "chic" y lleno de sabor. Estas investigaciones en el norte de Sonora, dan a luz a los detalles de una industria escondida. Este estudio es importante dada la creciente ola de la industria, población y áreas urbanas en la frontera, las cuales pueden aumentar la presión sobre los recursos naturales.

Palabras clave: *Sonora, carbón, mesquite, ejido*

Charcoal and firewood in the Mexican-American Borderlands

In 1998 I attempted to cross the rugged Sierra Madre Occidental from Sinoquite to Cucurpe. Despite the aid of good Mexican topographic maps, I lost my way on dirt roads that forever forked on the *ejido* lands of northeast Sonora. Instead of the beautiful, unused road to Cucurpe, I found three men making charcoal from large mesquite trees growing in riparian areas. At the time I did not realize that mesquite charcoal is produced primarily to satisfy the North American demand for a flavorful grilling fuel.

Years of subsequent research into the borderland mesquite trade followed this initial discovery. This paper, using mainly ethnographic evidence, documents the impact of a multi million-dollar trade of wood and charcoal on the dry borderland region of northern Sonora. This impact and current use of the environment is placed in the context of long-term environmental change in the region. Moreover, the use of biomass energy in the borderlands is placed in the context of biomass use around the world, which is the basic form of energy for billions of people around the world.

Conrad Bahre's (1991) classic account of vegetation change in the area, Hastings' and Turner's *The Changing Mile* (1965), and the special double issue of the *Journal of the Southwest* that documents social and environmental aspects of the bi-national Sonoran Desert Reserves (Felger and Broyles 1997) document environmental history of the dry borderlands region. They stop short, however, of documenting the recent trade in biomass, specifically mesquite wood and charcoal. This trade strips vegetation south of the border to meet demands north of the border. These authors do, however, leave readers with a vivid image of the "mesquite nemesis." Mesquite is the nemesis of ranchers in the area because it invades cattle pastures (with the help of cattle) and competes with grass for valuable water and sunlight. One could reason, armed with knowledge of how the tenacious mesquite tree (in this case the *Prosopis velutina*) infested many grasslands of the Arizona-Sonora borderland since the introduction of cattle, that charcoal and firewood production on Sonoran ejidos may not adversely impact ejido environments and sustainability because encroaching mesquite trees are eliminated. Research conducted for this paper revealed, contrary to expectations, that charcoal production and firewood harvesting for export do not utilize the scrubby type of mesquite that invades pastures and hillsides. Instead, *carboneros* (charcoal makers) and *leñeros* (wood cutters) take advantage of large, mature mesquite and ironwood trees growing in riparian areas. This paper, then, documents the details of the production, use, and trade of mesquite wood and charcoal in the Sonora-Arizona borderlands and relates current use of mesquite to the changes in mesquite use and density over several thousand years. It then discusses the ramifications of mesquite harvesting on the environment.

Methodology

Results presented in this paper rely on qualitative information collected in cooperation with residents of the region over a five-year period. The often illicit and diffuse nature of the charcoal and firewood business, in addition to the booming drug trade in the area (Perramond 1996, Yetman and Búrquez 1998) forced my gradual introduction to its main protagonists in remote, rural areas of Sonora. I chose to participate in daily activities and interview members in Ejidos La Arizona, La Cebolla, and San Juan in the Tubutama/Saric area, and Ejido El Berrendo in the Sonoyta/Lukeville area (Figure 1). Rather than just interview people and expect candid results, I "soaked and poked" (Bernard 1995). In other words, I participated in daily ejido life. For example, one cold December evening I loaded 22,000 pounds of charcoal into the back of an eighteen-wheel trailer. The *carbonero* (charcoal maker) handled the other 22,000 pounds while four men stacked the forty-pound bags in the trailer ready for the journey to the border at Nogales. This activity formed deep friendships and provided me with an insider view of ejido management of natural resources. First-hand observations of the charcoal and wood trade were backed up by data documenting the magnitude of trade in charcoal and firewood from the U.S. Department of Commerce (USDC 1995, 1997, 2001, and 2002) (Tables 1 and 2).

