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LOCAL PERSPECTIVES ON CONFLICTS WITH WILDLIFE AND THEIR MANAGEMENT IN THE SIERRA GORDA BIOSPHERE RESERVE, MEXICO

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Human-wildlife conflict (HWC) is a widespread issue of increasing concern to conservationists, as it impacts people's lives and livelihoods and reduces their tolerance to the species concerned. HWC is often interpreted as a result of people encroaching upon and destroying natural habitats, but some incidents could be linked to economically driven emigration that results in depopulation and institutional and cultural disruption. Here we use an ethnobiological approach to gain insights on HWC dynamics from a case study in Mexico, where emigration is common in rural areas. We carried out a five-year study of HWC in the Sierra Gorda Biosphere Reserve, a biodiversity-rich protected area in Mexico that also supports a human population of nearly 100,000 mostly poor and marginalized people. We found that villagers reported conflict incidents involving 25 terrestrial vertebrate species, contradicting the original self-perception that HWC mostly involved cattle ranchers and a few large carnivore species. As a response, we develop a multi-layered assessment of villagers' perspectives, emotions, and attitudes towards wildlife based on the local roles of gender, probability of encountering wildlife, and the conflicting moral beliefs and switching ethical responses of people with different cultural and economic backgrounds. Our assessment identifies the need for pluralistic approaches to enhance the sustainable use and management of wildlife in the Sierra Gorda Biosphere Reserve.

Keywords: *human-wildlife conflict, perspectives, management, Sierra Gorda, Mexico*

Introduction

Human-wildlife conflict (HWC) is a critical and widespread issue of concern for conservationists (Treves et al. 2006; Woodroffe et al. 2005; Zabel and Holm-Müller 2008) and a challenging aspect for most wildlife management actions around the globe (Kaltenborn et al. 2006; Treves et al. 2006). Wildlife and humans compete for space and resources, so HWC occurs when the needs and behavior of wildlife have a negative impact on the goals of humans or vice versa (Conover 2002; Madden 2004; Sitati 2003; Vaske and Manfredo 2004; Walpole et al. 2003). When such negative impacts occur, the experiences may cause increasingly negative attitudes of local people toward the species responsible for the damage (Liu et al. 2011; Naughton-Treves et al. 2003).

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This means that understanding and addressing local people's attitudes toward human-wildlife conflicts is imperative for the successful conservation of many species. Usually, such attitudes are studied in social contexts where HWC results from the unregulated expansion of economic activities, mainly through the extension of farming frontiers and housing (Naughton-Treves et al. 2003; Thouless and Sakwa 1995; Torres et al. 1996; Zabel and Holm-Müller 2008). Hence, attitudes such as tolerance are regarded as individual traits influenced by personal values, relative wealth, level of education, extent to which monetary or other type of benefits are derived from wildlife, and the magnitude of wildlife-associated costs (Naughton-Treves et al. 2003). These factors have been a major focus of research, particularly for choosing and targeting the most appropriate solutions, whether it is mitigation to reduce losses, education to improve awareness, or generation of benefits to provide incentives (Marker et al. 2003; Mishra et al. 2003; Ogada et al. 2003; Ogra 2009; Palmeira et al. 2008; Zabel and Holm-Müller 2008; Zimmermann et al. 2005).

HWC can occur in other situations, however, and this is the case in many protected areas in developing countries. In such situations, economic activity is strongly regulated by the State (i.e., federal government), but many local institutions have been weakened by the modernizing influence of the State or private sector and further disrupted by emigration and other economic dynamics. Thus, people are inadequately empowered to deal with HWC and might feel that wildlife is given priority over their own needs (Chappell et al. 2013; Knight 2006; Madden 2004; Taylor and García-Barrios 1999). This produces complexity in rural livelihood patterns, so that understanding relations with wildlife and psychological attitudes depends on adopting contingency-bound social analysis (e.g., Inskip and Zimmermann 2009a, 2009b; Kaltenborn et al. 2006; Manfredo and Dayer 2004; Marker et al. 2003; Palmeira et al. 2008; Sitati et al. 2003, 2005; Tourenq et al. 2001; Treves and Karanth 2003; Zimmermann et al. 2005).

Further, to understand the relationship between people and animals, insights may be gained through the interdisciplinary study of ethnobiology (Berkes 2012; Hunn 2007; Nabhan 2003, 2009; Wolverton et al. 2014). Ethnobiology's relevance and unique strengths arise from its position at the interstices of many disciplines and between worldviews and epistemologies (Wyndham et al. 2011). As explained by Nabhan (2009:3), "Ethnobiology has always served as a bridge between disciplines just as it has reminded us of the larger bridges or richer interactions between humans and other species, and those between cultures" (see Gagnon and Berteaux 2009; Nabhan 2003; Pungetti et al. 2012). Likewise, the field of Animal Studies has increasingly focused on human-wildlife interactions in the context of the appreciation and respect of the needs and livelihoods of both human and non-human animals, and on how humans and non-humans can be mutually beneficial to each other in a great variety of ways (Manfredo 2008; Waldau 2013).

With this in mind, here we describe an ethnobiological study from Mexico that investigates HWC in a protected area that is also home to a number of farmers and ranchers. We assess the perspectives, emotions, and attitudes of villagers towards wildlife, particularly focusing on how these differ with

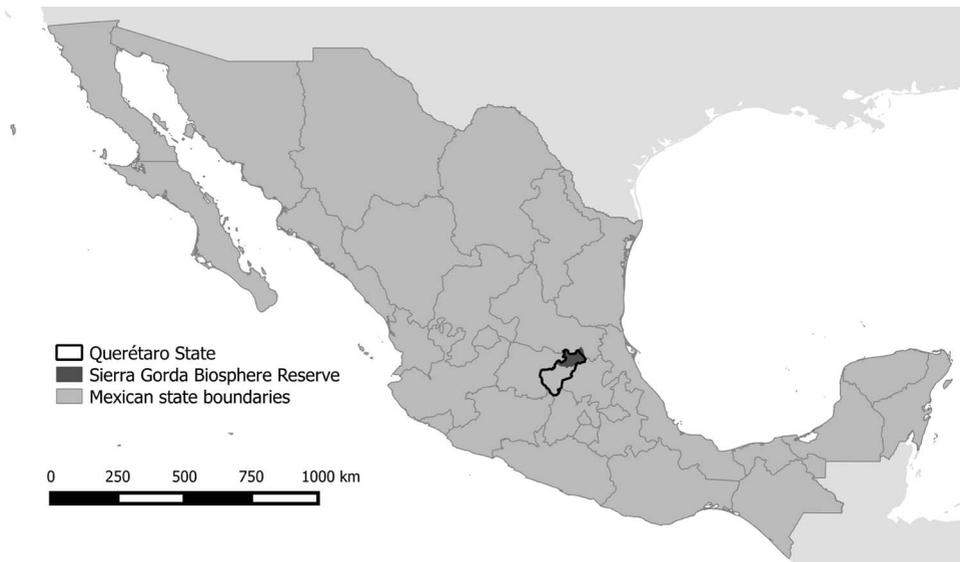


Figure 1. Location of the Sierra Gorda Biosphere Reserve in the state of Querétaro, Mexico. Source: World Database on Protected Areas (<http://www.protectedplanet.net/103166>)

