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COMMUNITY PROTECTED AREAS AND THE CONSERVATION OF JAGUAR (PANTHERA ONCA) AND THEIR PREY IN THE CHINANTLA REGION OF THE SIERRA NORTE, OAXACA, MEXICO

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by

Joe James Figel

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To: Dean Kenneth Furton
College of Arts and Science

This thesis, written by Joe James Figel, and entitled Community Protected Areas and the Conservation of Jaguar (*Panthera onca*) and their Prey in the Chinantla Region of the Sierra Norte, Oaxaca, Mexico, having been approved in respect to style and intellectual content, is referred to you for judgement.

We have read this thesis and recommend that it be approved.

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Date of Defense: November 12, 2008

The thesis of Joe James Figel is approved.

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ABSTRACT OF THE THESIS

COMMUNITY PROTECTED AREAS AND THE CONSERVATION OF JAGUAR (PANTHERA ONCA) AND THEIR PREY IN THE CHINANTLA REGION OF THE SIERRA NORTE, OAXACA, MEXICO

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Professor David Bray, Major Professor

This thesis studied jaguars (*Panthera onca*) and their prey and investigated human-jaguar interactions in the Chinantla Region of the Sierra Norte of Oaxaca, Mexico. The Chinantec communities in the study area have declared 205 km² of their land as community protected areas (CPAs). With 56-62% of its forests under community ownership and 11.5% of its land already in reserves, there are few significant public lands remaining in Mexico that could be designated as federal protected areas for jaguar conservation. Ecological research was done with camera-traps, which registered two jaguars in a 144 km² study area. Socioeconomic and cultural data on human-jaguar interactions were collected through interviews. This was the first study on local people's perceptions towards jaguars in Mexico and also the first to assess the status of jaguars in both the Chinantla and in Mexican CPAs.

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LIST OF ACRONYMS

ACRONYM	DEFINITION
AMNH	AMERICAN MUSEUM OF NATURAL HISTORY
BMM	BOSQUE MESÓFILO DE MONTAÑA
CFE	COMMUNITY FOREST ENTERPRISE
CIDIIR-OAXACA	CENTRO INTERDISCIPLINARIO DE INVESTIGACIÓN PARA EL DESARROLLO INTEGRAL REGIONAL, UNIDAD OAXACA
CONABIO	BIODIVERSITY COMMISSION OF MEXICO
CONAFOR	NATIONAL FOREST COMMISSION
CONANP	NATIONAL COMMISSION OF NATURAL PROTECTED AREAS
CORENCHI	NATURAL RESOURCE COMMITTEE OF THE UPPER CHINANTLA
FIU	FLORIDA INTERNATIONAL UNIVERSITY
GEF	GLOBAL ENVIRONMENTAL FACILITY
GIS	GEOGRAPHIC INFORMATION SYSTEMS
ICDP	INTEGRATED CONSERVATION AND DEVELOPMENT PROJECT
INEGI	INSTITUTO NACIONAL DE ESTADÍSTICA Y GEOGRAFÍA
IPA	INDIGENOUS PROTECTED AREA
IUCN	INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE AND NATURAL RESOURCES
JCU	JAGUAR CONSERVATION UNIT
JGR	JAGUAR GEOGRAPHIC REGION

LDC	LESS DEVELOPED COUNTRY
MMDM	MEAN MAXIMUM DISTANCE MOVED
NGO	NONGOVERNMENTAL ORGANIZATION
NPA	NATIONAL PROTECTED AREA
NTFP	NONTIMBER FOREST PRODUCT
PA	PROTECTED AREA
PES	PAYMENT FOR ENVIRONMENTAL SERVICES
PHES	PAYMENT FOR HYDROLOGIC ENVIRONMENTAL SERVICES
SAB	SAN ANTONIO DEL BARRIO
SCT	SANTA CRUZ TEPETOTUTLA
SPT	SAN PEDRO TLATEPUSCO
ST	SANTIAGO TLATEPUSCO
SEMARNAT	MEXICO'S SECRETARIAT OF THE ENVIRONMENT AND NATURAL RESOURCES
SNO	SIERRA NORTE OF OAXACA
SPSS	STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES
TN	TRAP NIGHT
TPA	TERRESTRIAL PROTECTED AREA
UNAM	UNIVERSIDAD NACIONAL AUTÓNOMA DE MEXICO
UNESCO	UNITED NATIONS EDUCATIONAL, SCIENTIFIC, AND CULTURAL ORGANIZATION
WCS	WILDLIFE CONSERVATION SOCIETY
WDPA	WORLD DATABASE ON PROTECTED AREAS

CHAPTER I

INTRODUCTION

"The National Parks do not suffice as a means of perpetuating the larger carnivores; witness the precarious status of the grizzly bear, and the fact that the park system is already wolfless…the most feasible way to enlarge the area available for wilderness fauna is for the wilder parts of the National Forests, which usually surround the Parks, to function as parks in respect of threatened species."

(Leopold, 1949: p. 198)

This thesis studied jaguars (*Panthera onca*) and their prey and human-wildlife interactions in community forests dominated by community protected areas (CPAs). The area studied is known as the Chinantla, an ethnic territory populated by Chinantec indigenous peoples (Bevan, 1938) in the Sierra Norte of Oaxaca (SNO), southern Mexico. As part of the Madrean Pine-Oak Woodlands Hotspot[1] (Koleff et al. 2004), the SNO is one of the World Wildlife Fund's (WWF) Global 200 ecoregions (WWF, 2005). It is also a priority site for jaguar conservation in Mexico (Chávez and Ceballos, 2006).

To my knowledge, this is the first project on jaguars in Mexico to apply both social science and ecological methods in the same study. Conforti and Azevedo (2003), Brechin et al. (2005), and Altrichter et al. (2006) used interviews during human-jaguar conflict investigations in South and Central America, but there have been no such studies examining social dimensions of jaguar conservation in Mexico. Nuñez et al. 2000; Ceballos et al. 2002; Rosas-Rosas, 2006 conducted long-term ecological studies on jaguar populations in Mexico, but this is the first study to combine methods from both

[1]To qualify as a hotspot, a region must meet two strict criteria: it has to contain at least 1,500 species of vascular plants (> 0.5 percent of the world's total) as endemics, and it has to have lost at least 70% of its original habitat (Mittermeier, 2004).

in the same study area. It is important to research social dimensions of jaguar conservation because, in the words of jaguar conservationist Alan Rabinowitz, "negative attitudes and perceptions by humans towards jaguars (are) clearly the greatest imminent threat to the species' survival" (Rabinowitz, 2005). Human perceptions of jaguars cannot be ignored if jaguar conservation efforts are to be sustained.

Mexico presents a national laboratory for studying jaguar conservation on lands beyond public PA boundaries. No other country in the jaguar's range has a greater percentage of its forests in community ownership than Mexico (Bray et al. 2005; J.J. Figel, unpublished data). With an estimated 56-62% of its forests governed by a common property regime (D.B. Bray, pers. comm.) that includes *ejidos* and *comunidades* (indigenous communities) and 11.56% of its national territory already designated as federal PAs (CONANP, 2008), it is unrealistic to expect Mexico's current reserve network to expand over much more of the jaguar's current range in the country.

Even if there were sufficient lands capable of reserve designation, serious and lasting problems can arise when there is a mismatch between the park type and the social context in the area (Brandon, 2002). Such conflict is especially relevant for Mexico where many PAs declared over the last two decades superseded prior land grants to communities, creating denial of access rights and resource conflicts with local communities (Bray et al. 2005).

The Mexican Constitution of 1917 established three forms of rural property: national lands, private property, and the agrarian reform sector composed of *ejidos* and *comunidades*. *Comunidades* refer to indigenous communities that have demonstrated long occupation of the land in contrast to *ejidos* which are based on a group's new land

grant from land redistributed through the agrarian reform process (Bray et al. 2006). *Comunidades* and *ejidos* were given substantial control over a territory, creating a structure of local, political and territorial governance (Bray et al. 2005). The controls over property provided a structured relationship between local communities and the state, which is now a deeply rooted aspect of rural culture in Mexico (Bray et al. 2006).

Mexico's unique land tenure provides an opportunity to examine jaguar conservation issues not only outside public PAs but also in a "larger landscape" almost completely dominated by community lands, a large portion of which are under community protection. The Chinantec CPAs cover 26,720 hectares (ha) (267 km²) and are certified by the National Commission of Natural Protected Areas (CONANP). With approximately 80% of the world's protected areas (PAs) in IUCN categories I-VI smaller than 10,000 hectares (Naughton-Treves et al. 2005), the Chinantec CPAs are larger than 80% of the world's PAs.

OBJECTIVES

My thesis research was driven by the following five objectives:

1) Assessing the current status of jaguars in the communal lands and CPAs of the four Chinantec study communities;
2) Evaluating the rules instituted for conservation, particularly with respect to prey species and jaguars;
3) Using camera traps, estimating an index of relative abundance of jaguar prey species in the study area;
4) Identifying major threats to jaguars in the Chinantla; and

5) Recommending conservation strategies to rectify those threats.

Objectives 1 and 3 will be addressed primarily in Chapter IV; Objective 2 will be discussed in Chapter V; and Objectives 4 and 5 will be addressed in the conclusions in Chapter VI.

STRUCTURE OF THIS THESIS

Chapter I will continue with a discussion on the ecology and conservation of jaguars in Mexico with special emphasis on jaguar conservation in the absence of traditional PAs. Prior jaguar research and current status in Mexico will be covered in detail. Separate sections will focus on previous jaguar research and current status in Oaxaca. The PA network in both Mexico and Oaxaca will be presented as well.

Chapter II will frame the theory of island biogeography in the context of jaguar conservation in Mexico. Community forests and community protected areas (CPAs) are covered later in the chapter. Chapter II concludes with a look at Payment for Environmental Services and its significance in terms of influencing conservation practices in the Chinantla.

The study area is introduced in Chapter III with notes on jaguar habitat quality included. Ecological and social methods on camera-trapping and interviews are covered in detail including a brief history of jaguar camera-trap studies in Mexico.

Chapter IV presents camera-trapping results and discusses jaguar prey in the Chinantla. A "crude" jaguar density estimate for the Chinantla is given. Also included is a table showing total traps nights and trap success among all species 'photo-captured'

during the study. A discussion on the limitations of using film cameras in the Chinantla is presented.

Human-wildlife interactions are covered in Chapter V. The chapter begins with a discussion of *nahuales* and a narrative on local perceptions of wildlife. Next is the section on Chinantec perceptions of jaguars and wild cats. Also discussed is the community hunting ban, the importance of which is addressed in the context of jaguar conservation in the Chinantla. The hunting of pest species is covered as well. Chapter V concludes with a look at the issues of livestock depredation and human-jaguar conflict. All known incidents of jaguars killed in the study area are given.

Conclusions are presented in Chapter VI. I make suggestions for further jaguar research in the Chinantla. Improved livestock husbandry is recommended. I also suggest that status surveys be conducted in the Chinantla *baja.* The thesis concludes with a discussion on future prospects for jaguar conservation in the Chinantla.

JAGUARS AND PROTECTED AREAS IN MEXICO

The jaguar is a landscape species occurring in a variety of habitats including tropical forests, mangroves, tropical savannahs, montane forests, and dry scrub forests (Seymour, 1989). Defined as species that "use large, ecologically diverse areas and often have significant impacts on the structure and function of natural ecosystems" (Redford et al. 2000 in Sanderson et al. 2002b), landscape species such as jaguars are rarely confined to a single PA. With a distributional range spanning 18 countries and over 8,000 km in longitude from northern Mexico to northern Argentina, the jaguar is one of the best examples of terrestrial landscape species in Latin America (Sanderson et al. 2002a).

Since jaguars have large home ranges up to 176 km² (Soisalo and Cavalcanti, 2006) and male home ranges usually do not overlap (Schaller and Crawshaw, 1980; Rabinowitz and Nottingham, 1986), several thousand square kilometers is required to sustain a population of the endangered big cats (Sanderson et al. 2002a). Redford and Robinson (1991:230) calculated 5,486 km² as the mean area necessary to support 500 jaguars, which is the estimated minimum number needed to maintain genetic diversity (Soulé and Wilcox, 1980). Assuming the area estimated by Redford and Robinson, only three Mexican PAs are capable of supporting "viable" jaguar populations: Calakmul and Sian Ka'an Biosphere Reserves and the Laguna de Terminos (Table 1.1). Similarly, Hernández-Huerta (1992) found only three Mexican PAs (Calakmul, Sian Ka'an and Monte Azules Biosphere Reserve) out of 80 to be of sufficient size for conserving jaguars.

In reference to the importance of reserves for the conservation of jaguars and other wild cats, Nowell and Jackson (1996:172) wrote: "The most important contribution that protected areas currently make to (jaguar) conservation is helping to prevent intraspecific genetic erosion by protecting important sub-populations." The problem now is that PAs surrounded by altered habitat usually have higher extinction rates than PAs with connectivity between them (Woodroofe and Ginsberg, 1998). Maintaining genetic diversity in PAs is wasted if jaguars have no place to disperse.

Quigley and Crawshaw (1992) estimated a PA of at least 3,200 km² in size is required to support a minimum population of 50 jaguars in the Brazilian Pantanal. The Pantanal is one of the most productive habitats anywhere in jaguar range with a year-

Table 1.1: Jaguar Inhabited Protected Areas in Mexico.

State	Name	Category	Hectares
Campeche	***Calakmul †***	VI	723,185
Campeche	***Laguna de Terminos †***	IV	706,148
Quintana Roo	***Sian Ka'an †***	VI	617,000
Tamaulipas	Laguna Madre*	IV	572,808
Chiapas	Monte Azules	VI	331,200
Tabasco	Pantanos de Centla	VI	302,706
Campeche	Los Petenes	VI	282,858
Sonora	Ajos Bavispe	Other	183,608
Nuevo Leon	Cumbres de Monterrey	II	177,396
Chiapas	La Sepultura	VI	167,310
Quintana Roo	Yum Belem	VI	154,052
Chiapas	La Encrucijada	VI	144,868
Tamaulipas	El Cielo	VI	144,531
Jalisco/Colima	Sierra de Manantlan	VI	139,577
Chiapas	El Triunfo	VI	119,177
Chiapas	Selva El Ocote	VI	101,288
Sonora	Sierra Los Alamos-Rio Cuchujaqui	Flora/Fauna PA	92,889
Quintana Roo	Uaymil	Flora/Fauna PA	89,118
Yucatan/Campeche	Ria Celestun	VI	81,482
Chiapas	Lacan-Tun	VI	61,874
Yucatan	Ria Lagartos	VI	60,348
Nayarit	Sierra Vallejo	VI	38,000
Jalisco	Chamela-Cuixmala	VI	13,142
			5,010,936

*Although they meet the size criteria, Laguna de Terminos and Laguna Madre do not contain enough ideal jaguar habitat, thus rendering them incapable of supporting 'viable' populations.

†Names in italicized bold font indicate PAs capable of supporting viable populations, using criteria as defined by Redford and Robinson (1991).

Source: The entries in this table were compiled by the author.

round water supply and a high prey biomass (Schaller and Crawshaw, 1980; Azevedo and Murray, 2007). Therefore the area of protected habitat would need to be much larger in less productive habitats such as the cloud forests in the Chinantla or pine-oak forest in the Sierra Madres. In eastern Sonora, for example, López-González and Lorenzana-Piña (2001) estimated a PA covering 6,600 km² would be needed to support between 60 and 100 jaguars.

PRIOR JAGUAR RESEARCH IN MEXICO

Most jaguar research in Mexico has been carried out in biosphere reserves (Medellín et al. 2002). Biosphere reserves are classified as category V reserves[2] by the International Union for the Conservation of Nature and Natural Resources (IUCN). Data on the species in Mexican community forests is almost entirely anecdotal (but see Ceballos et al. 2005), which is a serious hindrance for jaguar conservation considering roughly 60% of the country's forests are under community ownership (Bray et al. 2005) and substantial numbers of jaguars exist outside public parks (Chávez and Ceballos, 2006).

Long-term jaguar studies in Mexico have taken place in the Calakmul Biosphere Reserve in Campeche and Chamela-Cuixmala Biosphere Reserve in Jalisco. Notable jaguar studies in the lowland semi-deciduous forests of Calakmul have been conducted by Aranda and Sánchez-Cordero (1996), Aranda (1998), and Ceballos et al. (2002). Data from radio-collared jaguars in Calakmul revealed an estimated density of 1 individual/15 km². Extrapolating this density estimate to the reserve's entire 723,185 ha results in an

[2] Category V reserves are managed to combine both conservation and sustainable use of natural resources (see Appendix 3 for complete list and definitions of IUCN categories).

estimated population size of 482 jaguars for the park (Ceballos et al. 2002). This number is boosted to about 900 individual jaguars if the entire Calakmul region is considered as a single meta-population. Bala'an Ka'ah Biosphere Reserve in Quintana Roo and two *reserves estatales* (state reserves) in Campeche, Balam Kim and Balam Ku cover an area of 130,000 km², providing one of the most important blocks of habitat anywhere in the jaguar's range (Sanderson et al. 2002a).

In Chamela-Cuixmala, Nuñez et al. (2000) contributed much of what is known about jaguar feeding ecology in Mexican tropical dry deciduous forest, a threatened ecoregion covering some 31,000 km² in Mexico (Sanderson et al. 2002a). Their study found four mammals – white-tailed deer (*Odocoileus virginianus*), collared peccary (*Tayassu tajacu*), nine-banded armadillo (*Dasypus novemcincus)*, and coati (*Nasua narica*) – to provide 98% of the biomass taken. Only seven species were taken by jaguars overall (Nuñez et al. 2000).

Southern Sinaloa was believed to hold the northernmost breeding population of jaguars on Mexico's Pacific Coast (Swank and Teer, 1987; Carmony and Brown, 1991) until recently when a population of about 150 jaguars was discovered in the Aros-Yaqui region in the late-1990s (López-González and Lorenzana Piña, 2002). Widely considered extirpated from Sonora before this discovery, the Aros-Yaqui region is now one of only eight level I priority areas for jaguar conservation in Mexico (Chávez and Ceballos, 2006). Although unlikely, it is not impossible that other sizeable as-of-yet undetected jaguar populations exist in remote, unexplored pockets of the Mexican backcountry. For example, a population of another large carnivore was not discovered until the late 1950's

when a few grizzly bears were discovered by A. Starker Leopold in the rugged Sierra del Nido (Leopold, 1967) of Chihuahua State.

A. Starker Leopold (1913-1983) was one of the world's most influential and honored authorities on wildlife ecology and conservation. During the 1950's, Leopold embarked on a national survey investigating the status of Mexico's game birds and mammals. He found some of the highest jaguar densities in the country in southern Sinaloa and coastal Nayarit (Leopold, 1959). The tropical dry deciduous forests in Sinaloa and Nayarit and along the Pacific Coast have undergone extensive deforestation since Leopold's survey (Trejo and Dirzo, 2000) but remain priority areas for jaguar conservation in Mexico nonetheless. For example, the Sierra de Vallejo in Nayarit and Chamela-Cuixmala Biosphere Reserve in Jalisco were identified as two of only eight priority I areas for jaguar conservation in the country (Chávez and Ceballos, 2006). The designation of Chamela as a priority I site is questionable given this reserve is only 13,142 ha in size (Nuñez et al. 2000), which is too small an area to hold a significant jaguar population (Redford and Robinson, 1991).

PRIOR JAGUAR RESEARCH IN OAXACA

Despite being one of only four states with both a priority I and priority II jaguar conservation unit (JCU) (Chávez and Ceballos, 2006), there is little published research on jaguars in Oaxaca (but see Lira-Torres and Ramos-Fernández, 2007). Jaguar data is limited to notes on presence/absence in selected sites (Goodwin, 1969) and observations on human-jaguar conflict from the "gray literature" (Ramos-Fernández et al. 2007). In reference to jaguar distribution in Oaxaca, Goodwin (1969) noted its range covered

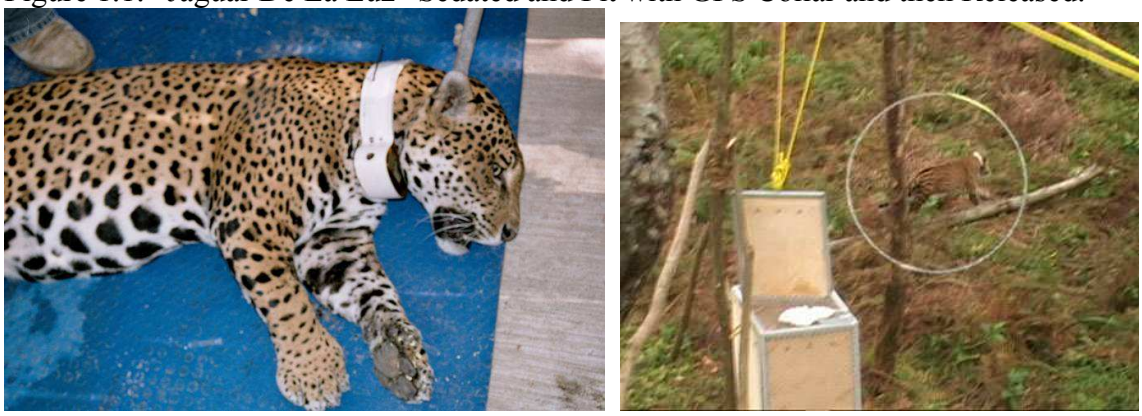
"tropical forested regions of the Isthmus of Tehuantepec and probably throughout the state." Jaguar population status in Oaxaca remains speculative because there have been no camera-trapping or telemetry studies. This study is the first to systematically research jaguar populations in Oaxaca using camera-traps.

The presence of jaguars in Oaxaca has had a more pronounced profile in recent years because of a series of events connected with what is known as the "*jaguar de la luz*" (the jaguar of light). On October 17, 2004 villagers in Asunción Lachixila, a small Zapotec community (11,155 ha; 270 villagers) in an area contiguous with the Chinantla ethic region made a live capture of a cattle-killing adult male jaguar. With a weight of 43 kg, the jaguar was in good condition with no broken canines or head injuries (G. Ramos-Fernández, pers. comm.), characteristics often predisposing big cats to livestock depredation (Rabinowitz, 1986b). The *jaguar de la luz* was turned over to environmental authorities and kept captive in Oaxaca City for about a year, where it was fed beef. A year later, and after reflecting on the fact that their founding mythologies suggested that their community had been founded by jaguars (D.B. Bray, pers. comm.), Asunción Lachixila community members decided the jaguar should be returned to their forests.

The *jaguar de la luz* was freed after a communal ceremony on December 17, 2005. Dr. Gabriel Ramos – Fernández, a wildlife biologist at CIIDIR-Oaxaca, fitted the jaguar with a GPS collar (Figure 1.1) and tracked it until June 26, 2006. The jaguar restricted its movements to lowland areas (200-800 m) in *selva alta perennifolia* (evergreen tropical rainforest) and pasture/agricultural areas during the time it was tracked and maintained a home range of 10-24 km.^{2} This home range should be

considered an absolute minimum estimate, however, since only 11 positions were obtained during the 6 months the jaguar was monitored (Ramos-Fernández et al. 2007).

Figure 1.1: "Jaguar De La Luz" Sedated and Fit with GPS Collar and then Released.



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Although it probably left more questions than answers, the *jaguar de la luz* incident did provide insight into the ecology of the jaguar in an ecosystem where very little data on the species has been collected and also in the context of lands owned by communities, and where the communities have declared major areas of their lands as CPAs.

JAGUAR STATUS IN MEXICO

"The highest densities of jaguars noted in the course of this survey were along the heavily forested flatlands and foothills of southern Sinaloa, the swamps of coastal Nayarit, the remaining uncut forests along the Gulf coast as far east as central Campeche, and the great rain forests of northern Chiapas."

A. Starker Leopold (1959: p.466)

In his book *Vanishing Wildlife of North America*, T.B. Allen (1974) claimed that shooting and loss of habitat "have reduced the jaguars within (Mexico's) borders to about

a thousand." Allen's estimation was undoubtedly based on speculative information because it was before the time of camera-trapping and radio telemetry. Current population estimates for Mexico claim there are no more than 5,000 jaguars remaining in Mexico (Chávez and Ceballos, 2006), no doubt only a small fraction of the numbers that existed at the turn of the 20th Century (Swank and Teer, 1989; Medellín et al. 2002).

It has been stated that the jaguar's range has been so reduced that the only important remaining populations are in the southeastern Mexican states (Navarro-Serment et al. 2005) of Quintana Roo, Campeche, and Chiapas (Chávez and Ceballos, 2006). But the lack of long-term jaguar research done outside of southeastern Mexico makes this claim speculative.

Rampant *narcotrafico (*drug trade*)* has served as a barrier to wildlife research throughout Mexico. Jaguar research in the remote areas surveyed by Leopold has been virtually nonexistent (but see Navarro-Serment et al. 2005). The drug trade is especially problematic in Sinaloa and Nayarit, with Sinaloa having the most extensive opium growing regions in the entire country (DEA, 2003; Freeman, 2006). As noted by Carmony and Brown (1991): "Much of the backcountry of Sinaloa and Nayarit where…some of the highest jaguar densities were reported by Leopold is now drug country and out of favor with hunters and curious biologists." As a result, Mexico's Pacific Coast remains a region where the status of jaguars is mostly unknown (Sanderson et al. 2002a).

Results from a Wildlife Conservation Society (WCS) jaguar workshop held in 1999 revealed that jaguar status and distribution was 'unknown' in 12% of all Jaguar Geographic Regions (JGRs) (Sanderson et al. 2002a). The ecology and status of jaguars

in most Mexican JCUs, including the Chinantla, is largely 'unknown' (Sanderson et al. 2002a). There has been little research done on jaguars in pine-oak temperate forest, a dominant habitat type in the Sierra Norte of Oaxaca (SNO) (but see Ortega-Huerta and Medley, 1999; Rosas-Rosas and Lopez-Soto, 2002). Some jaguar monitoring using camera-traps was conducted in the Sierra Gorda in Querétaro but this site was identified as a population sink (C. López-González, pers. comm.) and camera monitoring was sporadic.

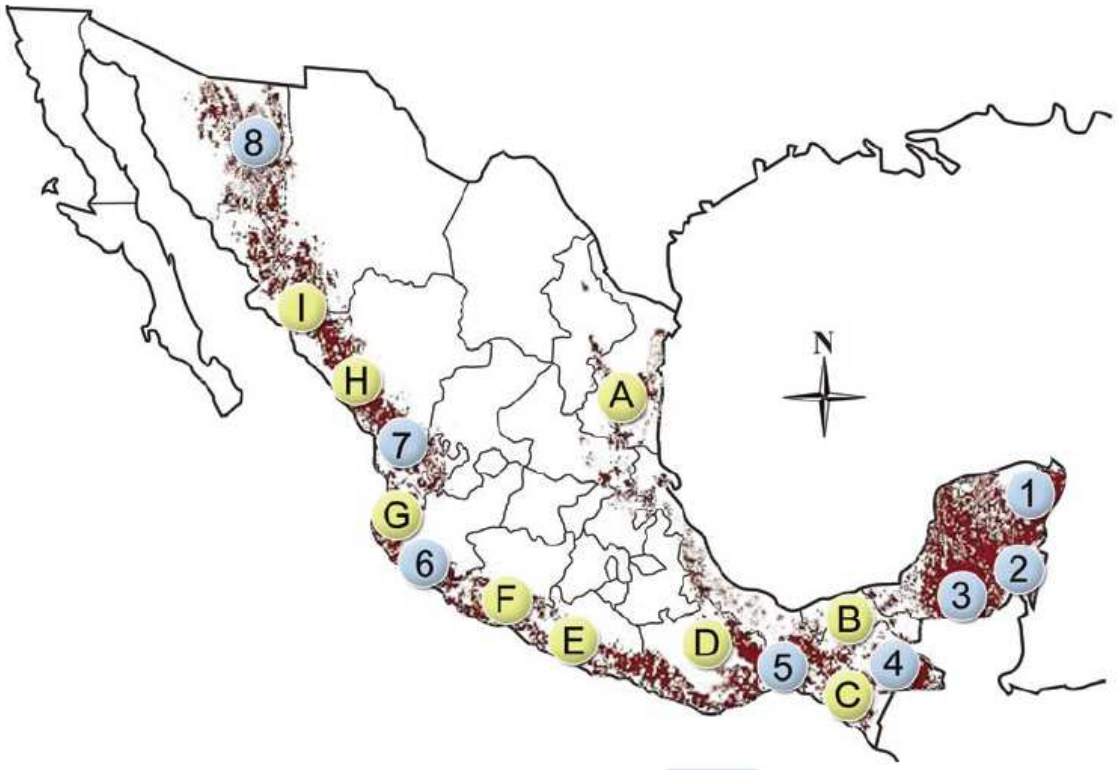
With jaguars occupying at least two dozen ecoregion types in Mexico (Dinerstein et al. 1995; J.J. Figel, unpublished data), there are significant gaps in knowledge for requirements of the species in different habitats. Mexican pine-oak forest, for example, comprises some 460,465 km² in Mexico and is the largest vegetational type in Mexico (Leopold, 1950). However, the geographic "extent of knowledge" about jaguar status and distribution in the pine-oak JGR is only 20 % (Sanderson et al. 2002a). It has been suggested that the evergreen woodlands of oak, juniper, and pine forest found in the Sierra Madre Oriental are important jaguar foraging locales (Brown and López-González, 2001). However, a recent jaguar interview survey in Sinaloa found only one record (out of a total of 57 records) of jaguars from pine-oak forest; most evidence was collected from tropical deciduous forest (Navarro-Serment et al. 2005).

JAGUAR STATUS IN OAXACA

Two priority areas for jaguar conservation have been identified in Oaxaca state: The Chimalapas and north Oaxaca (Chávez and Ceballos, 2006). North Oaxaca overlaps the Chinantla and is marked by the 'D' in Figure 1.2. The Chimalapas was given a

priority I ranking since this region is probably the third most important area for jaguar conservation in all of Mexico after the Calakmul Biosphere Reserve in Campeche and Selva Lacandona in Chiapas (Lira-Torres and Ramos-Fernández, 2007). North Oaxaca is one of nine priority II rankings given for jaguars in Mexico. Priority II regions were defined as areas that provide considerable habitat but where the status of jaguars has not been systematically evaluated (Chávez and Ceballos, 2006).

Figure 1.2: Priority Areas for Jaguar Conservation in Mexico.



Source: Chávez and Ceballos, 2006

The Chimalapa region located in Oaxaca's isthmus is further evidence of the significance of lands protecting jaguars outside public parks. Located about 200 km

southeast of the Chinantla, the remote 6,000 km² Chimalapa region is "perhaps the most (biologically) diverse region in the whole country" (Ceballos et al. 1998) despite the total absence of public PAs. Goodwin (1969) called it "probably the largest single unit of virgin rainforest in Mexico" noting that most of the Chimalapas has remained uninhabited and unexplored since the arrival of the Spaniards in Mexico.

How a completely unprotected region becomes the third most important area for jaguar conservation (after Calakmul and Selva Lacandona) in all of Mexico (Chávez and Ceballos, 2006) is remarkable given the fact that there are usually few substitutes for PAs when it comes to protecting wide-ranging big cats (Nowell and Jackson, 1996).

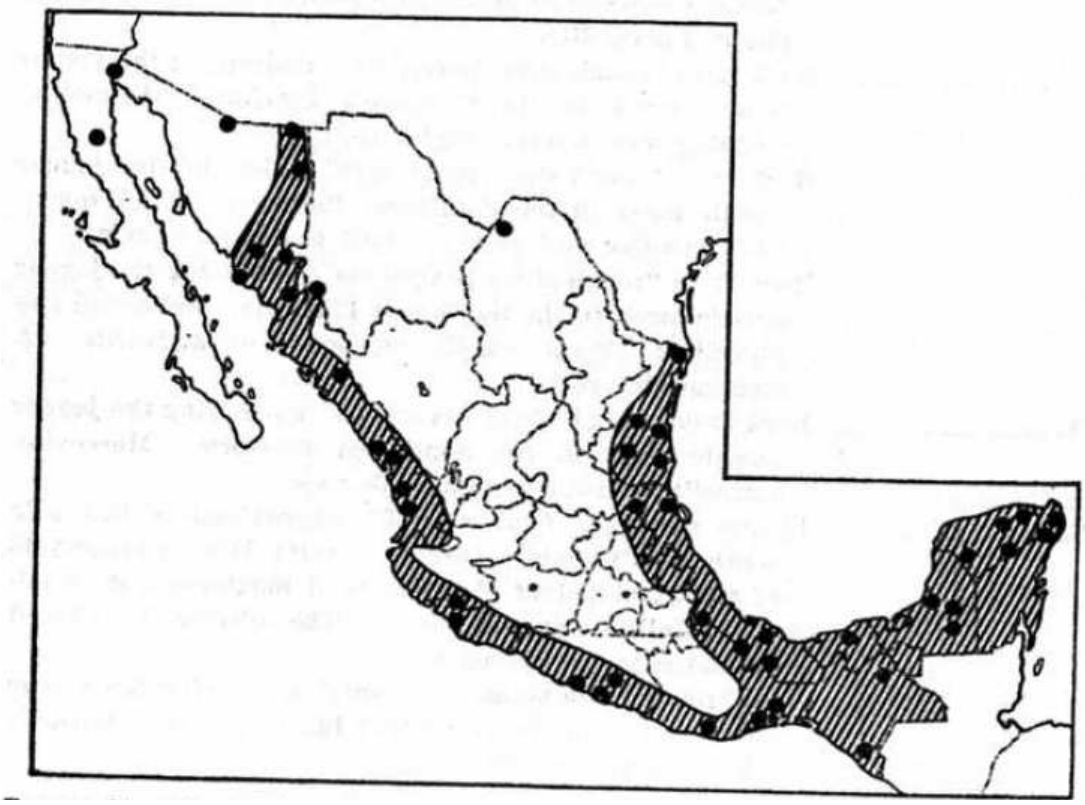
THREATS TO JAGUARS IN MEXICO

Deforestation rates in Mexico are among the highest in the world (Velázquez et al. 2002) and the country has lost almost one third of its original forest cover (Ricker et al. 2007). Sufficient jaguar habitat is now scarcer than ever with the big cats currently occupying a mere ~33% of their historical range in Mexico (Swank and Teer, 1989). Jaguar populations are fragmented and scattered across the country where they are at risk of local extirpation. Current range maps for the species in Mexico (Chávez and Ceballos, 2006) are fragmented patches compared to earlier jaguar range maps (i.e. Leopold, 1955) (Figure 1.3).