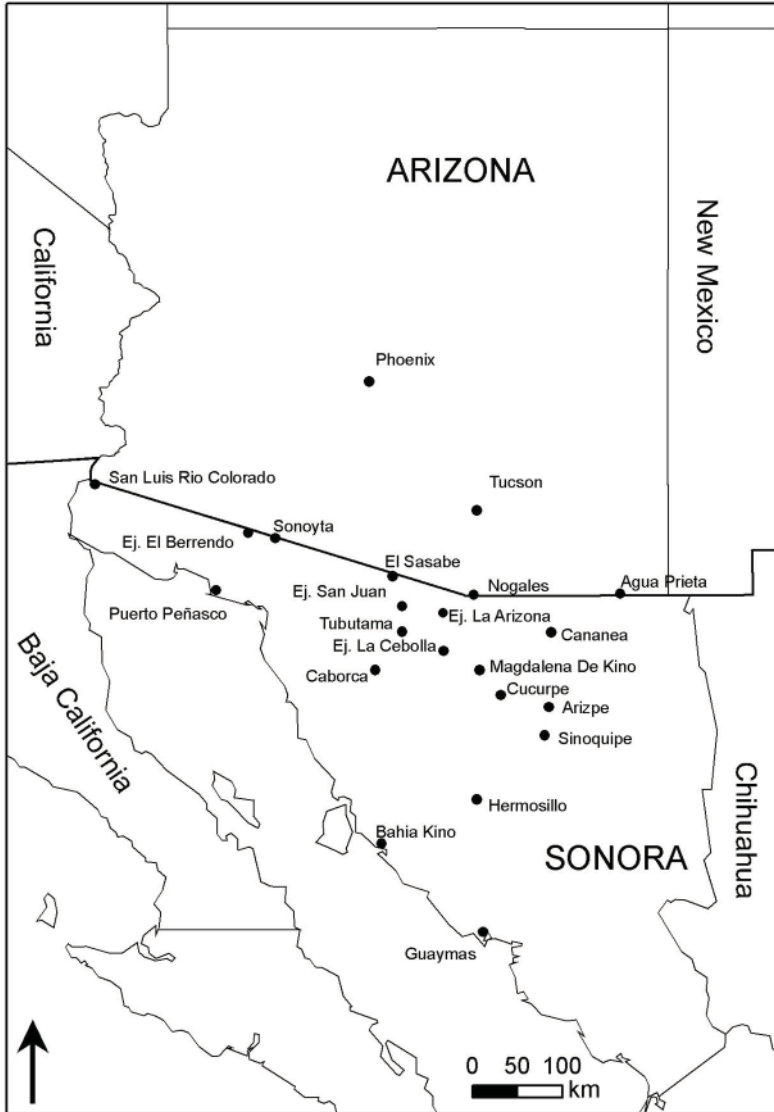


Figure 1. Study sites and place names mentioned in the text.

Background: A History of Mesquite use in the Borderlands

This history is provided to place current use of mesquite in a longer perspective and to show how use and density of mesquite in the borderlands has changed over time. Native people of Arizona and Sonora utilized, and continue to use, every part of the mesquite tree. Mesquite served as a primary source for food, fuel, shelter, medicine, weapons, and tools (Felger 1977). Because mesquite was, and is, so prevalent in the dry borderland it can be relied upon as a constant source of nourishment when all other

	Imports from Mexico	Nogales, AZ		
	tons	tons	customs value Thous \$	% of total from Mexico
Year				
1990	23330	18071	2225	77.5
1991	20466	15381	2337	75.0
1992	18940	16393	2174	86.5
1993	18718	16979	2239	90.7
1994	18384	16165	2560	87.9
1995	19281	16274	2641	84.4
1996	18981	14970	2187	78.9
1997	23229	17818	2187	76.7
1998	23875	18232	3354	76.4
1999	18581	14523	2758	78.2
2000	14025	10946	2106	78.0
2001	15025	12673	2327	84.0
2002	17855	14845	2452	83.0

Table 1. United States charcoal imports through the Nogales customs port of entry district. Nogales includes all Arizona ports of entry (USDC 1995, 1997, 2001, and 2002). Most charcoal passes through Nogales, Arizona.

	Imports from Mexico	Nogales, AZ	
	Customs value (Thous \$)	Customs value (Thous \$)	% of total imports from Mexico
Year			
1990	5.9	4.3	73.0
1991	22.2	2.2	10.0
1992	22.6	1.6	7.1
1993	4.1	0	0
1994	21.5	8	37.2
1995	34.0	25.6	75.3
1996	68.4	35.0	51.2
1997	359.4	65.4	18.2
1998	166.5	38.5	23.1
1999	109.9	28.5	26.0
2000	150.7	87.5	58.1

Table 2. United States fuel wood imports through the Nogales customs port of entry district. Nogales includes all Arizona ports of entry (USDC 1995, 1997, and 2001). Data not yet available for 2001 and 2002 (as of March 2005).

food sources fail (Rogers 2000, Yetman and Búrquez 1998).