people's gender, cultural and economic background, and likelihood of encountering wildlife. We follow Hill (2004) to establish four basic questions for the analysis of HWC: 1) What are the impacts on agricultural yields and household economics; 2) how and why people perceive losses the way they do; 3) who will take responsibility for the issues; and 4) what can they expect from any intervention? As part of this, we recorded and analyzed information and local perspectives based on the following categories: a) information about HWC incidents; b) local knowledge of the biological and ecological aspects of species perceived as problematic; c) extent of HWC incidents reported; d) impact on crops, livestock, human lives, and/or wildlife; e) information on existing strategies to reduce losses or cope with problems; and f) contrasting expectations of local inhabitants and staff from wildlife authorities and conservation agencies.

Environmental, Social, and Institutional Background

Mexico is a megadiverse and culturally rich country with a long history of development programs and institutional disruption. HWC has rarely been studied in Mexico, although some important efforts have been undertaken (Amador-Alcalá et al. 2013; Cupul-Magaña et al. 2010; Peña-Mondragón et al. 2013). This paper provides an assessment of the main conflicts between humans and terrestrial vertebrates in one of the largest, richest, and most diverse natural protected areas of Mexico, the Sierra Gorda Biosphere Reserve (SGBR). The SGBR is situated in central Mexico and covers an area of more than 383,000 ha. It encompasses the entire counties of Jalpan de Serra, Arroyo Seco, and Landa de Matamoros, and a large part of Pinal de Amoles and Peñamiller (Figures 1 and 2).

The SGBR has higher levels of ecological diversity than any of the other National Protected Areas in Mexico due to: 1) its position on the confluence of the

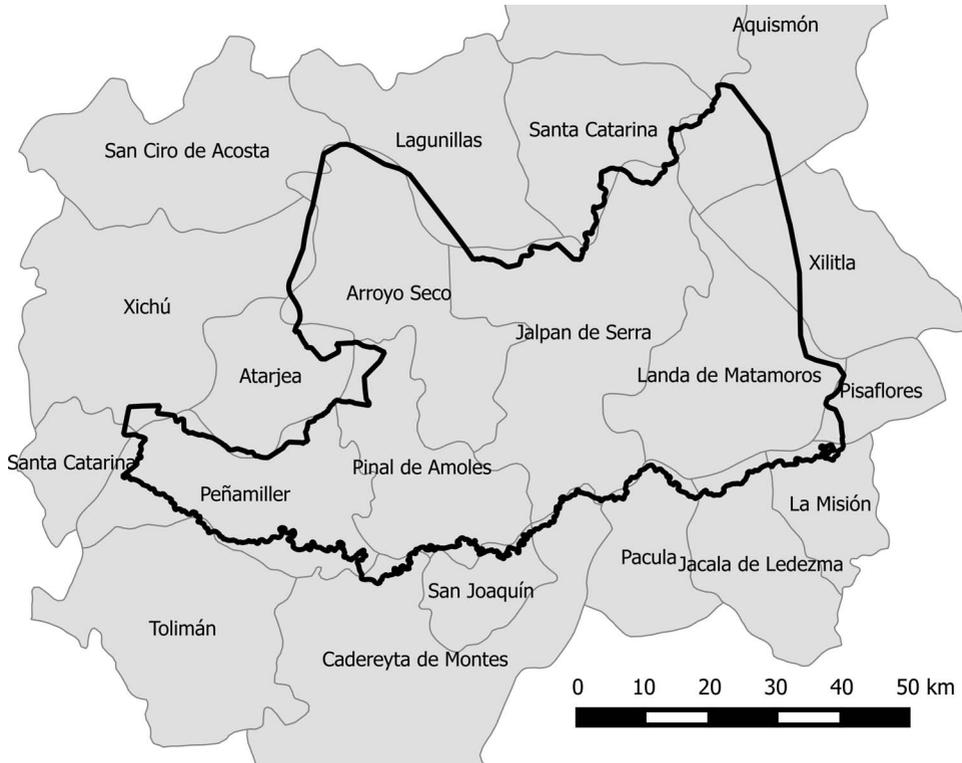


Figure 2. Counties of the Sierra Gorda Biosphere Reserve (reserve boundary shown in black). Source: World Borders Dataset (http://thematicmapping.org/downloads/world_borders.php)

Nearctic and Neotropical biogeographical regions; 2) its topographical complexity, with altitudes ranging from 300 to 3100 meters above sea level; and 3) its regional wind and rain patterns, which create precipitation of more than 5000 mm/yr in some areas. Such conditions allow for the presence of pine and pine oak forests, deserts, humid cloud forests, rainforests, and an equally notable diversity of animal species; 618 vertebrate species are reported in the region, including all six species of cats found in Mexico: jaguar (*Panthera onca*), puma (*Puma concolor*), bobcat (*Felis rufus*), margay (*Leopardus wiedii*), ocelot (*Felis pardalis*), and jaguarundi (*Felis yagouaroundi*) (CONANP 2007; GESGIAP 2015).