Over a 20 year period from 1980 to 2000, Oaxaca lost over 500,000 ha of forest with 23.8% of its natural habitat converted between 1990 and 2000 alone (Illoldi-Rangel et al. 2008, Gordon et al. 2004). The SNO experienced a 3% annual rate of tropical and temperate forest loss (Velázquez et al. 2003), although areas of highland pine forests

showed some forest recovery (Gómez-Mendoza et al. 2006). Lowland tropical forest, the best jaguar habitat, suffered the most extensive damage, losing about 40% of its area in Oaxaca (Lorence and García-Mendoza, 1989). The main proximate causes of land transformation were agricultural expansion and pasture creation for livestock.

Figure 1.3: Jaguar Range in Mexico Circa 1955. Solid spots are recorded occurrences.



Source: Leopold, 1955.

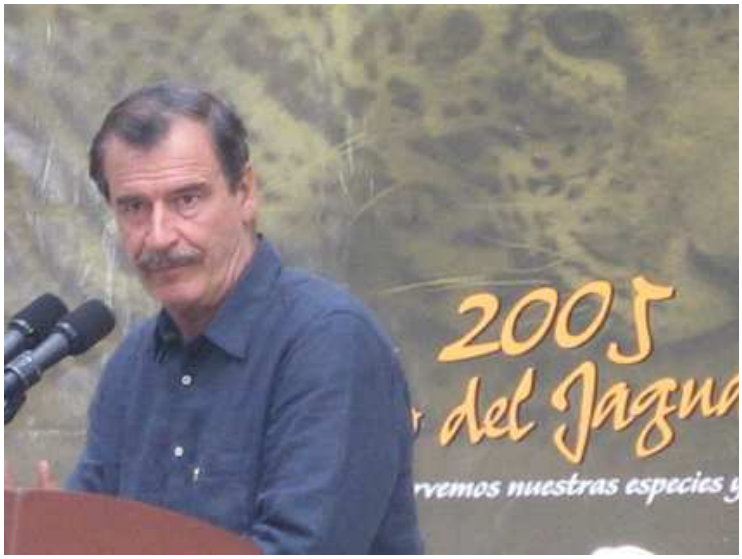
Significant parts of jaguar range in Mexico overlaps cattle grazing areas (Brown and López-González, 2001; Rosas-Rosas, 2006). Cattle ranching has been called the most ecologically incompatible kind of land use for lowland tropical forest (Dirzo and García, 1992). It is also usually the main source for human-jaguar conflict, as seen previously with the *jaguar de la luz*. Throughout Mexico, jaguars are persecuted by

ranchers for preying on livestock. Landowners in Sinaloa pay bounties of up to 5,000 pesos (US$500) for killing troublesome jaguars, and jaguar skins in that state sell for 1,500 – 3,000 pesos (US$150 to 300) (Navarro-Serment et al. 2005). Such lucrative rewards are no small sum to a poor subsistence rancher and only add incentive to exterminate the endangered cat. The hunting has taken its toll with extraordinary numbers of jaguars killed in very short periods of time.

At least 50 jaguars were killed in Sonora during the 1990's (Brown and López-González, 2001), decimating the population in northern Mexico and greatly reducing the chances of jaguars re-colonizing parts of their former range in southern Arizona. Another 11 jaguars were illegally killed in northeastern Sonora between 1999 and 2006 (Rosas-Rosas, 2006). The jaguar casualties would be even greater if undocumented cases were reported. If the species is to survive in Mexico, jaguar populations cannot sustain such high levels of mortality.

Recognizing the precarious state of jaguars, the Mexican government defined the big cat as a "priority species for conservation," placing it on the country's official endangered species list in 1994 (Brown and López-González, 2001; SEMARNAT – www.semarnat.gob.mx). In 2005 jaguar conservation was elevated to the highest level of government when Mexico's president, Vicente Fox, declared 2005 as the "Year of the Jaguar" (Figure 1.4). On October 12-15 2005, the Mexican government sponsored the 21st Century Mexican Jaguar Symposium under the direction of CONANP. In the wake of this conference, an important step was taken in ensuring the jaguar's existence on Mexico's Pacific Coast when 38,000 ha of the Sierra de Vallejo in Nayarit, a priority I jaguar conservation area, were decreed as a state National Protected Area (NPA).

Figure 1.4: Mexican President Vincente Fox at the 2005 Jaguar Symposium.



© CONANP (www.conanp.gob.mx/dcei/jaguar/h2.php)

RESERVE NETWORK IN MEGADIVERSE MEXICO

Mexico is one of the world's 12 megadiversity countries and is fourth only to Indonesia, Brazil, and Colombia among all countries worldwide in terms of total species diversity (Mittermeier, 2004). Oaxaca, the Mexican state where this study took place, contains more biological diversity than any other state in the country (García-Mendoza et al. 2004). Although Oaxaca (95,363 km²) includes only 5% of the total area of Mexico, it is home to 50% of Mexico's vascular plant species, 35% of its amphibian species, 26% of its reptile species, 63% of its bird species, and 55% of its terrestrial mammal species (Illoldi-Rangel et al. 2008). The rich Oaxacan biodiversity is even more impressive considering Mexico's top global ranking in terms of total species richness and the fact that the country does not have a large coverage of strictly protected reserves in categories I-III (Ceballos, 2007).

A total of 161 federally protected areas covering 22,712,284 ha (or 11.5% of the land area in Mexico) is now administered by CONANP (see Table. 1.2). Before 1935 Mexico had only two national parks: Desierto de los Leones (1917) and El Chico (1922). During his administration from 1934 to 1940, Mexican President Lázaro Cárdenas created forty national parks which by area constitute roughly three-quarters of Mexico's current national park system (Simonian, 1995). Between 1940 and 1970, only seven more parks were established.

Table 1.2: Mexico's Federal Protected Areas

Number	Category	Area (Hectares)
37	**VI. Biosphere**	**11,581,344**
68	**II. National Parks**	**1,505,643**
4	**III. Natural Monuments**	**14,093**
6	**V. Natural Resources**	**3,350,654**
29	**IV. Flora y Fauna**	**6,259,861**
17	**I. Sanctuaries**	**689**
161		**22,712,284**

Source: http://www.conanp.gob.mx

The United Nations Educational, Scientific, and Cultural Organization's (UNESCO) implementation of the Man and Biosphere Program in 1971 emphasized the connection between conservation and development. Mexican officials embraced the idea of intertwining conservation and development because they saw problems with the model

of traditional national parks from the US being applied to Mexico, a country with unique social and economic needs (Simonian, 1995).

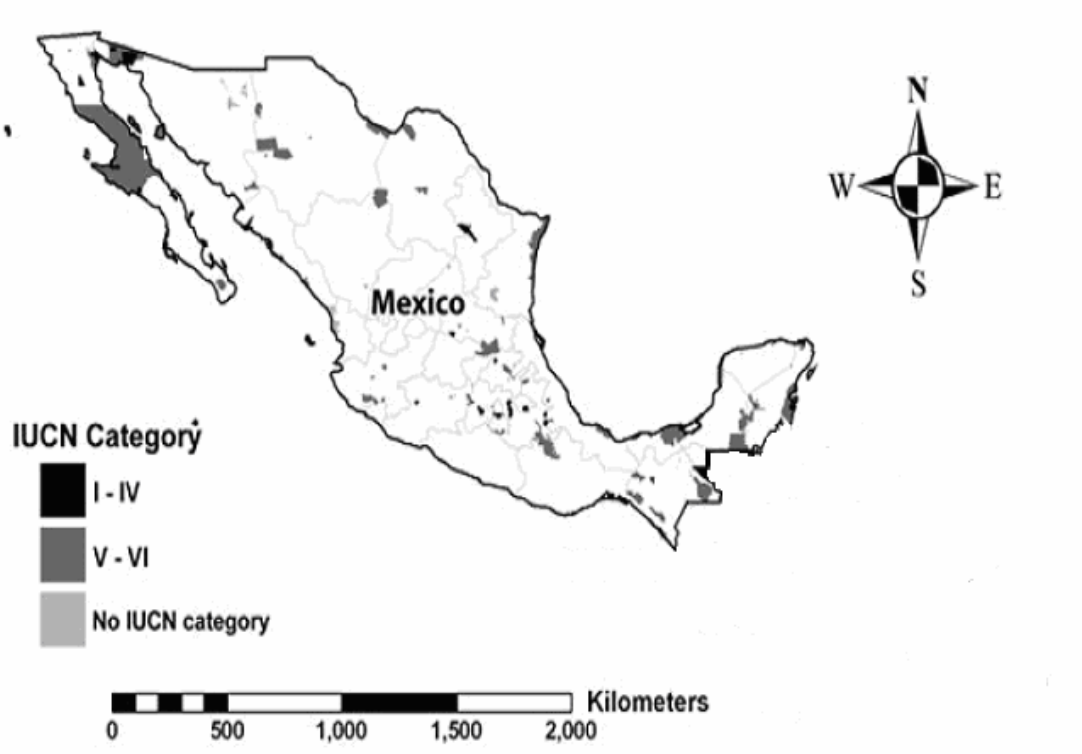
UNESCO proposed that all biosphere reserves should include three well-defined zones. A core zone, with strict protection is surrounded by the buffer zone, where non-destructive human activities are permitted and supervised to prevent negative impacts in the core zone (MacKinnon et al. 1986). The transition zone allows different activities such as agriculture and even human settlement. Biosphere reserves currently constitute about 85% of all PAs in Mexico, including three of the most important sites for jaguars in the country – Calakmul in Campeche, Sian'Kaan in Quintana Roo, and Montes Azules in Chiapas.

Mexico's current national reserve network (Figure 1.5) does not cover 32.6 % of the endemic species and 48.5 % of the globally threatened species occurring in Mexico, with 55.5 % of all globally threatened species endemic to Mexico (117 species) not covered in any part of their ranges (Brandon et al. 2005). In addressing the reserve deficiency, the Biodiversity Commission of Mexico (CONABIO) proposed 151 terrestrial priority areas for the creation of new PAs. As the government agency responsible for monitoring Mexican biodiversity, CONABIO proposed land that will be nearly impossible to designate as public PAs due to the large amounts of forests under community ownership. Research by Cantú et al (2004) found only 3.7 million ha (or about 7.1%) of the 51.4 million ha covered by the proposed sites is compatible with conservation in all 94 gap cells.

Areas identified by Leopold (1959) as having some the highest jaguar densities have almost nonexistent PA area coverage. On Mexico's Pacific Coast, for example,

reserves cover less than 1% of the total land area in both Sinaloa and Nayarit (CONANP, 2008). Despite few PAs, there are three priority JCUs in these two states (Chávez and Ceballos, 2006). The case of Sinaloa and Nayarit further highlights the importance of managing lands outside public PAs to support jaguar conservation in Mexico. Many species, jaguars included, have been persisting for decades on lands with no formal protection.

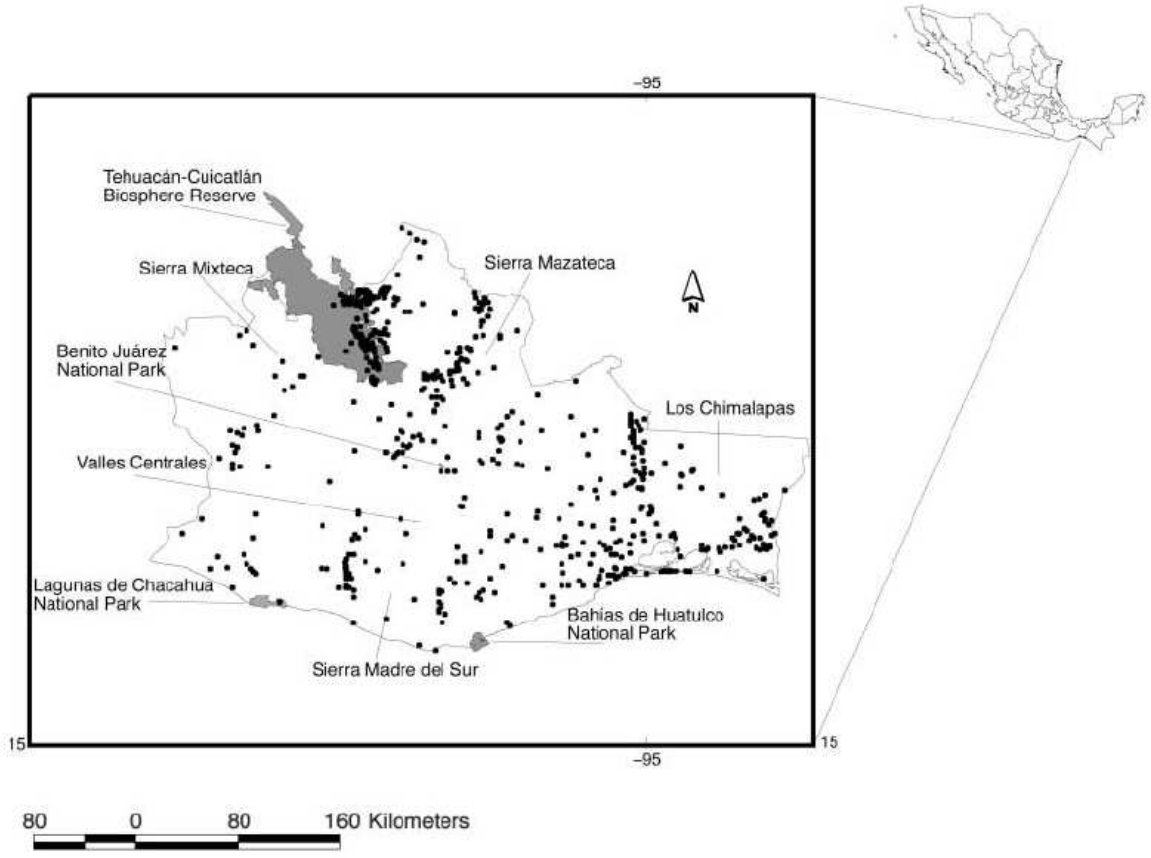
Figure 1.5: Protected Area Coverage in Mexico. (Modified from Jenkins and Giri, 2008).



RESERVE NETWORK IN OAXACA

As of 2008, Oaxaca has four federal NPAs, covering roughly 5% of the state's area. However, strictly protected sites comprise only 0.2% of the state (Figure 1.6) (Illoldi-Rangel et al. 2008). The Tehuacán-Cuicatlán Biosphere Reserve, considered part

Figure 1.6: Protected Areas in Oaxaca. Black Sites Represent Recorded Occurrences of Terrestrial Mammals.



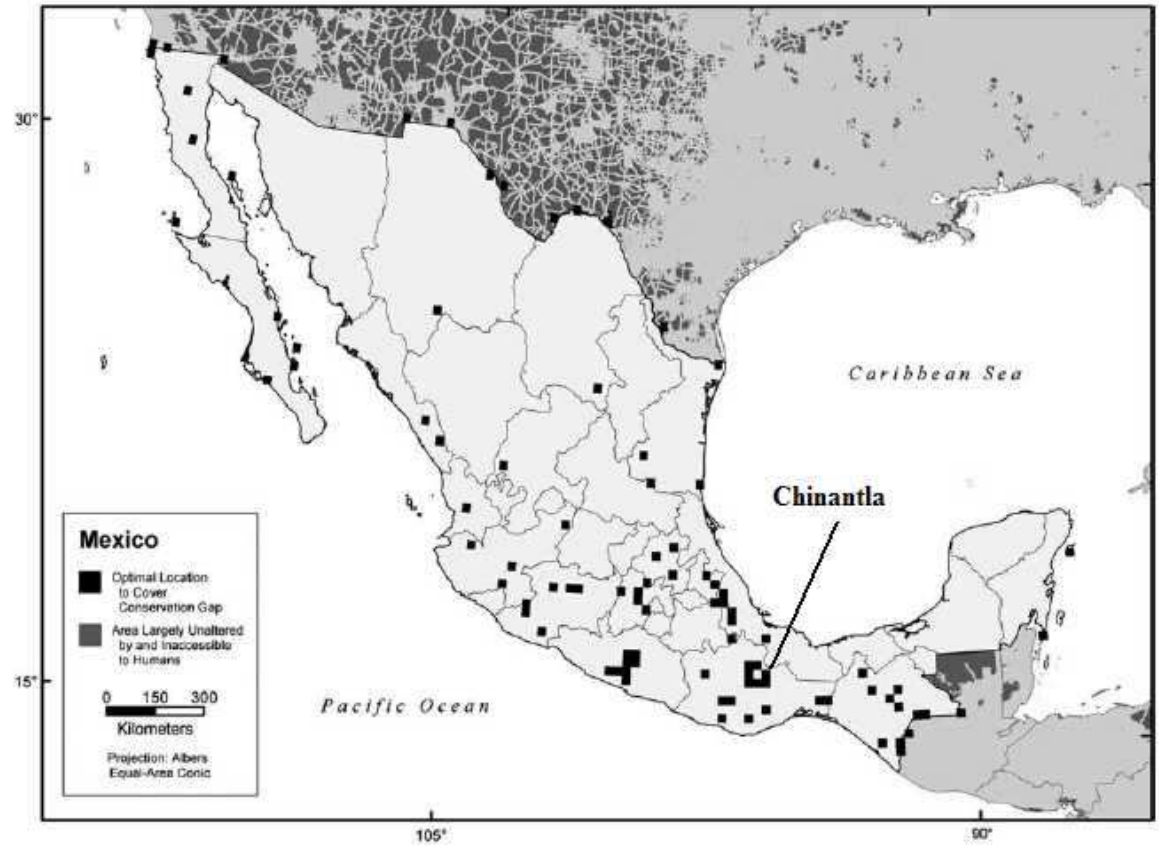
of the Mexican xerophytic region (Rzedowski, 1978) is the largest at 490,187 ha but this PA has no jaguars and pumas are "practically locally extinct" (Dávila et al. 2002). The other NPAs, Lagunas de Chacahua National Park (14,187 ha), Bahías de Huatulco

National Park (11,891 ha; of which 6,000 ha are terrestrial) and Benito Juárez National Park (2,737 ha), are too small to hold jaguars. A substantial amount of native biota must have been preserved in the absence of public parks (Robson, 2007) for Oaxaca to be labeled as one of the most biodiverse states (García-Mendoza et al. 2004) in one of the most biodiverse countries on earth (Mittermeier, 2004).

As mentioned before, the emergence of institutions connected with CPAs is one of the most promising new conservation practices in Mexico. The importance of this phenomenon was highlighted by a recent analysis of priority areas for biodiversity conservation in Mexico that identified the SNO as an area with outstanding flora and fauna diversity and a relatively low human footprint (Brandon et al. 2005). The study overlaid data on forests, agriculture, and wildlife to determine areas of rural Mexico that showed high forest cover, abundant wildlife, but little human presence as indicated by agriculture. The researchers found three major clusters of pixels in Mexico considered as ideal candidates for new public PAs. One cluster was the SNO and featured more than 30,000 ha of such land cover in the Chinantla, the area of study (Figure 1.7).

Brandon et al. (2005) did not include a land tenure layer in their study, which would have shown that the areas identified as having high conservation value are all community owned lands (Wilshusen et al. 2002). It seems apparent that something the communities have been doing over recent decades has produced this high conservation value landscape (Bray et al. 2008) and any new PAs would have to be instituted by the communities themselves.

Figure 1.7: Mexican Protected Area Gap Analysis (Brandon et al. 2005).



CHAPTER II

BEYOND PUBLIC PARKS: COMMUNITY FORESTS AND THE EMERGENCE OF COMMUNITY PROTECTED AREAS IN MEXICO

"Conservationists are becoming increasingly interested in land use issues beyond reserve boundaries, at corridor, ecoregional, and landscape scales to identify how strategies that support conservation and rural livelihoods might be better addressed away from protected areas."

(Brandon et al. 2005: p. 1413)

When A. Leopold made his prescient observation over half a century ago on the role of national forests in preserving large carnivores (see page 1), terms like "landscape-level conservation" or "genetic corridors" had not yet entered the conservation lexicon. The early National Park system was set up to conserve geological wonders or scenic

areas such as the geysers in Yellowstone and waterfalls in Yosemite (Lockwood et al. 2006). Preserving scenic "rocks and ice" took precedence over protecting biological diversity (MacKinnon et al. 1986). As habitat loss intensified, the field of landscape ecology grew in importance in the context of biological conservation at a regional rather than site-specific scale. Much of landscape ecology thinking is now rooted in the 'island biogeography' theory.

MEXICO'S COMMUNITY FORESTS IN THE CONTEXT OF ISLAND BIOGEOGRAPHY

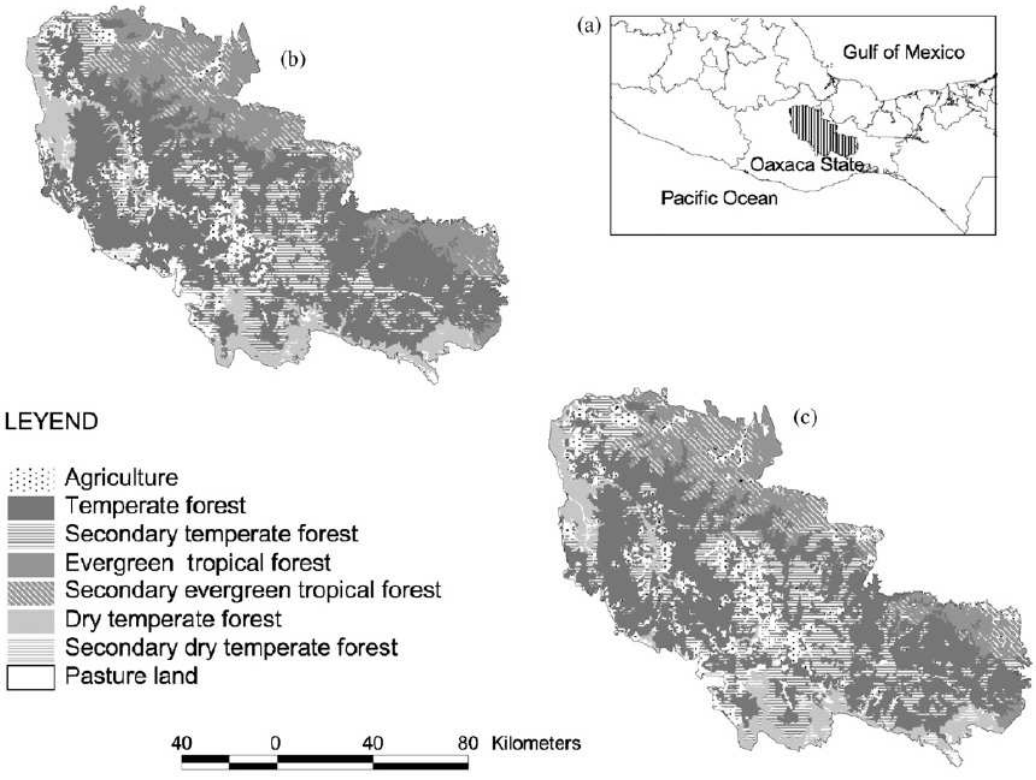
The island biogeography theory is based on the notion that the area in between patches of habitat (the 'matrix') is totally unsuitable for resident biota (MacArthur and Wilson, 1967). According to the theory, presence and persistence of wildlife species on true oceanic islands is governed by the size of the island, distance from the mainland, and habitat diversity on the island (MacArthur and Wilson, 1967). Species with limited dispersal capabilities are often at greater extinction risk in small habitat fragments than in a single habitat tract of the same total area (Diamond, 1975).

Principles of island biogeography are applicable to jaguars since their ability to disperse is dependent on adequate cover in the 'matrix'. Instead of oceanic islands, forested 'island' areas in Mexico have shrunk and large forested 'islands' are being broken into archipelagos of small 'islands'. The chances of a dispersing jaguar getting through a wide, low-cropped agricultural field are not much better than a non-aquatic island-dwelling mammal successfully crossing an open straight of ocean to get to an adjacent island. As space-demanding large carnivores at the top of the food chain, jaguars cannot persist in remnant scraps of natural habitat.

Thus the question now becomes: are the SNO community forests 'islands' or 'oceans'? Are they a source or a sink for jaguars? To what extent can human-dominated landscapes facilitate the movements of dispersing jaguars? These questions are broader in scale and beyond the scope of my thesis research but they should be targeted for future work on jaguars in north Oaxaca.

Figure 2.1 shows land-use cover changes in the SNO since 1980. Contiguous blocks of habitat do appear to exist along the Atlantic slope but further research is needed to determine the potential of these forests for facilitating jaguar dispersal. It is also important to pinpoint the locations of source populations so necessary corridors can be identified.

Figure 2.1: Land Use Change in the SNO. (a) Location of the SNO. (b) 1980 Land Use-Land Cover. (c) 2000 Land Use-Land Cover. Source: Gómez-Mendoza et al. 2006



COMMUNITY FORESTS IN MEXICO: COMUNIDADES AND EJIDOS

"It makes little sense to talk about creating village-level forestry cooperatives when the big players are wheeling and dealing in billion-dollar contracts signed at the level of ministers and presidents. It would make sense to talk about village-level forestry cooperatives if national policy actively favored them, but in too many countries that is not the case."

(Terborgh, 1999: p. 205)

Mexico is one of the few countries where national policy does favor community forestry. The massive transfer of natural assets from the state to the community level in Mexico appears to be virtually unparalleled among other nations in recent world history (Bray et al. 2006). Besides Papua New Guinea, no other country in the world has a greater proportion of forests in community ownership than Mexico (Klooster and Ambinakudige, 2005).

Driven by peasant demands for land, the Mexican Revolution prompted the redistribution of forested lands to communities. The Mexican agrarian reform process took place sporadically throughout the 20th Century and as time progressed the lands that were available for redistribution were increasingly in remote forested areas (Bray et al. 2006). Extensive land redistribution and agrarian reform policies left around 60% of Mexican forests in local community ownership (Bray et al. 2005).

Worldwide, an estimated 70% of all PAs have people living inside park boundaries (Terborgh and Peres, 2002). In South America approximately 84% of all national parks overlap with community lands and in many of these areas communities are regaining legal land and management rights (Amend and Amend, 1995). Some of these human-occupied parks have been successful in keeping the forest intact. For example, Nepstad et al. (2006) found Amazonian indigenous reserves in Brazil to be more effective

in inhibiting deforestation than uninhabited PAs in that country. This is a significant finding given the fact that indigenous lands cover one fifth of the Brazilian Amazon, which is five times the area under protection in parks (Nepstad et al. 2006).

Bhagwat et al. (2001) suggested that the most appropriate comparison by which to gauge PAs is not "no protection" but community-based management. Recent studies in Mexico have shown that differences between rates of land use change in some PAs and community forests are not statistically significant (Bray et al. 2005). For example Durán et al. (2005) found that community forests in Quintana Roo and Guerrero, in tropical and temperate forests, had low rates of land-use change compared to a national sample of 74 PAs. In some areas there has also been stronger tendencies for recovery of deforested lands in community forests than in PAs, although it was noted that this "does not necessarily say anything about what is going on beneath the forest canopy" (Bray et al. 2005). Further investigation is needed in community forests because standing forest cover alone is not an adequate criterion for assessing the status of wildlife (Redford, 1992), especially in human-inhabited forests where people and predators compete for wild meat (Jorgensen and Redford, 1993).

Hunting of wildlife can be intense in logging concessions where roads create access to previously inaccessible areas (Robinson and Bennett, 2000). In parts of the Chinantla and the SNO, community logging (albeit small-scale) has been a dominant activity for at least two decades (Bray, 1991) and, as has been noted, "there is virtually no information available on carnivore-logging interactions in the tropics" (Davies et al. 2001). However, recent studies by Ceballos et al. (2005) and Moreira et al. (2008) found healthy populations of jaguars and their prey in community- logged forests in southern

Quintana Roo and Guatemala's Peten region, respectively. The encouraging data on jaguars from community-managed forests makes the emerging institution of CPAs an even more promising mechanism for conservation in the larger landscapes of Mexico.

The SNO communities are developing new institutions and management practices around conservation (Wilshusen et al. 2002). They are also aware of the fact that their community lands provide jaguar habitat and that this is of interest to outside actors (Figure 2.2). Community activities in the SNO have been relatively sustainable because as stated by Heinen (1995), "cooperative management of resources is more likely to emanate from relatively small-scale, homogenous societies in which individuals have long-term reciprocal interactions and converging economic and social interests." In the case to be studied here, indigenous communities in the Chinantla represent such small and cohesive societies with evidence of millennial residence in the same region and communities (Bevan, 1938).

Figure 2.2 "Land of the Jaguar" Sign Constructed by Villagers in San Pedro Tlatepusco.

© J.J. Figel

COMMUNITY PROTECTED AREAS

"Protected areas of all types will not survive without people – inside them, using them in sensible ways, or outside them, respecting them and defending them."

(Redford et al. 2006: p. 2)

Since 1992, the top 10 forestry countries in the world have transferred ownership of 215 million ha of forests to communities (White and Martin, 2002). Worldwide, about 370 million ha of forest are owned by local communities, in comparison to the 470 million ha under government protection (Molnar et al. 2004). During the past two decades, the creation of new PAs as IUCN category I-III (sites under stricter protection) has been about equal to the amount of land declared under categories IV-VI (sites allowing sustainable use) (Naughton-Treves et al. 2005). Of the world's 98,400 terrestrial PAs, only 8,800 (8.9%) are listed under IUCN categories I or II (Naughton-Treves et al. 2005), which are the strictest categories. The shift from strict protection to a more socially centered approach was spurred by the widespread realization that PAs would inevitably fail if local people did not benefit from their creation (West and Brechin, 1991; Brandon, 1998; Chapin, 2004; Redford et al. 2006).

For example, in May 2005 squatters invaded a Wildlife Conservation Society (WCS) camp in Parque Nacional Laguna del Tigre in Guatemala, taking hostages and demanding rights to resources within the park. They claimed that their development took precedence over conservation and the rights of the local Qeq'chi indigenous people (Redford et al. 2006). When local people, especially those who depend on the forest for basic means of subsistence, feel like victims rather than beneficiaries of a PA, sustained conservation is a most difficult task (Bray, 2007). The example from the WCS camp also

highlights the importance of secure land tenure and clearly defined property rights (Bruner et al. 2001), two factors that have been instrumental to the establishment of CPAs in the Chinantla study area.

At the 1982 World Parks Congress in Bali, national governments were called upon to set aside 10% of their total land area in PAs. At the same conference, it was also declared that: "Protected areas in developing countries will survive only insofar as they address human concerns" (McNeely and Miller, 1982). Statements like the one from the World Parks Congress and other international conferences undoubtedly set the stage for the emergence of alternative PA management strategies. Community protected areas (CPAs) are one example of alternative PAs.

CPAs do not have much of a history in Mexico, or anywhere in the world for that matter. Running a search in WorldCat[3] in October 2008 under the keyword 'community protected areas' yielded only 62 results, a mere 1.8% of the 3,693 articles that result after searching for 'protected areas.' Another search, also done in October 2008, was conducted in the Web of Science online database under the 'article title' keyword search. Only 21 articles were found after searching for 'community protected areas,' a small fraction (2.5%) compared to 846 that resulted after the search for 'protected areas.' Of these 21 articles, 10 were on marine ecosystems. Thus only 11 were terrestrial and of these 11, the content of four was on tropical Asia, four on sub-Saharan Africa, and one on Japan. Only one article was based on a study from Mexico – Mersey et al. (2002) used the Sierra de Manantlan Biosphere Reserve in Jalisco as the setting for a case study looking at the roles Geographic Information Systems (GIS) can play in community-based

[3] These results are accurate as of October 2008, when this search was done. WorldCat is the world's largest bibliographic database with access to over 10,000 libraries worldwide.

management. Furthermore, every 'community-protected area' source dealt with the management of PAs, not communities declaring PAs on their lands.

