11-16-2016

Back to the Future: The Persistence of Horse Skidding in Large Scale Industrial Community Forests in Chihuahua, Mexico

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Recommended Citation
Back to the Future: The Persistence of Horse Skidding in Large Scale Industrial Community Forests in Chihuahua, Mexico David Barton Bray, Elvira Duran, Javier Hernández-Salas, Concepción Luján-Alvarez, Miguel Olivas-García, Iván Grijalva-Martínez Forests. 2016;7(11):283 DOI 10.3390/f7110283

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forests

MDPI

Communication

Back to the Future: The Persistence of Horse Skidding in Large Scale Industrial Community Forests in Chihuahua, Mexico

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Academic Editors: Kevin L. O'Hara and Timothy A. Martin
Received: 12 August 2016; Accepted: 8 November 2016; Published: 16 November 2016

Abstract: Horse skidding for extracting logwood is characterized as a niche activity in small-scale forestry, limited to small tracts and low volumes, where environmental impacts and aesthetics are concerned, and to operations with no wood-processing facilities. This article documents and analyzes the widespread persistence, current magnitude, and multiple advantages of horse skidding in large-scale industrial community forest enterprises in Chihuahua, Mexico. We extracted data from the logging permit files of 59 communities in the Sierra Tarahumara and conducted semi-structured interviews with community leaders and foresters in 18 communities, 17 random selections, and one purposefully selected case. There are nine communities that can be considered large-scale. Six of them use animal traction for 20%–100% of their volume. All have sawmills integrated with their operations. This includes the El Largo community with a ten-year volume of 3,169,019 m^3 extracted from 123,810 ha entirely with horses. Respondents to the interviews report that horse skidding is more cost-effective than mechanized skidding, generates more employment, and has less impact on forests due to reduced carbon emissions. The widespread use of animal traction in large-scale industrial community forestry in Chihuahua demonstrates that horse skidding is not only a niche activity in small-scale forestry. Our data is preliminary, but we suggest that it highlights a need for further assessments of whether animal traction should be part of future efforts towards reduced impact, lower carbon emissions, and socially and economically just forest management.

Keywords: Mexico; Chihuahua; animal traction; horse skidding; low-carbon forestry; reduced-impact logging; small-scale forestry

1. Introduction

The historic use of animal traction for extracting logwood began to fade as early as the 1930s, as diesel tractors begin to replace horses and mules in the Southern United States. Between the 1940s and 1960s at all scales of logging, horses and other animals for skidding were replaced by tractors and winches, with an ongoing transition to using purpose-built forwarders and processers [1,2]. Periodically, since the 1970s, there have been recurring reports of the persistence or return of horse skidding in small-scale forestry in many areas of the world [1,3,4]. However, the available literature suggests that horse skidding is entirely confined to a niche activity in small-scale forestry, where it appears to have a minor role compared to tractor-based systems and cable systems [2]. Small-scale

forestry commonly refers to "non-industrial private forests" (NIPFs) or smallholder forestry [4–6], with ownership usually by individuals who may have multiple objectives beyond timber production and who do not own a wood-processing facility [7]. Threshold limits that can range from 500 ha for smallholder tropical forestry in Brazil to 200 ha in Germany and as little as 3 ha in Italy and Spain have been suggested, while the average size of "family forests" in the US is 25 acres [2,6,8].

Limited use of horse logging in small-scale forestry has been reported in Europe, Eastern Europe, Asia, and Latin America. The Czech Republic, Italy, and South Africa are documented as having a somewhat more extensive use of horse skidding in small private forests or protected areas and it is present in the Eastern and Southern United States, particularly Northern Alabama [2,9]. In the province of Osa in Costa Rica and Acre, Brazil, the use of animal traction in small-scale forestry in tropical rain forests has been documented [3,4,6].

Thus, besides its persistence and possible slight expansion in NIPFs and in small-scale forest restoration [3,10], horse skidding apparently plays a negligible role in contemporary forestry. A major role for horse skidding in much larger-scale industrial forestry and community forestry, as opposed to NIPFs, has not been previously documented. In this short communication, we undertake a preliminary exploration of the research question, "What are the historical persistence, current magnitude, and the ecological, social, and economic advantages of horse skidding in large-scale industrial community forest enterprises (CFEs) in Chihuahua, Mexico?" [11,12].