The SGBR has a population of 100,000 people, half of them living in five villages ranging from 5 to 15,000 individuals and the rest in more than 630 highly dispersed and marginalized localities (*rancherías*). The great majority of the people are *mestizos* who speak Spanish, but there are still some native speaking indigenous communities (the Nahuas, Tenek, and Pames). Most people are poor and a large portion of their annual income comes from remittances from emigrants. Emigration has been considered a key historical and social process in Sierra Gorda since the second half of the twentieth century. Beginning in the 1970s, this emigration has been driven by people's need to subsist and their social and cultural expectations. This movement of people also led to transculturaliza-

tion and the 1980s were characterized by the loss of traditional and cultural activities, as well as by increased access to roads, healthcare, and education. Nonetheless, the counties of Sierra Gorda remain among the most marginalized in the state of Querétaro (Castilla-Vallejo 2008; Enciso 2004; García-Espejel 2003; Mejía et al. 2006) and economic activities are still based around seasonal rain-fed agriculture and low-intensity cattle ranching and forestry. Achieving sustainability in this extraordinary environment is, however, very difficult due to high levels of poverty and the complexity of the social dynamics.

The SGBR is under a unique co-management scheme between the Ministry of Environment and Natural Resources (SEMARNAT), the local NGOs Grupo Ecológico Sierra Gorda I.A.P. (GESGIAP) and Bosque Sustentable A.C., and the local representation of the United Nations Development Programme (CONANP 2007, 2016; DOF 2007; GESGIAP 2015; Nadal 2003). In particular, GESGIAP is an award-winning civil society organization built by inhabitants of the SGBR that has made decisive contributions to the conservation of this area. Although the management program of the SGBR (CONANP 2007; 2016) recognizes the value of engaging with local people to identify wildlife species, local villagers are seldom involved in proposing or developing conservation policies. The management program recognizes that tradition has value and that local knowledge has some importance in the study of topics such as migratory processes and animal species. However, the assumption persists that, given the low levels of development, people's current practices reduce rather than enhance sustainable development. Thus, the administrative authorities (Comisión Nacional de Áreas Naturales Protegidas, CONANP, SEMARNAT) have introduced and widely promoted modern principles of environmental awareness and nature conservation to local inhabitants (Castilla-Vallejo 2008; CONANP 2016). However, such principles are strained by the unresolved conflict from different discourses of modernity. While some public funds are used to try to articulate the notion of people cohabiting with nature and making use of natural resources without degrading them, other management components prioritize conservation over human development and still others push for pure economic growth.

The development of a management plan based on these conflictive principles has been carried out in such a way that the communities, even in remote localities, must (sometimes reluctantly) accept that catching or hunting wild animals is forbidden (DOF 2015). From their perspectives, such strong regulations contradicted inherited concepts of liberty and land tenure, as 70% of SGBR is private property and 27% is communally administered (*Ejido*). However, strong incentives have been put in place to circumvent this problem. Consider, for example, the cultural practice of releasing cattle to roam freely in forested areas. Due to active promotion by GESGIAP, in which people were invited and incentivized to adopt ecologically sound activities within the reserve, the number of freely roaming herds in the SGBR has dropped. In addition, to discontinue cattle ranching in areas regularly hit by predators, the government, with assistance from GESGIAP, set up a 8,000 ha unit for conservation, management, and sustainable utilization for jaguar, white-tailed deer (*Odocoileus virginianus*), Wild Turkey (*Meleagris gallopavo*), and collared peccary (*Pecary tajacu*) (Ruiz-Corzo and Pedraza-Ruiz 2007). Meanwhile, a total of 25 landowners

registered their land to obtain subsidies from the Governmental Environmental Services Program to further reduce the proportion of people depending exclusively on cattle ranching (R. Pedraza-Ruiz, personal communication, 2012). As a result of these and similar efforts, hundreds of hectares that were previously used as cattle ranching areas have been devoted to conservation, sustainable forestry, and/or environmental services, which in turn has alleviated, to some degree, severe poverty and associated emigration.

This study began in 2004 when some of the authors were approached by GESGIAP. At that time, local cattle ranchers claimed to be losing their livestock as a result of jaguar attacks and were unhappy because they felt that the needs or values of wildlife were given priority over their own. In addition, GESGIAP had recorded other types of conflict between wildlife and humans (R. Pedraza-Ruiz, personal communication, 2004; M. Rendón-Zorrilla, personal communication, 2004). Thus, GESGIAP asked us to take note of and assess the cases of livestock predation as recorded by ranchers, but also to document all the other types of interactions perceived and interpreted as problematic. No previous work on HWC had been conducted in the SGBR at a regional scale or had considered the diversity of animal species. Thus, to create this baseline, we conducted extensive fieldwork in the area. The interest of GESGIAP and the government in learning more about HWC grew when HWC incidents began changing people's perception and attitudes towards the benefits and purpose of nature conservation and management (see Müller and Guimbo 2011; Postigo 2014). For several years, the problems people claimed to have with wildlife were overlooked. These people argued that shifts in land had led to the return of certain wild species (e.g., white-tailed deer and wild turkey) and hence their major predators: the reappearance of puma recorded through prey remains (M. Pedraza-Ruiz, personal communication, 2007) and jaguar and jaguarundi recorded through photographs (R. Pedraza-Ruiz, personal communication, 2012). At this point, most local villagers were conscious of the SGBR prohibition on killing wild animals, but believed that GESGIAP had imposed this law on them. People perceived the ban as strong and rigid for the offender but too weak in offering practical alternatives, support, or compensation (see Müller and Guimbo 2011).

GESGIAP was also perceived as the source of these conflicts because people had the perspective that GESGIAP "brings the animals to release them in the woods," a further reason why they felt this non-governmental organization should take full responsibility for wild animals (see Amorim Conforti and Cascelli de Azevedo 2003). People in all the localities felt that authorities like GESGIAP should take a more active role in looking after and protecting people's interests instead of only protecting wildlife. Thus, it was important to reflect on the contrast between how the villagers in Sierra Gorda perceive the issues and emergencies arising from the development of the region and how these aspects were perceived by the local conservation organizations. This reflection was important because these differences had created a situation where, despite the good intentions of these groups, the modernizing approach they adopt was based on ignoring local development models that account for how these people view their heritage and resources.

Methods

Background Research and Sampling Locality Selection

We conducted fieldwork in the SGBR between 2004 and 2010, having been given permission to work with the communities by the local, regional, and state level authorities. Our first step was to gather the available information on previous reports of HWC collected by GESGIAP based on villagers' local knowledge and experiences. Although some of these reports showed that HWC incidents were more common where people concentrated around the main settlement in SGBR (the county town of Jalpan de Serra, with approximately 10,000 people), conflict was especially acute and included more severe incidents in the more remote areas (Knight 2006). Thus, the rationale behind our study was to collect data in localities based on their geographical location (distance to the county town), regardless of whether conflict had been reported in previous reports. We visited 90 localities, 61 of which were in close proximity to Jalpan de Serra (<1.30 hrs by car from the county town); 10 were in semi-remote localities (≥ 1.30 hrs by car from the county town); 15 in remote localities (>1.30 hrs by car from the county town plus hard walking access); and 4 on the outskirts of the Reserve (Appendix 1).