According to Kothari (2006), CPAs are typically "informal" in the case of being officially unrecognized and their contribution to a country's conservation system often goes unnoticed and unsupported. There are, however, examples of full state recognition of CPAs that are fully integrated within the respective national PA systems (Kothari, 2006). Examples of CPAs that are recognized by national governments include the Indigenous Protected Areas (IPAs) of Australia (Smyth 2003) and Alto Fragua-Indiwasi National Park in Colombia (Zuluaga and Giraldo, 2003). In Namibia (where about 75% of all wildlife is found outside formal PAs), community conservancies are major contributors to biodiversity conservation (Nuding, 2002). The Kayan Mentarang National Park is co-managed by the Dayak people in Indonesia and the Madagascar government is considering legal options for the recognition of CPAs as part of its PA system (Borrini-Feyerabend et al. 2004).

IPAs and CPAs are an attractive option to governments because they effectively add to the nation's conservation estate without the need to acquire the land, and without the financial burden of establishing the infrastructure, staffing, housing and other costs of a state-managed PA (Oviedo, 2002). However, it was not until 2003 after the Vth IUCN World Parks Congress convened to sign the Seventh Conference of Parties to the Convention on Biological Diversity (CBD) that CPAs were recognized as equivalent, in many ways, to government-managed PAs (Kothari, 2006). A definition of CPAs that emerged from the congress was:

"*Natural and modified ecosystems with significant biodiversity, ecological and related cultural values, voluntarily conserved by indigenous and local communities through customary laws or other effective means.*"

Key elements of PAs according to the International Union for the Conservation of Nature and Natural Resources (IUCN) are:

- Geographical limits or boundaries;
- Predominantly aimed at achieving conservation benefits, but not excluding other related benefits;
- Designation and management by legal or other effective means;
- Existence of a body of governing rules; and
- Clearly identified organization or individual with governance authority

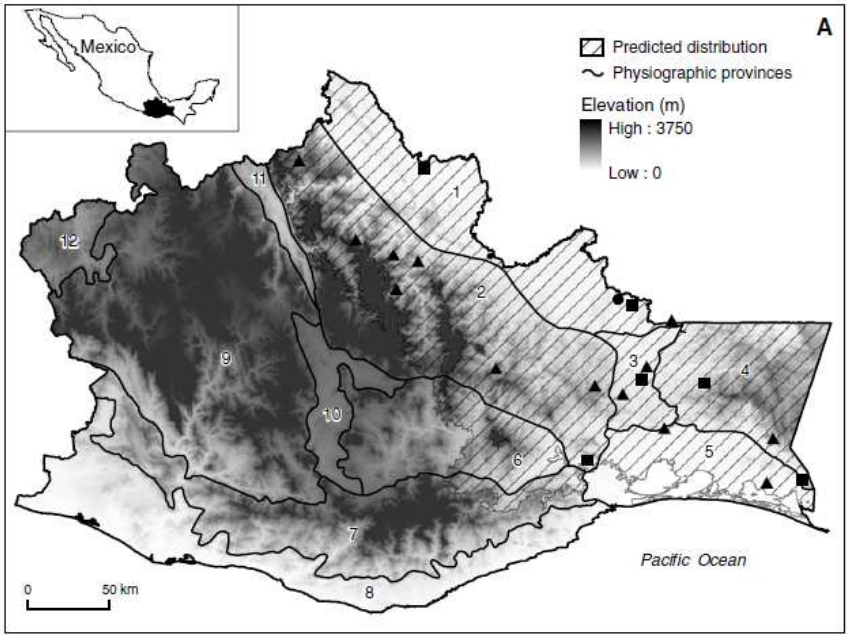
The CPAs declared by the Chinantec communities have all of these elements. Thus the question becomes: Are CPAs "true" PAs and if so, do they deserve recognition as such? The IUCN protected area category system is being updated to include a governance dimension, which will make it possible to include non-official conservation areas, such as CPAs, in national PA systems. The governance dimension is also to be added to the World Database on Protected Areas (WDPA), which will make it possible to list CPAs here as well (Kothari, 2006).

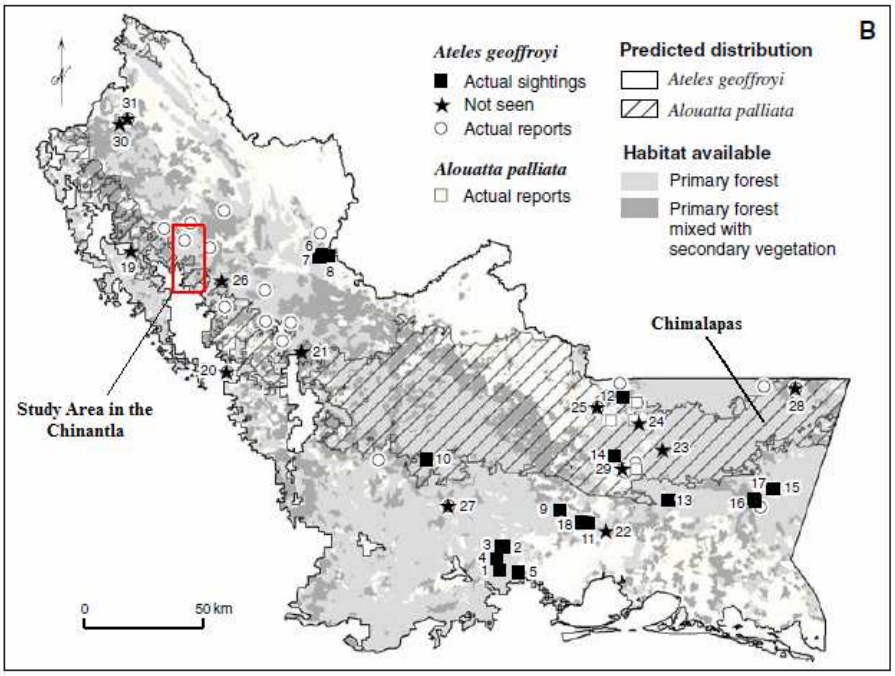
The first *ejido* land in Mexico to formally set aside land for conservation was not until January 2000 (McDonell and Vacariu, 2000). Some *ejido* lands hold significant wildlife populations, many of which are endangered. A single 4,047 ha tract in *ejido* Cebadillas in Chihuahua, for example, has been estimated to contain the nesting sites of up to half of all the remaining thick-billed parrots (*Rhynchopsitta pachyrhyncha*) in the

world (McDonell and Vacariu, 2000). Extirpated from Arizona and New Mexico, this endangered parrot is now restricted to forests above 1,200 m in the northern Sierra Madre Occidental (Howell and Webb, 1995).

Since 2003, the National Commission of Natural Protected Areas (CONANP) in Mexico has recognized 34 CPAs. Of these 34, 13 are in indigenous communities and 12 of these are in Oaxaca (Bray et al. 2008). Of the 12 CPAs in Oaxaca, at least five are known to protect habitat for spider monkeys (*Ateles geoffroyi*) and howler monkeys (*Alouatta palliata*) (Ortiz-Martínez et al. 2008). These same CPAs may provide habitat for jaguars as well since there are some similarities in habitat requirements between Neotropical primates and jaguars (Daily et al. 2003; Faller-Menéndez et al. 2005). Research is needed to see if howler and spider monkey habitat in the SNO is also sufficient for jaguars (Figure 2.3).

Figure 2.3: Elevation and Habitat Map for Howler Monkeys and Spider Monkeys in Oaxaca. These Same Forests may also Provide Habitat for Jaguars. Source: Ortiz-Martínez et al. 2008





PAYMENT FOR ENVIRONMENTAL SERVICES IN OAXACA

"Perhaps the most significant challenge facing both conservation and development is the need to support rural livelihoods by adequately assessing and capturing the value of environmental services."

(Kremen et al. 2000: p. 1828)

Markets rarely recognize or reward resource owners for the environmental services generated by natural ecosystems that are beneficial to society (Kremen et al. 2000). The watersheds of the Chinantla, for example, generate about 71% of all the electricity used in the state of Oaxaca (Aguilar, 2007) but this valuable ecosystem service went unnoticed until 2003. In 2003 the Mexican government took steps towards the difficult task of economically quantifying ecosystem services when it launched the 5-year Payment for Hydrologic Environmental Services (PSAH) program. PSAH provides

incentive for watershed protection and aquifer recharge by paying landowners as much as US $40 per hectare per year to keep the forest standing (Ellison and Hawn, 2005).

The PSAH program has clear rules for operation, establishment of a trust fund (*Fondo Forestal Mexicano*), and requires clear property rights for inclusion. Funding comes from a percentage of the federal fiscal revenue derived from water fees. Additional support comes from the World Bank, along with the Global Environment Facility (GEF). These organizations have committed $60 million for the expansion of PSAH and the Program to Develop Environmental Services Markets for Carbon Capture and Biodiversity and to Establish and Improve Agroforestry Systems (CABSA).

In 2004, one year after the PSAH was implemented, four Chinantec communities in the study area received certification from CONANP for declaring an intact cloud forest area as a CPA. PSAH gives landowners of primary forest cover in priority watersheds in the Chinantla a direct payment for maintaining forest cover. Priority watersheds are defined as over-exploited watersheds serving large populations (Ellison and Hawn, 2005). The National Forest Commission (CONAFOR) also awarded direct payment for a hydrological service program, which is an important event because it gave value to conservation practices in the Chinantla.

The study area communities, with the help of the Oaxaca City-based NGO Geoconservación, are also in negotiations with Grupo Modelo (Mexico's largest brewery) for payment for hydrologic services. Grupo Modelo's brewery is located in Tuxtepec, which lies downstream from these communities on the Papaloapan River. These communities have already received US $70,000 from Grupo Modelo for a

community administered research station in Santa Cruz. Construction on the research station was completed in the summer of 2008.

The PSAH program has provided incentive to protect the watershed and has been a significant element in the declaration of CPAs (J.J. Figel, pers. observ.) in the Chinantla because it gives economic value to conservation practices (D.B. Bray, pers. comm.). PSAH also holds potential as an important regulatory tool for poverty alleviation and watershed protection by providing a dependable source of income for poor, rural communities (Bray et al. 2003).

CHAPTER III
STUDY SITE AND METHODS

This study took place in four communities: Santa Cruz Tepetotutla, San Antonio del Barrio, San Pedro Tlatepusco, and Santiago Tlatepusco (hereafter Santa Cruz, San Antonio, San Pedro, and Santiago, respectively). Each community is located in the San Felipe Usila municipality. In this study, I will report on ecological and social data from all four communities: Santa Cruz and San Antonio (in the Rio Perfume watershed) and San Pedro and Santiago (in the Rio Santiago watershed). The CPAs are governed by a six-community regional association known as the Natural Resource Committee of the Upper Chinantla (CORENCHI).

This study was carried out in the context of an ongoing research project established between Florida International University (FIU), CIIDIR, and Geoconservación, a Oaxaca City-based non-governmental organization (NGO) working in the Chinantla. At the same time my fieldwork was being carried out, a larger study

focused on camera trapping for jaguar exclusively in the CPAs was being conducted by biologists from the Universidad Nacional Autónoma de Mexico (UNAM). Once complete, it is hoped that data from the UNAM study can be pooled with ours.

Table 3.1: Census Data and Community Protected Areas in the Study Area.

Locality	Population	Area (Ha)	Area Certified (Ha)	% of area conserved
Santa Cruz Tepetotutla	644	12,372	9,670	78%
San Antonio del Barrio	197	2,310	1,500	65%
San Pedro Tlatepusco	253	6,380	5,050	79%
Santiago Tlatepusco	552	5,928	4,300	73%
Total	1646	26,990	20,520	76%

Source: Geoconservación.

I was introduced to the Chinantla through a two-week course sponsored by CIIDIR-Oaxaca and FIU in May 2007. Over the course of my study, I spent a total of 65 nights in camp during four separate trips to the field (Jun-Aug 2007; Dec. 2007; May 2008; July 2008). The other days were spent processing film, entering data, stocking supplies, and meeting with local wildlife biologists in Oaxaca City.

STUDY AREA

"*Nowhere have the Chinantec effected a permanent transformation of the forest, and the Chinantla retains its true climax vegetation to a degree perhaps unequalled elsewhere in Mexico. Such is the habitat of the Chinantec – a luxuriant dripping forest, and where this forest comes to an end, there also ends their territory. So abrupt and striking is the transition that one finds along the very Chinantec border that the great hills present two different slopes: the one arid and treeless, or clad with a few oaks; the other moist and covered with dense tropical forest. The latter slope is Chinantec; the former belongs to another tribe.*"

(Bevan, 1938: p. 11)

Derived from the Aztec word *chinamitl*, meaning an "enclosed space," (Bevan, 1938) the Chinantla (17º22'-18º12'N and 95º43'-96º58'W) is a remote and rugged territory covering approximately 366,243 ha (~3,660 km²). The region is part of the northern humid zone (Goodwin, 1969) in the Sierra Norte of Oaxaca (SNO),[4] a mountain range 300 km long and 76 km wide (Figure 3.1). Elevations in the Chinantla range from 200 to 3,200 m and topography is very abrupt with slopes ranging between 10 and 50º (Velázquez-Rosas and Meave, 2002). Some estimates have the Chinantla as the third largest area of contiguous rain forest in the entire country (Aguilar, 2007), after the Lacandona jungle in Chiapas and the Chimalapa region in Oaxaca's isthmus.

The Chinantla has been labeled a "hyper-humid" region (Meave et al. 2006) because it is one of the wettest areas of Mexico. Velázquez-Rosas and Meave (2002) even called it "the rainiest region of Mexico" and recorded a mean annual precipitation of 5,800 mm from an abandoned meteorological station located at an elevation of 1450 m in Santa Cruz. Mean annual precipitation and temperatures of 3,590 mm and 24.9 ºC, and 4,000 mm and 24.8 ºC were recorded for two lowland localities (Rzedowski and Palacios-Chávez, 1977; Meave et al. 2006).

[4] The Sierra Juarez is another term often used for this region (Bray, 1991).

Figure 3.1: Sierra Norte of Oaxaca Map. Source: Martin, 1996.

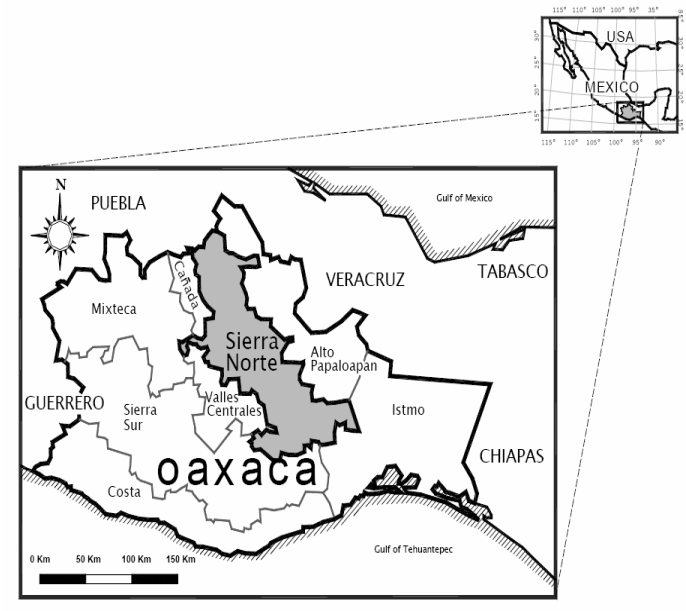


Figure 3.2: The Chinantla. Tuxtepec (pop. 145,000) is the major city and jungle port in the immediate area.

The high rainfall in the Chinantla is of significance for jaguar conservation because, with the possible exception of tigers (*Panthera tigris*), jaguars are more commonly associated with water than any other big cat (Hoogesteijn, 1992; Sunquist and Sunquist, 2002). In his book *Wild Cats of the World*, author C.A. Guggisberg (1975) even called jaguars "semi-aquatic" in some parts of their range. The ecological association with water can be traced back to ancient times in Mesoamerica where Olmec artworks depict the jaguars surrounded by sea shells and swimming in water (Benson, 1972).

Most scientific research in the Chinantla has been focused on ethnobotany (Schultes, 1941a; Martin, 1996; van der Wal, 2002; Murphy, 2005) and floristic inventories (Rzedowski and Palacios Chávez, 1977; Romero-Romero et al. 2000; Rincón Gutiérrez, 2007). The late Richard Evans Schultes (1915-2001), considered by some to be the father of modern ethnobotany (Davis, 2001), completed his fieldwork in the Chinantla for his dissertation from Harvard University. Wildlife research pales in comparison to the floristic work, although recent studies by students and biologists from CIIDIR-Oaxaca have begun to remedy this (Luna, 2005; Pérez et al. 2006; Prisciliano-Vázquez, 2008). Despite the preliminary data collected during this study, the Chinantla remains an area where the status of jaguars is largely 'unknown.'

The Chinantla has been classified as an "unknown area" not only from the standpoint of jaguar research but also because the region's territorial limits were not accurately defined until 1936 (Paray, 1951; Cline, 1957). In reference to its inhabitants and the isolation of the region, Cline (1959) wrote: "Relatively little is known of their

past…and the mountain Chinantec are still difficult of access and retain a high degree of monolingualism in their tonalized native dialect."

The study area is entirely roadless with the exception of a 45 km dirt road extended from the paved highway (Figure. 3.3). This road penetrated the study region in May 2003 and Santa Cruz is the only community with current access to the road[5]. Due to

Figure 3.3: Road to Santa Cruz. Steep Slopes and Dense Vegetation are Characteristic of the Region

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the ruggedness of the terrain and lack of forest trails, horses, mules and other domesticated beasts are not commonly used by the local people. Almost all transportation is done on foot (Figure 3.4). It is not surprising that much of the Chinantla has still not been completely mapped.

[5] As of this writing, this road was being extended to a second community, San Antonio del Barrio. The four other communities in the region remain roadless.

Figure 3.4: Author Crossing the Rio Santiago on a "Hammock" Suspension Bridge.

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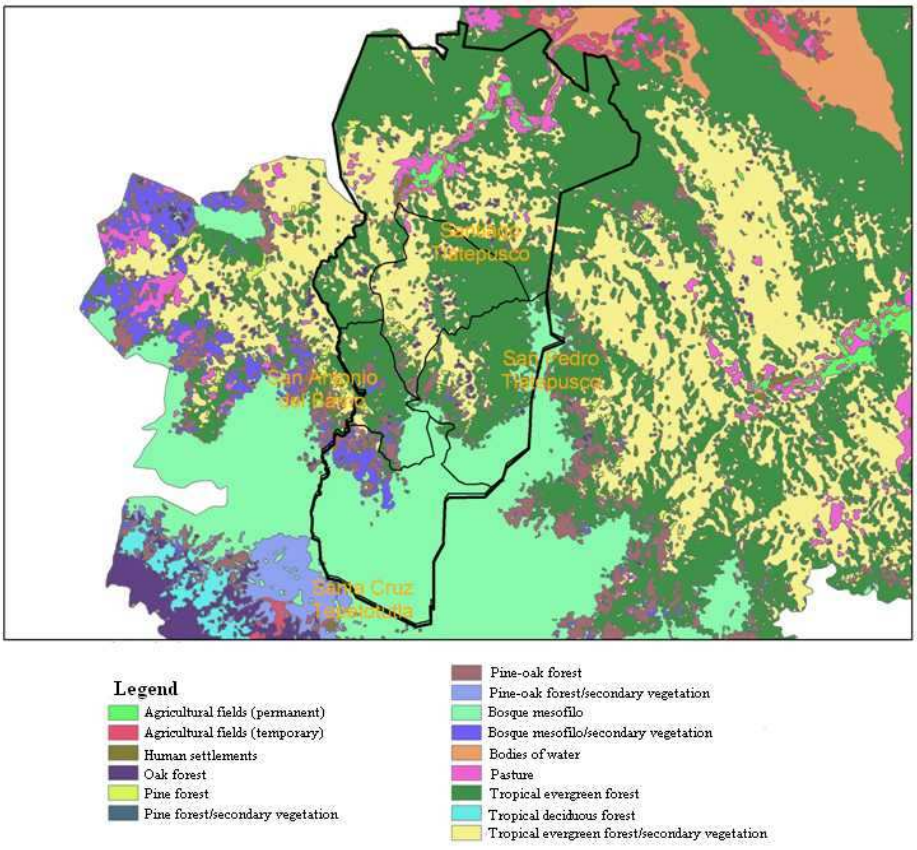
VEGETATION IN THE CHINANTLA

Three ecoregion types are found in north Oaxaca: Sierra Madre de Oaxaca pine-oak forests, Oaxacan montane forests, and Petén-Veracruz moist forests (Dinerstein et al. 1995). The main vegetation types in the Chinantla are temperate pine-oak forest (about 2000-3200 m), oak and oak-pine forests (1400-2000 m), dry tropical forest, agriculture and livestock land (1000 - 1200 m), cloud forest (1000 – 2600 m), and tropical evergreen forest (200 – 1600 m) (Martin, 1996) (Figure 3.5). Some of the most diverse and extensive of Mexico's remaining montane cloud forests are found in the Chinantla (Stattersfield et al. 1998). In reference to cloud forests, Archie Carr (1953:5) noted: "Each of the transition areas between these vertical zones (of cloud forests) is the

equivalent of many miles of latitude in the faunal and floral changes it brings." A notably diverse assemblage of flora species occur in the cloud forests, many of which are endemic and threatened (García-Mendoza et al. 2004).

Of all habitats found in Oaxaca, the SNO pine-oak forests rank among the highest in terms of biological richness and endemism of fauna (Ceballos et al. 1998). Oaxaca has the highest oak richness in Mexico with 70 species (Kappelle, 2006) and the Chinantla is one of the few areas in the country where large, undisturbed tracts of oak forests still remain (Meave et al. 2006).

Figure 3.5: Vegetation in the Study Area.



Source: Geoconservación

The SNO is the world's greatest centre of endemism for the genera *Pinus* and *Quercus* and also has the greatest area of pine forest in Oaxaca (García-Mendoza et al. 2004) in a country that has more pine species than any other nation. Both pine and oak reach their highest global diversity in the SNO ecoregion (Mittermeier et al. 2005). Some of the mature stands have been managed for commercial timber production (Bray, 1991), while others, like the region of study, have low extraction rates due to inaccessibility, lack of commercial species, and community action.

Another habitat type known in Mexico as *bosque mesófilo de montaña*[6] (BMM) is also found in the Chinantla. BMM is a general category that includes transitional forests between lowland tropical forests and highland pine-oak forests. Dominant tree species found in BMM habitat in Santa Cruz include: *Oreomunea mexicana, Ticodendendron incognitum, Clethra integerrima, Miconia trinervia, Matayaba oppositifolia, Swartzia sp., Rheedia edulis y Gautteria galeotiana, Cyrrila racemifolia* (Rincón Gutiérrez, 2007).

NOTES ON JAGUAR HABITAT QUALITY IN THE CHINANTLA

"A feature of the cloud forests almost as striking as the lavishness of their plant life is their relative poverty in animals – a poverty both in species and in individuals, but most markedly in the latter."

(Carr, 1953: p. 8)

Abundant prey, access to water, and adequate cover are the three most important characteristics of high quality jaguar habitat (Medellín et al. 2002). High elevation *bosque mesófilo* covers 58,073 ha in the Chinantla, representing 16% of the total land area of the region (Romero-Romero et al. 2000). *Bosque mesófilo* and cloud forests are

[6] Another term for these forests is *bosques tropicales humedos de montana* (*BTHM*) (Rincón Gutiérrez, 2007) which translates to montane humid tropical forests.

not ideal jaguar habitat (Hoogesteijn and Mondolfi, 1992) because these high elevation forests are usually marked with more rugged terrain and thus a poorer prey base. On the basis of research in southeastern Peru, Pacheco et al. (1993) showed that there was a net loss of about 80% of mammalian species richness (both bats and nonvolant mammals) along a habitat gradient from lowland rainforest to tree-line. They recorded 149 species below 500 m and only 26 were found above 300 m.

These findings have important implications even for opportunistic predators such as jaguars because prey encounter rates are probably significantly lower at higher elevations. Most mammals that occur in lowland rainforest do not occur above 1500 m (Voss and Emmons, 1996). Although the Chinantla does have significant areas of lowland evergreen tropical forest, the region is characterized by high elevation cloud forest and transitional or montane tropical forests with very steep slopes (Figure 3.6). Hoogesteijn and Mondolfi (1992:25) suggested that cloud forests are not optimum jaguar habitat: "Unlike the puma, the jaguar, although occasionally passing through, does not adapt to zones above 1,500 – 2,500 m elevation." However, this claim has been refuted by some, such as Brown and López-González (2001:61) who stated: "Although jaguars in Central and South America have been reported to prefer wetter, lower sites and larger prey than pumas, such is not necessarily the case in Mexico and the American Southwest." It is thus an unresolved question to what extent these steeper slopes and montane tropical areas provide in terms of supplementary habitat for jaguars in Mexico.

The declaration of the CPAs, monitoring of the rules to support conservation, and high rates of agricultural abandonment due to emigration all suggest that forest cover has expanded in the Chinantla, potentially creating more jaguar habitat. In recent years,

widespread agricultural abandonment associated with emigration has led to more extensive areas of secondary succession and overgrown coffee plots near the villages (D.B. Bray, pers. comm.), which may help explain more reported jaguar forays into the village edges.

Figure 3.6: Atlantic Slope View of the Chinantla.

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Secondary forests, agricultural areas, pasture, and patches of intact mature forest are found on the slopes from 200 m up to around 1600 m in the study region. Interspersed throughout the diverse habitats in the Chinantla are coffee plantations, *milpas* (maize fields), *frijolares* (bean fields), sugarcane fields, home gardens, and fallow fields. Such a mosaic of habitat types could offset inferior jaguar habitat quality in the

Chinantla by providing foraging opportunities for ungulates and other herbivores (Davies et al. 2001; J.J. Figel pers. observ.).

Brocket deer and other browsers feed on the ground vegetation around small clearings, especially where maize, beans and other food crops have been planted. In the Peruvian Amazon, Naughton-Treves (2002) labeled adaptable, fast-reproducing species such as paca and armadillo "anthropogenic fauna" because they benefited from the supplementary food sources in the villagers' swidden gardens. Rabinowitz (1986a) found that prey species abounded in the second growth and edge habitats at his study site in Belize. Some prey species such as collared peccary and brocket deer may actually be more abundant in these areas of agricultural/forest mosaic because primary forest typically does not produce year-round availability of foods for forest ungulates and herbivores (Leopold, 1959; Davies et al. 2001; Naughton-Treves, 2002).

If habitat types such as secondary forests or mosaics of degraded forest and plantation forest such as those found in the Chinantla do indeed provide better foraging habitat for prey species, higher jaguar densities could be supported (Karanth et al. 2004). In a field study on Sumatran tigers (*Panthera tigris sumatrae*), sambar deer (*Cervus unicolor*) were most common in forest edge habitats and densities of wild pigs (*Sus scrofa*) were four times as high in gardens and farms on the parks edge as they were in primary rainforest (Griffiths, 1994). Sambar and wild pigs are important tiger prey species (Schaller, 1967).

It has also been noted that congregations of browsing prey species such as brocket deer and tapir (*Tapirus bairdii*), which feed on the ground vegetation of recently logged forest, caused associated rises in jaguar densities in Peru (Johns, 1997). In the Chinantla,

certain prey species such as coati and collared peccary may actually be better suited for habitat disturbance (Davies et al. 2001), thus possibly supporting higher density of jaguars. A trapping rate index of abundance for prey species was estimated from camera traps, which is discussed in the next section.

ECOLOGICAL METHODS: CAMERA-TRAPPING

INTRODUCTION

Censusing populations and addressing parameters such as population size, density, survival and recruitment (Karanth, 1995) is critical information for jaguar conservation. However, most techniques for estimating jaguar densities are ineffective because they fail to incorporate three important ecological characteristics of the species: scarcity, extensive range, and secretiveness (Karanth and Nichols, 1998). Early population estimates for jaguars and other large cats were not generated from statistically robust analyses on sampled populations.

For example, Indochinese tiger (*Panthera tigris corbetti*) numbers were estimated from percent forest cover in Thailand (Rabinowitz, 1993); snow leopard (*Uncia uncia*) population estimates in northwest India and Nepal were derived from the frequency of scrapes observed in valley bottoms (Jackson, 1979); and track surveys were used for early estimates of tigers in India and Nepal (see Karanth, 1987 for an argument against the latter technique). Monitoring and conservation plans have been impeded due to the lack of systematic population estimation.

Adapted from pioneering studies on tigers in India (Karanth, 1995), photographic capture-recapture models are now the most efficient and commonly used

method for estimating densities and other population parameters of jaguars throughout the range of the species (Silver et al. 2004). However, most camera-trap research on jaguars has been conducted in lowland tropical forest, which favors such studies from a logistical standpoint and also because the cats generally reach higher densities at lower elevations (Sunquist and Sunquist, 2002). With the exception of the Chinantla and northern Sonora, all sites in Table 3.2 are in lowland tropical forest. But jaguars occur in large tracts of other habitat types in Mexico where little is known about their ecology relative to other JGRs (Sanderson et al. 2002a). Data is needed in the "unknown" areas for national jaguar conservation plans.

Table 3.2: Camera-Trap Studies on Jaguars in Mexico

Site	State	Dominant Habitat Type	Elevation (m)*
Aros-Yaqui Region[1]	Sonora	Sinaloan thornscrub (ST)/ Oak woodland (OW)	400-1400
Rio Aros Basin[2]	Sonora	Sinaloan thornscrub	400-1200
El Zapatol Private Reserve[3]	Yucatan	Tropical semi-evergreen	100-250
Selva Lacandona[4]	Chiapas	Tropical moist lowland forest	600-1000
Calakmul Biosphere Reserve[5]	Campeche	Semi-deciduous forest	260-385
Chinantla[6]	Oaxaca	BMM†/tropical evergreen	414-1997

Source: The entries in this table were compiled by the author.

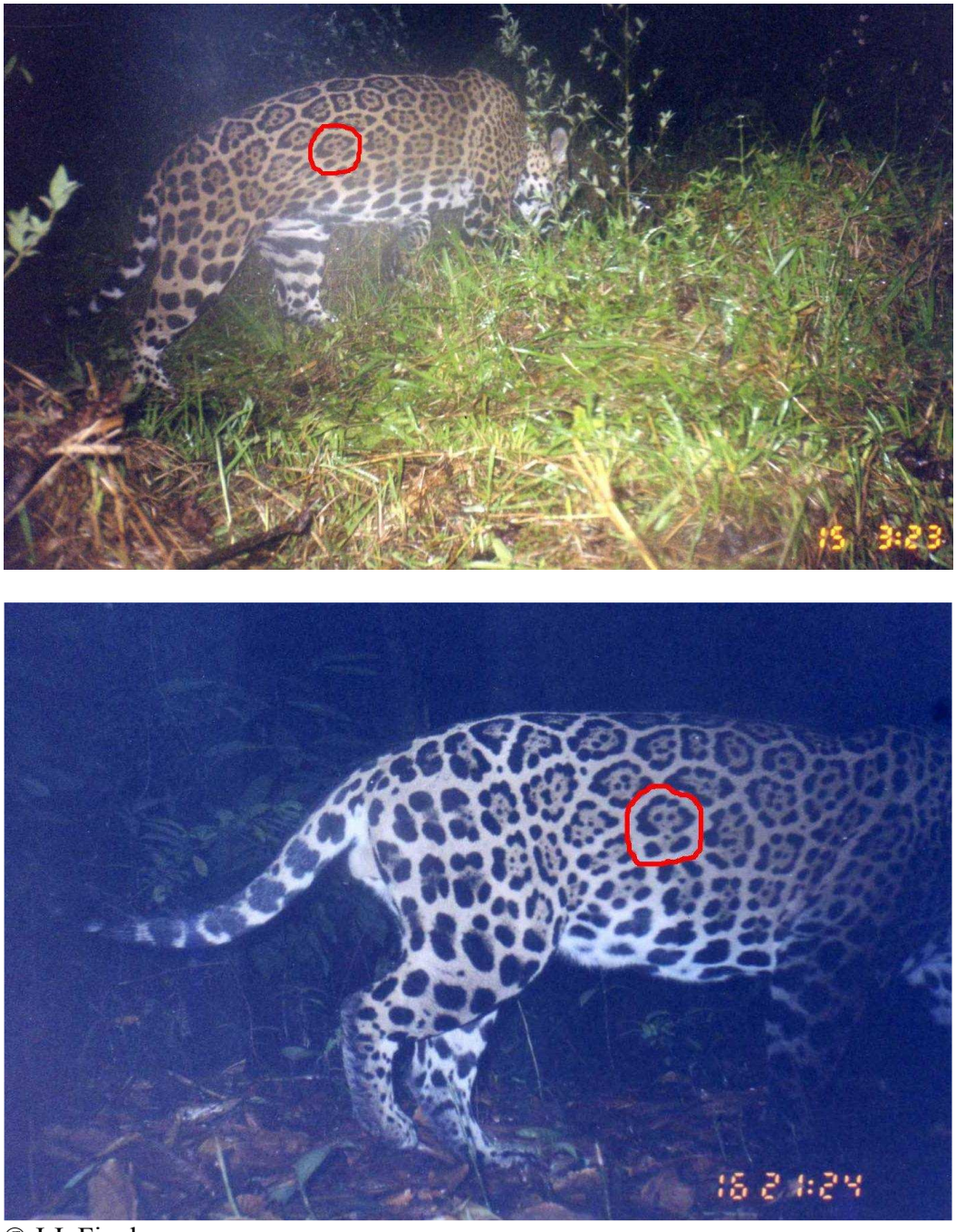
* Estimated elevation of the reserve or region where camera trapping took place.
† *Bosque Mesófilo de la Montaña*
[1] Lopez-González and Lorenzana Piña, (2002)
[2] Rosas-Rosas, O.C. (2006)
[3] Faller-Menéndez et al. (2005)
[4] Azuara (2005)
[5] Ceballos et al. (2005)
[6] Figel et al. (in submission)

Camera-trapping studies on jaguars yielded large variations in density estimates based on trap placement and other study design characteristics (Maffei, et al. 2004; G. Ayala, pers. comm.). In a comparison of jaguar densities across five study sites in Belize and Bolivia, a range of 18-66 camera stations were used ($\bar{x}$ = 32) to sample a range of 137-458 km² ($\bar{x}$ = 226.6 km²) (Silver et al. 2004). Salom-Pérez et al. (2007) were able to make a density estimate for jaguars using only 12 trap stations in an 86 km² study area in Corcovado National Park, Costa Rica. Subsequent research by Maffei and Noss (2008) would suggest that a survey area of only 86 km² is too small thereby inflating population estimates. With too small a sample area (i.e. Salom-Pérez et al. 2007), there is always a risk of edge effect increasing the chances for accounting partial residents in density estimation (Henschel and Ray, 2003). Flawed data collection can skew population estimates and pseudoreplication can significantly bias density results from subsequent studies (Anderson, 2001).