The literature on horse skidding in small-scale forestry suggests it has important ecological and economic advantages in certain conditions [7,10,13–15]. Studies from China, Africa, Iran, and the Missouri Ozarks show very light residual stand damage with animal traction [13–16]. Trees growing close to animal skid trails, compared with mechanized skid trails, show higher rates of growth [16]. Soil compaction has been shown to be much lower with horse skidding compared with mechanized skidding. Studies comparing soil compaction in mechanical and animal skidding (both horses and mules) have either found much lower soil compaction or even zero compaction. Horses are also more maneuverable and flexible in handling varying timber dimensions [17–20].

In addition, benefits have been found both in costs and in fossil fuel consumption and thus carbon emission reductions [21]. A comparison of costs and the use of fossil fuel energy between horse skidding (using both one and two horses) and tractor skidding in an Italian protected area found that tractor skidding is cheaper than horse skidding at extraction distances greater than 50 m, assuming skid trails have already been built. However, if new skidding trails have to be built, one-horse skidding is cheaper than tractor skidding in distances up to 200 m, although two-horse teams are less expensive, even at greater distances. In the evaluation of fossil fuel intensity, it was found that the use of horses, compared with the use of tractors, takes from 8 to 20 times less fossil fuel energy, with as much as 50% of that due to the transportation of horses in motor vehicles. It is thus found that the use of horses is clearly a reduced impact alternative compared with tractors, and the costs are lower than those of tractor skidding when extraction distance is short and skid trails are not present [22]. Other studies have confirmed that extraction distance plays a crucial role in the productivity of animal skidding [20]. Exploratory research reported here for the Sierra Tarahumara in the Northern Mexican state of Chihuahua suggest that many of these advantages may be true there as well, but in a context very different from that described for small-scale forestry. The widespread use of animal traction in large-scale industrial community forestry in Chihuahua demonstrates that horse skidding is not only a niche activity in small-scale forestry.

2. Materials and Methods

We used a mixed methods approach, which consisted in drawing a sample from a database, selecting a purposeful case, conducting semi-structured interviews, and taking informal field observations. However, our approach is basically qualitative in an effort to call attention to a previously undocumented but significant phenomenon. Our sample is too small and we do not have data on some important variables, such as slope, to be able to conduct meaningful statistical analyses [21].

We compiled a database on forest management for 59 communities with authorized logging permits in the southern Sierra Tarahumara, a region defined as an Early Action REDD+ area by the Alianza Mexico Redd+ http://www.alianza-mredd.org/. Data was taken from the forest management programs on file in the offices of the Secretariá de Medio Ambiente y Recursos Naturales (SEMARNAT) in Chihuahua City. We then randomly selected a sample of 17 communities for semi-structured interviews with responsible foresters and the elected community leader to collect supplementary data, which included data on the use of animal traction not reported in the forest management programs [12]. The surveys are available online [12]. We also made a direct observation of logging damage of an exploratory sample of five communities, one that used only animal traction, one that used both animals and winches, and three that used only winches. We also purposefully selected an additional case, the community of El Largo in the northern Sierra Tarahumara of Chihuahua, and collected comparable information in a site visit. Purposeful selection can be used to add information-rich or outlier cases for learning about a phenomena of interest [21]. We added this community since the authors were aware that it is the most important example of the use of horse skidding in the state, as well as being the largest forest ejido in Mexico, and one of the authors has decades of experience there. We acknowledge that this introduces a pro-horse skidding bias. However, the goal of our research is only to document the presence and widespread use in large-scale industrial community logging operations of horse skidding, and suggest that some of ecological and economic advantages are similar to those noted in the literature, to which we add the social and economic advantage of employment generation. To explore our question, we also need a classification of "scale" in logging. As noted, small-scale has commonly been defined by the area logged, with dimensions from 3 to 500 ha suggested in different contexts. For our purposes and for the context of the community forests of Chihuahua, we suggest that less than 1000 ha be classified as small-scale, 1000–5000 ha be classified as medium-scale, and more than 5000 ha as large-scale.

Chihuahua is Mexico's second largest forestry state with a large community forest sector with some CFEs established as early as the 1950s [23]. All of the forest communities have a common property land tenure regime based on Mexican agrarian law [12]. A number of CFEs in the state are now being heavily impacted by organized crime, including disappearances of forest community leaders. The commercial community forests of Chihuahua are in the Western Sierra Madre in pine-oak and pine forests, found in a range of 1800–3300 m, with the most important commercial pine species being *Pinus arizonica*, *P. durangensis*, and *P. engelmannii*. The forests have been heavily exploited since the early 20th century and are regarded as heavily degraded, with trees with a much smaller diameter compared with those in earlier periods; however, generally improved silvicultural practices in recent decades have allowed for some recovery [24]. Logging in Mexico is heavily regulated, and permits are given for ten-year cutting cycles on the basis of voluminous management programs developed by professional foresters [12].