Data Collection

Since we were interested in the whole universe of recent (no more than a year) human-vertebrate wildlife conflicts in this large but well-bounded and connected region, we decided to rely on local information networks and used a snowball sampling technique to gain access to new information (Atkinson and Flint 2001; Browne 2005; Faugier and Sargeant 1997; Given 2008; Vogt 2005). We also benefitted from the guidance and continuous company of GESGIAP members, who introduced us to the villagers but respectfully refrained from interfering with the conversations or interviews. Following this approach, we conducted a total of 214 semi-structured and open-ended interviews, as well as many field observations to characterize the HWC incidents. All participants in the interviews gave oral consent to participate.

Each interview lasted about 40 minutes, was conducted in Spanish, and took place in the villager's home. The number of people present and the number of respondents was not controlled during the interview process, as in some cases additional people who had heard the interview was taking place came along. These relatives, friends, or neighbors also freely participated in the conversation and supplied additional information.

The average age of the interviewees was 53 (no one was younger than 25 years); 100% of the interviewees were *mestizos* and members of the Roman Catholic religion. We used this entire set of 214 interviews for the characterization of HWC incidents and species reports, but for the qualitative research analysis we selected 80 interviews based on: 1) gender (regardless of age) to learn the perspective of men and women as regards to problems with wildlife (Vázquez-García and Godínez-Guevara 2005); 2) representation of local geographic diversity (Knight 2006); 3) richness of the information with the aim of fulfilling

Table 1. Number of interviews selected for the qualitative research analysis.

County	In close proximity		Semi remote		Remote	
	Male interviews	Female interviews	Male interviews	Female interviews	Male interviews	Female interviews
Arroyo Seco	6	5	0	0	6	0
Jalpan de Serra	8	4	7	6	12	6
Landa de Matamoros	2	4	1	1	1	1
Peñamiller	0	1	0	0	0	0
Pinal de Amoles	4	2	1	0	2	0

the objectives as well as to avoid the saturation of data (Patton 2002; Vasilachis de Gialdino et al. 2006); 4) quality of the interview in terms of sound clarity; and 5) number of participants disclosing information about HWC during the interview (Table 1).

Data Analysis

We analyzed the data using descriptive statistics and textual analysis. To describe the conflict incident results, we calculated the percentage of people reporting conflict with each species. For the analysis on perspectives, we used qualitative research methods to study a combination of two equally important approaches, namely the local communities' perspectives of particular HWC issues in the everyday world (Strauss and Corbin 2002; Vasilachis de Gialdino et al. 2006) and the conservation perspective (Conover 2002; Durand 2008; Madden 2004; Treves et al. 2006). The main areas considered were: how the local communities accessed and valued the local natural resources; how they perceived particular HWC issues; whether they were afraid of particular species; and knowledge of the degree of people's perception of risk. The interviews were recorded, transcribed digitally, and imported into Atlas.ti qualitative data analysis software (v 5.7.1) for coding and content analysis. Then, following grounded theory principles we constructed families, categories, and their respective components and variations (subcategories) (Strauss and Corbin 2002; Vasilachis de Gialdino et al. 2006).

Results

We first present our results on conflicts between people and wildlife and analyze villagers' perspectives on economic losses and sense of risk due to HWC, using the context of local household organization and regional conservation policy and practice (Hill 2004). Second, we present our results on the emotional responses of both women and men to the different species involved in HWC, focusing on the gender and geographical variations in local perspectives of the severity and distribution of conflict and the villagers' response (Wieczorek Hudenko 2012). Third, following Graeber (2011), we discuss a multi-layered construction of farmers' perspectives and attitudes to show how villagers relate

to wildlife in various contradictory ways that reflect the conflicting moral layers of their own cultural and economic background. Finally, we conclude with some reflections on the consequences and limitations of our study, and on the possibilities of future research and policy-making.

Details on Human-Wildlife Conflict Incidents

The rural people who we interviewed mentioned 25 sets of wild species thought to be responsible for causing most of the damage in the SGBR, based on their recent interactions (Table 2). Fourteen sets of species were mentioned by more than 1% of the respondents and three sets of species (squirrels [Sciuridae], pumas, and hawks [Accipitridae]) were mentioned by more than 10% of respondents. The main emotional reaction to incidents involving these species was anger but people were also fearful of the large carnivores, snakes, and vampire bats (*Desmodus rotundus*) (Table 2).

Although the jaguar is included in the 14 species causing most of the damage in SGBR, local people believe other species are more problematic. From these, squirrel species and puma were seen as the most damaging. However, while squirrels damage several resources, they do not threaten people's lives. In contrast, pumas injure or kill a wide variety of domestic animals and also make people feel unsafe and scared. In addition, pumas feed on white-tailed deer, which makes people in SGBR angry because this species is appreciated for its beauty. Although the puma is seen as one of the most troublesome species, our results show that people reported damage of crops as well as livestock. Thus, conflicts with wildlife in the SGBR go beyond the original indication that cattle ranchers are the prime victims of HWC. Indeed, some species inflict higher damage but are tolerated because they are not feared as a direct threat to humans.

Crop raiding incidents and wildlife attacks on domestic animals represent species increasingly coming into contact with people due to habitat loss (CONABIO 2009). However, in some of the remote areas of the SGBR, this conflict has arisen for the opposite reason, as the emigration by men has reduced the human population, a situation common in other parts of the world (Knight 2006). People abandoning farmland has resulted in less investment in herding, guarding of animals, and tending to plantations. This then leads to an increase in the number of HWC incidents, even though fewer people live in these remote areas. Thus, as identified by GESGIAP, the effect of predators is felt more severely than decades ago because there are fewer ranchers and fewer cattle herds (Ruiz-Corzo and Pedraza-Ruiz 2007). For example, in the locality of San Antonio Tancoyol in Jalpan de Serra, there used to be 6,000 cattle owned by more than 100 ranchers, whereas today there are fewer than 1,000 cattle owned by 28 ranchers (R. Pedraza-Ruiz, personal communication, 2012).