One of the most important assumptions in camera-trapping is to ensure that every animal inhabiting the study area has at least some probability of being photographed (Karanth and Nichols, 2002). During this study, camera-traps were placed to ensure that there were no holes or gaps within the study area that could contain the home range of a single jaguar, thus rendering a zero capture probability. Since each jaguar has a unique coat pattern as in a human fingerprint (Figure 3.7), individual cats can be identified and given "capture-histories" enabling researchers to estimate various population-related parameters. (Figure 3.6 shows how one of the two jaguars 'photo-captured' in the study area was identified by its distinctive spot not unlike the face of a ghost).

Since there is no minimum home range estimate for a female jaguar in the Chinantla (Ramos-Fernández et al. 2007) or in Mexican pine-oak forest (M.J. Kelly, pers. comm.), the commonly cited figure of 10 km² based on research in Belize was used as the

Figure 3.7: Example of how Jaguars can be Identified by their Unique Coat Patterns.



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"best guess" for this study (Rabinowitz and Nottingham, 1986). The 10 km² for the two un-collared resident female jaguars in Belize was calculated by tracks, which has been recognized as an unreliable census method (see Karanth, 1987). Nonetheless, 3.6 km (the diameter of a circle with an area of 10 km²) was used as the maximum straight line distance between cameras because most other jaguar camera trap studies have used this estimate (Silver et al. 2004) and I wanted there to be as little variation as possible in terms of survey design between my study and other studies.

Cameras were activated 24 hours/day. Forest trails, waterways, and natural "funnels" such as valley bottoms and hill ridges served as the major "trap-lines" traversing the sampled area because jaguars have been documented to use such areas as travel routes (Rabinowitz and Nottingham, 1986; Figel, 2005) (Figure 3.8). No lures were used to attract jaguars or other animals. Lures could alter jaguar behavior and ranging patterns.

Figure 3.8: Camera-Traps Showed Jaguars Often Used the Same Trails as Villagers

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Some of the more accessible camera sites were monitored every 7 – 10 days, but most cameras were left for *c.* 1 month before they could be checked. The number of trap days for each film was defined as the period beginning with camera activated until the film was retrieved, if the film had exposures remaining, or until the time and date stamped on the final exposure.

A pilot study was conducted from June - August 2007 with 12 cameras (Deer Cam™ DC-200, 860 Park Lane, Park Falls, WI 54552) set for a total of 387 trap nights (TN). Camera sites were chosen based on areas that had jaguar or prey signs. Sites were recorded using a handheld GPS unit (Garmin GPSMap 76S, 1200 East 151st Street, Olathe, KS 66062) and the locations were logged onto topographic base-maps using MapSource™ software and a laptop computer. Camera-traps were placed at locations to maximize the possibility for camera-trapping jaguars while also covering as large an area as possible to increase the probability of photo 'capturing' a maximum number of individuals. Since only 12 units were available during the pilot study, camera-traps were sometimes moved to sites that had recent signs of either jaguar or prey species, thus increasing the probability of 'photo-captures'.

During the pilot survey, cameras were set at an average elevation of 1,104 meters (± 345 m). Cameras accumulated a total of 40 TN on the gravel road leading into Santa Cruz. Despite its higher elevation, I thought the road would make an ideal 'trap-line' because it was a limited resource and big cats generally use convenient routes for travel and hunting (Schaller, 1967; Rabinowitz, 1983; Sunquist and Sunquist, 2002; Henschel and Ray, 2003; Figel, 2005).

Camera-trap monitoring continued from September 2007 through April 2008. I returned to the United States after the first field season in mid-August 2007 to attend Fall semester courses at FIU. Because of funding received by the Wildlife Conservation Society's (WCS) Jaguar Small Grants Program, I was able to return with six more cameras in December 2007. Thus, a total of 18 cameras (14 Deer Cam DC-200 units, 2 Camtrakker™ units, Camtrak South Inc., Watkinsville, GA, and 2 Cuddeback digital 3.0 mega pixel cameras, Non-Typical Inc., Park Falls, WI) operated from December 2007 through the completion of the camera survey in June 2008. My research assistant J. Rogelio Prisciliano-Vázquez made three trips back to camp to continue interview surveys and change the film and batteries at camera-trap stations.

After both flanks of one jaguar were photographed simultaneously at a camera station in April 2008, cameras were deployed individually. Pairing cameras is probably more important in areas with higher jaguar densities (J.J. Figel, pers. observ.) because of the greater likelihood that jaguars will pass the cameras and individuals have to be identified from both flanks for population analyses (Karanth and Nichols, 2002). It is a trade-off but I thought it would be more important to cover a larger sampling area then reducing this coverage by pairing cameras. Sampling too small an area runs the risk of overestimating densities. For example, Maffei and Noss (2008) found that if the study area covered by camera-traps is reduced to less than three to four times the average home range for the target species, then density estimates from camera-trapping were exaggerated. Although paired cameras is recommend for camera-trapping studies (Karanth and Nichols, 2002), some researchers were able to do analyses using only one flank of the study animal (i.e. O'Brien et al. 2003 with Sumatran tigers).

For estimating the total area surveyed, Karanth and Nichols (1998) recommend computing a boundary strip width using the Mean Maximum Distance Moved (MMDM) for all individuals that are captured on more than one occasion. Since only one of the two jaguars was 'photo-captured' at least once, the effective trap area had to be calculated by adding ½ of the trap spacings to the grid area (Skalski and Robson, 1992):

$(a + s)(b + s) - (1- .25\pi)s^2$

where a and b are the grid length and width, respectively.

Jaguar density can then be estimated as

D = N / A(W),

Where D=Density, N=Number of Animals in the Sample, A=Sample Area without buffer, W=Width.

SOCIAL SCIENCE METHODS:

This study used informal, semi-structured, and structured interviews, as well as participant observation, with the help of two undergraduate thesis students from Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional, Unidad Oaxaca (CIIDIR – Oaxaca), José Rogelio Prisciliano-Vázquez and Liliana Andres-Cruz, both under the supervision of Dr. Elvira Durán. Interview data were entered into an excel spreadsheet, coded, and analyzed using the Statistical Package for the Social Sciences (SPSS). Due to small sample sizes, most of the data presented in this thesis is descriptive statistics. Interview results are presented in chapter V on human-wildlife interactions in the Chinantla.

SEMI – STRUCTURED INTERVIEWS

Semi-structured interviews were applied first to get an overview on the nature of human-jaguar relations in the study area. In semi-structured interviews, respondents give extensive responses to a series of general questions, some of which have been prepared in advance and some of which arise naturally during the course of the conversation (Martin, 1996). Interviewees were selected through snowball sampling and asked to give a narrative on any jaguar-related experiences. Interviewees were asked to describe the nature of the incident in as much detail as possible, i.e. a jaguar sighting or case of domestic livestock depredation.

Semi-structured interviews were not used for comparisons across villages because the interviewees were not asked the "same" questions. As stated by Bernard (1995:349), semi-structured interviews are best used in the early stages of investigations…"but such probes quickly leads to more specific, fact-finding questions." Data on more detailed information concerning villager perceptions of jaguars and other wildlife were collected through the application of structured interviews.

STRUCTURED INTERVIEWS

Structured interviews involve asking a group of selected informants to respond to the same set of questions, which allows for a valid comparison of data (Bernard, 1995). This approach is a quantitative technique that can be analyzed with various statistical methods (Martin, 1996). Data on jaguar presence/absence, prey availability, hunting, and livestock depredation were collected using standardized interview forms modified from

other big cat surveys (Hean, 2000; Conforti and Azevedo, 2003; Brechin et al. 2005) (see Appendix 1b for the complete set of interview questions).

Laminated sheets with animal photos were used to avoid confusion about local names of certain species. The laminated sheets had pictures of wild cats (both native and nonnative species), prey animals, and other species of interest such as harpy eagles (*Harpia harpyja*) and the spider monkey, an endangered primate restricted to the Atlantic slope of the SNO (Ortiz-Martínez et al. 2008). When questioning about wild cat species present in the study area, photos of non-native felids were included as a way to test the reliability of the interviewee (Rabinowitz, 1997). Included on the photo sheets were pictures of Canadian lynx (*Lynx canadensis*), common and white Bengal tigers, and a maned male African lion (*Panthera leo*), none of which occur naturally in Latin America. If a respondent did say a nonnative cat species occurred in his community, it was important that the interviewer kept a straight face without laughing or frowning (J. Rogelio Prisciliano Vázquez, pers. comm.). That way the interviewee would not be uncomfortable or give biased answers based on what he thought we might want or expect to know.

A total of 84 structured interviews were applied in all four communities (49 in the Rio Perfume watershed and 39 in the Rio Santiago watershed). Roughly 25% of the population in each community was interviewed. 8.2% (n=7) of the structured interviews had to be translated with the assistance of a villager who spoke both Spanish and Chinantec because many of the village elders were monolingual, speaking only their native tongue.

CHAPTER IV

CAMERA-TRAPPING RESULTS WITH NOTES ON JAGUAR PREY IN THE CHINANTLA

The first photograph of a jaguar was taken on October 22, 2007. Over the course of the study, two individual jaguars[7] were 'photo-captured' (Figure 4.1) over an 11 month sampling period in a total sampling area of 144 km². The effective sampled area was estimated by adding ½ of the trap spacings to the grid area, as explained in the previous section on camera-trapping methodology. With these data, I was able to calculate a crude density estimate of 1.39 jaguars/100 km² for the Chinantla[8].

One jaguar had a maximum distance moved (MDM) of 12.6 km and was photographed at five different sites, enabling a minimum home range size calculation of 17.8 km² (Figure 4.2). This is the first such home range estimate for both the Chinantla and in cloud forest/*bosque mesófilo* habitat. However, with only five sample points, the estimate of 17.8 km² is no doubt only a fraction of the true home range size. For example in a study combining the use of camera-traps and GPS telemetry in the Brazilian Pantanal, Soisalo and Cavalcanti (2006) found that jaguar home ranges estimated from camera trap data were, on average, only 8-9% of the true ranges found from telemetry. If a similar ratio were applicable to my study area, a male jaguar in the Chinantla would have a home range of between 198 – 223 km².

Jaguar photographs were taken at an average elevation of 1,195 m (± 224). A total of 1,164 TN were accumulated from June 2007 - June 2008, resulting in 7.82 jaguar

[7] In September 2008, another jaguar was reportedly photographed in the same study area by camera-traps owned by Geoconservación (E. Durán, pers. comm.).

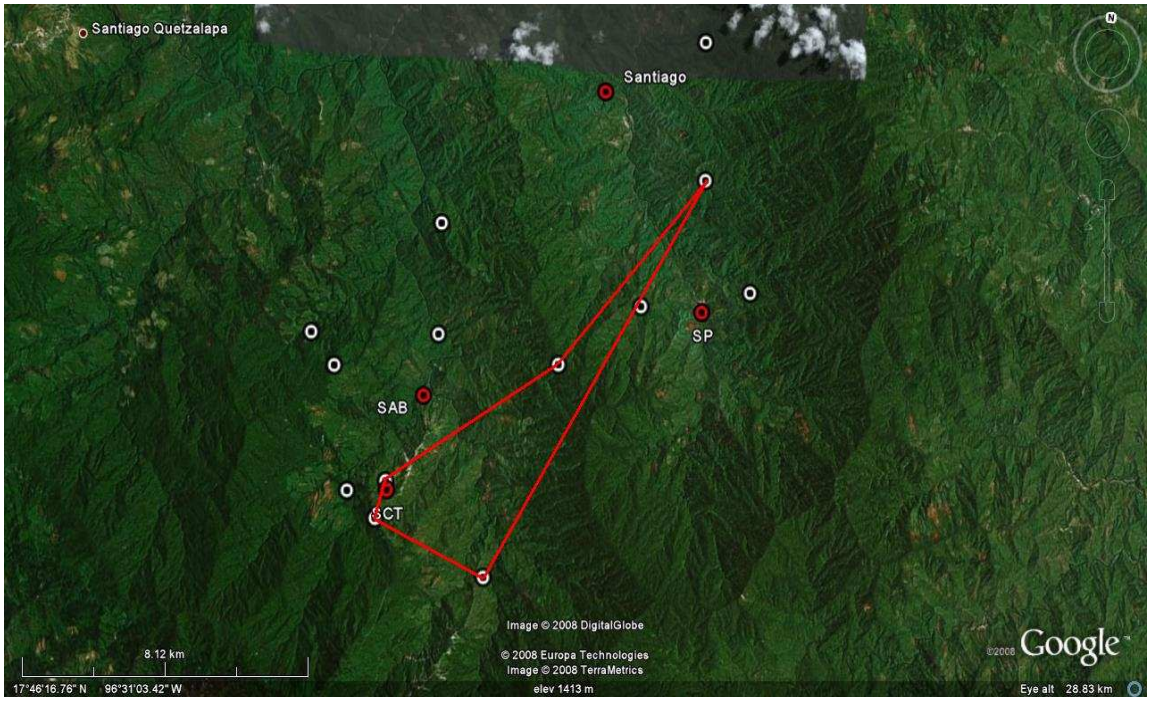
[8] It is critically important that this jaguar density estimate be considered preliminary and not compared with estimates generated from the program CAPTURE.

Figure 4.1: First Jaguar Camera Trap Photos from the Sierra Norte and the Chinantla. Photos are of Two Different Individuals. Note the Fallen Oak Leaves in the First photo. Trap Site Elevations are 912 m and 1428 m respectively.

captures/1,000 TN. During the monitoring period there were 11.35 jaguar captures/1000 TN (Table 4.1).

The total number of TN from May – June 2008 was 313, a low number considering six more cameras were used. Humid conditions resulting from high rainfall damaged many rolls of film, making the processed images unclear. Out of 426 total frames, 6% were unidentifiable and 18% were 'nil' images. Thus nearly ¼ of all processed film failed to produce any discernible image during the final trapping session.

Figure 4.2: Minimum Home Range Estimate for Male Jaguar in the Chinantla.



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No jaguars were photo-captured during the preliminary sampling session but photographs of puma (*Puma concolor*), ocelot (*Leopardus pardalis*), and margay (*Leopardus wiedii*) were taken. The margay photos were of interest because relatively little is known about this small arboreal cat (Sunquist and Sunquist, 2002). Of the 15,000 Mexican mammals collected by E.A. Goldman and E.W. Nelson over a twelve year

period, only two were margays (Goldman, 1920). It is probably safe to say that the margay is one of the rarest mammals in Mexico. Because of its secretive and solitary nature, nocturnal activities and semi-arboreal habits, it is certainly one of the least commonly seen.

Table 4.1: Jaguar Trap Success During Pilot Study, Monitoring, and Final Session

Study Site*	Trap Nights	No. of camera stations†	Captures	Captures/ 1000 trap nights	Individuals
SC/SA	385	12	0	0	0
SC/SA/SP/ST	764	18	9	11.35	2
SC/SA/SP/ST	313	20	0	0	0

*Abbreviations: SC, Santa Cruz Tepetotutla; SA, San Antonio del Barrio; SP, San Pedro Tlatepusco; ST, Santiago Tlatepusco

† Other than 3 locations during the monitoring period, all camera stations had only a single camera trap.

As an index of human disturbance, photos of vehicles were included in the camera-trapping data table (Table 4.3). A total of 52 vehicle photos were taken at an average rate of 1.6 vehicles/day in the month of July 2007. This is probably a low estimate of vehicle traffic on the road due to the delayed time between detection of a rapidly moving object and photo. There were many blank photos from the road, which would justify this assumption. No jaguar photos were taken and a single coati photo was the only evidence of any wildlife activity on the road. However the low number of TN is inadequate for making conclusions about the impact of vehicle traffic on wildlife utilization of the road as a resource to facilitate travel or foraging.

CAMERA-TRAPPING DISCUSSION

The density estimate of 1.39 jaguars/100 km² calculated for the Chinantla should not be compared with jaguar density estimates from mark-recapture studies. The small sample size of only two individuals and five recaptured events of only one individual created problems for producing more accurate estimates (Thompson et al. 2004). Small sample sizes are common in camera-trap studies on large felids such as tigers (e.g. Lynam et al. 2008; Wibisono et al. in press) and jaguars (Wallace et al. 2003; Rosas-Rosas, 2006). Since only one of the jaguars was photographed more than once at different locations, a MMDM could not be used to estimate the buffer zone around outermost trap sites. Including a buffer is recommended for camera trap studies on large felids because treating each trap site as a distinct sampled area can make it unclear what the sampled population represents (Karanth and Nichols, 2002). Unfortunately, a buffer around each trap site had to be calculated since an accurate buffer from MMDM data could not be estimated based on the recaptures of only a single animal.

Another limitation of this study was that the lengthy time frame (11 months) of the camera survey violated the "closed population" assumption. In capture-recapture models, abundance estimation requires that the population be closed i.e. no births, deaths, immigrations or emigrations during the sampling period (Otis et al. 1978). Generally a 2-3 month sampling period is recommended to ensure this assumption although it is "difficult, if not impossible, to ascertain closure of a biological population" (Soisalo and Cavalcanti, 2006). However Simcharoen et al. (2007) calculated a tiger density estimate using program CAPTURE after a survey duration of 12 months in Thailand.

Despite arguments claiming the technique is over-simplistic and fraught with bias (Jennelle et al. 2002), some tiger researchers have suggested that the number of camera days/tiger photograph correlates with independent estimates of densities for that species (Carbone et al. 2001). If this is the case, then jaguar densities in the Chinantla are low in comparison to other sites. Kelly (2003), for example, photographed over three times as many jaguars (7) in the Chiquibul Forest in Belize during a trapping period of only 486 TN, less than half (42%) of the survey effort for this study. There were 3.50 jaguar captures/100 TN (~4.5 times as many as this study) and the density at that study area was estimated to be 7.48 jaguars per 100 km² (Kelly, 2003). Trap-success data across species can, at the least, lead to hypotheses on species occurrence in relation to habitat variables and/or other species (Kelly and Holub, 2008).

Unequal sampling effort resulted in other flaws during the study. Eight more camera stations were added to the study area by June 2008. Also, because of limited trained personnel, extremely rugged terrain and other logistical constraints, cameras could not be monitored continuously (i.e. every *c*. 7-14 days as is recommended for camera trapping studies). Camera stations were monitored sporadically resulting in significant "holes" in the sampling sessions where no photos were taken because either film had finished or batteries were depleted.

Bernard Bevan, team leader of a 1938 exploratory survey through the Chinantla, wrote the following about the difficulty of transport in the area:

"Since the streams are often very difficult to ford both because of their rocky bed and swirling torrent, it is no advantage to own a horse, mule or donkey. With four horses, the crossing near Lacova of the comparatively insignificant Rio de Lalana occupied us nearly three hours. Baggage and saddles had to be unloaded and carried one by one over the 'hammock', after which it was necessary to cut a path down to the river brink and, tying the four bridle-ropes together, haul each animal, plundering and kicking, across the stream."

Bevan's descriptive passage of the unforgiving Chinantla exemplifies the unsuitability of the region for a labor-intensive task such as camera-trapping with film cameras. In hindsight, digital camera-traps would have been more appropriate for the study area because the near total absence of roads and navigable rivers presents logistical difficulties in revising film units. Kelly and Holub (2008) also found digital cameras to significantly outperform film cameras in a study comparing trap success among camera types.

Another note of interest is the fact that two pumas (Figure 4.3) were repeatedly photographed along a lowland riparian site where cameras documented an abundant and

Figure. 4.3: Puma Camera Trap Photo

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diverse prey base. Nine puma events were recorded along a ~10 km stretch of trail where the elevation ranged from 533 - 763 m. No jaguars were photographed in this area. Most jaguar photographs were taken at higher elevations (see Table 4.2). Where jaguars and pumas are sympatric, pumas typically occur in the higher, drier areas while jaguars are usually found in low, wet areas (F. de Azevedo, pers. comm.).

This was not the case in my study area. More puma photographs were taken at lower elevations. Predators often occupy different habitats or use the same one at different times to avoid competition of a resource such as prey (Seidensticker, 1976). The absence of turtles and caimans, which are important jaguar prey in South America (Emmons, 1987), from the study site could have contributed to the finding of jaguars showing a less than expected preference for lowland riparian areas. Schaller (1967) also found that leopards in India tended to be scarce where tigers were abundant and vice versa. That only a puma was photographed in this seemingly ideal jaguar habitat could suggest the scarcity of jaguars at least in the immediate area.

Table 4.2: Distribution of Camera Trap Sites in Relation to Elevation and Habitat Type

Elevation	Forest Type	# Camera Trap Sites*	Jaguar Presence
≤ 900 m	Evergreen and semi-evergreen tropical forest	18	1 detection
> 900 ≥ 1200	Transitional forest	17	2 detections
≥ 1200	Montane cloud tropical forest	28	6 detection

* Cameras were moved periodically over the course of the study.

JAGUAR PREY IN THE CHINANTLA

"The jaguar is the largest and most powerful carnivore in Central America and stands at the top of the food chain, eating carrion, crippled animals, garbage, fruit, and now and then some healthy prey."

(Allen, 2001: p. 21)

William Allen's egregious quote is a prime example of why the jaguar is commonly referred to as the "least-known" among all four big cat species in the *Panthera* genus (Valdez, 2000). Although Allen is an accomplished and award-winning science writer, his description of jaguar feeding ecology could not be any further off the mark. Any normal wild jaguar does not subsist on fruit and garbage. Jaguars, rather, are opportunistic feeders, with over 85 species recorded in their diet (Seymour, 1989).

Despite their flexibility in prey selection, jaguar densities are correlated with prey abundance as is the case with tigers in Asia (Karanth et al. 2004). Therefore gathering data on prey species through both camera-traps and interviews was a principle objective of this study. Hard, rocky substrate in the study area made tracking impracticable so most of the data on jaguar prey were obtained from camera-traps, village interviews, and a small sample of scats (n=8). Since a visual census of prey is generally not feasible in evergreen tropical forest habitat (Carrillo et al. 2000) (Figure 4.4), a rough index of relative abundance was recorded from camera-trapping data (after Carbone et al. 2001 and Kawanishi, 2002) (see Table 4.3 for trap success of all species 'photo-captured').

Of the eight big cat scats collected during the course of this study, I sent four samples to the Center for Conservation Genetics and Global Felid Genetics Program at the American Museum of Natural History (AMNH). Two of the samples were identified as puma, one was jaguar, and the other sample failed to yield positive identification. The

jaguar scat sample contained the remains of a calf that had been killed the previous night. The use of scat detection dogs is becoming more common as a noninvasive survey method for carnivores (Wasser et al. 2004; Long et al. 2008) and could be a more suitable research technique in mountainous areas such as the Chinantla where monitoring camera-traps is problematic.

Figure 4.4: Coati Obscured by Thick Vegetation in the Study Area.

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The number of photographs of jaguar prey species ranged from 4 for collared peccary to 24 for paca. Thus the trapping effort needed to collect a photograph of each species ranged between 288 TN for collared peccary and 48 TN for coati. Over the course of the survey, the cameras registered a total of nine jaguar prey species: nine-banded armadillo (*Dasypus novemcinctus*), collared peccary, red brocket deer (*Mazama americana*), paca (*Agouti paca*), coati, great curassow (*Crax rubra*), opossum (*Didelphis*

sp.), Central American agouti (*Dasyprocta punctata*), and Mexican black agouti (*Dasyprocta mexicana*). Camera-traps inventoried all prey species in the region except for white-tailed deer and tapir (Figure 4.5).

Table 4.3: Total Trap Nights and Trap Success

	Trap Success (# of Captures/100 Trap Nights)			
	Pilot	Monitoring	Final	Total
TOTAL TRAP NIGHTS	385	466	313	1,164
Vehicle	(12.92)	(0.00)	(0.00)	(4.30)
Cow (*Bos taurus*)	(9.09)	(8.80)	(0.64)	(6.70)
Villager (*Homo sapien*)	(7.24)	(10.20)	(30.99)	(14.86)
Domestic Dog (*Canus lupus familiaris*)	(2.84)	(0.22)	(1.60)	(1.46)
<u>Jaguar (Wild) Prey Species</u>				
Central American Agouti (*Dasyprocta punctata*)	(0.26)	(0.00)	(0.00)	(0.09)
Mexican Black Agouti (*Dasyprocta mexicana*)	(0.26)	(0.00)	(0.00)	(0.09)
Red Brocket deer (*Mazama americana*)	(0.26)	(1.55)	(1.60)	(1.12)
Paca (*Agouti paca*)	(1.03)	(4.43)	(0.00)	(2.15)
Great Currasow (*Crax rubra*)	(1.03)	(1.93)	(0.00)	(1.12)
Opposum (*Didelphis* sp.)	(2.34)	(2.28)	(3.19)	(2.58)
Armadillo (*Dasypus novemcinctus*)	(0.78)	(0.86)	(3.51)	(1.55)
Coati (*Nasua narica*)	(2.07)	(2.28)	(0.00)	(1.63)
Collared peccary (*Tayassu tajacu*)	(0.00)	(0.86)	(0.00)	(0.34)
<u>Carnivores</u>				
Jaguar (*Panthera onca*)	(0.00)	(1.93)	(0.00)	(0.77)
Puma (*Puma concolor*)	(2.07)	(1.33)	(0.96)	(1.46)

Ocelot (*Leopardus pardalis*)	(0.26)	(0.00)	(0.32)	(0.26)
Margay (*Leopardus wiedii*)	(0.26)	(0.86)	(0.32)	(0.52)
Tayra (*Eira barbara*)	(0.26)	(0.00)	(0.00)	(0.09)
Gray Fox (*Urocyon cinereoargenteus*)	(0.00)	(1.29)	(0.32)	(0.60)
Hooded Skunk (*Mephitis macroura*)	(0.00)	(0.86)	(0.32)	(0.43)
Small mammals				
Cacomistle (*Bassariscus sumichrasti*)	(0.26)	(0.00)	(0.00)	(0.09)
Mexican Deer Mouse) (*Peromyscus mexicanus*)	(1.82)	(0.86)	(1.28)	(1.29)
Mexican mouse opossum (*Marmosa mexicana*)	(0.00)	(0.21)	(0.96)	(0.34)
Squirrel (*Spermophilus* sp.)	(1.03)	(0.86)	(0.32)	(0.77)
Birds				
Ground Doves (*Columbina sp*.)	(7.27)	(7.08)	(1.28)	(5.15)
Plain Chachalaca (*Ortalis v. vetula*)	(0.26)	(0.00)	(0.00)	(0.09)
Tinamou (*Crypturellus boucardi*)	(1.30)	(0.86)	(0.00)	(0.77)
Crested Guan (*Penelope purpurascens*)	(0.00)	(0.21)	(0.00)	(0.09)
Long-tailed Wood Partridge (*Dendrortyx macroura*)	(0.00)	(1.07)	(0.07)	(0.43)
Common Black Hawk (*Buteogallus a. anthracinus*)	(0.26)	(0.00)	(0.32)	(0.17)

It is important to note that there are significant limitations to using camera-trap photos for analysis of prey populations (Jennelle et al. 2002) because, with the exception of paca, jaguar prey species are not individually marked (see drawings in Reid, 1997). Also, many prey species such as the paca (known regionally as *tepezcuintle*) are nocturnal and wary making them difficult to census. But just because a species is not recorded does not mean is it absent or even rare in a particular region. For example, in a study on forest antelopes in Tanzania, Rovero et al. (2005) photographed species rarely

encountered in census walks. Similarly, cameras in the study site regularly captured brocket deer, a wary animal not commonly seen (Leopold, 1959).

Figure 4.5: Camera Trap Photos of Prey Species in the Study Area. Clockwise from Upper Left: Collared Peccary, Coati, Paca, Brocket Deer.

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During the interviews, 57% (n=84) of the villagers recognized the white-lipped peccary (*Tayassu pecari*) drawing and claimed this wild pig was present in their forests. White-lipped peccaries are a good indicator species for the "wildness" of an area because they are sensitive to human disturbance, have large home ranges, and require extensive tracts of lowland tropical forest (Leopold, 1959). They are also an important prey species for jaguars. When pressed to describe this bigger, more gregarious species of peccary, most interviewees correctly described the white patch of fur on the lower jaw, larger body size, and also of seeing herds with as many as 20-30 individuals. Collared peccary

groups, in contrast, are usually seen in feeding groups of only 2-5 individuals (Reid, 1997).

White-lipped peccaries were not photo-captured by camera-traps, but the accurate descriptions given during interviews indicate that they are present in the Chinantla. This would represent a considerable range extension of some 200-300 km, presumably from the nearest source population in the Chimalapa region located in eastern Oaxaca along the southeastern Veracruz border. Goodwin (1969) stated that the range of white-lipped peccaries "extended to, but not west of, the Isthmus of Tehuantepec."

Interview data found the most important prey for jaguars and pumas to be brocket deer, collared peccary, coati, armadillo, paca, and great curassow (in that order) (Figure 4.6). These data were collected by asking villagers which animal carcasses they most often encountered in the forest or in the *milpa* (Figure 4.7). These data are subject to bias because encounter rates could be higher on well-traveled footpaths and villagers could easily miss animal carcasses that are dragged into heavy cover, a common habit of both pumas and jaguars (Brown and López González, 2001; Sunquist and Sunquist, 2002). Therefore these data should not be compared with scat analysis data. Nonetheless it does shed some light into which species are being killed by big cats in the study area.

It is clear from basic principles of animal energetics (Eisenberg, 1980) that medium and larger prey species are more important than small prey species for jaguars (Azevedo and Murray, 2007a). High prey abundance should not be confused with high prey biomass. For example, just as tigers cannot live off the high biomass of termites in Indian grasslands, jaguars cannot attain high densities in the absence of enough medium to large size prey (Karanth and Nichols, 2002). Therefore less human hunting of

ungulates and other large prey species could lead to a recovery of prey thus increasing the amount of jaguars a given area can support.

Figure 4.6: Percentage of Prey Animals most often Encountered by Santa Cruz Villagers

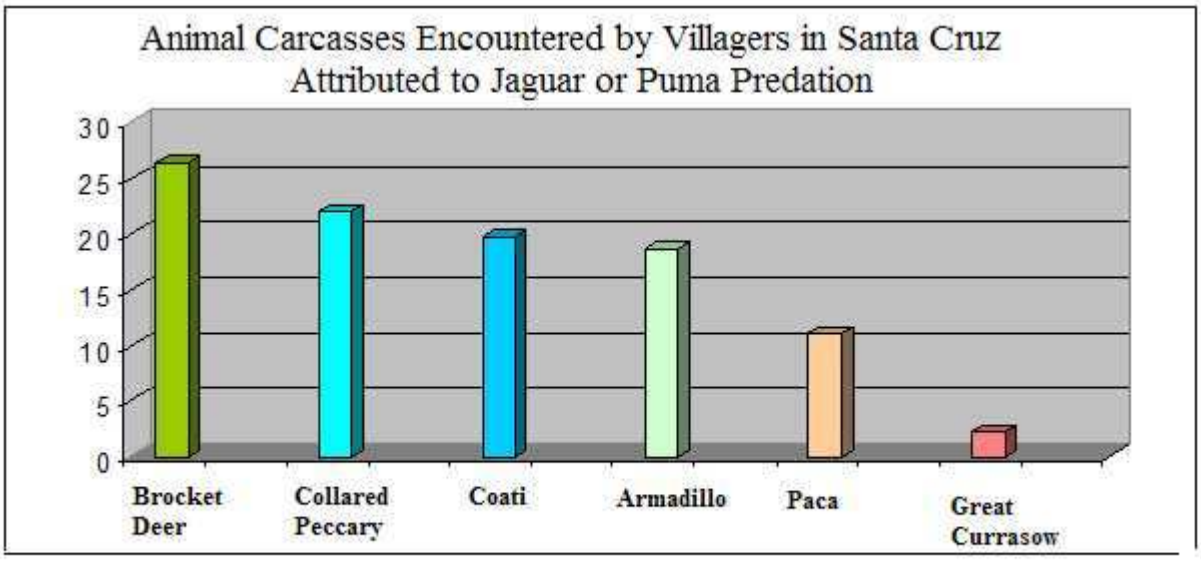

Figure 4.7: Armadillo Shell and Brocket Deer Skull Found by Villagers in the Milpa.