The quasi-stable relationship between desert grasslands and desert scrub responds to several human-induced factors. The density (not range) of mesquite trees in the dry borderlands area that was established during centuries of use by indigenous populations increased due to grazing of grasslands by cattle and/or fire exclusion beginning with the arrival of Spanish colonists (Harris, 1966; Fisher 1977; Bahre 1991, 1978; Búrquez and Martínez-Yrizar 1997). Spanish colonists introduced cattle and other livestock to the region before the 1880s (Bahre 1991, West 1993), but the real boom in cattle ranching and large-scale modification of the environment began when the Southern Pacific Railroad reached southern Arizona. Southeastern Arizona supported almost 400,000 head at the end of the 19th century (Bahre 1991). As mesquite density increased in the Arizona-Sonora borderland, its morphology changed from single-stemmed, large individuals to smaller, multi-stemmed individuals (Fisher 1977; Simpson and Solbrig 1977). If the principal growth stem of mesquite is disturbed in any fashion, such as trampling by livestock, underground buds initiate new growth around the base of the plant, which results in smaller, multi-stemmed trees (Fisher 1977). It is important to relate recent changes of mesquite morphology and density to the recent Holocene record of climate and vegetation history in the area. Indeed, mesquite growth outside of desert washes as seen today, albeit with cattle and human help, is not new to southern Arizona and Northern Mexico. During the Holocene (12,000 years B.P. to the present) mesquite grew in areas that are now too dry. It was only about 3,800 years B.P., and in some areas as late as 1,000 years B.P., that mesquite retreated to nearby washes (Turner et al. 1995). In Arizona the only regions of mature, single-stemmed mesquite occur in relatively undisturbed areas along desert washes (Felger 1997, Simpson and Solbrig 1977).

The mines of Sonora and Arizona made extensive use of mesquite and oak trees. West (1993) clearly documents the gradual encroachment of mining communities into Sonora during the 1600s and 1700s. As mining spread into Arizona and operations increased in size during the following centuries, the demand for fuel also multiplied (Dobyns 1981). Mesquite and oak wood powered boilers for stamp mills and heated blowers in the smelting process (Bahre 1991). Cutting of woodlands to obtain wood to make charcoal for mining enterprises is not unique to the Mexican-American borderland and has been documented in other areas of Mexico (West 1994).

In addition to the demand placed on wood such as mesquite for powering mining operations, growing urban areas like Tucson, Bisbee, and Tombstone required enormous quantities of wood to fuel fireplaces and stoves. According to Bahre (1991), timber depredation around mining centers and emerging towns was so severe that it soon became a common issue appearing in Arizona newspapers. Demand for wood in Arizona led to the importation of firewood from Sonora, Mexico (Bahre 1991), a tradition that continues today (see Table 2).

Use of mesquite in mining operations declined in the early part of the twentieth century, however, domestic heating and cooking still put heavy demands on trees. For example, as late as 1940, about 44 percent of homes in Arizona used wood-fuel for heating and cooking (Bahre 1991). Since the 1940s, wood-fuel for personal consumption declined for several decades, but in the last two decades mesquite and other woods have made a comeback into Arizona fireplaces and kitchens as a trendy wood.

Biomass energy and its contribution to energy budgets

Even though biomass provides a vital source of energy to millions of families around the world in places like the Mexican-American borderlands, it is often ignored by politicians and energy analysts who focus on more sophisticated forms of energy (Taylor

2005). Indeed, thirty to forty percent of the world's population (mainly in less developed countries) already employs a form of renewable energy – biomass, and because alternative forms of affordable renewable energy are not going to reach the rural poor any time soon, it is vital to examine this resource with sustainable use in mind (Hosier et al. 1992; O'Keefe 1996, Taylor 2005). Rural energy planning can be most efficient if it strengthens – *not replaces* – local integrated production systems (Mahiri and Howorth, 2001). Energy budgets from the developing world continue to reflect a heavy reliance on biomass (Carroll 1982; O'Keefe 1996), yet few studies capture local variations in the use of biomass fuels such as firewood, and even fewer government and NGO programs incorporate biomass fuels into their development programs. This paper takes a step in the direction of understanding how biomass is used by borderland residents for various purposes, including firewood for survival (i.e., cooking and space heating).