Local inhabitants in the SGBR use certain deterrent measures to prevent loss (Table 3), however, in the case of cattle ranching, the way local people carry out this practice encourages attacks from predators: cattle roam freely in the mountains or range land; large paddocks are delimited only by barbwire fences or small walls made of piled rocks; often no herder accompanies the cattle because it is expensive to hire one; the herd is left alone for long periods, often for several months; and, during the calving and weaning stages, cattle are usually

Table 2. Ranking of wildlife species believed responsible for losses in the Sierra Gorda Biosphere Reserve, Mexico.

Scientific name	Common name	Damage to resources	Percentage of people reporting (%)	Emotional reaction
1. Sciuridae	Squirrels	Feeds on corn, beans, and bark	17.9	Anger
2. <i>Puma concolor</i>	Puma	Feeds on sheep and donkeys, calves, goats, horses, chicken, deer, and dogs. Threatens people's lives	14.0	Anger and fear
3. Accipitridae	Hawks	Feeds on chicken	12.2	Anger
4. <i>Nasua narica</i>	White nosed coati	Feeds on corn and beans, peanuts, and fruits (e.g., papaya, avocado, mango, banana)	9.7	Anger
5. <i>Urocyon cinereoargenteus</i>	Gray fox	Feeds on chicken, and corn	9.1	Anger
6. <i>Canis latrans</i>	Coyote	Feeds on chicken, turkeys, sheep, lamb, goats, and donkeys	6.1	Anger and fear
7. <i>Panthera onca</i>	Jaguar	Feeds on cows, horses, and calves	4.3	Anger and fear
8. <i>Crotalus</i> spp.	Rattle snakes	Bites people and cattle	3.6	Anger and fear
9. <i>Desmodus rotundus</i>	Vampire bat	Bites cattle and donkeys	3.6	Anger and fear
10. Leporidae	Rabbits / Hares	Feeds on corn and beans	3.6	Anger
11. <i>Odocoileus virginianus</i>	White tailed deer	Feeds on corn, beans, pumpkin, and chick-peas	3.3	Anger and appreciation
12. <i>Herpailurus yagouaroundi</i>	Jaguarundi	Feeds on chicken	1.8	Anger
13. <i>Micruurus fulvius</i>	Coral snake	Bites people and cattle	1.2	Anger and fear
14. <i>Procyon lotor</i>	Northern raccoon	Feeds on corn	1.2	Anger
15. <i>Spizaetus ornatus</i>	Ornate eagle	Feeds on chicken	0.9	Anger
16. <i>Dasyppus novemcinctus</i>	Nine-banded Armadillo	Feeds on peas and chick-peas	0.6	Anger
17. <i>Atropoides nummifer</i>	Mexican jumping pit viper	Bites people, cattle, and horses	0.6	Anger and fear
18. <i>Bothrops</i> spp.	Pit vipers	Bites people	0.6	Anger and fear
19. Muridae	Rodents	Feeds on stored corn	0.3	Anger
20. Psittacidae	Parrots	Feeds on corn	0.3	Anger
21. <i>Didelphis virginiana</i>	Opossum	Feeds on corn	0.3	Anger
22. <i>Lynx rufus</i>	Bobcat	Feeds on chicken and turkey	0.3	Anger
23. <i>Pseudoeurycea bellii</i>	Salamander	Its shadow is believed to dry people's hand	0.3	Fear
24. <i>Rattus rattus</i>	Rat	Feeds on stored corn	0.3	Anger
25. <i>Ursus americanus</i>	Black bear	Feeds on cattle and donkeys	0.3	Fear

Table 3. Measures practiced by some of the local inhabitants of the Sierra Gorda Biosphere Reserve to prevent conflicts with wild species.

Conflicting species	Mitigation Measures	Resources under protection
<i>Sciurus</i> spp. (squirrel)	Soak corn seeds in herbicide as bait	Crop fields
<i>Nasua narica</i> (white nosed-coati)	Tie dogs to trees to scare species; Fence crop fields to block access	
<i>Odocoileus virginianus</i> (white-tailed deer)	Hang tape recorder or glass bottles over barbwire surrounding crops which move with the wind producing noises that scare away conflictive species	
<i>Canis latrans</i> (coyote)	Provide shelter to poultry over night	Chicken and turkey
<i>Urocyon cinereoargenteus</i> (gray fox)		
<i>Herpailurus yagouaroundi</i> (jaguarondi)		
<i>Dion edule</i> (cycad)	Move cattle from paddock to paddock, depending on the season, to prevent poisoning caused by cycads	Cattle
	Remove cycad specimens to reduce probabilities of poisoning	
<i>Panthera onca</i> (jaguar)	Move cattle between paddocks, depending on the season, to prevent predator attacks and paddocks near premises to prevent predator attacks	Cattle
<i>Puma concolor</i> (puma)	Relocate newborn calves and cows giving birth from remote paddocks to corrals	
	Keep groups of cows in higher densities, for they defend one another against predator attacks	
	Carry out herding personally or hire herders to take care of cattle against predator attacks	
	Place bells to cattle to scare predators away	
	Discontinue cattle ranching in areas regularly hit by predators	

left on their own in the paddocks or range. In addition, paddocks are located very close to prime puma and jaguar habitat, the terrain is steep and rocky and there are cycads (e.g., *Dion edule*) that are eaten by the cattle despite being poisonous. Thus, although cattle ranching has been practiced for over eight decades, this activity is not developed properly and the region is not suited for this productive activity (R. Pedraza-Ruiz, personal communication, 2007, 2012).

Gender and Geographical Variations in Local Perspectives of HWC

The knowledge of men and women about HWC depends on the division of work within the family unit. The relationship with farmland is intensely male, so it is rare to see a woman working in the fields. In turn, rural women have a broader relationship with their environment and are less specialized in the sexual division of labor. Mountains are predominantly represented by local people as masculine, which is reinforced by a patriarchal culture that restricts female free movement, although this aspect is changing as male emigration is leading to women having a more active role in public life (Castilla-Vallejo 2008). Thus, in our interviews, men provided information about species found in plantations and forests (i.e., squirrels, pumas, gray fox [*Urocyon cinereoargenteus*], jaguar, white-nosed coati [*Nasua narica*], and white-tailed deer), whereas women provided information on wildlife that fed on garden crops or on poultry, sheep, and donkeys (i.e., hawks, puma, coyote [*Canis latrans*], vampire bats, rabbits [Leporidae], and jaguarundi).