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NOTES ON REPTILIAN PREY

Turtles are an important prey item in South America (Emmons, 1989) but were curiously absent from the study area. The Central American river turtle (*Dermatemys mawii*), a species weighing up to 20 kg, was not recognized by villagers despite being present in the Rio Papaloapan, a river located less than 80 km north of the study area (IUCN, 1989). Morelet's crocodile (*Crocodylus moreletii*), a species found in the Yucatan, has escaped from farms and established small populations in Pacific-slope Chiapas and adjacent Oaxaca (V. Dinets, pers. comm.) but most likely has not reached the Chinantla. According to village surveys, green iguanas (*Iguana iguana*) are present in both Santiago and San Pedro Tlatepusco and probably occur in all lowland areas of the Chinantla *baja* below about 1,000 m. Iguanas weigh up to 5 kg and were an important food source for jaguar in Costa Rica (Chinchilla, 1997).

CHAPTER V

HUMAN-WILDLIFE INTERACTIONS IN THE CHINANTLA

"All the big cats have inspired their share of myths and legends, but only the jaguar has dominated the religion and culture of a continent."

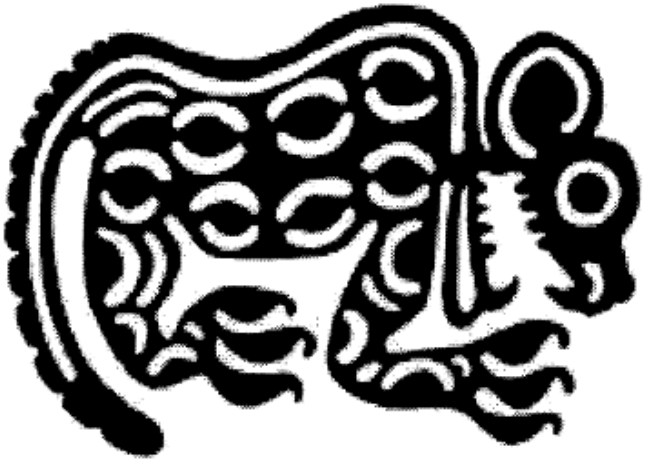
(Sunquist and Sunquist, 2002: p.306)

INTRODUCTION

In historical times, jaguar symbolism pervaded the ancient religion, mythology, art, and iconography of Mexican civilizations such as the Olmec and Maya (Figure 5.1) (Saunders, 1998; Brown and López González, 2002). In reference to the Pre-Olmecs, Covarrubias (1946) wrote: "Their gods were all jaguars: sky-jaguars, rain-jaguars, and

earth-jaguars. The earth was symbolized by a jaguar's open mouth, the caves from which their mythical chiefs, the leaders of humanity, had sprung." Cultural relevance toward the cats is still alive in some places today, the Chinantla being one of them.

Figure 5.1: Prehispanic Representation of the Jaguar from Valle Nacional, Oaxaca. Source: Enciso, 1953; cited in Chávez and Ceballos, 2006.



Most Chinantec villagers (77%) believed in *nahuales* which is like a spirit being that manifested itself in the form of an animal. Some community members are believed to have a *nahual* who watches over and protects them, not unlike a guardian angel. One of my guides, a loquacious 32 year-old who had emigrated to Georgia and South Carolina, told a story describing his belief in *nahuales*. He explained how the spots on the skin of a killed jaguar resembled the initials of a woman who had died unexpectedly at a young age in San Antonio just a few days before the jaguar was shot. Another villager in San Pedro said the skin of a killed jaguar[9] had a spot that looked like a face of someone he knew. Both incidents were seen as bad luck omens, with the human spirit (taking on the animal form) dying once the animal was killed. While the legitimacy of

[9] Exact dates of the jaguar killings are not known but it is believed both happened >10 years ago.

the *nahuale* belief is open to personal opinion, it is evident that some villagers have a profound spiritual connection with the natural world.

As shown in the following narrative (from Bennett and Warrington, 2004), a strong environmental ethic and responsibility for being stewards of the land was present in many of the local people. The narrative was related by a Zapotec inhabitant from Ixtlan, a village located less than 50 km south of the study area:

"On one side [the outsiders] carried their rifles and on the other side they carried their catapults to kill birds…and in their bags these people carried their hunting lamps to be able to hunt animals at night. Well, I think it was a sad and dangerous life for the animals at that time…these people enter the forest when they feel like it to hunt animals and cut down trees…According to what people say, one single person from La Luz managed to kill 25 tapirs, and today – well, we don't know what these animals are like anymore…Before these people came – well, all that side was forest and there were many wild animals…Our mountains have changed…When there were still big trees – you could see wild turkey, coati, [collared peccary] and tapir everywhere…the tepezcuintle (paca) are being finished off…There used to be some tigrillos (margays or ocelots) – they look like cats – and they aren't seen anymore…Now [the forest] is being finished off – and if we want to [conserve it], we can, but all the ciudadanos (villagers) and the comisariados (town mayors) have to agree. They have to see what is happening to us so that we can have the animals again…If we leave them alone like before, animals like the tapir will return."

The extent to which this respect toward wildlife remains present in the Chinantla has important implications for jaguar conservation. Local people can do much more to safeguard their forests and wildlife than outside researchers making sporadic stops in their communities (see Dinerstein et al. 1999). However, the Chinantec communities need to be educated about the animals because interview data found their knowledge of native wildlife to be poor. Informative *folletos* (pamphelts) made by Elvira Durán and J. Rogelio Prisciliano-Vázque are in press (see Appendix 5) and will be distributed amongst the communities to raise awareness about local wildlife. The educational flyer in Appendix 6 has already been distributed in the study area communities.

AMBIGUITY IN CHINANTEC PERCEPTIONS OF JAGUARS AND WILD CATS

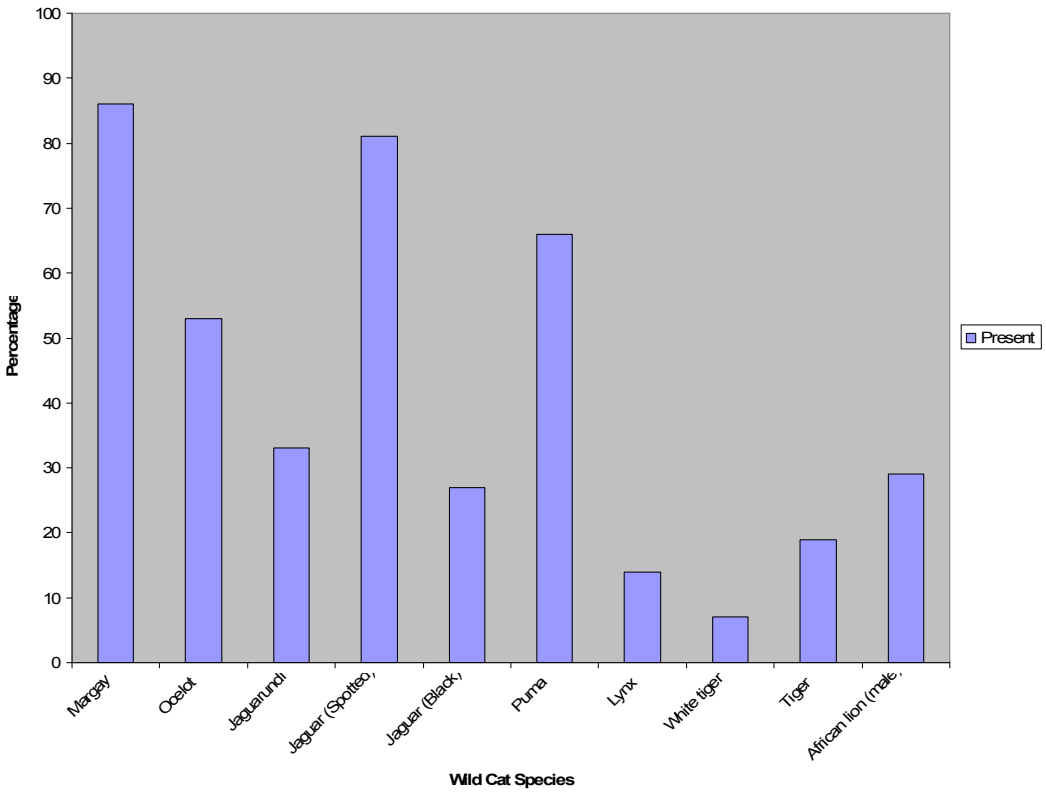
Ambiguity on wild cat identification presented problems during interviews because it was often difficult to determine which wild cat species the interviewee was referring to. Many villagers seemed especially uncertain about pumas and some were convinced that lions also lived in their forests (evidence of this can be seen in Appendix 2, where the Santa Cruz law bans hunting of both puma and lion). During interviews and informal conversations with guides, villagers described seeing a lion-like animal with a mane, similar to a male African lion (*Panthera leo*). In fact, questionnaire data found 28% of villagers believed an animal looking like a male African lion was present in their communities. In reference to other non-native cats, 14% of villagers interviewed believed lynx lived nearby, 19% believed tigers (*Panthera tigris*), and 7% thought white tigers lived in their forests (Figure 5.2; 5.3)

Figure 5.2: Tiger Painting on Schoolhouse in San Antonio del Barrio - an Indication that Schoolchildren and some Villagers Believe Tigers Roam their Forests. The Red Brocket Deer and Collared Peccary, also in the Painting, are Native Species.

Migratory status influenced perceptions of wild cats. For example, villagers who migrated to other parts of Mexico or the United States were 81% less likely to recognize the black jaguar photo ($\chi^2 = 4.71$, $P < 0.030$), 94% more likely to recognize the lion photo ($\chi^2 = 5.67$, $P < 0.017$), and 83% more likely to say tigers were not present ($\chi^2 = 6.60$, $P < 0.010$). Villagers who did not migrate, on the other hand, were 84% less likely to recognize the white tiger photo ($\chi^2 = 7.13$, $P < 0.008$).

Varying local names and perceptions of wild cats made their true identification a difficult task. This was especially problematic when trying to determine the species responsible for an attack on livestock. When shown photos from the camera traps, almost every villagers called ocelots and even the diminutive margays "*tigres*" (Figure 5.4).

Figure 5.3: Percentage of Interviewees Believing in the Presence of Native and Nonnative Wild Cats.



Hall and Dalquest (1963) stated that locals in Veracruz called any jungle cat *tigre*. Likewise Rabinowitz (1986a) claimed the Mayans did not differentiate a third species of spotted cat in Belize and only 13% (n= 402) of residents interviewed along the Texas/Tamaulipas border could identify an ocelot (Peterson et al. 2008). Clearly, a 4 kg margay is incapable of taking down a full-grown donkey but it could have killed a chicken. But if the interviewee said a *tigre* attacked both animals, a jaguar or puma was probably responsible for the donkey but any number of predator could have attacked the chicken. Some interview data that was vague or completely erroneous had to be omitted during later analyses.

Figure 5.4: Villagers Using Field Guide to Identify Wild Cats.

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Difficulty in determining which animals were really seen was not limited to the villagers' identification of illustrated plates or camera-trap photos. In June 2007, the San

Antonio *comisariado* excitedly reported seeing jaguar tracks less than 2 km from the village. I set off with a bag of plaster-of-Paris hoping to make a mold of the print but upon arriving at the site, I immediately recognized the "*tigre* tracks" as puma prints. The *comisariado's* misidentification was not surprising, given that only 4 of the 84 respondents (5%) gave answers that would indicate they know the difference between the jaguar and puma tracks. In response to the question, "How did you know the footprints were from a jaguar and not another animal such as a puma," most (62%) answered that the tracks they saw were simply *muy grande* (very big), which just as easily could have been a large puma. Others (6%) said the tracks of pumas and jaguars were *igual* (the same) while some (4%) claimed the tracks were from jaguars because they believed puma common were less common in the area. Interestingly, the respondents who did know the difference (n=4) correctly stated that jaguar tracks were *muy grande con dedos gordos* (very big with round toes).

COMMUNITY HUNTING BAN

Community statutes are legally recognized under the political constitution of Mexico and have been instrumental in nascent community-based conservation policies in Oaxaca. As stated by Oviedo (2002): "The legally endorsed power of communities to establish norms for governing the use and management of natural resources falling within their territories has been a fundamental factor in the adoption of community strategies for biodiversity in the state of Oaxaca." The community laws are taken seriously – every Chinantec villager interviewed (100%; n=84) was aware of the community hunting rules. The laws are also strictly enforced. For example, two Santa Cruz villagers were

imprisoned in the community jail after found guilty of killing a brocket deer outside the *milpa* in January 2007.

Article 85 of the Santa Cruz *statutos* (community laws), clearly outlines the prohibition of hunting certain wildlife (see Appendix 2 for original copy of the statutes in Spanish):

"The hunting of the following wild animals is prohibited: brocket deer, long-tailed wood-partridge, monkeys, toucans, great curassow, jaguar, ocelot and margay, puma, and lion. And when females are pregnant or have young, hunting is allowed only with permission."

Just why Santa Cruz implemented the hunting bans was an especially pressing question I had going into this study. Was it a natural conservation ethic exemplified by Bernard Bevan's observations on forest cover (Bevan, 1938:11) in his expedition through the Chinantla in the 1930's? Did the environmental education work of Geoconservación have an influence in the creation of the hunting ban? Or did payment for ecosystem services cause Chinantec villagers to see conservation through a new lens? These questions are largely beyond the scope of my study but the hunting ban is undoubtedly one of the most significant events related to jaguar conservation in the Chinantla because big cat densities are strongly correlated with prey abundance (see Karanth et al. 2004).

Not surprisingly, subsistence hunting has depleted prey populations in areas of the tropics lacking strict protection (Robinson and Bennett, 2000; Naughton-Treves, 2002). In reference to forests that have been overhunted, Redford (1992) coined the phrase "empty forests," describing an ecosystem that appears to have a healthy plant community but is "empty" of animal populations.

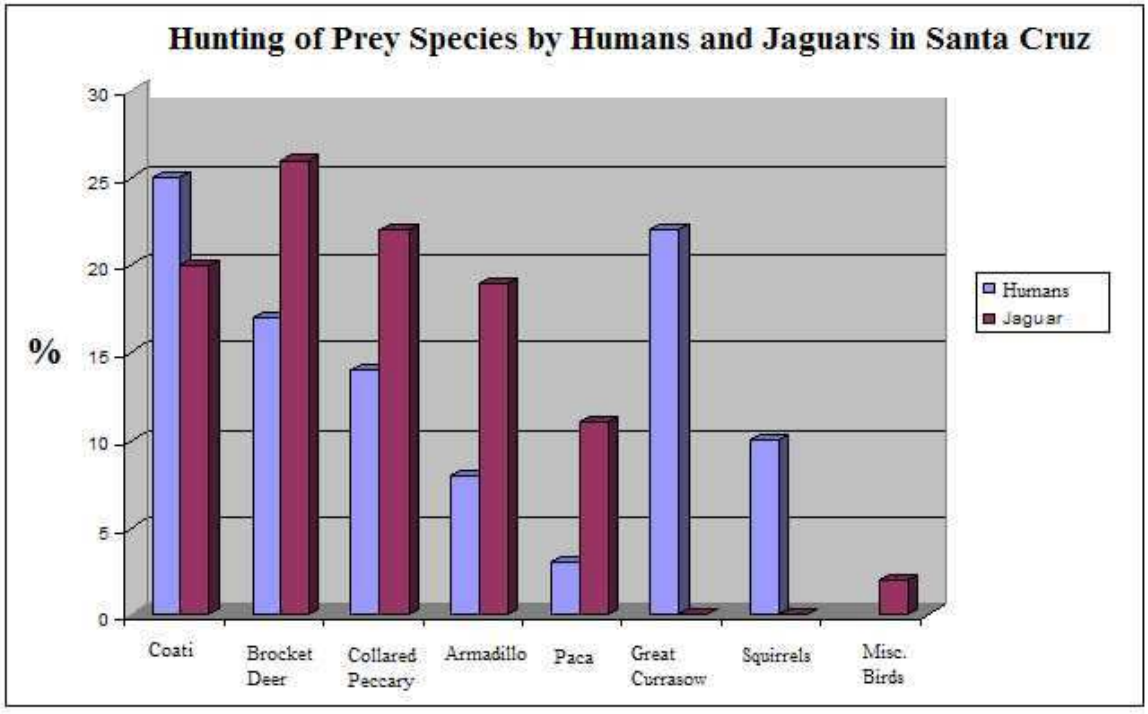
Robinson and Bennett (2000) suggested that community management of wildlife in tropical forests for meat is unlikely to be successful once human population densities

rise above 1 person/km². The four study communities have a combined human population density of 0.06 people/km², which is significantly below the threshold estimated by Robinson and Bennett.

There is usually significant overlap in prey selection by jaguars and human hunters in Latin America. In a study comparing humans and big cats as predators in the Neotropics, peccaries were ranked as the top prey species favored by both jaguars and humans (Jorgenson and Redford, 1993). The overlap in preference for the wild pigs is significant because several researchers have suggested that jaguars have a marked preference for peccary (Goldman, 1920; Leopold, 1959; Aranda, 1994).

Interview data from Santa Cruz shows humans and jaguars in the Chinantla as competitors for the same wild animals (Figure 5.5). There was significant overlap for

Figure 5.5: People and Jaguars as Competing Hunters in the Chinantla.



coati, brocket deer, and collared peccary. Data was taken from part IV of the interview questionnaire (see Appendix 1) asking about animal carcasses encountered by villagers in the forest and *milpa*. Reponses were compared with answers from part III, which asked about hunting in the *milpa.*

The hunting law does allow the hunting of "pest" animals causing damage in the *milpa*. There is ambiguity in this part of the law because what makes a certain animal a "pest" is dependent on a villager's level of tolerance for animals entering his *milpa*. Jaguar prey species such as coati and collared peccary can cause extensive crop damage by making regular foraging forays into agricultural areas whereas other species such as paca may venture into the *milpa* only sporadically.

Interview data found that many villagers tolerated jaguars and pumas because they recognized that these carnivores help keep crop-raiding animals in check. Crop damage from wild animals is probably the most widespread and persistent form of human-wildlife conflict in the tropics (Karanth and Madhusudan, 2002). The *comisariado* of Santiago made reference to jaguars being like a scarecrow, guarding his *milpa* while he wasn't there. In response to the open-ended question, "What is your opinion about jaguars living on your community's land, a high percentage of all positive answers were in reference to jaguars being "scarecrows" (Table 5.1).

Coatis were identified by the majority of villagers (93%) as the worst pest species in their *milpas* because they made regular forays into agricultural areas in large groups often causing significant crop damage. Collared peccaries came a distant second in the ranking, with 60% of the interviewees identifying the wild pigs as the second-most

troublesome pest. Squirrels, paca, pocket gophers, and birds (in that order) were the other pest animals most commonly reported.

Table 5.1: Villager Perceptions of Jaguars and Reason for Viewpoint (by %)

	SC	SAB	SPT	ST
Good	**57**	**21**	**59**	**89**
Scarecrow (in *milpa*)	18	50	40	38
Have always liked	6	0	0	0
Other places do not have	6	0	0	0
Pride of the community	12	0	0	6
Beautiful	32	0	54	12
Protects forest	6	0	0	0
Right to life	12	0	0	0
Never enters village	0	50	6	19
Conserve for future generations	0	0	0	6
Bad	**20**	**21**	**12**	**6**
Afraid of	17	0	50	100
Attacks livestock	83	100	50	0
Competition for game meat	0	13	0	0
Mixed	**23**	**57**	**29**	**6**
Beautiful but attacks livestock	100	25	100	100
Scarecrow but attacks livestock	0	75	0	0

The three animals most commonly hunted were, not surprisingly, coati (86%) followed by collared peccary (16%), squirrels (15%), birds (6%), and rodents (3%). Interestingly, paca, were not hunted and only one respondent claimed to hunt brocket deer in the *milpa,* which would have been illegal by community statute. The brocket deer (Figure 5.6) could very well be in a recovery period following decades of more intensive hunting. The relatively high camera trap success (1.55 photo captures/100 TN) for this tropical cervid supports this theory.

I was never offered bushmeat during meals with the village *comisariados*, a normal custom in other rural villages I've visited in the tropics. Furthermore, I was aware of only one coati that had been shot in retaliation for its destructive foraging in a

milpa. Besides the single coati, there was no evidence of animals killed and I never heard gunshots despite seeing at least one villager carrying his *scopeta* (rifle) almost daily. However, there were certainly more hunting incidents that were not noticed because 50% of the villagers said they currently hunted in their *milpa*. I presume that any killing of animals, regardless of whether they were pests, was done clandestinely, especially when outside researchers interested in wildlife conservation were in camp.

Figure 5.6: Brocket Deer Photographed by a Camera Trap in the Milpa.

The killing of pest animals in the *milpa* could be significantly reducing the wild prey base, offsetting the conservation potential of the hunting ban. It is likely that agricultural areas are a population "sink" for certain prey species such as coati and collares peccary. Based on the structured interview data, villagers in the Perfume watershed were killing an estimated 2,323 coatis and 274 collared peccaries per year.

These numbers are high compared to the Jorgenson (2001) study monitoring community hunting[10]. One Santa Cruz hunter alone was responsible for 28% of the total offtake of coatis and 38% of collared peccaries. The total combined weights of killed coatis and collared peccaries from the four study communities equals ~11,677 kg/meat. Emmons (1987) estimated 34 grams of meat per day per kg of cat was required for a jaguar in the Peruvian Amazon. Taking the weight of 43 kg as recorded for the *jaguar de la luz*, the male jaguar captured in Asunción Lachixila in 2004, the average Chinantla jaguar would need a minimum of 534 kg of meat, or about 33 large ungulates a year to survive[11]. Chinantec hunters have been removing enough coati and collared peccary to be supporting a significant number of jaguars in the 269 km² of land owned by the four communities. The intensity of hunting could also be lowering the likelihood of jaguars encountering wild prey thereby increasing the chances for domestic livestock depredation.

LIVESTOCK DEPREDATION

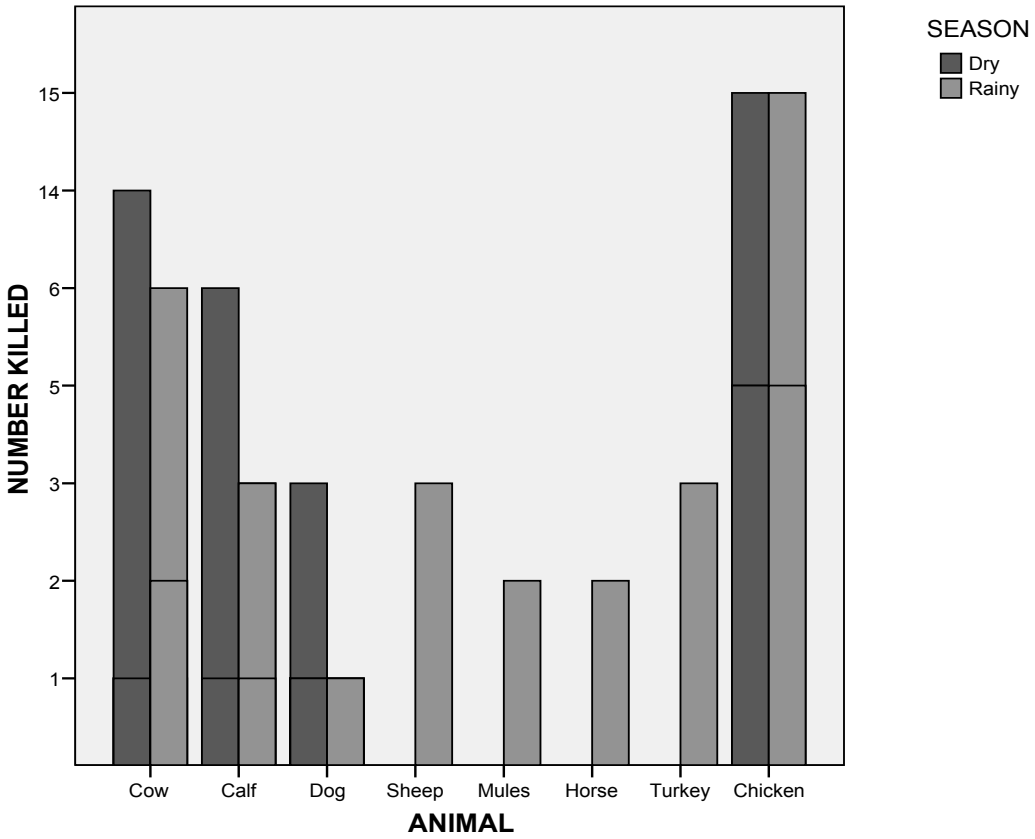
Of the 84 villagers interviewed, 27 (32%) claimed to have lost domestic animals (cows, dogs, sheep, horses, or mules) to jaguar attacks. Pumas were never blamed for loss of livestock, despite having a history of prodigious cattle-killing in Mexico. For example, one female puma in northern Mexico killed 72 horses, mule yearlings, and colts over a nine-and-a-half-month period (McBride, 1976). Also, in a puma diet selection

[10] Jorgenson (2000) recorded a total of 584 wild animals taken by hunters at X-Hazil Sur, a ejido with a population of 1040 during the time of the study from June 1989 – October 1990.
[11] This is a rough estimation I made given the average weights for brocket deer (12-32 kg) and collared peccary (12-26 kg) (Reid, 1997). Jaguars would have to supplement their diet by preying on smaller animals ranging in weight from 3-7 kg (armadillo) to paca (5-12 kg) or coati (7 kg).

study in southeastern Arizona, livestock (sheep and cattle) made up 34% of puma diet (Cunningham et al. 1999).

Survey data found 23 cows, 13 calves, 6 mules, 4 horses, 6 sheep, and 17 dogs were attributed to jaguar depredation in the four study communities during the past ten years. At least six pigs were reportedly killed by jaguars between December 2007 and June 2008 in Santa Cruz alone (Figel, 2008). Most attacks on domestic livestock occurred during the rainy season over this ten year period (Figure 5.7). It should be noted that attacks on chicken were most likely made by small carnivores such as ocelot or fox. They are reported in the figure because villagers blamed jaguars for all attacks.

Figure 5.7: Jaguar Predation on Domestic Livestock by Season



The depredation numbers may not seem significant in comparison to the extent of depredation in other jaguar range countries such as Brazil or Venezuela (Roosevelt, 1926; Hoogesteijn et al. 1993). However, it is important to note that the numbers reported here represent a much larger percentage of total livestock holdings than those in South America. A Chinantec villager that loses two of his four cattle to jaguars is no less likely to shoot a cattle-killing jaguar as a Brazilian cowboy who suffers a < 1% loss (out of a total of some 200-300 head) to jaguars.

It was important to investigate the kill site to determine which predator was responsible for the attack. Jaguars, for example, will commonly eat the tongue, a habit not normally observed in the puma (Childs, 1998). Jaguars also typically begin feeding from the head/neck area while the puma will begin eating from the hindquarters (Hoogesteijn, 2001). One respondent who lost 3 goats in early 2004 said the carcasses were covered with leaves, a habit indicative of pumas (Childs, 1998; Brown and López-González, 2001). Of the 14 cases where domestic livestock carcasses were encountered by villagers, six of the interviewees claimed the tongue was eaten first.

Jaguars in Belize readily attacked pigs tied up in the forest and also killed dogs that had wandered into the forest (Rabinowitz, 1986a). However, whereas Belizean jaguars never came into the village after dogs or pigs, a jaguar in Santa Cruz was responsible for fatally mauling at least three dogs, four pigs, and two cows during the summer of 2008 alone. All depredation incidents took place < 1 km from the village. In the case of both dogs and pigs, the jaguar actually entered the village to attack, a bold and odd behavior not normally seen from jaguars in Mexico (R.A. Medellín, pers. comm.). It

is also suggestive that this jaguar was injured making it difficult for it to catch wild prey (Figure 5.8).

Figure 5.8: The Santa Cruz *comisariado* (town mayor) hinted that a villager shot, but didn't kill, the jaguar responsible for attacking a pig a few weeks earlier. The gash on this jaguar's upper arm is likely a bullet wound.

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HUMAN-JAGUAR CONFLICT

"Negative attitudes and perceptions by humans towards jaguars (are) clearly the greatest imminent threat to the species' survival."

(A. Rabinowitz, 2005: p. 281)

Whether it is a Chinantec village in Oaxaca, an indigenous tribe in Nicaragua's Bosawas Biosphere Reserve, or a ranch of *vaqueros* in the Paraguayan Chaco, human-

occupied land overlaps with jaguar-inhabited forests throughout the jaguar's distribution. In some areas coexistence between people and jaguars is more peaceful; in other areas it is marked by conflict and local hostility toward the cats. More often than not, however, jaguars are unpopular with the people that share their range because they are blamed for loss of life and livestock (Schaller and Crawshaw, 1980; Rabinowitz, 2005) and viewed as competitors for bushmeat (Jorgenson and Redford, 1993).

On July 6, 2007 I encountered a Santa Cruz villager walking back from his *potrero* (cattle pasture) carrying a shotgun followed by a pack of hunting dogs after an unsuccessful attempt to put a bullet in the culprit responsible for the death of one of his 3-month-old calves, the villager was frustrated with a predator he saw as a pest. A hill littered with fresh tracks, a scat, and claw marks on a tree (Figure 5.9) confirmed his story that a jaguar had passed through the previous night. When I questioned him that day about his opinion of jaguars, the villager responded rather frankly, "They are beautiful, but cause a lot of damage." It is not surprising that cattle owners have little tolerance for cattle-killing jaguars when a full grown cow sells for roughly 10% of the average Chinantec's annual salary (J.J. Figel, unpublished data).

Human-jaguar conflict is probably the most immediate threat to the species in the Chinantla (J.J. Figel, pers. observ.). This is somewhat surprising because there are only about 70 head of cattle present in Santa Cruz, owned by nine or ten individuals. Informal interviews also suggest that cattle ranching in the Chinantla has diminished significantly since the mid-1990s. The most common reason given for the gradual abandonment of cattle is jaguar predation (D.B. Bray, pers. comm.).

Figure 5.9: Site of Jaguar Attack on Calf in Cattle Pasture and Claw Marks on Tree.

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I estimated the Santa Cruz cattle herd to have a biomass of 88.70 kg/km² in the Rio Perfume watershed. In making the biomass estimate, I classified cattle into two weight classes: adults (200-300 kg) and calves (40-100 kg). Biomass calculations are often rough estimates (Schaller, 1967) but as noted by Bourlière (1963): "Overestimation caused by attributing to the young the weight of an adult is more or less compensated for by the underestimation of the weight of the oldest individuals." The biomass estimate is important because it gives a crude measure of the ecological dominance (Eisenberg, 1980) of cattle in the study areas.

Usually in areas with a stable and diverse prey base, livestock losses to jaguars are uncommon (Azevedo and Murray, 2007) or even nonexistent (Miller, 2002) but livestock depredation can be a problem where the prey base is depleted (Roosevelt, 1926; Hoogesteijn and Hoogesteijn, 2007). Theodore Roosevelt (1926) was the first to suggest

that jaguar predation on livestock in Brazil was prevalent on ranches with a scarcity of wild prey but occurred infrequently in areas where wild prey animals were abundant. Higher livestock losses to jaguars have been documented in arid habitats such as the Sonoran thornscrub in northwestern Mexico (Rosas-Rosas et al. 2008) and where prey animals are intensely hunted by people (Hoogesteijn and Hoogesteijn, 2007). A depleted prey base leaves jaguars with fewer possibilities of encountering wild animals and makes them more likely to kill livestock. The frequent livestock depredation reported from the study communities is suggestive of a depleted wild prey base, which is discouraging given the community hunting ban.