3. Results

Table 1 shows the 18 communities, including the 17 randomly sampled and the one case purposefully selected, stratified by the scale classifications as noted above. It shows the municipality where they are located, their total area, the percentage of the area in forest, the total volume authorized to be extracted in the ten-year plans, whether animal traction is used, the estimated volume of the timber harvest extracted with horses, whether the community is considering expanding the use of horses, and whether it has a community- or privately owned sawmill. Logging is economically important, since survey respondents reported that forest management for timber extraction is the first or second most important source of income in all 18 communities.

Table 1. Community forest enterprises in Chihuahua by scale (n = 17 + 1 purposeful case).

Community Name	Municipality	Total Area	Logging Area (ha)	Total Volume Authorized Harvest (m^3) (for 10 Year Periods)	Use of Animal Traction	Volume of Timber (%) with Animal Traction	Tendency to Use More Animal Traction	Sawmill
Small-Scale								
TUCEROS	GUACHOCHI	65	23	ND	yes	60	no	no
AGUA ZARCA	GUACHOCHI	118	72	6496	yes	100	NA	no
CRUZ DE PIEDRA	GUADALUPE Y CALVO	4575	279	7259	yes	30	no	no
Medium-Scale								
CORONADO O GUADALUPE CORONADO	URIQUE	14,363	1245	18,600	yes	30	no	yes **
LA CATEDRAL Y SUS ANEXOS	GUADALUPE Y CALVO	35,600	2428	255,843	yes	35	no	yes
SAN JUAN NEPOMUCENO	GUADALUPE Y CALVO	16,671	3737	75,361	no	0	no	yes **
EL PINITO	GUADALUPE Y CALVO	8306	3919	101,158	no	0	no	yes **
ABOREACHI	GUACHOCHI	22,780	4067	140,316	yes	98	yes	yes
BARBECHITOS	GUADALUPE Y CALVO	11,236	4601	100,900	no	0	no	yes
Large-Scale								
PAPAJICHI	GUACHOCHI	29,816	7675	91,484	yes	40	yes	yes
CABORACHI	GUACHOCHI	27,178	10,112	172,274	yes	65	no	yes
BABORIGAME	GUADALUPE Y CALVO	38,813	10,338	225,488	no	0	no	yes **
GUACHOCHI Y SUS ANEXOS	GUACHOCHI	22,139	10,554	135,860	yes	40	yes	yes **
SAMACHIQUE	GUACHOCHI	39,657	11,023	260,458	yes	40	no	yes
YOQUIVO	BATOPILAS	60,844	27,428	164,528	no	0	no	yes
LA TRINIDAD Y SUS ANEXOS	GUADALUPE Y CALVO	46,387	ND ***	337,402	no	0	no	yes
CHINATU	GUADALUPE Y CALVO	113,736	33,823	577,007	yes	20	no	yes
EL LARGO *	MADERA	261,460	123,810	3,160,019	yes	100	NA	yes

* Purposeful case. ** Privately owned sawmill, all others are community-owned. *** We do not have data for the logging area of La Trinidad. However, its very large volume of timber suggests this approximate placement in the ranking by logging area.

Table 1 shows that all three of the small-scale CFEs use animal traction, but none have sawmills as part of their direct operation. There are six communities that can be classified as medium-scale on the basis of their logging areas, four of them with over 100,000 m^3 of authorized volume in the ten-year plans. Only one of these, Aboreachi, uses animal traction, but it uses it for almost the entirety of its harvest (98%). There are nine communities that can be considered large-scale. Six of them use animal traction, and all have sawmills integrated with their operations, four of which are community-owned, and two of which are privately owned. Only one of them, El Largo, uses 100% animal traction, but it uses it over an enormous territory and with a huge volume of timber, over 3 million m^3 during the ten-year management plan. The other five who use horse skidding use it to variable degrees. Caborachi is the next largest user, with 65% of its volume over 10,112 ha being harvested with horses. Three others (Samachique, Guachochi, and Papajichi) log an estimated 40% of their volume with horses. Finally, Chinatú only logs 20% of its trees with horses. However, given the enormous volume logged (577,007 m^3), this equals or surpasses the volume harvested in communities with much larger percentages. Of the 12 total at all scales who use horses, 3 are at or near 100%, 3 report a tendency to use more animal traction, and 6 report no such tendency. Nine of the 12 that use horses also have

on-site wood processing facilities, either community- or privately owned. Of the remaining five, two (Agua Zarca and Tuceros) are too small to warrant having sawmills.