Current Uses of Mesquite in the Arizona-Sonora Borderland

In the Kitchen

The qualities of mesquite for cooking food have long been recognized. In 1922 Aldo Leopold (1991) stated his preference for mesquite wood in an elegant fashion:

On the Delta [Colorado] one burns only mesquite, the ultimate in fragrant fuels. Brittle with a hundred frosts and floods, baked by a thousand suns, the gnarled imperishable bones of these ancient trees lie ready-to-hand at every camp, ready to slant blue smoke across the twilight, sing a song of teapots, bake a loaf, brown a kettle of quail, and warm the shins of man and beast...We had cooked with white-oak coals in the Corn Belt, we had smudged our pots with pine in the north woods, we had browned venison ribs over Arizona juniper, but we had not seen perfection until we roasted a young goose with Delta mesquite.

Today mesquite charcoal is a desirable fuel, especially in restaurants in the United States that use mesquite as a chic grilling fuel (Kay 1993). Most mesquite used in California and Arizona restaurants that specialize in grilled meats comes from Sonora, Mexico (Kay 1993; Higuera 1997; Nabhan 1985). Most charcoal entering the United States comes from Mexico. Examination of the charcoal imports from Mexico over the last twelve years reveals that 81% of Mexican charcoal passes through the Arizona border (Table 1). For example, in 2000 eleven thousand tons of charcoal with a customs value of 21 million dollars entered Arizona from Mexico. This amount of charcoal is the equivalent of 550 trailers, each laden with 1,100 forty-pound bags of charcoal.

Mesquite charcoal is also employed in eateries in Mexico, especially when *carne asada* and *tortillas* are served. Upon crossing the border at Sonoyta the desire for *tacos de carne asada* can be satisfied almost immediately by roadside eateries catering to North American tourists and native Sonorans. The smoke billowing out of these mobile roadside eateries is produced by *carbón de mesquite* (mesquite charcoal). The charcoal used in Sonoyta is produced locally, and some of the wood for the charcoal comes from mesquite and ironwood trees in the Organ Pipe National Monument and the Tohono O'odham Indian Reservation Arizona because mesquite trees around Sonoyta can no longer meet the demand (Suzán et al. 1997, 1999). During the peak of charcoal production around Sonoyta in the 1980s, woodcutters dismantled historic mesquite corrals in the Organ Pipe National Monument (Nabhan 1985). Residents of Ejido El Berrendo, who live just 5 km west of Sonoyta near the dry bed of the Sonoita Wash, say that char-

coal is no longer the big business of the 1980s. Now only a few carboneros work to meet local demand.

Mesquite charcoal produced in the Sonoyta region also fuels the grills of the restaurants that line Avenida Obregón in San Luis Río Colorado. Mexicans and North Americans who venture into San Luis expect the food to be grilled over mesquite coals: "*es que da sabor, no hay otro modo, es suave*" ("it's the best, there is no other way to get such flavor"), one food preparer emphatically stated.

Mesquite charcoal is primarily used in commercial cooking places. Mesquite firewood, on the other hand, is used in private kitchens. In many rural and peri-urban areas of Sonora, wood is the only fuel used for cooking (Sheridan 1988, Yetman, 1996). Without wood and woodcutters "urban riots would surely erupt... raw beans and rice are decidedly unpalatable" (Yetman 1996; p. 132). Although many women in the borderland have gas stoves they still prefer to prepare certain foods using *leña*. Tortillas must be prepared on a grill or *comal* that is heated by mesquite or other wood. Wood is used because it is normally free and easily available, especially in rural areas. Even if women live in the middle of charcoal producing areas, like Doña Maria Molino, a grandmother and mother of ten children, who lives on Ejido La Cebolla (25 km west of Magdalena de Kino), women generally prefer to cook certain foods using wood, not charcoal. Wood, they say, is easier to manage and extinguish.

Wood for household heating

Almost 50,000 homes (about 3% of all homes) in Arizona rely on wood as the primary household heating fuel. It is unlikely that wood for central heating comes from Sonora. An analysis of census tracts in Arizona where most wood is used for heating homes shows that these people obtain their wood from adjacent National Forests (US Census 2000). In many Mexican homes in the borderland, especially at higher elevations, wood is the only source for cooking (Suzán et al. 1997, 1999, INEGI 2001). We must note that the Mexican Census records the type of fuel used for cooking rather than fuel used to heat homes (INEGI 2001). The rural homes visited in Sonora for this study do not have any form of central heating or cooling. Houses are self-built and added to over the years (Sheridan 1988, Yetman 1996). The only heat is provided by wood-burning kitchen stoves where family members gather on cold nights and even colder mornings. Wood collection and its impact on the landscape for household use in Sonora, especially in rural areas, is distinct from wood harvested for charcoal and exported firewood. Wood for local consumption comes from dead and fallen limbs or branches that can be removed with one or two swings of a machete. The type of wood required by women for cooking allows them to take advantage of the scrubby, thin-limbed specimens so pervasive in the Sonoran Desert.