The last confirmed record of a jaguar being killed in the study area was in 1999 (Figure 5.10). The fact that the most recent jaguar shooting happened nearly ten years ago is indicative of either low human-jaguar conflict or low jaguar abundance in the immediate area. I presume it is the latter because this study found severe human-jaguar conflict, especially in Santa Cruz. The jaguar killed in 1999 was an old male with a broken canine and a body ravaged by parasites, two characteristics commonly seen in so called "problem" animals (Rabinowitz, 1986b). The old jaguar was responsible for killing at least 24 head of cattle (J. Rogelio Prisciliano-Vázquez, pers. comm.) before its death.

A young male jaguar was also killed in San Pedro Tlatepusco (Figure 5.10; on the right) but villagers there seemed wary of being reported to authorities so I was unable to obtain the date of this incident. Apparently, the owner of an attacked calf waited in a tree during the night and shot the jaguar when it returned to feed on its kill.

Figure 5.10: Human-Jaguar Conflict. Clockwise – Unsecured Pig-Pen Near Forest; Pig Killed by Jaguar; Jaguar Shot in San Antonio.

© Clockwise – J.J. Figel, Mariano Jimenez, Pedro Victoriano Martinez

Another jaguar was reportedly shot in 1990 in Santiago (see Figure 5.11; on the left) but nothing is known about this story. The villagers' reluctance to disclose the details of both incidents can be taken as an encouraging sign because it shows that they are aware of laws prohibiting the killing of jaguars.

Figure 5.11: Jaguars Killed in the Study Area

© J. Rogelio Prisciliano-Vázquez/ J.J. Figel

CHAPTER VI

CONCLUSIONS

"We continue to lose many of our most magnificent species because most protected areas are not large enough to encompass viable populations of such species, and because we are unable or unwilling to address the human-wildlife interface outside protected areas."

(A. Rabinowitz, 2008: p. 67)

The traditional paradigm of conservation for jaguars and other large carnivores is failing (Rabinowitz, 2008). Setting aside hard-boundary wilderness areas with the

animals inside and the people outside is not going to be the long-term answer for conserving landscape species such as jaguars. It is unrealistic to believe PAs alone will be sufficient for conserving jaguars because increasing numbers of jaguars live outside PAs and most protected sites are too small or fragmented to maintain sizeable jaguar populations (Rabinowitz, 2005). Jaguars are especially prone to extirpation in isolated parks, especially those <1,000 km² in size (Medellín et al. 2002).

The possibilities for designating additional PAs large enough to contain relevant jaguar populations in Mexico are limited due to the large amount of land under community ownership in *ejidos* and *comunidades* (Bray et al. 2005; Valdez et al. 2006). Lands outside PAs are becoming increasingly important in landscape-level conservation (O'Riordan and Stoll-Kleemann, 2002; Daily et al. 2003), especially in the case of wide-ranging carnivores such as jaguars (Sanderson et al. 2002b). The conservation of jaguars on private and communal lands and habitat beyond public PA boundaries should become an increased priority for the conservation of the species in Mexico.

SUGGESTIONS FOR FURTHER JAGUAR RESEARCH AND CONSERVATION IN THE CHINANTLA

Among jaguar range countries, Mexico is especially susceptible to human-jaguar and human-wildlife conflict because much of its forests are located outside public PAs in landscapes dominated by humans and cattle (Brown and López-González, 2001; Rosas-Rosas et al. 2008). Human-jaguar conflict is probably the most urgent threat to the species in the Chinantla (J.J. Figel, pers. observ.). Future research projects should concentrate on assisting Chinantec communities improve livestock husbandry, with special attention to domestic pigs (*Sus scrofa domesticus*).

Pig pens should never be constructed near forest cover and need covers made of thatch (coconut, reed, grass, etc) or aluminum (Serres, 1992) to provide shade for the pigs and more security from predators. Lining pig-pens with wiring emitting an electric shock upon contact could be an option for keeping predators away (Schiaffino et al. 2002). Another alternative worthy of consideration would be a timber pen with a raised slatted bamboo floor (Payne and Wilson, 1999). A raised pen could also act as a deterrent to marauding jaguars and pumas.

For protection of cattle, buffalo or donkeys could be substituted or added to livestock herds since they have better defense mechanisms against predators (J.T. Heinen, pers. comm.). In Venezuela, predation on cattle was 20 times more likely than predation by jaguars and pumas on buffalo (Hoogesteijn and Hoogesteijn, 2007). The rugged Chinantla is far from ideal for cattle ranching (Ramos-Fernández et al. 2007) but the encouraging results from Venezuela are worthy of consideration. Buffalo should be looked into as an alternative for domestic meat and/or for better defense of existing Chinantec cattle herds.

Another priority should be to investigate the status of jaguars in other parts of the Chinantla. The *tierra baja* (lowlands) should be targeted for future field surveys because jaguars are probably more common in the lower elevation tropical forests of the Chinantla (D. Woolrich, pers. comm.). However, areas of the Chinantla *baja* have undergone extensive deforestation (Murphy, 2005). Interview and camera-trapping surveys should be conducted to assess the status of jaguars in the lowlands and also to evaluate the Chinantla's designation as a dispersal corridor (Figure 6.1).

Figure 6.1: The Chinantla as a Jaguar Dispersal Corridor

Source: Panthera Foundation

PROSPECTS FOR JAGUAR CONSERVATION IN THE CHINANTLA

Results from this study do not rebut the Chinantla's recent classification as a priority II area for jaguar conservation in Mexico (Chávez and Ceballos, 2006). Although much of the area is high altitude cloud forest, the Chinantla is an intact habitat greater than 3,000 km² in size and has a relatively low human population density. The persistence of Mexico's last grizzly bear population was attributed to the jagged topography of the Sierra del Nido in Chihuahua (Leopold, 1967). Similarly, the remoteness of the Chinantla and lack of roads and major infrastructure partly due to the

extremely rugged terrain and high rainfall are important considerations because jaguars are naturally better protected in more secluded habitats.

Communities have taken steps towards resolving livestock depredation conflict, which is probably the most immediate threat to jaguars in the Chinantla. Santa Cruz, for example, organized a community assembly on April 29, 2008 to address the livestock depredation problem. After the meeting, villager officials submitted a funding proposal requesting $96,000 pesos (US $9,600) to the Secretaria de Medio Ambiente y Recursos – "Conservación del jaguar (*Panthera onca*) mediante la construcción de cercas para evitar ataques a animales domésticos" (Appendix 4). Funding was subsequently awarded to the community and construction plans on new, more secure livestock enclosures were being planned in July 2008.

Providing inhabitants of the Chinantla with resources to better safeguard their livestock would go a long way toward changing their attitudes about living near jaguars. The less pigs and cows killed by jaguars should translate into a lower likelihood of jaguars being shot. As an example of the success of efforts to alleviate human-wildlife conflict, Jackson and Wangchuk (2004) estimated that for every nighttime livestock pen that was "predator-proofed" in Himalayan villages, up to five snow leopards were saved from retaliatory poaching. Introducing better livestock management in Chinantec villages should have the same benefit for preventing the killing of jaguars. People are a large part of the problem but they should also be a big part of the solution (Adams, 2007) if jaguars are to survive.

CONCLUDING REMARKS

The intent of this study was not to diminish the importance of public PAs for protecting jaguars. Instead, it was to research and evaluate the contributions that CPAs and community forests of the SNO could make to jaguar conservation. This includes community forests managed for a range of uses such as logging, non-timber forest product (NTFP) harvest, ecotourism, payment for environmental services, and strict protection. As stated by Berkes (2004): "The activities of communities of small-scale farmers, fishers, and forest users may not fit well with the narrower definitions of conservation, but in many cases they are the best natural allies for conservationists." While Mexico's community forests may not have biodiversity conservation at the forefront (Bray et al. 2005), they do hold potential to provide significant jaguar habitat or dispersal corridors outside PAs (Ceballos et al. 2005).

With the worldwide trend of the devolution of authority over forest lands from state to communities (White and Martin, 2002), an important factor for the conservation of jaguars may be the transition away from state-managed forests to private and community-governed land tenure. Mexico, presents a national laboratory for researching ways to protect jaguars in the context of landscape-level conservation. The extent to which Mexico's community forests and CPAs remain sustainable and support wildlife conservation could be a big piece of the conservation puzzle in securing a future for Mexico's jaguars.

LIST OF REFERENCES

Adams, W.M. (2007) Thinking like a human: social science and the two cultures problem. *Oryx*, 41:275-276.

Aguilar, O.A. (2007) La Chinantla, esquina pródiga de la biodiversidad Mexicana (http://www.mexicoforestal.gob.mx/imprimir.php?seccion=notasyid=44)

Allen, T.B. (1974) Vanishing Wildlife of North America. National Geographic Society, Washington D.C.

Allen, W. (2001) Green Phoenix: Restoring the Tropical Forests of Guanacaste, Costa Rica. Oxford University Press, New York.

Altrichter, M., G. Boaglio, and P. Perovic. (2006) The decline of jaguars *Panthera onca* in the Argentine Chaco. *Oryx*, 40:302-309.

Amend, S. and T. Amend. (1995) National Parks Without People? The South American Experience. IUCN. Quito, Ecuador.

Anderson, D.R. (2001) The need to get the basics right in wildlife field studies. *Wildlife Society Bulletin*, 29:1294-1297.

Aranda, M. (1994) Importancia de los pecaríes (*Tayassu* spp.) en la alimentación del jaguar (*Panthera onca*). *Acta Zoológica Mexicana*, 62:11-22.

Aranda, M. and V. Sánchez-Cordero. (1996) Prey spectra of jaguar and puma in tropical forests of Mexico. *Studies on Neotropical Fauna and Environment*, 31:65-67.

Aranda, M. (1998) Densidad y estructura de una población del jaguar (*Panthera onca*) en la reserva de la Biosfera Calakmul, Campeche, Mexico. *Acta Zoológica Mexicana,* 75:199-201.

Azevedo, F.C.C. and D.M. Murray. (2007) Spatial organization and food habits of jaguars (*Panthera onca*) in a floodplain forest. *Biological Conservation*, 137:391-402.

Azuara, S.D. (2005) Estimación de abundancia de mamíferos terrestres en un área de la Selva Lacandona, Chiapas. Tesis Licenciatura, Facultad de Ciencias, UNAM.

Bennett, O. and S. Warrington, series editors. (2004) Voices from the Mountain: Oral Testimonies from the Sierra Norte, Oaxaca, Mexico. The Panos Institute, London, U.K.

Benson, E.P., editor. (1972) The Cult of the Feline. Trustees for Harvard University.

Berkes, F. (2004) Rethinking community-based conservation. *Conservation Biology*, 18:621-630.

Bernard, H.R., editor. (1995) Research Methods in Anthropology: Qualitative and Quantitative Approaches. 2nd edition. AltaMira Press, London, U.K.

Bevan, B. (1938) The Chinantec and their Habitat. Instituto Panamericano de Geografia e Historia. Mexico D.F., Mexico. 229 pp.

Bhagwat, S., N. Brown, T. Evans, S. Jennings, and P. Savill. (2001) Parks and factors in their success. *Science*, 293:1045-1046

Borrini-Feyerabend, G., A. Kothari, and G. Oviedo. (2004) Indigenous and Local Communities and Protected Areas: Towards Equity and Enhanced Conservation. IUCN, Gland, Switzerland and Cambridge, U.K. xviii + 111 pp.

Bourlière, F. (1963) Observations on the ecology of some large African mammals. Pages 43-54 in F. Howell and F. Bourlière, editors. *African Ecology and Human Evolution*. Viking Fund Publ. Anthr. No. 36. New York.

Brandon, K. (1998) Perils to parks: the social context of threats. Pages. 415-439 in K. Brandon, K.H. Redford and S.E. Sanderson, editors. *Parks in Peril: People, Politics, and Protected Areas.* Island Press, Washington, D.C.

Brandon, K. (2002) Putting the right parks in the right places. Pages 443-467 in J. Terborgh, C. van Schaik, L. Davenport, and M. Rao, editors. *Making Parks Work: Strategies for Preserving Tropical Nature.* Island Press, Washington DC.

Brandon, K., L.J. Gorgenflo, A. Rodrigues, and R.W. Waller. (2005) Reconciling biodiversity conservation, people, protected areas, and agricultural suitability in Mexico. *World Development*, 33:1403-1418.

Bray, D.B. (1991) The struggle for the forest: conservation and development in the Sierra Juarez, Oaxaca. *Grassroots Development,* 15:13-25.

Bray, D.B., L. Merino-Perez, P. Negreros-Castillo, G. Segura-Warnholtz, J.M. Torres-Rojo, and H.F.M. Vester. (2003) Mexico's community-managed forests as a global model for sustainable landscapes. *Conservation Biology*, 17:672-677.

Bray, D.B., L. Merino Perez, and D. Barry. (2005) The Community Forests of Mexico: Managing for Sustainable Landscapes. University of Texas Press, Austin.

Bray, D.B., C. Antinori, and J.M Torres-Rojo. (2006) The Mexican model of community forest management: the role of agrarian policy, forest policy and entrepreneurial organization. *Forest Policy and Economics*, 8:470-484.

Bray, D.B. (2007) From displacement conservation to place-based conservation. Wildlife Conservation Society, Working Paper No. 29:103-105.

Bray, D.B., E. Durán, S. Anta, G.J. Martin, and F. Mondragón. (2008) A new conservation and development frontier: community protected areas in Oaxaca, Mexico. *Current Conservation*, 2.2:7-9.

Brechin, S., J. Buff, and R. Blanco. (2005) Exploring human-jaguar conflicts in Belize, Central America, Part II: a nation-wide study. Twelve Month Final Progress Report to the Wildlife Conservation Society.

Brown, D. E. and C. A. López González. (2001) Borderland Jaguars: Tigres de la Frontera. University of Utah Press, Salt Lake City.

Bruner, A.G., R.E. Gullison, R.E. Rice, and G.A.B. da Fonseca. (2001) Effectiveness of parks in protecting tropical biodiversity. *Science*, 291:125-128.

Cantú, C., R.G. Wright, J.M. Scott, and E. Strand. (2004) Assessment of current and proposed nature reserves of Mexico based on their capacity to protect geophysical features and biodiversity. *Biological Conservation*, 115:411-417.

Carbone, C., S. Christie, K. Conforti, T. Coulson, N. Franklin, J.R. Ginsberg, M. Griffiths, J. Holden, K. Kawanishi, M. Kinnaird, R. Laidlaw, A. Lynam, D.W. MacDonald, D. Martyr, C. McDougal, L. Nath, T. O'Brien, J. Seidensticker, J.L.D. Smith, M. Sunquist, R. Tilson, and W.N. Wan Shahruddin. (2001) The use of photographic rates to estimate densities of tigers and other cryptic mammals. *Animal Conservation,* 4:75-79.

Carrillo, E., G. Wong, and A.D. Cuaron. (2000) Monitoring mammal populations in Costa Rican protected areas under different hunting restrictions. *Conservation Biology*, 14:1580-1591.

Carmony, N.B. and D.E. Brown. (1991) Mexican Game Trails: Americans Afield in Old Mexico, 1866-1940. University of Oklahoma Press, Norman.

Carr, A. (1953) High Jungles and Low. University of Florida Press, Gainesville.

Ceballos, G., P. Rodríguez, and R.A. Medellín. (1998) Assessing conservation priorities in megadiverse Mexico: mammalian diversity, endemicity, and endangerment. *Ecological Applications*, 8: 8-17.

Ceballos, G., C. Chávez, A. Rivera, C. Manterota, and B. Wall. (2002) Tamaño poblacional y conservación del jaguar en la reserva de la biosfera Calakmul, Campeche, México. Pages 403-418 in R.A. Medellín, C. Equihua, C.L.B Chetkiewicz, P.G. Crawshaw, A. Rabinowitz, K.H. Redford, J.G. Robinson, E.W. Sanderson, and A.B. Taber*,* editors*. El Jaguar en el Nuevo Milenio*. Fondo de cultura economica, Universidad Nacional Autónoma de México, Wildlife Conservation Society, Mexico.

Ceballos, G., C. Chávez, H. Zarza, and C. Manterola. (2005) Ecologia y conservación del jaguar en la region de Calakmul. *Biodiversitas*, 62:1-7.

Ceballos, G. (2007) Conservation priorities for mammals in megadiverse Mexico: the efficiency of reserve networks. *Ecological Applications*, 17:569-578.

Chapin, M. (2004) A challenge to conservationists. *World Watch*, 17-31.

Chávez, C. and G. Geballos. 2006. Memorias del Primer Simposio. El Jaguar Mexicano en el Siglo XXI: Situacion Actual y Manejo. CONABIO-Alianza WWF Telcel-Universidad Nacional Autonoma de Mexico. Mexico D.F.

Childs, J.L. (1998) Tracking the Felids of the Borderlands. Printing Corner Press, Texas.

Chinchilla, F.A. (1997) La dieta del jaguar (*Panthera onca*), el puma (*Felis concolor*) y el manigordo (*Felis pardalis*) (Carnivora: Felidae) en el parque nacional Corcovado, Costa Rica. *Revista Biología Tropical,* 45:1223-1229.

Cline, H.F. (1957) Problems of Mexican ethno-history: the ancient Chinantla, a case study. *The Hispanic American Historical Review*, 37:273-295.

Cline, H.F. (1959) Nicolas de la Barreda and his works on the Chinantec Indians of Mexico. *The Papers of the Bibliographical Society of America*, 53:1-14.

CONANP (Comisión Nacional de Áreas Naturales Protegidas). (2003) Áreas Naturales Protegidas. [Available: www.conanp.gob.mx/]

Conforti, V.A. and F.C.C. de Azevedo. (2003) Local perceptions of jaguars and pumas in Iguaçu National Park area, south Brazil. *Biological Conservation,* 111:215-221.

Covarrubias, M. (1946) Mexico South, the Isthmus of Tehuantepec. A.Knopf, New York.

Crawshaw, P.G. and H.B. Quigley. (1991) Jaguar spacing and habitat use in a seasonally flooded environment in Brazil. *Journal of Zoology* (London), 223:357-370.

Cunningham, S.C., C.R. Gustavson, and W.B. Ballard. (1999) Diet selection of mountain lions in southeastern Arizona. *Journal of Range Management*, 52:202-207.

Daily, G.C., G. Ceballos, J. Pacheco, G. Suzán, and A. Sánchez-Azofeifa. (2003) Countryside biogeography of Neotropical mammals: conservation opportunities in agricultural landscapes of Costa Rica. *Conservation Biology*, 17:1814-1826.

Davies, G., M. Heydon, N. Leader-Williams, J. MacKinnon, and H. Newing. (2001) The effects of logging on tropical forest ungulates. Pages 93-124 in R.A. Fimbel, A. Grajal, and J.G. Robinson, editors. *The Cutting Edge: Conserving Wildlife in Logged Tropical Forests.* Columbia University Press, New York.

Dávila, P., M. Del Coro Arizmendi, A. Valiente-Banuet, J.L. Villaseñor, A. Casas, and R. Lira. (2002) Biological diversity in the Tehuacán-Cuicatlán Valley, Mexico. *Biodiversity and Conservation*, 11:421-442.

Davis, W. (1997) One River. Simon and Schuster, New York City.

DEA. (2003) Mexico: Country Profile for 2003. Drug Intelligence Report DEA-03047. U.S. Drug Enforcement Administration. Washington, D.C.

Diamond, J.M. (1975) The island dilemma: lessons of modern biogeographic studies for the design of natural reserves. *Biological Conservation*, 7:129-146.

Dillon, A. (2005) Ocelot density and home range in Belize, Central America: Camera-trapping and radio telemetry. M.Sc. thesis. Virginia Tech University, Blacksburg.

Dinerstein, E., D.M. Olson, D.J. Graham, A.L. Webster, S.A. Primm, M.P. Bookbinder, and G. Ledec. (1995) A Conservation Assessment of the Terrestrial Ecoregions of Latin America and the Caribbean. World Bank, Washington D.C.

Dinerstein, E., A. Rijal, M. Bookbinder, B. Kattel, and A. Rajuria. (1999) Tigers as neighbors: efforts to promote local guardianship of endangered species in lowland Nepal. Pages 316-333 in J. Seidensticker, S. Christie, and P. Jackson, editors. *Riding the Tiger: Tiger Conservation in Human-Dominated Landscapes* Cambridge University Press, U.K.

Dirzo, R. and M. García. (1992) Rates of deforestation in Los Tuxtlas, a neotropical area in southeast Mexico. *Conservation Biology*, 6:84-90.

Durán, E., J.F. Mas, and A. Velázquez. (2005) Land use/cover change in community-based forest management regions and protected areas in Mexico. Pages 215-238 in D.B. Bray, L. Merino-Perez and D. Barry, editors. *The Community Forests of Mexico: Managing for Sustainable Landscapes.* University of Texas Press, Austin.

Durán, E., J.R. Prisciliano-Vázquez, D. Bray, and J. Figel. (2008) El jaguar en la Chinantla, Oaxaca: retos para su conservación. CIIDIR – Oaxaca.

Eisenberg, J.F. (1980) The density and biomass of tropical mammals. Pages 35-55 in M.E. Soulé and B.A. Wilcox, editors. *Conservation Biology: An Evolutionary-Ecological Perspective*. Sinauer Associates, Massachusetts, U.S.A.

Ellison, K.E. and A. Hawn. (2005) Liquid assets. *Conservation in Practice*, 6:20-27.

Emmons, L.H. (1987) Comparative feeding ecology of felids in a Neotropical rainforest. *Behav. Ecol. Sociobiol*., 20:271-283.

Emmons, L. (1989) Jaguar predation on chelonians. *Journal of Herpetology*, 23:311-314.

Enciso, J. (1953) Design Motifs of Ancient Mexico. Dover Publications, New York.

Faller-Menéndez, J. C., T. Urquiza-Hass, C. Chávez, S. Johnson, and G. Ceballos. (2005) Registros de mamíferos en la Reserva Privada El Zapotal, en el noreste de la Península de Yucatán. *Revista Mexicana de Mastozoología,* 9:127-139.

Figel, J.J. (2005) Camera trapping for ocelot (*Leopardus pardalis*) in Madidi National Park, Bolivia. BSc thesis, University of Washington, Seattle.

Figel, J.J. (2008) Advance Report: Community Protected Areas and Jaguar Conservation in Oaxaca, Mexico. Unpublished report to the Wildlife Conservation Society.

Figel, J.J., E. Durán, D. Bray, and J.R. Prisciliano-Vázquez. Camera trapping for jaguar (*Panthera onca*) at a priority site in southern Mexico. In submission, *Cat News.*

Freeman, L. (2006) State of Siege: Drug-Related Violence and Corruption in Mexico. Washington Office on Latin America, Special Report.

Fuller, T., V. Sánchez-Cordero, P. Illoldi-Rangel, M. Linaje, and S. Sarkar. (2007) The cost of postponing biodiversity conservation in Mexico. *Biological Conservation*, 134:593-600.

García-Mendoza, A.J., M. de Jesus Ordoñez, and M. Briones-Salas, editors. (2004) *Biodiversidad de Oaxaca*. Universidad Nacional Autónoma de Mexico.

Goldman, E.A. (1920) Mammals of Panama. Smithsonian Institution, Washington D.C.

Gómez-Mendoza, L., E. Vega-Peña, M.I. Ramírez, J.L. Palacio-Prieto, and L. Galicia. (2006) Projecting land-use change processes in the Sierra Norte of Oaxaca, Mexico. *Applied Geography*, 26:276-290.

Goodwin, G.G. (1969) Mammals from the state of Oaxaca, Mexico, in the American Museum of Natural History. *Bulletin of the American Museum of Natural History*, 141:1-269.

Gordon, J.E., W.D. Hawthorne, A. Reyes-García, G. Sandoval, and A.J. Barrance. (2004) Assessing landscapes: a case study of tree and shrub diversity in the seasonally dry tropical forests of Oaxaca, Mexico and southern Honduras. *Biological Conservation*, 117:429-442.

Griffiths, M.G. (1994) Population density of Sumatran tigers in Gunung Leuser National Park. Pages 93-102 in R. Tilson, K. Soemarna, W. Ramono, S. Lusli, K. Traylor-Holzer, and U. Seal, editors. *Sumatran Tiger Population and Habitat Viability Analysis Report*. Apple Valley, Minnesota, Indonesian Directorate of Forest Protection and Nature Conservation and IUCN/SSC Conservation Breeding Specialist Group.

Guggisberg, C.A. (1975) Wild Cats of the World. Taplinger Press, New York.

Hall, E.R. and W.W. Dalquest. (1963) The mammals of Veracruz. *University of Kansas Publications, Museum of Natural History*, 14:165-362.

Hean, S. (2000) Status of the tiger and its conservation in Cambodia. M.Sc. Thesis. University of Minnesota, Minneapolis.

Heinen, J.T. (1995) Human behavior, incentives, and protected area management. *Conservation Biology*, 10:681-684.

Henschel, P. and J. Ray. (2003) Leopards in African Rainforests: Survey and Monitoring Techniques. WCS Global Carnivore Program.

Hernández-Huerta, A. (1992) Los carnivoros y sus perspectivas de conservación en las áreas protegidas de Mexico. *Acta Zool. Mex*., 54:1-23.

Hoogesteijn, R. and E. Mondolfi. (1992) The Jaguar. Armitano Publishers, Venezuela.

Hoogesteijn, R., A. Hoogesteijn, and E. Mondolfi. (1993) Jaguar predation and conservation: cattle mortality caused by felines on three ranches in the Venezuelan llanos. *Symposium of the Zoological Society of London*, 65:391-407.

Hoogesteijn, R. (2001) Manual on the problem of depredation caused by jaguars and pumas on cattle ranches. Unpublished report to the Wildlife Conservation Society.

Hoogesteijn, R. and A. Hoogesteijn. (2007) Could water buffalo presence facilitate jaguar conservation in the Neotropics? *Cat News*, 46:41-44.

Howell, S.N.G and S. Webb. (1995) A Guide to the Birds of Mexico and Northern Central America. Oxford University Press, U.K.

Illoldi-Rangel, P., T. Fuller, M. Linaje, C. Pappas, V. Sánchez-Cordero, and S. Sarkar. (2008) Solving the maximum representation problem to prioritize areas for the conservation of terrestrial mammals at risk in Oaxaca. *Diversity and Distributions*, 14:493-508.

IUCN. (1989) Tortoises and Freshwater Turtles: An Action Plan for their Conservation. IUCN/SSC Tortoise and Freshwater Turtle Specialist Group, Gland, Switzerland.

Jackson, R. (1979) Snow leopards in Nepal. *Oryx*, 15:191-195.

Jackson, R.M. and R. Wangchuk. (2004) A community-based approach to mitigating livestock depredation by snow leopards. *Human Dimensions of Wildlife*, 9:307-315.

Jenkins, C.N. and C. Giri. (2008) Protection of mammal diversity in Central America. *Conservation Biology*, 22:1037-1044.

Jennelle, C.S., M.C. Runge, and D.I. MacKenzie. (2002) The use of photographic rates to estimate densities of tigers and other cryptic mammals: a comment on misleading conclusions. *Animal Conservation*, 5:119-120.

Johns, A.G. (1997) Timber Production and Biodiversity Conservation in Tropical Rain Forests. Cambridge University Press, U.K.

Jorgenson, J.P. and K.H. Redford. (1993) Humans and big cats as predators in the Neotropics. *Symposium of the Zoological Society of London*, 65:367-390.

Jorgensen, J.P. (2000) Wildlife conservation and game harvest by Maya hunters in Quintana Roo, Mexico. Pgs. 251-266 in J.G. Robinson and E.L. Bennett, editors. *Hunting for Sustainability in Tropical Forests.* Columbia University Press, New York.

Kappelle, M., editor. (2006) Ecology and Conservation of Neotropical Montane Oak forests. Springer-Verlag Berlin Heidelberg, Germany.

Karanth, K.U. (1987) Tigers in India: a critical review of field censuses. Pgs 118-133 in R.L. Tilson and U.S. Seal, editors. *Tigers of the World: The Biology, Biopolitics, Management and Conservation of an Endangered Species*. Noyes Publications, U.S.A.

Karanth, K.U. (1995) Estimating tiger Panthera tigris populations from camera-trap data using capture-recapture models. *Biological Conservation*, 71:333-338.

Karanth, U. and J. Nichols. (1998) Estimation of tiger densities in India using photographic captures and recaptures. *Ecology*, 79:2852-2862.

Karanth, U.K. and J.D. Nichols. (2002) Monitoring Tigers and their Prey: a Manual for Researchers, Managers, and Conservationists in Tropical Asia. Centre for Wildlife Studies, India.

Karanth, K.U. and M.D. Madhusudan. (2002) Mitigating human-wildlife conflicts in southern Asia. Pages in J. Terborgh, C. van Schaik, L. Davenport, and M. Rao, editors. *Making Parks Work: Strategies for Preserving Tropical Nature*. Island Press, Washington D.C.

Karanth, K.U., J.D. Nichols, N.S. Kumar, W.A. Link, and J.E. Hines (2004) Tigers and their prey: predicting carnivore densities from prey abundance. *Proceedings of the National Academy of Sciences USA,* 101:4854-4858.

Kawanishi, K. (2002) Population status of tigers *(Panthera tigris)* in a primary rainforest of peninsular Malaysia. Ph.D. dissertation. University of Florida, Gainesville.

Kelly, M.J. (2003) Jaguar monitoring in the Chiquibul Forest, Belize. *Caribbean Geography*, 13:19-32.

Kelly, M.J. and E.L. Holub. (2008) Camera trapping of carnivores: trap success among camera types and across species, and habitat selection by species, on Salt Pond Mountain, Giles County, Virginia. *Northeastern Naturalist*, 15:249-262.

Kelly, M.J., A.J. Noss, M.S. Di Bitetti, L. Maffei, R.L. Arispe, A. Paviolo, C.D. De Angelo, and Y.E. Di Blanco. (2008) Estimating puma densities from camera trapping across three sites: Bolivia, Argentina, and Belize. *Journal of Mammalogy*, 89:408-418.

Klooster, D and S. Ambinakudige (2005). The global significance of Mexican community forestry. Pages 305-334 in D. Bray, L. Merino-Perez and D. Barry, editors. *The Community Forests of Mexico: Managing for Sustainable Landscapes.* University of Texas Press, Austin.

Koleff, P., J. Soberón, and A. Smith. (2004) Madrean pine-oak woodlands. Pages 204-217 in R.A. Mittermeier, P. Robles Gil, M. Hoffmann, J. Pilgrim, T. Brooks, C.G. Mittermeier, J. Lamoreux, and G.A.B. da Fonseca, editors. *Hotspots Revisited*. CEMEX.

Kothari, A. (2006) Community conserved areas. Pages 549-573 in M. Lockwood, G.L. Worboys, and A. Kothari, editors. *Managing Protected Areas: A Global Guide*. Earthscan Publications, London, U.K.

Kremen, C., J.O. Niles, M.G. Dalton, G.C. Daily, P.R. Ehrlich, J.P. Fay, D. Grewal, and R.P. Guillery. (2000) Economic incentives for rain forest conservation across scales. *Science*, 288:1828-1832.

Leopold, A. (1949) A Sand County Almanac. Oxford University Press.

Leopold, A.S. (1950) Vegetation zones of Mexico. *Ecology*, 31:507-518.

Leopold, A.S. (1955) Appendix 5: the range of the jaguar in Mexico. *Smithsonian Institution Bureau of American Ethnology Bulletin*, 170:20-291.

Leopold, A.S. (1959) Wildlife of Mexico. University of California Press, Berkeley.

Leopold, A.S. (1967) Grizzlies of the Sierra del Nido. *Pacific Discovery*, 20:30-32.

Lira-Torres, I. and G. Ramos-Fernández. (2007) El estado del jaguar en los Chimalapas, Oaxaca. Pgs 71-80 in G. Ceballos, C. Chávez, R. List, and H. Zarza, editors. CONABIO – Alianza WWF/Telcel – Universidad Nacional Autónoma de Mexico, Mexico, D.F.

Lockwood, M., G.L. Worboys, and A. Kothari. (2006) Managing Protected Areas: A Global Guide. Earthscan, London, U.K.

Long, R.A., P. MacKay, W.J. Zielinski, and J.C. Ray, editors. (2008) Noninvasive Survey Methods for Carnivores. Island Press, Washington, DC.

López-González, C.A. and G. Lorenzana Piña. (2001) Sonoran jaguars: conserving borderland cats. *Wild Earth*, 11:60-65.

Lorence, D.H. and A. García-Mendoza. (1989) Oaxaca, Mexico. Pages 253-269 in D.G. Campbell and H.D. Hammond, editors. *Floristic Inventory of Tropical Countries.* New York Botanical Garden, USA.

Luna K., M.D. (2005) Distribución, abundancia y conservación de carnívoros de Santiago Comaltepec, Sierra Norte de Oaxaca, México. Tesis de Licenciatura. Instituto Tecnológico del Valle de Oaxaca, IPN CIIDIR-Oaxaca. Oaxaca, México.

Lynam, A. J., A. Rabinowitz, T. Myint, M. Maung, K.T. Latt, and S.T.T. Po. (2008) Estimating abundance with sparse data; tigers in northern Myanmar. *Population Ecology*

MacArthur, R.H. and E.O. Wilson. (1967) The Theory of Island Biogeography. Princeton University Press, New Jersey.