Two of the large-scale community's merit special attention. As noted, El Largo has a ten-year volume of 3,169,019 m^3 extracted from 123,810 ha. El Largo has the largest area with the largest community forest in all of Mexico, with 261,460 ha of total territory with almost 96% estimated forest cover. It has a ten-year allowable cut of 3,169,019 m^3, administers 10 sawmills, and usually employs more than 2600 people. "By many measures it is probably the world's largest CFE" [25]. In addition, nearly 49% of the total forested area, some 128,000 ha, are managed primarily for conservation. As noted, the large volume of timber, which constitutes 5% of all timber production in Mexico, is extracted using horses, involving some 800 horse skidding teams in an average year. Logging foremen called "monteros" oversee an average of 100 teams, each composed of a chainsaw operator, a bucker, and a person (or in one observed case a married couple) who skids logs using two-horse teams, in what was observed to be very physically demanding work requiring specialized skills [26]. The medium-scale community of Aboreachi, which, as noted above, extracts 98% of its volume with horses, is one documented case where horse skidding has increased over the last decade. Around ten years ago, Aboreachi began making a transition from using winches to animal traction. They had three truck-mounted winches, but now have only one, having sold one and discarded the other. The great majority of the harvest is now skidded with horses, with the community leader stating that horse skidding entailed lower costs and higher profits.

Respondents to the survey, informal interviews, and a very small sample of direct observations suggest that horse skidding is more cost-effective than mechanized skidding, generates more employment, has less impact on the forest, and reduces carbon emissions. Respondents agreed that the costs of using animal traction are around half that of using truck-mounted winches. Animal traction is also used to load the logging trunks using ramps. One forester noted that animal traction is more productive in loading and that horses can load three trucks in the time that a winch can load two, since mechanized loading has to do more maneuvering. Additionally, and importantly, the teams of animals are owned and maintained by individual members of the community, so the CFE does not have the cost of maintenance, and it generates employment and income for some 800 families in the community of El Largo alone. Responses to the survey and direct observations also confirmed that there is only light residual stand damage and soil compaction with horse skidding, with an apparent reduction in carbon emissions due to the absence of fossil-fuel driven skidders. It was also observed that these community forests have multiple uses, from firewood gathering to livestock grazing, as has been observed elsewhere in Mexico [12]. The combination of using winches and animal traction appears to be particularly common in the southern Sierra Tarahumara, with winches used on steeper slopes and animal traction on gentler slopes. All of the sample that use animal traction use horses, but the use of oxen is also reported in the region. Oxen are stronger and more productive, since they can haul larger trees on steeper slopes, but they are also more difficult to manage.

4. Discussion

The literature reports that the use of animals in log extraction is a niche, limited to small tracts and to very low volumes, and thus only has a role in small-scale forestry or NIPFs. It is also suggested that its use is confined to protected areas, urban fringes, or other areas where environmental issues and aesthetics are relevant [2,22]. The widespread use of animal traction in industrial community forestry over large areas, with large volumes and with on-site wood processing facilities in the form of sawmills in Chihuahua, demonstrates that none of these conditions necessarily hold. On the other hand, large-scale industrial community forestry in Chihuahua does exhibit at least one of the reported characteristics of small-scale forestry, the presence of multiple objectives [7]. CFEs in Chihuahua, like CFEs elsewhere in Mexico, are not seeking to maximize profits but to prioritize employment generation and to use their forests for multiple purposes, from firewood gathering to livestock grazing. Although horse skidding is clearly a factor in large-scale forestry in Chihuahua, the community of El Largo is

clearly an outlier with its enormous volume extracted exclusively with animal traction. This may be a case of historical path dependency. El Largo's forests were originally owned and logged first by the US and later by Mexican corporations [23]. However, beginning with a federal government expropriation in 1971, a long process whereby El Largo gained full control of the forest ensued. The use of the horse teams was a historical legacy, but has persisted due to its apparent ongoing advantages.