The recent demand for mesquite wood to fuel cosmetic fireplaces in Arizona (Hoye 1993; Laughlin 1994) has created a thriving trade across the border, although not on the same scale as charcoal (Tables 1 and 2). Mexican trucks loaded with mesquite cross the international border at Sasabe and head for wood yards in Arizona. Sasabe, Mexico is only accessible from other parts of Sonora by unpaved roads in bad condition. This suggests that much of this wood is harvested in the near vicinity of Sasabe; otherwise truckers would choose Nogales or Sonoyta as a crossing point into the U.S. Interviews with truck drivers about 5 km south of Sasabe in Sonora reveal that most of the wood they haul comes from the ejidos within a 20 km radius of Sasabe.

Other uses of Mesquite

Mesquite serves several other purposes in the Arizona-Sonora borderland. It is

used as a fuel to bake bricks, as a material in fence and corral construction, and for artisan furniture production. Mesquite branches and logs are used to make corrals primarily in southeastern Arizona and northeastern Sonora, where cattle ranching is one of the economic mainstays. Although building such corrals is a labor-intensive task, they last up to seventy years and make use of a readily available material (Figure 2).



Figure 2. Mesquite corral just north of Cucurpe, Sonora. November 1999.

Production of fired adobe bricks is most evident in western Sonora, especially in the ejidos occupying the fertile land of the Colorado Delta. The emphasis of brick making in western Sonora arose in response to population increases in the area (Peach and Williams 2000, West 1993) and demand for bricks, and consequently wood used to fire bricks, is high. Adobe brick production is clearly evident in the areas south and west of San Luis Rio Colorado. Family-run operations form adobe bricks from local silt, straw and horse/cattle bedding, and water. Kilns are then erected of the bricks themselves and can contain up to 50,000 bricks. Traditionally, mesquite wood was used to fire the kilns because it burned longer and hotter. Brick makers lament the reduction in the availability of large mesquite and ironwood trees because with the use of wood such as Tamarisk they have to constantly stoke the fire and add more fuel – as one brick maker put it: “*con mesquite sólo echaba una o dos veces y ya*” (with mesquite I only added it once or twice and that was it).

Production and International Trade of Mesquite Charcoal

Demand for mesquite charcoal in the United States creates an elaborate system of manufacture and marketing. Observations reported in this paper of charcoal production for export in Ejidos La Cebolla, San Juan, La Arizona, and El Berrendo are complemented by reports from other researchers. Perramond (2000) reported a large-scale charcoal production area in Carbó, 35 km north of Hermosillo, and Yetman (2001) mentioned the complete removal of a dense mesquite *bosque* (forest) to the axe and charcoal pits just east of Hermosillo. Charcoal that is produced in the lands of *ejido* La

Cebolla reaches restaurants in urban places such as Los Angeles (CA), Magdalena de Kino, Hermosillo, and San Luis Río Colorado, Mexico.

In the mesquite-infested landscape of La Cebolla, Mario Molino described the process of charcoal production. He began making carbón 25 years ago to supplement income from his few head of cattle. He no longer produces charcoal on his own ejido, but pays members of other ejidos and private ranches for the right to exploit their biomass at the rate of \$30 per ton of charcoal produced. He then sells this charcoal to brokers in Nogales for about \$300 a ton. Once enough charcoal has been collected, it is shipped off by large trailers to the United States or by smaller trucks for local use.

Producing charcoal is labor intensive. Teams of three men first excavate a row of charcoal pits with hand shovels and picks. Each pit is roughly 4 meters long, 2 meters deep and 1.5 meters wide and produces a ton of charcoal. Old flat bed trucks driven by men with charcoal-blackened faces then make their own roads through the desert to large mesquite trees where woodcutters trim or completely remove all limbs with chainsaws. Mesquite wood is then neatly stacked in the pits. Carboneros then seal the pit with old tin roofing sheets, ignite the wood and let it smoulder three to four days (Figure 3).