MacKinnon, J., K. MacKinnon, G. Child, and J. Thorsell. (1986) Managing Protected Areas in the Tropics. IUCN: Gland, Switzerland.

Maffei, L., E. Cuellar, E., and A. Noss. (2004) One thousand jaguars (*Panthera onca*) in Bolivia's Chaco? Camera trapping in Kaa-Iya National Park. *J. Zool. Lond*, 262:295-304.

Maffei, L. and A.J. Noss (2008) How small is too small? Camera trap survey areas and density estimates for ocelots in the Bolivian Chaco. *Biotropica*, 40:71-75.

Martin, G.J. (1996) Comparative ethnobotany of the Chinantec and Mixe of the Sierra Norte, Oaxaca, Mexico. PhD thesis, University of California, Berkeley. 960 pp.

McBride, R.T. (1976) Status and ecology of the mountain lion (*Felis concolor stanleyana*) of the Texas-Mexico border. M.Sc. thesis, Sul Ros State University, Texas.

McDonell, A. and K. Vacariu. (2000) Ejido Cebadillas, imperiled parrots, and a historic conservation partnership. *Wild Earth*, 55-56.

McNeely, J.A. and K.R. Miller. (1982) National Parks, Conservation, and Development: The Role of Protected Areas in Sustaining Society. Smithsonian Instit. Press, Wash., D.C.

Meave, J.A., A. Rincon, and M.A. Romero-Romero. (2006) Oak forests of the hyper-humid region of La Chinantla, Northern Oaxaca Range, Mexico. Pages 113-126 in M. Kappelle, editor. *Ecology and Conservation of Neotropical Montane Oak Forests*. Springer-Verlag Berlin Heidelberg, Germany.

Medellín, R.A. C. Equihua, C.L.B Chetkiewicz, P.G. Crawshaw, A. Rabinowitz, K.H. Redford, J.G. Robinson, E.W. Sanderson, and A.B. Taber, editors. (2002) El Jaguar en el Nuevo Milenio. Fondo de cultura economica, Universidad Nacional Autónoma de México, Wildlife Conservation Society, Mexico.

Mehta, J.A. and J.T. Heinen. (2001) Does community-based conservation shape favorable attitudes among locals? An empirical study from Nepal. *Environmental Management*, 28:165-177.

Mersey, J.E., A.A. Millward, and L.M. Martinez. (2002) Realizing the potential of GIS in community-based management of protected areas. *International Journal of Sustainable Development and World Ecology*, 9:208-222.

Miller, C. (2002) Jaguares, ganado y humanos: un ejemplo de coexistencia pacífica en el noroeste de Belice. Pgs. 477-492 in R.A. Medellín, C. Equihua, C.L.B Chetkiewicz, P.G. Crawshaw, A. Rabinowitz, K.H. Redford, J.G. Robinson, E.W. Sanderson & A.B. Taber, editors. *El Jaguar en El Nuevo Milenio*. Fondo de cultura economica, Universidad Nacional Autonoma de Mexico, Wildlife Conservation Society, Mexico.

Mishra, C., P. Allen, T. McCarthy, M.D. Madhusudan, A. Bayarjargal, and H.H.T. Prins. (2003) The role of incentive programs in conserving the snow leopard. *Conservation Biology*, 17:1512-1520.

Mittermeier, R. (2004) Megadiversity: earth's biologically wealthiest nations. Graphic Arts Center Publishing.

Mittermeier, R., P. Robles-Gil, and C.G. Mittermeier. (2005) Mexico: Biological Heritage. SEMARNAT/CEMEX, Mexico City.

Molnar, A., S.J. Scherr, and A. Khare. (2004) Who conserves the world's forests? Community-driven strategies to Protect forests and respect rights.

Moreira, J. R.B. McNab, R. García, V. Méndez, M. Barnes, G. Ponce, A. Vanegas, G. Ical, E. Zepeda, I. García, and M. Córdova. (2008) Densidad de jaguares dentro de la concesión comunitaria de Carmelita y de la Asociación Forestal Integral San Andrés Petén, Guatemala. Wildlife Conservation Society report – Guatemala Program. 17 pp.

Murphy, S.R. (2005) Organizations, livelihoods, and the landscape mosaic: a sustainability evaluation of pita (*Aechmea magdalenae*) production in Oaxaca, Mexico. M.Sc. thesis, Florida International University, Miami.

Naughton-Treves, L. (2002) Wild animals in the garden: conserving wildlife in Amazonian agroecosystems. *Annals of the Association of American Geographers*, 92:488-506.

Naughton-Treves, L., M.B. Holland, and K. Brandon. (2005) The role of protected areas in conserving biodiversity and sustaining local livelihoods. *Annu. Rev. Environ. Resour*., 30:219-252.

Navarro-Serment, C.J., C.A. Lopez-Gonzalez, and J.P. Gallo-Reynoso. (2005) Occurrence of jaguar (Panthera onca) in Sinaloa, Mexico. *Southwestern Naturalist*, 50:102-106.

Nepstad, D. S. Schwartzman, B. Bamberger, M. Santilli, D. Ray, P. Schlesinger, P. Lefebvre, A. Alencar, E. Prinz, G. Fiske, and A. Rolla. (2006) Inhibition of Amazon deforestation and fire by parks and indigenous lands. *Conservation Biology*, 20:65-73.

Nowell, K. and P. Jackson. (1996) Wild Cats: Status Survey and Conservation Action Plan. IUCN. Gland, Switzerland.

Nuding, M.A. (2002) Wildlife Management in Namibia: the conservancy approach. Pages 189 – 209 in T. O'Riordan and S. Stoll-Kleemann, eds. *Biodiversity, Sustainability, and Human Communities: Protecting Beyond the Protected.* Cambridge University Press.

Nuñez, R., B. Miller, and F. Lindzey. (2000) Food habits of jaguars and pumas in Jalisco, Mexico. *Journal of Zoology*, 252:373-379

O'Brien, T.G., M.F. Kinnaird, and H.T. Wibisono. (2003) Crouching tigers, hidden prey: Sumatran tiger and prey populations in a tropical forest landscape. *Animal Conservation*, 6:131-139.

O'Riordan, T. and S. Stoll-Kleemann, editors. (2002) *Biodiversity, Sustainability, and Human Communities: Protecting Beyond the Protected.* United Kingdom: Cambridge University Press.

Ortega-Huerta, M.A. and K.E. Medley. (1999) Landscape analysis of jaguar (*Panthera onca*) habitat using sighting records in the Sierra de Tamaulipas, Mexico. *Environmental Conservation,* 26:257-269.

Ortiz-Martínez, T., V. Rico-Gray, and E. Martínez-Meyer. (2008) Predicted and verified distributions of Ateles geoffroyi and Alouatta palliata in Oaxaca, Mexico. *Primates*, 49:186-194.

Otis, D. L, K. P. Burnham, G. C. White, and D. R. Anderson. 1978. Statistical inference from capture data on closed animal populations. *Wildlife Monographs,* 62:1-135.

Oviedo, G., editor. (2002) The community protected natural areas in the state of Oaxaca, Mexico. WWF Publication, Gland, Switzerland.

Pacheco, V., B.D. Patterson, J.L. Patton, L.H. Emmons, S. Solari, and C.F. Ascorra. (1993) List of mammal species known to occur in Manu Biosphere Reserve, Peru. *Publicaciones del Museo de Historia Natural*, Universidad Nacional Mayor de San Marcos, 44:1-12.

Paray, L. (1951) Exploraciones en la Sierra de Juarez. *Bol. Soc. Bot. Mexico*, 13:4-10.

Payne, W.J.A. and R.T. Wilson. (1999) An Introduction to Animal Husbandry in the Tropics. Blackwell Science, Oxford.

Pérez, L.M., R.G. Contreras, and A. Santos-Moreno. (2006) Mamíferos del bosque mesófilo de montaña del Municipio de San Felipe Usila, Tuxtepec, Oaxaca, Mexico. *Revista Mexicana de Mastozoología*, 10:29-40.

Peterson, M.N., M. Sternberg, A. Lopez, and J. Liu. (2008) Ocelot awareness among latinos on the Texas and Tamaulipas border. *Human Dimensions of Wildlife*, 13:339-347.

Prisciliano-Vázquez, J.R. (2008) Hábitat y participación social para la conservación del jaguar en áreas comunitarias protegidas de la región Chinantla alta, Oaxaca, México. Tesis de Licenciatura. Instituto Tecnológico de la Cuenca del Papaloapan. Oaxaca.

Quigley, H. and P.G. Crawshaw (1992) A conservation plan for the jaguar *Panthera onca* in the Pantanal region of Brazil. *Biological Conservation*, 61:149-157.

Rabinowitz, A. (1983) A preliminary jaguar survey in Belize, Central America. New York Zoological Society Report. 18 pp.

Rabinowitz, A. (1986a) Jaguar: Struggle and Triumph in the Jungles of Belize. Arbor House, New York.

Rabinowitz, A. (1986b) Jaguar predation on domestic livestock in Belize. *Wildlife Society Bulletin,* 14:170-174.

Rabinowitz, A. and B.G. Nottingham. (1986) Ecology and behavior of the jaguar (*Panthera onca*) in Belize, Central America. *Journal of Zoology*, 210:149-159.

Rabinowitz, A. (1993) Estimating the Indochinese tiger *Panthera tigris corbetti* population in Thailand. *Biological Conservation*, 65:213-217

Rabinowitz, A. (1997) Wildlife Field Research and Conservation Training Manual. Paul-Art Press Inc., New York City.

Rabinowitz, A. (2005) Jaguars and livestock: living with the world's third largest cat. Pages 278-285 in R. Woodroffe, S. Thirgood, and A. Rabinowitz, editors. *People and Wildlife: Conflict or Coexistence?* Cambridge University Press, U.K.

Rabinowitz, A. (2008) Life in the Valley of Death: The Fight to Save Tigers in a Land of Guns, Gold, and Greed. Island Press, Washington D.C.

Ramos-Fernandez, G., J.J. González, F. Guadarrama-Overa, R. Eichenberger, and D.W. Bermúdez. (2007) El Jaguar de la Luz: Solucionando el Conflicto Jaguar-Ganando para Conservar La Biodiversidad. En: *II Simposio Biodiversidad de Oaxaca: Una Visión Integral de los Recursos Naturales en Oaxaca.* CIIDIR- Oaxaca, IPN, IEEO, COPLADE, SEMARNAT, CONANP, CONBIO, WWF, ITVO y UABJO. Oaxaca, México.

Redford, K.H. and J.G. Robinson. (1991) Park size and the conservation of forest mammals in Latin America. Pages 227-234 in M.A. Mares and D.J. Schmidly, editors. *Latin American Mammalogy: History, Biodiversity, and Conservation.* University of Oklahoma Press, Norman.

Redford, K.H. (1992) The empty forest. *BioScience*, 42:412-422.

Redford, K.H., E.W. Sanderson, J.G. Robinson, and A. Vedder. (2000) Landscape species and their conservation: report from a WCS Meeting, May 2000. Wildlife Conservation Society, Bronx, NY.

Redford, K.H., J.G. Robinson, and W.M. Adams. (2006) Parks as shibboleths. *Conservation Biology*, 20:1-2.

Reid, F.A. (1997) A Field Guide to the Mammals of Central America and Southeast Mexico. Oxford University Press, U.K.

Ricker, M., I Ramírez-Krauss, G. Ibarra-Maríquez, E. Martínez, C.H. Ramos, G. González-Medellín, G. Gómez-Rodríguez, J.L. Palacio-Prieto, and H.M Hernández. (2007) Optimizing conservation of forest diversity: a country-wide approach in Mexico. *Biodiversity Conservation*, 16:1927-1957.

Rincón Gutiérrez, A.A. (2007) Estructura y composición florística de los bosques tropicales húmedos de montaña de Santa Cruz Tepetotutla, Oaxaca, México. Tesis, Universidad Nacional Autónoma de México.

Robinson, J.G. and E.L. Bennett, editors. (2000) Hunting for Sustainability in Tropical Forests. Columbia University Press, New York.

Robson, J.P. (2007) Local approaches to biodiversity conservation: lessons from Oaxaca, southern Mexico. *International Journal of Sustainable Development*, 10:267-286.

Romero-Romero, M.A., S. Castillo, J. Meave, and H. Van der Wal. (2000) Análisis floristico de la vegetación secundaria derivada de la selva húmeda de montaña de Santa Cruz Tepetotutla (Oaxaca). *Boletin de la Sociedad Botanica de Mexico*, 67:89-106.

Roosevelt, T. (1926) Through the Brazilian Wilderness. New York, Scribner.

Rosas-Rosas, O.C. and J.H. Lopez-Soto. (2002) Distribución y estado de conservación del jaguar en Nuevo Leon, Mexico. Pages 107-126 in R.A. Medellín, C. Equihua, C.L.B

Chetkiewicz, P.G. Crawshaw, A. Rabinowitz, K.H. Redford, J.G. Robinson, E.W. Sanderson, and A.B. Taber, eds. *El Jaguar en El Nuevo Milenio*. Fondo de Cultura Economica, UNAM, Wildlife Conservation Society, Mexico.

Rosas-Rosas, O.C. (2006) Ecological status and conservation of jaguars in northeastern Sonora, Mexico. Ph.D. dissertation. New Mexico State University, Las Cruces, USA.

Rosas-Rosas, O.C., L.C. Bender, and R. Valdez. (2008) Jaguar and puma predation on cattle calves in northeastern Sonora, Mexico. *Rangeland Ecol. Manage*. 61:554-560.

Rovero, F., T. Jones and J. Sanderson. (2005) Notes on Abbott's duiker and other forest antelopes of Mwanihana Forest, Udzungwa Mountains, Tanzania, as revealed by camera-trapping and direct observations. *Tropical Zoology*, 18:13-23.

Rzedowski, J. & R. Palacios Chávez. (1977) El bosque de *Engelhardtia mexicana* en la región de la Chinantla, una reliquia del Cenozoico. *Bol. Soc. Bot. Mexico*, 29:121-177.

Rzedowski, J. (1978). Vegetación de México. Editorial Limusa. México, D.F.

Salom-Pérez, R., E. Carrillo, J.C. Sáenz, and J.M. Mora. (2007) Critical condition of the jaguar population in Corcovado Nacional Park, Costa Rica. *Oryx*, 41:51-56.

Sanderson, E.W., K.H. Redford, A. Vedder, P.B. Coppolillo and S.E. Ward. (2002a) A conceptual model for conservation planning based on landscape species requirements. *Landscape and Urban Planning*, 58: 41-56.

Sanderson, E.W., K.H. Redford, C.B. Chetkiewicz, R.A. Medellin, A.R. Rabinowitz, J.G. Robinson, and A.B. Taber. (2002b) Planning to save a species: the jaguar as a model. *Conservation Biology*, 16:58-72.

Saunders, N.J., editor. (1998) Icons of Power: Feline Symbolism in the Americas. Routledge Press, London, U.K.

Schaller, G.B. (1967) The Deer and the Tiger. University of Chicago Press.

Schaller, G.B. and P.G. Crawshaw. (1980) Movement patterns of jaguar. *Biotropica*, 12:161-168.

Schiaffino, K., L. Malmierca, and P.G. Perovic. (2002) Depredación de cerdos domésticos por jaguar en un area rural vecina a un parque nacional en el noreste de Argentina. Pages 251-264 in R.A. Medellín, C. Equihua, C.L.B Chetkiewicz, P.G. Crawshaw, A. Rabinowitz, K.H. Redford, J.G. Robinson, E.W. Sanderson, and A.B. Taber, editors. *El Jaguar en El Nuevo Milenio*. Fondo de Cultura Economica, UNAM, Wildlife Conservation Society, Mexico.

Schultes, R.E. (1941a) The meaning and usage of the Mexican place-name "Chinantla." *Botanical Museum Leaflets, Harvard University*, 9:101-116.

Schultes, R.E. (1941b) Economic aspects of the flora of northeastern Oaxaca, Mexico. Ph.D. Thesis, Harvard University, Cambridge, MA.

Seidensticker, J. (1976) On the ecological separation between tigers and leopards. *Biotropica*, 8:225-234.

Serres, H. (1992) Manual of Pig Production in the Tropics. C.A.B. International, U.K.

Seymour, K.L. (1989) Panthera onca. *Mammalian Species*, 240:1-9.

Silver, S.C., L. Ostro, K. Marsh, L. Maffei, A.J. Noss, M.J. Kelly, R.B. Wallace, H. Gomez, and G. Ayala. (2004) The use of camera traps for estimating jaguar *Panthera onca* abundance and density using capture/recapture analysis. *Oryx*, 38:148-154.

Simcharoen, S., A. Pattanavibool, K.U. Karanth, J.D. Nichols, and N.S. Kumar. (2007) How many tigers *Panthera tigris* are there in Huai Kha Khaeng Wildlife Sanctuary, Thailand? An estimate using photographic capture-recapture sampling. *Oryx*, 41:447-453.

Simonian, L. (1995) Defending the Land of the Jaguar: A History of Conservation in Mexico. University of Texas Press, Austin.

Skalski, J.R. and D.S. Robson. (1992) Techniques for Wildlife Investigations. Academic Press, San Diego, CA.

Soisalo, K.M. and S.M.C. Cavalcanti. (2006) Estimating the density of a jaguar population in the Brazilian Pantanal using camera-traps and capture-recaptures sampling in combination with GPS radio-telemetry. *Biological Conservation*, 129:487-496.

Soulé, M.E. and B.A. Wilcox, editors. (1980) Conservation Biology: An Evolutionary-Ecological Perspective. Sinauer Associates, Massachusetts, U.S.A.

Stattersfield, A.J., M.J. Crosby, A.J. Long, and D.C. Wege. (1998) Endemic Bird Areas of the World, Priorities for Biodiversity Conservation. BirdLife International, Cambridge.

Sunquist, M. and F. Sunquist. (2002) Wild Cats of the World. University of Chicago Press, USA.

Swank, W.G. and J.G. Teer. (1989) Status of the jaguar-1987. *Oryx*, 23:14-21

Terborgh, J. (1999) Requiem for Nature. Island Press, Washington D.C.

Terborgh, J. and C. Peres. (2002) The problem of people in parks. Pages 307-319 in J. Terborgh, C. van Schaik, L. Davenport, and M. Rao, editors. *Making Parks Work: Strategies for Preserving Tropical Nature.* Island Press, Washington D.C.

Thompson, W.L., editor. (2004) Sampling Rare or Elusive Species: Concepts, Designs, and Techniques for Estimating Population Parameters. Island Press, Washington, D.C.

Tilson, R. and P. Nyhus. (1998) Keeping problem tigers from becoming a problem species. *Conservation Biology*, 12:261-262.

Trejo, I. and R. Dirzo. (2000) Deforestation of seasonally dry tropical forest: a national and local analysis in Mexico. *Biological Conservation*, 94:133-142.

Valdez, R. (2000) Jaguar. Pgs. 378-388 in S. Demarais and P.R. Krausman, eds. *Ecology and Management of Large Mammals in North America*. Prentice Hall, New Jersey.

Valdez, R., J.C. Guzmán-Aranda, F.J. Abarca, L.A. Tarango-Arámbula, and F.C. Sánchez. (2006) Wildlife conservation and management in Mexico. *Wildlife Society Bulletin*, 34:270-282.

Van der wal, H. (1998) Chinantec Shifting Cultivation and Secondary Vegetation: a Case-Study on Secondary Vegetation Resulting from Indigenous Shifting Cultivation in the Chinantla, Mexico. BOS Foundation, Wageningen.

Velázquez, A., E. Durán, I. Ramírez, J. Mas, G. Bocco, G. Ramírez, and J.L. Palacio. (2003) Land use-cover change processes in highly biodiverse areas: the case of Oaxaca, Mexico. *Global Environmental Change,* 13:175-184.

Velázquez-Rosas, N. and J. Meave. (2002) Elevational variation of leaf traits in montane rain forest tree species at la Chinantla, southern Mexico. *Biotropica*, 34:534-546.

Voss, R.S. and L.H. Emmons. (1996) Mammalian diversity in Neotropical lowland rainforests: a preliminary assessment. *Bull. Amer. Mus. Nat. Hist.*, 230:3-115.

Wallace, R.B., H. Gomez, G. Ayala, and F. Espinoza. (2003) Camera trapping for jaguar (*Panthera onca*) in the Tuichi valley, Bolivia. *J. Neotrop. Mammal*., 10:133-139.

Wasser, S.K., B. Davenport, E.R. Ramage, K.E. Hunt, M. Parker, C. Clarke, and G. Stenhouse. (2004) Scat detection dogs in wildlife research and management: application to grizzly and black bears in the Yellowhead Ecosystem, Alberta, Canada. *Canadian Journal of Zoology*, 82:475-492.

West, P.C. and S.R. Brechin, editors. (1991) Resident Peoples and Protected Areas: Social Dilemmas and Strategies in International Conservation. University of Arizona Press, Tucson.

White, A. and A. Martin. (2002) Who owns the world's forests? Forest tenure and public forests in transition. Forest Trends/Center for International Environmental Law, Washington D.C.

Wibisono, H., J.J. Figel, S.M. Arif, A. Ario, and A.H. Lubis. (2008) Assessing the status of the Sumatran tiger in a new Indonesian Protected Area: Batang Gadis National Park. In press, *Oryx.*

Wilshusen, P.R., L. Raleigh, and V.A. Russell. (2002) By, for and of the people: the development of two community-managed protected areas in Oaxaca, Mexico. *Journal of Sustainable Forestry*, 15:113-126.

Woodroofe, R. and J. Ginsberg. (1998) Edge effects and the extinction of populations inside protected areas. *Science*, 280:2126-2128.

WWF (2005) Conservation Science: Global 200 Ecoregions, www.worldwildlife.org/science/ecoregions/g200.cfm

Zuluaga, G., J. Giraldo, and M. Larrarte. (2003) Un ejemplo de conservación bio-cultural - el Parque Nacional Alto Fragua-Indiwasi en Colombia. *Policy Matters*, 12:171-180.
Appendix 1

STRUCTURED INTERVIEW

Human-wildlife interactions in four CORENCHI communities - Santa Cruz Tepetotutla, San Antonio del Barrio, San Pedro Tlatepusco, Santiago Tlatepusco

CIIDIR-Oaxaca, Florida International University

Summer, 2007

Good morning/afternoon/evening. I am/we are investigating the relationship between the community and wild animals; therefore, we are interested to know about your experiences with wild animals here in your community. This study has has been approved by community authorities, but we would like to comment that you are not obligated to respond. Do you permit us to continue with the interview?

1. # Interview: _____ 2. Date: _____ 3. Municipal: _____

4. Community: _____

5. Name of interviewer: _____

PART I. GENERAL DATA ABOUT THE INTERVIEWEE

6. Name: _____ 7. Age: _____

Income and Occupation

8. What is your principal source of income?
A) Remittances (Money sent from outside the community)
B) Store or business
C) Agriculture
D) Other _____

9. What is your second source of income:
A) Remittances (Money sent from outside the community)
B) Store or business
C) Agriculture
D) Other _____

10. Do you currently own cattle?
Yes_____ No_____ If they answer yes, how many do they own? _____

11. Did you own cattle in the past? Yes___ No___ (if the answer is no, move on to question #14)

12. What type of cattle? a) _____b) _____

13. What was the most head of cattle you ever owned? a) _____ b) _____

MIGRATORY STATUS

14. Have you spend time away from your community? Yes_____ No_____
If they answer yes, ask where they went; if they answer no, continue to question #17
A) United States
B) Another city or village in Oaxaca
C) Another city or village in Mexico
D) Other _____

15. How many years were you away? _____

16. When did you return to your community (what year)? _____

PART II. Wildlife Data

Now I would like to ask some questions about the animals that live in the forest.

17. Could you comment on the following animals and if they are present in your community and which you consider to be more abundant?

Name of Animal	Present		Abundance		
	Yes	No	High	Medium	Low
Jaguar					
Puma					
Ocelot					
Margay					
Jaguarundi					
Kinkajou					
Collared anteater (tamandua)					
Tapir					
Coati					
Collared Peccary					
White-lipped peccary					
Armadillo					
Brocket deer					
Paca					
Agouti					
White-tailed deer					
Spider monkey					
River otter					
Iguana					
Racoon					
Turtles					
Mexican porcupine					
Currasow					
Tayra					

18. Which animals do you consider more abundant in agricultural areas?

19. Which animals do you consider more abundant in the forest?

20. Do you know of any animals that were once abundant and that are now nearly gone?

21. Do you know of any animals that once existed in your community and have now totally disappeared? Yes____No_____ What animal(s)?

22. Which animals do you consider more abundant after the community conservation areas were established?

PART III – HUNTING AND COMMUNITY LAWS

23. Do you hunt? Yes_____ No_____
If they answer yes, continue; otherwise move on to question #30.

24. For how many years did you hunt (before the community law prohibited hunting)?

25. When was the last time you hunted _____ (years/months)

26. How often did you go hunting? (*Do not mention the options*)
A) every week (# of times_____)
B) every month _____
C) every year_____
D) rarely_____

27. Did you ever sell the meat? Yes_____No_____
(If they answer yes, continue; otherwise move on to question #29)

28. How often did you sell the meat?_____

29. Where did you sell the meat? _____

30. Which three animals did you hunt most often?
A _____ B_____ C_____

	Animal A	Animal B	Animal C
a) In what season			
b) Where			
c) How long before you encountered the animal (hrs)			
d) Were dogs used?			
e) Number of animals killed			
f) Since the conservation program, the abundance of this animal has: Increased Decreased Remained the same			

31. Before hunting was prohibited, how often did you eat bushmeat? (Do not mention the options)
A) Never
B) Once a week
C) Once a month
D) A few times a year.

32. Do you know about the community law that prohibits hunting? Yes_____No_____
(If they answer yes, continue; otherwise move on to question #35)

33. Do you know what this law says (in the community statutes)?

34. Did you participate in assembly discussions about creating the law or statute?
Yes___ No___

35. Do you agree with what is said about hunting in this law or statute? Yes____ No____
Why?

ABOUT THE HUNTING OF PEST ANIMALS IN THE MILPA

36. What animals do you consider to be the biggest pests (that cause damage in your milpa)?
A)_____B_____C_____
D_____E_____F_____

37. Do you kill pest animals in your milpa or cattle pasture? Yes____ No____

38. What animals do you kill in your milpa or cattle pasture?
A) _____
B) _____
C) _____

39. What other animals do you kill during the week?

40. If jaguars or other carnivores did not exist, do you believe there would be more pest animals? Yes___ No ___
Why?

PART IV. INTERVIEW ABOUT JAGUARS

Now I would like to ask some questions about wild animals

41. Have you ever seen a jaguar? Yes ___ No ___
If they answer yes, continue; otherwise move on to question #43

42. How many times? ____

42.a 1st *Narrative.* Comments on the last time they saw the jaguar (*be sure to describe when and where the encounter occured, if the jaguar had cubs, and if it was attacking livestock*):

42.b 2nd *Narrative*. Comments on the last time they saw the jaguar (*be sure to describe when and where the encounter occured, if the jaguar had cubs, and if it was attacking livestock*):

42.c *Narrativo*. Comments on the last time they saw the jaguar (*be sure to describe when and where the encounter occured, if the jaguar had cubs, and if it was attacking livestock*):

INDENTIFICATION OF FELINE ILLUSTRATIONS

43. I would like you to help me identify the jaguar and some other animals in the following illustrations (*use the laminated picture sheet*):

ANIMAL DRAWING	RECOGNIZED	NAME	PRESENT IN COMMUNITY
Margay			
Ocelot			
Jaguarundi			
Lynx			
Jaguar (spotted)			
Jaguar (black)			
Puma			
White tiger			
Tiger			
Male African lion			

ABOUT JAGUAR PREY

44. Do you what animals the jaguar eats?

45. Have you ever seen animal carcasses in your milpa or cattle pasture that were attacked by jaguars? Yes ___ No ____
(*If they answer yes, continue; otherwise move on to question #47*)

46. How many times *(if it is two or more times, record the dates)*? _____
When? _____
Where? _____
What animal? _____

47. Have you ever seen animal carcasses in the forest that were attacked by jaguars? Yes ___ No ____
(*If they answer yes, continue; otherwise move on to question #47*)

48. How many times *(if it is two or more times, record the dates)*? _____

When? _____
Where? _____
What animal? _____

49. Have jaguars killed any of your domestic animals (cows, horses, mules, pigs, dogs, chickens, or others) Yes ___ No ___
How many times? ____
When? _____
What animal?_____
Where? _____

50. How did you know that the animal that attacked your domestic animals was a jaguar and not another carnivore such as a puma, ocelot, margay, jaguarundi?

51. Have you seen jaguar footprints in the forest? Yes ___ No ___ How many times? __
When? _____
Where? _____

51.a. In what season? A) Dry_____B)Wet_____C) Other_____
51.b. Where? A) Agricultural area_____B) Forest_____C) Near the village_____
D) Other_____

52. How did you know the footprints were from a jaguar and not another animal such as a puma, for example?

53. In what part(s) of your community land does the jaguar like to hunt and live?

CULTURAL ASPECTS ABOUT JAGUARS

54. Did your grandparents or parents ever talk about jaguars? Yes ____ No _____
If the answer is yes, briefly explain what they talked about?

55. Do you know any stories or legends about jaguars? Yes___No_____Could you briefly explain them?

56. Do you believe people can have the spirit of a jaguar (nahuales)? Yes ____ No _____
If they answer yes, briefly explain why?

57. Do you know somebody in your community who has seen a jaguar? Yes___No___

58. Do you believe jaguars and man can live in the same area? Yes ___ No ____
Why?

PART V – FOREST CONSERVATION

59. What is your opinion about jaguars living on your community's land?

60. Do you know about the forest conservation projects being developed in your community?
Yes ___ No ___
If the answer is yes, could you mention what they are?

61. Do you receive economic benefit from the community conservation projects?
Yes ___ No ___
If the answer is yes, explain

62. Do you agree with the community conservation projects?
Yes _____ No _____
Why?

63. Do you believe the community projects are doing a good job of conserving the forest and managing the natural resources? Yes _____ No _____
Why?

Appendix 2: Article 85 of the Santa Cruz Community Statutes Banning Hunting

Artículo 75.- El aprovechamiento de los recursos maderables y no maderables para uso comercial será permitido previo acuerdo de asamblea, cumpliendo con [illegible] requisitos que marca la ley forestal.

Articulo 76.- El comunero que necesite realizar la quema de rozos, acahuales y potreros, tiene la obligación de avisar al Código de Vigilancia.

Articulo 77.- Para evitar que el fuego se extienda a los acahuales, selvas o bosques, el Comunero deberá tomas las precauciones de una quema controlada, resaltando las siguientes.

I.- Quienes desmonten para el cultivo de maiz, realizaran guardarrayas con amplitud de dos metros, según la Norma Oficial Mexicana.
II.- Pedir ayuda a los comuneros para evitar propagación del fuego.
III.- Realizar la quema cuando no exista viento fuerte, durante las primeras horas del dia.
IV.- Notificar a los comuneros colindantes.
V.- La quema de los potreros se realizara después del la primera lluvia, a finales de los meses de mayo o junio.
VI.- Si el terreno es inclinado, deberá comenzar desde arriba y con el viento en contra.

Articulo 78.- Los recursos maderables no maderables, como frutos de la selva, ixtle o palma, plantas medicinales, orquideas y otros, serán aprovechados por los comuneros, siempre y cuando no se encuentren en peligro de extinción, teniendo la obligación de cuidarlos y protegerlos en todo momento.

Articulo 79.- Queda prohibido hacer desmontes en donde se encuentran ubicados los aguajes. Las áreas especificas serán dadas a conocer dos veces al año por el Comisariado de Bienes Comunales, previa aprobación de la asamblea.

Articulo 80.- Todos los comuneros, posesionarios y avecindados deberán de realizar labores de reforestación al nuncio de cada época de lluvia en la áreas que determine la Asamblea General de Comuneros.

Articulo 81.- Cada comunero esta obligado a participar en las actividades de reforestación, de preferencia con especies de la región.

Artículo 82.- Se deberán de integrar brigadas comunitarias para el combate de incendios forestales y la tal clandestina de madera. Estas brigadas estarán coordinadas por el Comisariado de Bienes Comunales y el Consejo de Vigilancia.

Artículo 83.- Las brigadas evitaran la tala de madera hecha por la gente ajena a la comunidad.

Artículo 84.- La asamblea integrara comisiones para proteger los recursos naturales, plantas silvestres y animales, conforme a los planes y programas de trabajo que elabore el Comisariado, el Consejo de Vigilancia y participación de las autoridades municipales.

Articulo 85.- Se prohíbe la caza de animales silvestres como Temazate, Gallina de Monte, Mono, Tucanes, Negro Verde y Pico Amarillo, Faisan Real, Jaguar, Ocelote y Triguillo, Puma, Leon y cuando las hembras estén preñadas o criando; solo se podrá cazar con los permisos correspondientes, de conformidad con la Ley de la materia, y ala asamblea de Comuneros.