Our preliminary data from Chihuahua also suggest that the use of animal traction has similar economic and ecological benefits to those reported in the literature, as well as the social benefits of employment generation. The literature suggests that it can be more cost-effective than mechanized skidding, particularly when skidding distances, slopes, and tree dimensions are not excessive [20,26]. We do not have data on these variables in Chihuahua, but the widespread presence of horse skidding suggests that some of these factors are likely relevant. The literature also reports much less residual stand damage and soil compaction [13,16], and our preliminary data suggest that this is also true of Chihuahua. Direct observations in Chihuahua also suggest that horse skidding has far lower carbon emissions than mechanized skidding, making it a component to consider in a transition to low-impact, low-carbon forestry. A disadvantage of horse skidding that has been noted is that it is physically demanding and that the frequent unavailability of skilled operators due to the "special skills required to effectively manage draught animals" limits their use [9,22]. In Chihuahua, evidence suggests that there are likely thousands of skilled horse skidding teams accustomed to hard physical labor, who would likely be available to train new operators elsewhere. Horse skidding is also important in Mexico's most productive forest state, Durango. Though it is scarcely documented there, its use is also reported to cause little damage to the residual mass and to be more efficient and cost-effective [27].

As our data indicates, not all of the sampled CFEs, including some with large volumes, use animal traction. Others combine animal and mechanical logwood extraction, and only a few report a tendency to use more animal traction. Thus, the communities that use both may feel that they are at an optimal mix of the two technologies. The variables that may drive this differential use are not clear, although the degree of slope could be paramount among them. However, it is also possible that the Mexican national forest policy and a culture of industrial forestry that has encouraged the use of mechanical skidding may be causing some communities to overlook the advantages of horse skidding. Currently, horse skidding is characterized as an example of technological backwardness and elevated costs in forest management by the Mexican forest and environmental agencies, who have argued for the need to modernize the sector [28,29]. However, our research suggests that great caution should be taken before merely characterizing horse skidding as backwards. Its purported backwardness may be more apparent than real in some circumstances.

The advantages and disadvantages of horse skidding in Chihuahua, Durango, and other states in Northern Mexico merit much further study and policy support. We hope that this study can stimulate further research on the economic, social, and ecological advantages and disadvantages of animal traction in Mexico and elsewhere. Revaluing the use of horse skidding may be an important contribution to environmentally friendly and low-impact logging globally. The well-documented reduction in colateral damage in timber harvesting practices suggests that it could play an important role in practices of reduced impact logging (RIL) [30]. Other advantages include a very low carbon footprint and social and household economic benefits of significant local employment [11,26]. Our data is preliminary, but we think it argues for further assessments of whether animal traction has a role in promoting reduced impact, lower carbon emissions, and socially and economically just forest management. It may be that going "back to the future" and reevaluating the use of animal traction beyond small-scale logging will contribute to an expanded suite of forest engineering technology options, particularly in developing countries where employment generation is important.

Acknowledgments: The authors are grateful for the generous support of the people of the United States through the United States Agency for International Development under the terms of the Cooperative Agreement No. AID-523-A-11-00001 (Proyecto de Reducción de Emisiones por la Deforestación y la Degradación de Bosques de México) implemented by the principal contractor The Nature Conservancy and its partners (Rainforest Alliance, Woods Hole Research Center y Espacios Naturales y Desarrollo Sustentable). Special thanks to Peter Ellis and

Bronson Griscom of TNC for their able and interested stewardship of the consultancy and to the Rainforest Alliance team in Chihuahua. In Chihuahua, Ing. Arturo Heredia, Subdelegate, and Ing. Arturo Cedillo, Chief of the Unidad de Aprovechamiento y Restauración de Recursos Naturales of SEMARNAT-Chihuahua and Lic. Bernardo Ruiz, Conafor Delegate-Chihuahua, were extraordinary helpful and generous with their time. Thanks also to Ing. Guadalupe Cedillo for her able research assistance. Finally, thanks to Cara Rockwell for helpful comments on an earlier version of the manuscript.

Author Contributions: David Barton Bray conceived the paper, conducted field research, and drafted the paper. Elvira Duran organized and analyzed the database and edited the paper. Javier Hernández-Salas contributed data and edited the paper. Concepción Luján-Alvarez contributed data and edited the paper. Miguel Olívas-García contributed data and edited the paper. Iván Grijalva-Martínez conducted field research and contributed data.

Conflicts of Interest: The authors declare no conflict of interest.

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