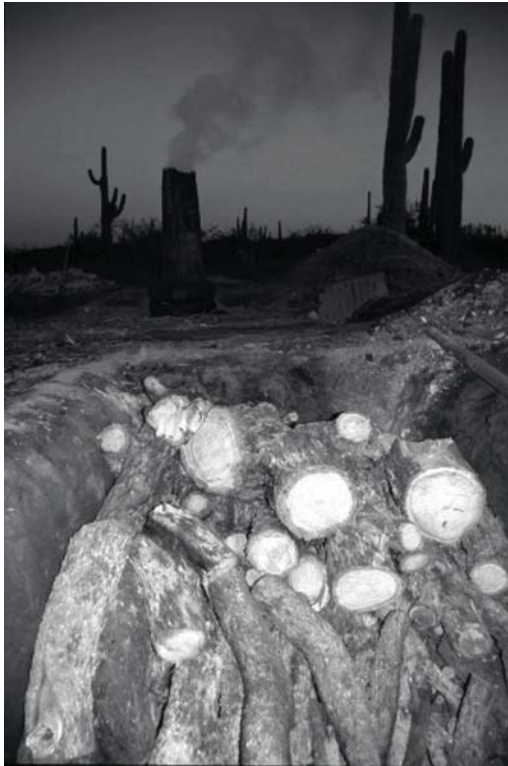


Figure 3. An empty charcoal pit measures roughly 4 meters long, 1.5 meters wide, and 2 meters deep. The pit is sealed with tin roofing sheets and then set to burn for three to four days using a chimney constructed of tin roofing sheets and used tires. A chimney is seen in the background. December 2001.

Three weeks of backbreaking work produces sufficient charcoal to fill a trailer destined for the United States, which holds 1,100 forty-pound bags. Men laboring in the charcoal business earn ten dollars a day. This low return for hard labor means that often the work is conducted by men with no land or by men who have fallen on hard times who are using this as a staging post before they cross the US-Mexico border – after all, Sonora's main exports to the USA include cattle and men (Sheridan 1988), and now the very forests of the Sonoran Desert too.

Charcoal production not only occurs on ejidos, but on privately owned ranches. In this case, and increasingly so on ejido lands in eastern Sonora, production is associated with large scale clearing of desert scrub prior to the seeding of buffelgrass from Africa (*Pennisetum ciliare*). Buffelgrass permits more cattle per hectare and allows for stocking of better breeds, which are more desirable in North American markets (Perramond 1996, Yetman 1996, Yetman and Búrquez 1998). Bulldozers raze all vegetation and wood is piled for later sorting for the charcoal and firewood markets (Figure 4).



Figure 4. Clearing mature mesquite to plant buffelgrass. Saric, Sonora. March 2002.

The state of Sonora covers 18.5 million hectares. Buffelgrass has been planted on one million hectares and has invaded another million hectares of desert scrub and thorn forest (Yetman and Búrquez 1998).

An example: Charcoal production on Ejidos San Juan and La Cebolla

Both Ejido San Juan and Ejido La Cebolla are firmly planted in the midst of classic Sonoran Desert plant assemblages. Saguaros and their associated nurse plants dominate the drier, rockier hillsides and flat areas between washes. Large mesquite trees dominate *bajios* (low lying areas) and desert washes. Charcoal camps hide in the slim shade of cacti and cattle browse the scrubby mesquite forests of their own making (Figure 5).

Charcoal production is in full swing in the lower lands of the Río Las Pedradas. Most residents of these ejidos can give directions to several sites of charcoal production



Figure 5. Charcoal camp near Ejido La Cebolla, Sonora, MX. Note the chimney in the left middle ground of the photograph. December 2001.

Finding the sites is not so easy though. “Oh yes, in San Juan they [the charcoal makers] are on the property of Jaime Rodriguez. Go to Tubutama, and then on the dirt road that heads north *anda recto, recto* (go dead ahead, dead ahead) for thirty kilometers, after the third *falso* (a part of a ranch fence that swings open – “false” because it is not a true gate and looks like the fence) take a right and there you are!” “Go dead ahead” is not easy on continually forking roads. After finding hidden camps, though, research proceeded.

Perched on a sturdy stock horse, Jaime Rodriguez let his horse avoid the cacti as he portrayed mesquite management and cattle ranching on his and nearby ejidos. His comments echo the opinions of other ejiditarios of San Juan and La Cebolla. These, Jaime proudly claimed, are not like other ejidos where slackers can ride on the success of hard workers. Here “*el quien trabaja dura, es el que gana*” (he who works hard is he who reaps the benefits). “If you work hard you can have 500 or a 1000 head of cattle, besides many people are just too lazy to work and therefore there is more space available for us who are willing to work in the desert” Jaime related.

Jaime explained his motives for allowing charcoal production on his land. First, he said, the trees here are too tight and need opening to give grass a fighting chance. Many ejiditarios see charcoal production on their private plots and communal rangeland as a win-win situation. It costs them nothing to remove the vegetation; in fact they are paid \$30 per ton of charcoal produced. Additionally, the carboneros obtain the permits from the appropriate government office.