Women usually talked more about the difficulties of trying to quantify the wildlife damage, while men rarely mentioned this subject. This is probably because emigration has led to fewer men being involved in planting food crops, so they complain less about damage from wild animals. Similarly, they are less involved in raising domestic animals, making it difficult to quantify losses. Women living in semi-remote and remote localities said they appreciated wild species but were more negative about HWC and had higher expectations of damage compensation. They also mentioned the stress they felt through having to live with cryptic predators. Women living in localities close to the county town were more involved in community affairs and more aware of the presence of authorities, though they did not have a clear understanding about which authority is responsible for HWC. For example, they often confused the reserve experts with those from environmental authorities (e.g., the Office of the Attorney General for Protection of the Environment, PROFEPA).

Meanwhile, men living in localities close to the county town had the perspective that wild animals do not come as close as they used to because there are more villagers and dogs living in the area. They believe that animals that forage in the crops do not cause serious damage. Men living in semi-remote and remote localities working in the field still have the capacity to identify wild animals. They believe that there are not as many wild animals in the forests and mountains as before, but they do not see themselves as responsible for these diminishing numbers. Instead, they think diseases and food shortage were responsible. They claim wild animals do not come close to their properties because there are more people and dogs or because of the presence of pumas and

jaguars near their premises. However, they still feel unable to avoid or control the damage caused by wildlife.

Multi-layered Construction of Perspectives and Attitudes

Indigenous people and *mestizo* villagers relate to wildlife in various contradictory ways that reflect the conflicting moral layers of their own cultural and economic background. As in other regions of Mexico, people share a syncretic and somewhat eclectic moral core made up of both indigenous and Catholic beliefs. They believe wild animals do not belong to them or to the government, but do have ideas about the existence of a “lord of the mountains” and a “lord of the animals” and consider that such “lords” mediate their relationships with wildlife (Argueta-Villamar 2008; Beaucage and TTO 2012; Castilla-Vallejo 2008; López-Austin 1994; Santos-Fita 2013). As such, they consider wild animals part of the “creation” and so have intrinsic importance; people recognize their beauty and right to survive and also their incapacity to work, so people have a moral duty to support them and their habitats. Thus, core communitarian entitlements based on the principle “from each according to their abilities, to each according to their needs” are extended to wild animals (for a discussion of the principle, see Graeber 2011).

Such entitlements emerge in various ways. For example, in localities close to the county town, where people do not feel threatened by wildlife, villagers declare they miss those animals that used to be present and even feed them to encourage their return. For many mountain villagers living in remote localities, wild animals are not bad and some people defend them and want wild animals around as they were before. Moreover, some species that cause crop damage are tolerated because they are gentle, beautiful, and do not threaten peoples’ lives. For example, people consider the white-tailed deer a beautiful animal and they enjoy having them around their households and in their crops purely for aesthetic and emotional pleasure. Some people plant more seeds, so there are enough crops for their families as well as for the deer. People explain that some wild animals cause damage when deprived of their normal food. These nutritionally deprived animals seek other foraging alternatives and become fond of eating domestic animals that are easy to catch. Hence, people agree that wild animals should not be mistreated or abused.

Communitarian attitudes have a limit, not only towards non-human animals but also with other people, when their activities pose a threat to livelihood, cause excessive waste, or involve trespass. In these cases, other sets of norms, emotions, propensities, and attitudes seem to prevail. Although mountain villagers recognize the right and beauty of wildlife, and that these species have been mistreated in the past, they also have feelings of anger and resentment towards those animals causing excessive damage. These situations seem to involve expectations of fair exchange and retribution for their violation, which constitute a second layer of beliefs based on a completely different moral principle, that of reciprocity (see Descola 2001). Locals use this moral principle to qualify many interactions taking place between humans and non-human animals in the SGBR, which may be classified as interactions between: 1) humans and domesticated non-human species; 2) humans and wild non-human species; and 3) predatory

wild non-human species and free-ranging domesticated non-humans. With respect to interaction type 1, both men and women recognize there is a constant exchange of services, so for utilitarian reasons they protect these species that depend entirely on humans for their reproduction and well-being. In reciprocity for the perpetuation of a successful domination, people protect them and acknowledge God through prayers. In interaction type 2, people rarely feel the need to reciprocate since they do not obtain anything from wild non-human species and the damage caused by animals to humans has no fair retribution. Although wild species have a right to exist, they do not have the right to threaten or damage property since they do not provide any compensation. Once the damage has exceeded some limits, the only common ground between people and most wildlife is their conflicting interest in the same resources (i.e., crops, cattle, forests; that is, a “mutual rapacity” interaction). As with the interaction between mountain villagers and white-tailed deer described above, this seems to confirm a reciprocity perspective, as mountain villagers let the deer eat part of their crops because in return they have the pleasure of admiring their beauty. Finally, in interaction type 3, there is also only harm caused by wild species and no reciprocal exchange, since there is no equivalent given in return for the damage or life that is taken.

The nature and intensity of the feelings emerging from HWC qualified by reciprocity moral grounds depends on the context. Above all, people are angered by and resent those animals that represent a threat to their well-being: pumas, coyotes, jaguars, rattlesnakes (*Crotalus* spp.), coral snakes (*Micrurus fulvius*), and pit vipers (*Bothrops* spp.). Poor villagers under attack from wildlife feel at a disadvantage, since it is difficult to prevent or avoid damage from these animals that roam too close to their premises and are often too fast to stop. It can even be difficult to identify the animal causing damage, which compounds a sense of uncertainty. In fact, people wish they could kill the animals responsible for impacting their livelihoods, but they are not able to do so because it is against the law. Any alternative moral grounds, which may have led people to accept conflict with wildlife as “rightful acts of God,” have now been exceeded, so people feel wildlife damage as something they have to cope with, creating sentiments of unfulfilled retribution. Hence, many farmers show anger, fear, frustration, and resignation when it comes to sharing resources with wild animals.