Forestry officials from Hermosillo issue permits based on inspection and estimation of usable biomass (i.e. dead and “extra” branches). Whole tree harvesting is not permitted. *Carboneros* run on a thin profit margin, however, and often ignore official quotas and regulations. They attempt to get the maximum possible out of a designated area. Charcoal produced in excess of permits leaves the site in the back of pick-up trucks

and filters into the local market. The immediate area around charcoal pits is often left treeless. Walking transects away from charcoal pits reveals that all trees within a one km radius bear the scars of the chainsaw. Harvesting of wood in excess of permits can take place in this region for several reasons. First, permits are issued in a centralized manner from Hermosillo, often without first-hand inspection of the ejidos and their biomass capacities. Second, even if wood harvesting permits were based on the visits of inspectors to the field, enforcement of permits by a few officers over millions of hectares of ejido land is almost impossible. This situation reflects the gap between official, centralized conservation discourse and the reality of biomass management on the ground by ejido members and carboneros. This disparity is not unique to the Mexican-American borderlands. Indeed, the difference between official/scientific discourse and categories is an issue that is often revealed and discussed by political ecologists (e.g., Robbins 2000).

Ejido members and charcoal makers are not concerned about enforcement of permits. Likewise, they express little concern for the loss of large mature trees. They commonly cite the rapid regenerative properties of mesquite as justification for harsh logging. At the same time, though, they understand that the trees they removed or drastically trimmed take up to 100 years to reach pre-cutting size. Ejiditarios know who is doing what. On this ejido, however, few norms and rules governing resource use exist, and those that do exist are not enforced. For example, all residents know that professional woodcutters can only collect dead wood. Woodcutters know that Arizona consumers require seasoned, not green wood. Dead wood to meet export demands is getting hard to come by. A simple solution practiced by many woodcutters is to ring trees and let them die. Dead wood is then legally collected.

Another example: past charcoal production on Ejido El Berrendo

Eroded *arroyos* (desert washes) run deeply from north to south in El Berrendo, Sonora. Desert channels in Sonora have nothing in common with their roots a mere 2 km to the north in the Organ Pipe National Monument, Arizona. The line formed by the border reveals the role humans play in the vegetation differences between North and South. Washes in the Organ Pipe National Monument in Arizona support healthy ironwood, paloverde, and mesquite trees, as well as grand saguaro cacti. Ejido El Berrendo sports cracked stumps that sit high in the washes with their roots exposed by the increased erosive power of flashy summer monsoon rains. Here mesquite dominates and is of a different form to its forbearers.

Es que ya no hay monte (simply, that's it, there is no more forest) a 67 year old ejiditario put it bluntly as he allowed his horse to gently strip the tiny mesquite leaves off a small tree growing in the dry bed of the Río Sonoyta. We discussed forest change under the glaring sun (read: no shade from large trees) just west of Sonoyta and southwest of Lukeville (Gringo Pass), Arizona. This resource-poor ejido sits on the edge of the Pinacate Lava Field at about 350 msl. The ejiditarios abandoned their original settlements along the Río Sonoyta in favor of the band of asphalt that is Mexican Highway 2. Many newcomers to the area, especially in ejidos closer to Sonoyta, now own houses on ejido lands. Newcomers have little ties to the land and original community structure is far from original ejido formation. In this area in the 1980s and early 1990s, ejido wood fell prey to the axe and charcoal ovens.

Rogelio, the mounted cowboy, witnessed it all. He described magnificent mesquite and ironwood trees in and around the washes where we stood. "Large enough so that 20 or 30 cattle could gather below a single tree to escape the summer sun." "*Ya no hay monte y ya no se hace carbón*" (the forests are gone and so have the *carboneros*). Rogelio, Bernardo, and Alberto voiced similar opinions. Forestry laws here were not respected.

Ejido members sought to make what they could from the land. Ties to the land and community are weak as residents see the ejido as simply a place to live.

A walk around the washes in El Berrendo reflects the stories of past charcoal production told by Rogelio. I was hard pushed to identify trees untouched by human hands. Every large tree in three transects had been cut for firewood or charcoal production. Mesquite and ironwood trees regenerated, but represent only a fragment of their former stature. Rogelio and this research can objectively state that the structure of the riparian forests is transformed. Rogelio can no longer rest his horse and 30 cows under a stately mesquite.

A Geography of Mesquite in the Borderlands: Different Mesquite for Different Purposes

Mesquite wood serves numerous purposes in the Arizona-Sonora borderland. First, it must be noted that charcoal production and wood for space heating do not tap into the unlimited supply of scrubby mesquite that is characteristic of cattle ranching areas. Instead, large, mature mesquite trees are used. Wood used in Sonoran kitchens for the daily production of traditional foods comes from smaller, multi-stemmed mesquite trees. Additionally, wood used in home kitchens is often collected without harvesting the whole tree, therefore ensuring a steady supply (Sheridan 1988).