The demand for reciprocity projects beyond the human-nonhuman relationship extends into the realm of human-human relationships. Many villagers think the government and GESGIAP are responsible for increasing the number of wild species in the forests, as their return is interpreted as resulting from the unnatural process of “bringing in wild animals and releasing them in the forests” (male participant, 60 years, Acatitlán de Zaragoza, Landa de Matamoros). Hence, villagers think these institutions should be responsible for compensating for the damage caused by wildlife, and complain because this does not happen. But this extends the relationship beyond reciprocity into a new layer of moral responsibility, that of hierarchy and authority. Villagers do abide by the law and would like to receive not only compensation for the damage from the state and its NGO substitute, but also attention, presence, advice, technical support, practical solutions, and guidance (i.e., long-term bonding and protection).

Moreover, they believe the authorities should use their power and resources to “take away or lock up wildlife” (male participant, 64 years, Santa Águeda, Pinal de Amoles). Further, the legitimacy of the prohibition suffers as some people think that it is imposed by officials “who work in their offices, where neither threat nor damage is felt” (female participant, 45 years, El Pino, Arroyo Seco). However, these perspectives are tempered by the belief of many locals that GESGIAP has been good at disclosing information on conservation and have implemented some programs that have been beneficial, such as reforestation.

Discussion

There are notable differences between the discourses of the experts and villagers about the meaning of the SGBR and its natural resources. The management program sees the villagers as essential sources of knowledge and trusts the villagers’ ability to identify animal species, but the administrative personal assumes their values and expert knowledge are more important than local knowledge. The staff also sees the reserve as a natural space containing people, rather than a landscape where people and other species co-exist. This does not mean the program considers the development activities in the reserve as unimportant, but it illustrates their inclination towards a hierarchy where non-human nature is ahead of human nature. In contrast, the villagers equate the reserve with “the ecologists,” and they do not see the area as divided into zones or associate specific zones with the management program. Similarly, the villagers do not see the future of the reserves as relying only on the conservation of plants and animals. Instead they consider the Sierra Gorda as an integrated body of humans and non-humans, where humans have priority but diminishing presence, as the young generation often choose to emigrate rather than work in the fields (Castilla-Vallejo 2008).

These differences between the management program staff and villagers complicate local participation. It is now well accepted that members of rural communities are creative agents with knowledge, values, and skills capable to create and deploy innovative solutions to contemporary conservation challenges that reflect their desires, ethical considerations, and aspirations (Davidson-Hunt et al. 2012; Minter and Miller 2011; Wyndham et al. 2011). Moreover, these capabilities are needed to generate alternatives that circumvent regional poverty traps and provide stronger local investments in wildlife conservation (Chappell et al. 2013). However, although in global discourses of conservation sustainable management plays a large role in the conservation of economically valuable species (Robinson 2011), this discourse is not well represented in the SGBR, despite recent attempts to provide community members with direct benefits and to implement management programs for some valuable species. Moreover, not only is the implementation of non-consumptive conservation in the SGBR still the major paradigm (Müller and Guimbo 2011), but, at present, the villagers are in fact disempowered and trapped between different moral imperatives and a contradictory incentive/institutional framework for tackling conflict with both

wildlife and wildlife managers. A historical tolerance between wildlife and traditional villagers has been disrupted by the return of wildlife and the restrictions imposed on local human response to HWC. The actual significance of losses through HWC in the SGBR is dynamic and follows a case-by-case basis. The more sensitive people do not plant crops or keep cattle anymore because they are frightened of living near some species. Moreover, their perceptions of damage are undeniably influenced by the phenomenon of emigration to the United States; households with lower incomes are more affected by losses, particularly if they do not rely on remittances sent by migrant relatives.

The result is that even though the right of wildlife to live is acknowledged, people feel disadvantaged, unprotected, and vulnerable. Thus predation, damage, and wildlife management policies are accepted unenthusiastically and with resignation and local people do little to mitigate this damage. One aspect of this acquired attitude is that no accurate record keeping has been in place to document interactions with wildlife, let alone measure its economic implications. Thus, the impact of HWC on households and their members is very difficult to assess, not only because of uncertainty in attributing damage, which makes it complicated to quantify losses on a daily basis, but because perceptions of the opportunity costs of HWC incidents vary with household structure and living standards. This may be the reason why the negative interactions have not led to a public outcry; it has definitely stopped people expressing the importance of HWC in their lives.

Conclusions

In this article we followed Hill (2004) to establish four basic questions for the analysis of HWC in the SGBR: 1) What are the impacts on agricultural yields and household economics; 2) how and why people perceive losses the way they do; 3) who will take responsibility for the issues; 4) what can villagers expect from any intervention? We have provided plausible answers to each one of these questions and the outlook is not optimistic. However, we have also uncovered some areas of opportunity for new ways of intervening that may mitigate some of the worst problems since much can be done to devise systematic and innovative mechanisms to prevent or minimize conflicts with wildlife in the SGBR. Thus, we conclude, providing the following recommendations:

1. It is imperative that the current feelings of retribution directed against both the wildlife and the managers are alleviated. Beyond the openly recognized need to follow up cattle ranchers' concerns and claims, it is vital to design policies and finance mechanisms that minimize negative interactions between humans and wildlife and maximize positive interactions. This should build on other conservation projects based on the adoption of a biocultural approach (Davidson-Hunt et al. 2012; Gavin et al. 2015), the sustainable use of biological resources and incentive driven conservation (Hutton and Leader-Williams 2003; Robinson 2011), but always weighing up the ethical, value, and ideological dimensions of the different social-ecological contexts (Leader-

Williams et al. 2010; Lertzman 2009; Manfredo 2008; McShane et al. 2011; Miller et al. 2011). For example, with regard to the organization of the Units for conservation, management and sustainable use of wildlife (UMAS) (CONABIO 2016) controlled by local owners, these are known to provide hunting opportunities for outsiders and generate income opportunities, while also acting as a control mechanism to reduce HWC by removing surplus populations of key species. However, hunting quotas should also be provided to individual villagers so they can exert an autonomous and traditional process of control, mainly in high conflict areas. More thought is needed on alternatives to purely economic compensation, most importantly to reimburse women for the continuous stress from the presence of cryptic predators. Such compensation schemes are not easy to develop and would have to be based on effective mechanisms to avoid fictitious damage reports (R. Pedraza-Ruiz, personal communication, 2012; Zabel and Holm-Müller 2008).