Charcoal and firewood producing areas

Most charcoal production occurs in an area extending east from Sonoyta to Magdalena and south to Guaymas (Figure 1). Other major charcoal producing areas include Hermosillo, Guaymas, and Puerto Peñasco (Búrquez and Martínez-Yrizar 1997, Yetman 2001), but do not include areas of eastern Sonora. Limited charcoal production occurs in the Sierra Madre Occidental (*La Serrana*). For example, Sheridan (1988; 142) stated that when some resource-poor ejidatarios of Cucurpe fall on hard times during droughts they work as day laborers producing charcoal in La Serrana. Yetman and Búrquez (1998) and Lindquist (2001), who work in southeastern Sonora, report that ejidatarios sometimes produce charcoal on communal lands to supplement income. They stress, though, that production is small-scale and is done just as other members distill *bacanora* (an agave-based liquor), sell cheese, or make furniture. A possible reason for this unequal distribution may be that eastern Sonora relies more on the traditional economies of cattle ranching and mining and there is less need for monies received by the sale of charcoal. Higher precipitation is more amenable to sustained cattle ranching in eastern Sonora. Here, in eastern Sonora, mesquite is primarily used for corral construction and home cooking. Ejidos west of Magdalena, however, rely on a less plentiful environment and therefore must turn to charcoal production for survival. This geographic division in charcoal production reflects Robert West's (1993) idea of "two Sonoras" – the western desert lowland dominated by "new" industries, irrigation agriculture, tourism, and large cities, whereas La Serrana of eastern Sonora remains unchanged and is still dominated by cattle and mining introduced by Spanish colonists.

Conclusion

Demand for mesquite charcoal and firewood contributes to a loss of extensive mature mesquite forests in riparian areas of northern Mexico. Mining of mature mesquite in the Sonoran desert for charcoal and firewood permanently alters desert ecosystems because leguminous trees like mesquite and ironwood are such important anchors in these systems and are important nurse trees for other flora and fauna (Búrquez and Angeles Quintana 1994, Suzán et al. 1997, 1999). This paper helps us to better under-

stand the details behind this multi-million dollar business and how this business changes local landscapes, ecosystems, and lives. This paper demonstrated, using local voices and histories, how the demand for charcoal in Arizona and the United States has provoked changes in the density and morphology of mesquite forests in riparian areas of northern Sonora. This paper also illustrated how local borderland residents, especially in Sonora, use biomass fuel for heating and cooking. This type of analysis is especially important in light of the increasing number of people around the world who rely on biomass fuel for survival. Contrast these ejiditarios who rely on biomass fuel for survival with those who burn Sonoran wood as a luxury item. The distant consumers of Sonoran biomass do not pay the true external costs of energy consumption. Moreover, sites of energy production sit far from their everyday landscapes. This physical distance between the sites of production and consumption often makes modern society less likely to consider the true impacts of current consumption trends. Users of mesquite charcoal would pause before striking the match if, from their Southern California decks, they could see smoking charcoal pits consuming the oak trees and golden grasses of nearby rolling hills.

Details of mesquite use in the dry borderlands is important in light of rapid population growth along the border, provision of energy to new industries and the thousands of families that migrate in the wake of industrialization, and the environmental changes brought about by urban growth in the Mexican-American borderland. This paper reveals how locals secure a livelihood from mesquite by producing charcoal and firewood for export and also shows how local households use mesquite wood on a daily basis. Ejiditarios in Sonora involved in the charcoal and firewood business see themselves in a win-win situation. They see profits and an agreeable landscape. Landscapes agreeable to ejiditarios include mesquite-free areas open to pasture and cattle (see Sundberg 1998 for a similar scenario where Guatemalans from eastern Guatemala see pasture and cattle as desirable landscapes in Guatemala's northern rainforests).

Moreover, the examples presented here help explain community scale processes that contribute to the marked differences in landscapes that regional scientists see in their analyses of satellite imagery, climate data, and environmental issues along the Mexican-American border (Bahre and Bradbury 1978, Liverman 1990, Bahre and Shelton 1993, Kepner et al. 2000, Liverman et al 1999). In other words, analysis of charcoal and firewood production and use helps explain differences in land cover seen in remotely sensed data.

Acknowledgements

I thank David Yetman and Eric Perramond for pointers along the roads of rural Mexico. I also thank the reviewers for their constructive comments.

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