2. Reinforce communitarian structures and institutions that may allow villagers to fully accept their need to develop a response-ability towards wildlife and to take any future possibilities of embracing this co-existence more seriously (Waldau 2013). All involved parties must learn from projects in other parts of Mexico where stakeholder participation in the design of policy and management of reserves on communally owned land has produced better relationships between humans and wildlife (e.g., Bray et al. 2007; De la Tejera-Hernández and García-Barríos 2008). Such studies, for example, discuss the means to mitigate outmigration and its consequences on family and community disruption, not only by providing new economic opportunities to local people but also by providing them the participatory means and financial support to organize regional production and political action according to community sustainability criteria.
3. Develop a larger cross-disciplinary and multi-sectorial process of cooperative planning based in a shared understanding of the biological, historical, social, and cultural context of HWC in the region (Berkes 2007; Brand [1964] 2012; Descola 2001, 2005; Gavin et al. 2015; Maldonado-Koerdell [1940] 2012; Manfredo 2008). Stronger and more structured communication is necessary between managers and local people to provide for mutual understanding and joint participation in planning, production, and assessment. Not only the government and the NGOs have a role in this process, but most importantly the Catholic Church could (and must) become a proper field for the encounter. The concepts used in law and policy that are designed to secure a balanced relationship between humans and nature, such as “sustainable use” may sound newly invented but are, in truth, not new at all. Instead, such concepts were well known to ancient human communities and they evolved through traditions and are also found in religious texts that speak of our responsibility as stewards of nature (Harrop 2013). Recently, Pope Francis wrote the Encyclical letter *Laudato Si* (Bergoglio 2015), described as “an encyclical in which the Pope addresses (with very good scientific advise) problems that have resulted from human activity and therefore come under moral analysis regarding our obligation to our fellow man, especially the poor, and our responsibilities as ‘stewards’ of the Earth, ‘our common home.’” Indeed, it has

already been suggested that collaborative ventures between secular and faith-based organizations in the field of environmental ethics are of great value (McKay 2013; Turner and Berkes 2006). As pointed out by Harrop (2013), the power of religious belief may be all that is required to put conservation into effective practice: the principles found in customary law, stories, and myths within local traditions and within the precepts and sacred texts of global religions provide us with a heritage of sustainable practices that can potentially operate without the help of the State and because of the strength of belief behind these ethics, there may be no need to strengthen their effect by bolstering them with obligations in national or international legal instruments.

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Appendix 1. Localities visited in the Sierra Gorda Biosphere Reserve between 2004 and 2010 by county.

County	Locality	Geographical location in relation to the county seat	
Arroyo Seco	1. Agua Fría de los Fresnos	in close proximity	
	2. Ayutla	in close proximity	
	3. Milpas Viejas	remote	
	4. El Bosque	remote	
	5. El Carrizalito	in close proximity	
	6. El Jardín	in close proximity	
	7. El Pino	in close proximity	
	8. El Pocito	in close proximity	
	9. El Quirino	in close proximity	
	10. El Sabinito	in close proximity	
	11. El Tepozán	remote	
	12. Laguna de la Cruz	in close proximity	
	13. La Florida	in close proximity	
	14. La Lagunita	in close proximity	
	15. La Mojonera de Osorio	in close proximity	
	16. Purísima de Arista	in close proximity	
	17. Río Carrizal	in close proximity	
	18. Salitrillo	in close proximity	
	19. San José de las Flores	semi remote	
	20. Santa María de Cocos	remote	
Jalpan de Serra	21. Acatitlán del Río	in close proximity	
	22. Agua Fría	in close proximity	
	23. Barreales	in close proximity	
	24. Carrizal de los Sánchez	in close proximity	
	25. El Álamo	in close proximity	
	26. El Pocito	remote	
	27. El Carrizal de los Durán	semi remote	
	28. El Saucito	in close proximity	
	29. El Tepozán	remote	
	30. Jaguey Grande	in close proximity	
	31. La Esperanza	semi remote	
	32. Los Charcos	in close proximity	
	33. Guayabos	in close proximity	
	34. Los Jassos	remote	
	35. Malila	in close proximity	
	36. Petzcola	semi remote	
	37. Piedras Anchas	in close proximity	
	38. Rancho Nuevo	semi remote	
	39. Rincón de Dios	in close proximity	
	40. Saldiveña	in close proximity	
	41. San Antonio Tancoyol	remote	
	42. San Isidro	semi remote	
	43. San Juan de los Durán	semi remote	
	44. San Vicente	in close proximity	
	45. Soledad de Guadalupe	in close proximity	
	46. Soledad del Refugio	remote	
	47. Tierra Fría	in close proximity	
	Landa de Matamoros	48. Acatitlán de Zaragoza	in close proximity
		49. El Lobo	in close proximity

Appendix 1. Continued.

County	Locality	Geographical location in relation to the county seat
Peñamiller	50. El Madroño	in close proximity
	51. Encino Solo	in close proximity
	52. La Joya Chiquita de San Antonio	remote
	53. La Lagunita	remote
	54. La Reforma	in close proximity
	55. Matzacintla	in close proximity
	56. Mesa de la Cruz	in close proximity
	57. Neblinas	semi remote
	58. Otates	in close proximity
	59. Palo Verde	in close proximity
	60. Polvareda	in close proximity
	61. Valle de Guadalupe	semi remote
	62. Agua Fría	in close proximity
	63. Camargo	in close proximity
	64. Extoráz	in close proximity
	65. La Colonia	in close proximity
	66. La Estación	in close proximity
	67. Peña Blanca	in close proximity
	68. Peñamiller	in close proximity
Pinal de Amoles	69. Plazuela	in close proximity
	70. San Juanico	in close proximity
	71. El Pilón	in close proximity
	72. Agua del Maíz	in close proximity
	73. Agua Amarga	in close proximity
	74. Bucareli	semi remote
	75. Cuesta Blanca	in close proximity
	76. Derramadero de Juárez	in close proximity
	77. El Cantón	remote
	78. Epazotes Grandes	remote
	79. La Colgada	in close proximity
	80. La Tinaja	in close proximity
	81. Los Pinos	remote
	82. Río Escanela	semi remote
Xilitla (San Luis Potosí)	83. Santa Águeda	in close proximity
	84. Tierras Coloradas	in close proximity
	85. Tonicico	in close proximity
	86. Hierba Buena	in close proximity
	87. El Retén	outskirts of the Reserve
	88. Potrerillos	outskirts of the Reserve
	89. Soledad de Zaragoza	outskirts of the Reserve
Atarjea (Guanajuato)	90. Atarjea	outskirts of the Reserve