Articulo 86.- Los animales muertos deberán enterrarse o quemarse para evitar la contaminación del medio ambiente, tambien se consideran que los animales dañeros que se pueden cazar dentro de las tierras de cultivos son los siguientes, Tlacuache, Comadreja, Tuza, Ardilla ,Mapache, Jabali, Conejo y Tejon.

Articulo 87.- Gestionar y procurar el establecimiento de viveros.

Articulo 88.- Se establecerán zonas de conservación de flora y fauna, las cuales tendrán el carácter de zonas de reserva comunitaria en las que no se podrá llevar a cabo aprovechamiento.

Articulo 89.- El aprovechamiento de la fauna silvestre solo se podrá llevar a cabo a través de las unidades de aprovechamiento y conservación de al vida silvestre (UMA) mediante previa aprobación de la SEMARNAP y en correlación a la solicitud de aprobación de la Asamblea General De Comuneros.

Appendix 3: IUCN Protected Area Categories

Category 1a: Strict Nature Reserve: protected area managed mainly for science
Definition: Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

Category 1b: Wilderness Area: protected area managed mainly for wilderness protection
Definition: Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.

Category II: National Park: protected area managed mainly for ecosystem protection and recreation
Definition: Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

Category III: Natural Monument: protected area managed mainly for conservation of specific natural features
Definition: Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.

Category IV: Habitat/Species Management Area: protected area managed mainly for conservation through management intervention
Definition: Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.

Category V: Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation
Definition: Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

Category VI: Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems
Definition: Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

Appendix 4: Funding Proposal Submitted by Chinantec Villagers to the Mexican Secretariat. Proposal Requests Aid to Prevent Further Jaguar Predation on Livestock.

SECRETARIA DE MEDIO AMBIENTE Y RECURSOS NATURALES

NUMERO DE CONVENIO: CONANP/20/RP07/PROCODES/16/08

CONVENIO DE CONCERTACIÓN PARA APOYAR EL PROYECTO COMUNITARIO DEL PROGRAMA DE CONSERVACIÓN PARA EL DESARROLLO SOSTENIBLE DENOMINADO CONSERVACIÓN DEL JAGUAR (*PANTHERA ONCA*) MEDIANTE LA CONSTRUCCIÓN DE CERCAS PARA EVITAR ATAQUES A ANIMALES DOMÉSTICOS EN LA REGIÓN PRIORITARIA CHINANTLA, UBICADA EN EL ESTADO DE OAXACA, QUE CELEBRAN POR UNA PARTE, EL EJECUTIVO FEDERAL A TRAVÉS DE LA SECRETARIA DE MEDIO AMBIENTE Y RECURSOS NATURALES, REPRESENTADA EN ESTE ACTO POR EL C. FRANCISCO JAVIER JIMÉNEZ GONZÁLEZ DIRECTOR DE LA REGIÓN FRONTERA SUR, ISTMO Y PACIFICO SUR DE LA CONANP A QUIEN EN LO SUCESIVO SE LE DENOMINARA "LA SECRETARIA", Y POR LA OTRA, EL LA COMUNIDAD DE SANTA CRUZ TEPETOTUTLA, MUNICIPIO DE SAN FELIPE USILA, A QUIEN EN ADELANTE SE DESIGNARA COMO "EL BENEFICIARIO", REPRESENTADO POR LOS CC. VICTORINO GARCÍA CORTEZ, CELESTINO OSORIO OSORIO Y FERNANDO POLICARPO BENITEZ, EN SU CARACTER DE PRESIDENTE, SECRETARIO Y TESORERO DEL COMITÉ PRO-OBRA RESPECTIVAMENTE, DE CONFORMIDAD CON LAS SIGUIENTES DECLARACIONES Y CLÁUSULAS:

DECLARACIONES

I. "LA SECRETARIA" declara:

a) Que es una dependencia del Poder Ejecutivo Federal de acuerdo a lo establecido en el Artículo 26 de la Ley Orgánica de la Administración Pública Federal y que conforme al Artículo 32 Bis del mismo ordenamiento le corresponde, entre otros asuntos, promover la participación social en la formulación, aplicación y vigilancia de la política ambiental y concertar acciones e inversiones con los sectores social y privado para la protección y reparación del ambiente.

b) Que con este fin tiene interés en convenir con la comunidad de Santa Cruz Tepetotutla para desarrollar los trabajos motivo de este convenio, mismos que cumplen con todos los requisitos y especificaciones previstos en el Acuerdo por el que se establecen las Reglas de Operación para el Programa de Conservación para el Desarrollo Sostenible.

c) Que para cumplir con el compromiso a que se refiere el presente convenio, aportará la cantidad de $ 96,000.00 (Noventa seis mil pesos 00/100 M.N.) con cargo a la partida 4104 denominada "Subsidios para Inversión", del presupuesto autorizado a la Secretaría de Medio Ambiente y Recursos Naturales, por la Secretaría de Hacienda y Crédito Público, con cargo al Presupuesto de Egresos de la Federación para el presente ejercicio fiscal.

d) Que tiene su domicilio en Palacio Federal, 3er. piso, 2ª. Oriente Norte No. 227, colonia centro, Tuxtla Gutiérrez, Chiapas.

II. Por su parte, **"EL BENEFICIARIO"** declara:

a) Que tiene su domicilio en la comunidad de Santa Cruz Tepetotutla, San Felipe Usila.

b) Que para llevar a cabo sus objetivos requiere del apoyo de "LA SECRETARIA" en el proyecto comunitario "Conservación del jaguar (*Panthera onca*) mediante la construcción de cercas para evitar ataques a animales domésticos".

c) Que mediante Acta de Asamblea de fecha 29 de abril de 2008, se constituyó el Comité Pro-obra de la comunidad de Santa Cruz Tepetotutla, cuya representación

legal para efectos del presente convenio recae en las CC. Victorino García Cortez, Celestino Osorio Osorio y Fernando Policarpo Benítez, según lo acreditan con el Acta de referencia.

d) Que previo a la firma del presente convenio, se integró el expediente técnico que contiene el programa de trabajo, conceptos de obra y de constitución del Comité Pro-obra.

e) Que para los efectos legales del presente convenio, señala como su domicilio en la comunidad de Santa Cruz Tepetotutla, municipio de San Felipe Usila, Oaxaca.

III. Ambas partes declaran:

Que es compromiso del Gobierno de la República la atención prioritaria a la población indígena que vive en condiciones de pobreza y marginación social, así como promover la participación de forma equitativa de mujeres y hombres en actividades productivas, con respeto a su organización social.

En virtud de lo anterior y con fundamento en los artículos 26 de la Constitución Política de los Estados Unidos Mexicanos; 26 y 32 Bis de la Ley Orgánica de la Administración Pública Federal; 9, 21, 32, 33, 98 y 107 de la Ley Agraria; 37, 38, 39 y 40 de la Ley de Planeación; y los relativos de la Ley Federal de Presupuesto y Responsabilidad Hacendaria y demás relativos del Decreto que contiene el Presupuesto de Egresos de la Federación para el Ejercicio Fiscal de 2008; 4°, 141 y 150 del Reglamento Interior de la Secretaria de Medio Ambiente y Recursos Naturales, así como en lo previsto en el Acuerdo por el que se establecen las Reglas de Operación para el Programa de Conservación para el Desarrollo Sostenible en vigor, las partes celebran el presente convenio de concertación al tenor de las siguientes:

CLÁUSULAS

PRIMERA.- Las Partes convienen en unir sus esfuerzos y capacidades para llevar a cabo el proyecto denominado "Conservación del jaguar (*Panthera onca*) mediante la construcción de cercas para evitar ataques a animales domésticos", cuyos objetivos se enlistan a continuación:

OBJETIVOS:

Proteger a los animales domésticos del ataque del jaguar a través de cercas de protección.

SEGUNDA.- "LA SECRETARIA" a través del C. Francisco Javier Jiménez González se compromete a entregar recursos financieros, mismos que serán administrados por "EL BENEFICIARIO" a través del Comité Pro-obra.

TERCERA.- Para la realización de los objetivos del presente convenio, "LA SECRETARIA" aportará la cantidad de $ 96,000.00 (Noventa seis mil pesos 00/100 M.N), misma que corresponde al 80% del costo del proyecto y la aportación del restante del 20% será responsabilidad de "EL BENEFICIARIO", la aportación de "LA SECRETARIA" proviene de los recursos presupuéstales autorizados a la Comisión Nacional de Áreas Naturales Protegidas en su presupuesto anual 2008, conforme a la normatividad respectiva y previas las autorizaciones que jurídicamente correspondan, sujetos de la disponibilidad del Presupuesto de Egresos de la Federación para el Ejercicio Fiscal 2008. Dichos recursos serán radicados a través de la Comisión Nacional de Áreas Naturales Protegidas y serán ejercidos de acuerdo a los términos del expediente técnico que rubricado por las partes forma parte integrante del presente convenio. Estos recursos constituyen la aportación para ejecutar el proyecto comunitario denominado "Conservación del jaguar (*Panthera onca*) mediante la construcción de cercas para evitar ataques a animales domésticos".

ACTA CONSTITUTIVA DEL COMITÉ PRO–OBRA DE LA COMUNIDAD DE SANTA CRUZ TEPETOTUTLA DEL MUNICIPIO SAN FELIPE USILA EN EL ESTADO DE OAXACA.

En la localidad de Santa Cruz tepetotutla, Municipio de San Felipe Usila, Oaxaca siendo las 17:00 horas del día 29 de abril de 2008, se reunieron en asamblea general los integrantes de la comunidad de Santa Cruz Tepetotutla, con el C. José Luis Noria Sánchez representante de la Dirección Regional Frontera Sur, Istmo y Pacífico Sur en el Estado de Oaxaca con el propósito de formar el "Comité Pro–Obra" del proyecto comunitario «Conservación del jaguar (*Panthera onca*) mediante la construcción de cercas para evitar ataques a animales domésticos».

El C. representante de la Dirección Regional Frontera Sur, Istmo y Pacífico Sur procede a informar a los presentes sobre la posibilidad de realizar proyectos o acciones de construcción, rehabilitación, conservación y aprovechamiento sustentable de los recursos naturales locales.

Asimismo, dicho representante informa del proyecto programado para ser ejecutados en ese sitio, comprendidos dentro de las líneas de trabajo establecidas en el Programa de Conservación y Manejo y/o Programas de Desarrollo Comunitario de la Región Chinantla.

Para lograr lo anterior es necesario que los beneficiarios conozcan las características del proyecto a ejecutar, definiendo al mismo tiempo su forma de participación en tal proyecto.

A fin de cumplir con lo antes expuesto, es necesario que los beneficiarios se organicen en un Comité Pro–Obra, que en su nombre formalicen los compromisos acordados y cumpla las siguientes funciones:

a) Informar a los Beneficiarios, sobre todos y cada uno de los aspectos de la obra.
b) De acuerdo con la Dirección Regional Frontera Sur, Istmo y Pacífico Sur y según las necesidades que la obra requiera, organizar la participación de los beneficiarios.
c) Atender y solucionar los problemas que se pudieran presentar con los participantes durante la ejecución de los trabajos.
d) Dar solución a los problemas operativos que se pudieran crear por la realización de los trabajos en áreas o terrenos de propiedad común, así como por la donación de materiales de la región que pudieran ser requeridos.

A la terminación de los trabajos realizados, la asamblea general de Beneficiarios, conocerá el informe del "Comité Pro–Obra", así como de las necesidades de conservación y mantenimiento de las obras.

Con el fin de dar cumplimiento y legalidad a la presente, los asambleístas proceden con el C. representante de la Dirección Regional Frontera Sur, Istmo y Pacífico Sur como moderador, a la elección de los responsables del Comité que desarrollará el proyecto

El primer pago por parte de "LA SECRETARIA" se hará a más tardar en 10 días hábiles posteriores a la firma del presente convenio por un monto de $ 48,000.00 (Cuarenta y ocho mil pesos 00/100 M.N), que representa el 50% de la aportación total de "LA SECRETARIA", y las siguientes ministraciones se llevarán a cabo contra avance de obra según el calendario y sobre dictamen técnico validado por "LA SECRETARIA" y por el Comité Pro-obra.

El ejercicio de los recursos se hará únicamente para los conceptos de gastos establecidos en el expediente técnico mismo que forma parte del presente convenio.

CUARTA.- "EL BENEFICIARIO" se compromete a garantizar la participación democrática y equitativa de mujeres, hombres y población indígena y a que cada una de las actividades que se aprueben se haga con base en las directrices que en materia ambiental determine "LA SECRETARIA".

Asimismo, "EL BENEFICIARIO" se compromete a ejecutar los trabajos para la realización del proyecto comunitario, en los términos previstos en el expediente técnico a que se refiere la declaración II inciso d) del presente Convenio, y cuyas metas se enlistan a continuación

METAS:

El proyecto comunitario denominado "Conservación del jaguar (*Panthera onca*) mediante la construcción de cercas para evitar ataques a animales domésticos", tiene previsto realizar:

Construcción de 10 cercas vivas de protección

Para la ejecución de las obras materia del presente convenio "EL BENEFICIARIO", se compromete a obtener de las autoridades competentes los permisos, autorización y licencias que se requieran, de conformidad con las disposiciones legales y reglamentarias aplicables.

QUINTA.- "LA SECRETARIA" por conducto de los representantes que designe para tal efecto, tendrá acceso en todo momento a la información contable y financiera que genere el proyecto comunitario "Conservación del jaguar (*Panthera onca*) mediante la construcción de cercas para evitar ataques a animales domésticos".

SEXTA.- "EL BENEFICIARIO" a través del comité promotor de la obra, se obliga a conservar los recibos y notas de comprobación de los recursos financieros objeto de este convenio, así como entregarlos a la "LA SECRETARIA" cuando se le requiera.

SÉPTIMA.- "EL BENEFICIARIO" y "LA SECRETARIA" por conducto del representante que para tal efecto designe, se comprometen a levantar un acta de entrega recepción por cada una de las acciones y/o proyectos terminados. Asimismo, "EL BENEFICIARIO" se compromete a entregar mensualmente un informe de avance de metas, inversión operada y disponible y sobre problemas en la operación del proyecto.

OCTAVA.- Para el seguimiento y de las acciones convenidas, así como para brindar la asistencia técnica y apoyo que requiera "EL BENEFICIARIO" para el logro de los objetivos de este convenio, "LA SECRETARIA" designa al C. José Luis Noria Sánchez Coordinador Regional del Proyecto MIE Chinantla para dar el seguimiento de las acciones convenidas.

NOVENA.- La Secretaría de la Función Pública, llevará a cabo el seguimiento, evaluación y control de las acciones materia de este convenio, en el ámbito de su competencia.

DÉCIMA.- "LA SECRETARIA" podrá rescindir administrativamente el presente instrumento, si "EL BENEFICIARIO" incurre en alguno de los siguientes casos:

a) Si incumple con las obligaciones a su cargo.

b) Si transmite total o parcialmente, por cualquier título, los derechos derivados de este convenio.

c) Si hace mal uso de los recursos federales objeto de este instrumento.

d) Si realiza acciones diferentes a las pactadas en este instrumento.

e) En general, por incumplimiento de "EL BENEFICIARIO" a cualquiera de sus obligaciones que deriven de este convenio, así como de las Reglas de Operación para el Programa de Conservación para el Desarrollo Sostenible.

DÉCIMA PRIMERA.- Si "LA SECRETARIA" considera que "EL BENEFICIARIO" ha incurrido en algunas de las causas de rescisión administrativa que se consignan en la cláusula anterior, se observará lo siguiente:

a) "LA SECRETARIA" comunicará por escrito a "EL BENEFICIARIO" los hechos que constituyen su incumplimiento para que en un término de quince días hábiles exponga lo que a su derecho convenga y aporte, en su caso, las pruebas que estime pertinentes.

b) Transcurrido el término citado en el inciso anterior, se resolverá considerando los argumentos y pruebas que "EL BENEFICIARIO" hubiera hecho valer.

c) "LA SECRETARIA" tomando en cuenta los argumentos y pruebas ofrecidos por "EL BENEFICIARIO" determinará de manera fundada y motivada, si resulta procedente o no rescindir este instrumento y comunicará por escrito dicha determinación.

DÉCIMA SEGUNDA.- Si "LA SECRETARIA" opta por la rescisión de este convenio, "EL BENEFICIARIO" estará obligado a pagar por concepto de daños y perjuicios una pena convencional a juicio de "LA SECRETARIA", que podrá ser hasta por el 20% del monto total de este convenio.

DÉCIMA TERCERA.- Cualquiera de las partes podrá dar por terminado el presente Convenio, mediante aviso por escrito, que con treinta (30) días de anticipación haga llegar a la otra, en donde se justifiquen las causas que dieron origen a tal decisión, tomándose en este caso, las medidas necesarias para evitar los perjuicios que se pudieran causar con dicha situación.

DÉCIMA CUARTA.- Las partes convienen que serán causas de terminación del presente instrumento, las siguientes:

a) La voluntad de las partes, manifiesta mediante el mecanismo previsto en la cláusula anterior del presente instrumento.

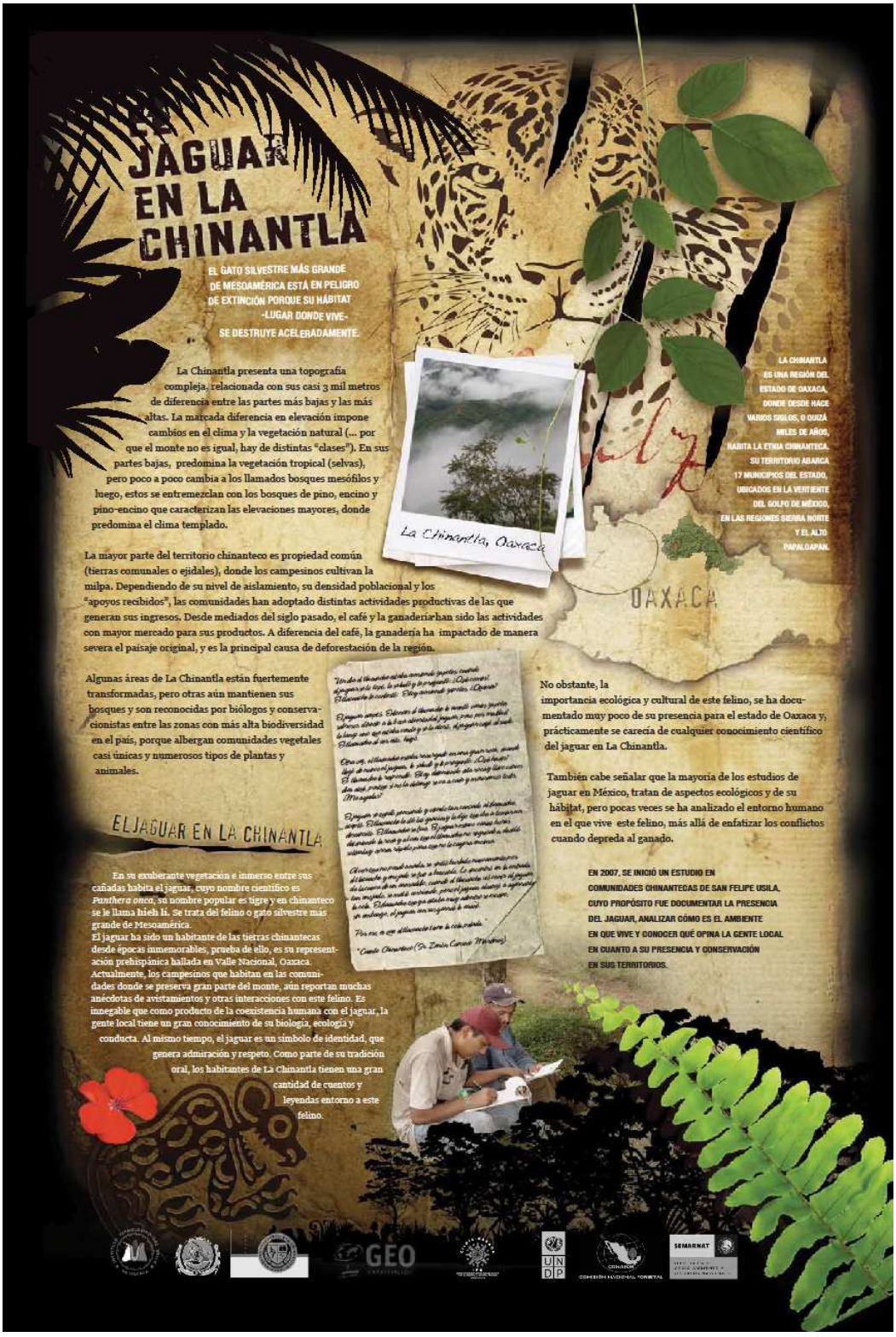
b) El incumplimiento de alguna de las partes a las obligaciones adquiridas en el presente convenio.

c) La imposibilidad física o jurídica para continuar con el objeto de este instrumento.

d) El caso fortuito o fuerza mayor que impidan proseguir con los fines del presente convenio.

DÉCIMA QUINTA.- El personal que cada una de las partes designe, comisione o contrate con motivo de la ejecución de las acciones objeto de este convenio de concertación se entenderá exclusivamente relacionado con la parte que lo designó, comisionó o contrató, quedando bajo su absoluta responsabilidad y dirección, sin que de ello se derive la adquisición de algún tipo de derechos u obligaciones para la otra parte, por lo que en ningún caso podrá considerárseles mutuamente como intermediarios, o como patrones sustitutos o solidarios,

Appendix 5: Wildlife Pamphlets Distributed to Study Area Communities © Elvira Durán.



ESTUDIO DEL JAGUAR EN LA CHINANTLA

ESPERAMOS QUE LA INFORMACIÓN AQUÍ PRESENTADA AYUDE A ESTABLECER UNA ESTRATEGIA DE CONSERVACIÓN PARA EL JAGUAR EN TIERRAS CHINANTECAS, EL CUAL NECESARIAMENTE DEBE INVOLUCRAR A LA GENTE LOCAL.

LOS QUE NO SOMOS DE LA CHINANTLA,... DEBEMOS SUMARNOS A SUS ESFUERZOS.

PORQUE LA EXISTENCIA DEL JAGUAR Y DE OTRAS ESPECIES, SIGNIFICA ENRIQUECER NUESTRA EXISTENCIA.

En este folleto se presentan los resultados del conocimiento y la percepción local sobre el jaguar. Esta información se derivó de una serie de entrevistas realizadas a algunas autoridades, líderes y comuneros de cuatro comunidades chinantecas del municipio de San Felipe Usila (San Antonio Del Barrio, San Pedro Tlatepusco, Santiago Tlatepusco y Santa Cruz Tepetotutla).

Se entrevistó a un 25% los comuneros del padrón de cada comunidad (86 entrevistas). Casi todos los entrevistados viven de trabajar sus cultivos de maíz, frijol, calabaza y café. Casi la mitad, solía practicar la cacería al menos una vez al mes, antes que en 2004, fuera prohibida por acuerdos de sus asambleas comunitarias. En su mayoría, han vivido dentro de sus comunidades, pero muchos han salido por periodos de varios años a trabajar fuera.
Las entrevistas incluyeron dibujos, en ellos la más de la mitad de los comuneros entrevistados reconocieron al jaguar y al puma. Casi todos dijeron que el jaguar, el tigrillo y el ocelote eran "tigres", pero en chinanteco les dieron distinto nombre a los gatos con manchas en la piel.
El jaguar es nombrado como **hieh li**, el ocelote como **hieh huánh/sín nung** y el tigrillo como **sín nung/ hieh huánh.**

En general, la gente local tiene un amplio conocimiento no sólo sobre el jaguar, sino sobre gran parte de la fauna que habita en sus tierras. Sin embargo, este conocimiento varía con la edad de los entrevistados, principalmente éste es menor entre los jóvenes que han migrado antes de ingresar como comuneros.

Casi todos los animales que causan mayor daño a los cultivos también eran aprovechados como alimento, pero ahora sólo las pueden cazar en la milpa. Los pobladores creen que debido a la prohibición de la cacería muchas de estos animales ahora ya son más abundantes. Así que de no ser por el jaguar y los otros felinos que se los comen, tendrían más pérdidas en sus cultivos.

A pesar de la baja aptitud del terreno para la ganadería, las comunidades o campesinos individualmente se han esforzado para introducir y mantener ganado en sus terrenos. Aunque hoy en día, el número de ganaderos es reducido y su actividad es a muy pequeña escala, es un hecho que esta actividad se percibe como "rentable". Además de que es promovida por distintas dependencias de gobierno, quienes argumentan su interés por ayudar al desarrollo de las comunidades y como una alternativa ante los bajos precios del café. Estos apoyos implican la entrega de vacas o borregos, pero lamentablemente no incluyen asesoría para el manejo adecuado de los pastizales o potreros.

Los conflictos con el jaguar parecen no estar solamente determinados por la presencia de ganado en la zona, sino también por la costumbre de los campesinos de casi todos los pueblos chinantecos de dispararles cuando les ven. Aunque no los maten, esto puede dañarlos y con ello reducir su capacidad para cazar su alimento natural y, como hacen los jaguares viejos y enfermos, para sobrevivir recurren a "presas" menos ágiles, como las vacas o los borregos. Así que sin proponérselo, la gente local puede promover los ataques a su ganado.

Se cuenta que a uno de los jaguares muerto después de que mató dos vacas, al quitarle la piel, se encontró que en distintas partes de su cuerpo presentaba restos de pólvora y balas. Además también estaba tuerto.

Pocos reconocen que el puma o los otros felinos pueden causar muertes de ganado joven, cerdos o gallinas, por lo que el hecho de atribuirlos sólo al "tigre" hacen que se sobreestimen los daños que causa el jaguar.

El jaguar parece reconocer todo el territorio como suyo, ya que se desplaza entre el monte y las zonas agrícolas y aún muy cerca de las casas. Por ello, frecuentemente los campesinos señalan haber visto huellas o al animal mismo cerca del pueblo, en sus milpas o en sus cafetales. Específicamente en Santa Cruz Tepetotutla, en una casa del borde del poblado, hubo el ataque a un cerdo. Se constató que se trataba de un jaguar porque se le tomaron huellas y fotos con una cámara automática. A pesar del daño, el Sr. Pepe, el dueño del cerdo, dijo que "le gustaba saber que el jaguar pasaba cerca de su casa".

En plática con algunos campesinos, surgieron tres posibles razones, de porque un animal tan evasivo como el jaguar, se está acercando tanto a la gente:

1) Como es un animal con actividades desde el atardecer y hasta el amanecer es poco probable de encontrarse con la gente, aunque vaya a sus parcelas o transite por sus caminos.

2) Como se ha prohibido su cacería, ya casi no se siente en peligro con la presencia de la gente en la zona, y quizá los más jóvenes no tienen antecedentes de ser perseguidos por cazadores.

3) Porque el abandono de cafetales y milpas ha expandido las zonas de acahuales, cerca de los poblados y con ello, la presencia de animales que le sirven de alimento a éste y otros felinos.

LA MAYORÍA DE LOS CAMPESINOS IDENTIFICARON A MUCHOS DE LOS ANIMALES QUE SIRVEN DE ALIMENTO AL JAGUAR, E INCLUSIVE SEÑALARON CUALES SON SUS FAVORITOS. EN ORDEN DE FRECUENCIA: EL MAZATE, EL JABALÍ, EL TEJÓN Y EL ARMADILLO.

Explican que el jaguar frecuenta las milpas y cafetales porque allí abundan los animales que más perjudican a los cultivos: el tejón, el jabalí, el mazate y diversas especies de aves. Por ello, consideran que cuando el jaguar se los come, es benéfico, porque reduce la posibilidad de daño. El 13% (15 personas) de los campesinos ven al jaguar como un problema, porque se come al ganado. 11% reportaron tener vacas o borregos, y 24% reportaron haber tenido daños por ataques de este felino en los últimos 15 años. En la Chinantla, como en la mayor parte de las zonas rurales de México, perder una vaca, un borrego o un cerdo, es perder un ahorro. Así, se logró conocer que al menos cinco jaguares y un puma han muerto en los últimos 15 años, después de pérdidas de ganado atribuidas a ellos.

Aunque varios campesinos entrevistados han visto jaguares en el monte, en los caminos y en sus cultivos, nadie reportó sentirse amenazado de ser atacado por el jaguar. Sus anécdotas más bien confirman lo que se sabe, que es un animal sumamente esquivo ante la presencia humana directa. La percepción negativa sobre el jaguar no es generalizada, ya que la mayoría de los campesinos, incluidos algunos que han tenido pérdida de sus animales domésticos, dijeron sentir orgullo de que ese animal viva en sus montes y creen que como ha ocurrido en el pasado, en el futuro también pueden convivir con él. De cualquier manera es un reto enfrentar la resolución de conflictos de ataque del jaguar y otros felinos al ganado. Si bien, existen una serie de métodos preventivos de ataques como los cercos electrificados, la baja aptitud ganadera del terreno, ofrece pocas posibilidades de recuperar la alta inversión que implican dichos sistemas. De ser un apoyo gubernamental parecería algo bueno, pero las comunidades tienen muchas necesidades que son más urgentes, como la construcción de sus caminos de acceso y el mejorar el precio de su café. Indudablemente, es un reto encontrar mecanismos que permitan la convivencia de los felinos con la gente, pero se deben fomentar alternativas productivas para los campesinos, que sean más acordes con la conservación. Pero también deberán considerar que los productos puedan llegar y venderse en el mercado, para que sean fuentes de ingreso reales. En las comunidades de estudio, se deberían dar más apoyos, porque a pesar de ser pobres y marginadas, ya realizan acciones en favor de la conservación en general, incluyendo al jaguar.

1) Se han organizado.
2) Reconocieron y certificaron mas de 21 un mil hectáreas como Áreas Comunitarias Protegidas.
3) Se están apegando a sus ordenamientos territoriales comunitarios, que les define claramente las zonas de cultivo.
4) En sus reglamentos establecieron clausulas para un manejo sustentable de sus bosques.
5) Gestionaron y lograron el pago por servicios hidrológicos por parte de la CONAFOR.
6) Están promoviendo el ecoturismo comunitario.
7) Han dado apertura a que investigadores realicen estudios en sus comunidades y han pedido participar en los trabajos de campo.

Pero el dinero y los apoyos de asistencia técnica no son todo, también es urgente implementar un programa de educación ambiental adaptado a la gente local, particularmente a los jóvenes y los niños. Una estrategia de información y educación Sin embargo, éste deberá incluir a las comunidades circunvecinas, porque es necesario sumar esfuerzos, ya que el jaguar demanda áreas muy extensas.

Appendix 6: Wild Cat Flyer Distributed in Chinantec Communities.

Los Bosques y la diversidad
De felinos en la Chinantla, Oaxaca.

Las comunidades asociadas al Comité Regional de Recursos Naturales de la Chinantla Alta - CORENCHI - (Santiago y San Pedro Tlatepusco, San Antonio del Barrio, Santa Cruz Tepetotutla, Nopalera del Rosario y San Antonio Analco), tienen en sus territorios extensiones importantes de Selva Alta Perennifolia, Bosque de Pino, Pino-Encino y Bosque de Niebla. La vegetación, aunada al peculiar relieve propicia una gran variedad de habitats que hace a la región muy biodiversa, presentando así gran variedad de plantas, anfibios, reptiles, aves y mamíferos; entre estos últimos los felinos.

El estudio realizado en dos comunidades indígenas chinantecas (San Antonio del Barrio y Santa Cruz Tepetotutla), del mes de julio a septiembre de 2007, en las cuales se aplicaron entrevistas semiestructuradas y estructuradas y se colocaron trampas-cámara para el monitoreo del jaguar y sus presas; permitió reconocer a varios animales presa, entre ellos, al tepezcuintle, el armadillo, el faisán, el temazate, el jabalí, el pecari y el tejón, y a cinco felinos: el jaguar, el puma, el ocelote, el tigrillo y yaguarundí; además, se percibió la necesidad de identificar a nivel popular a estos felinos.

El nivel de conocimiento de los encuestados en relación a los animales presas es amplio pues los pueden identificar, pero puesto que muchos de los felinos son difíciles de observar el conocimiento de estos es menor.

[1]El CORENCHI nace en el 2005 como un mecanismo impulsor y de gestión de las acciones de conservación.

No todos los pintos son 'tigres' ni todos los 'tigres' son Jaguar...

Para apoyar la difusión de un conocimiento más amplio de los felinos en la Chinantla, se elaboró este tríptico de divulgación.

Felinos de la Chinantla:
(tamaño comparativo en estado adulto)

Iá-cuá
Onza
Herpailurus yaguarondi

Mishinouw
Tigrillo/gato montes
Leopardus wiedii

Iá-pií
Ocelote/tigrillo
Leopardus pardalis

Iá-ll /dzyj-ia-ll
Jaguar/tigre
Phantera onca

Iá-cuá/iá-güie
Puma/León
Puma concolor

0 Cm 50 Cm 100 Cm 150 Cm

La dieta de los felinos

Los felinos, entre ellos el Jaguar, son carnívoros; es decir, comen animales como el armadillo, el tepezcuintle[1], el serete, la ardilla, el tlacuache, el temazate, el jabalí, el tejón[2], el faisán[3] y otras aves.

Érase una vez...

En la Chinantla existen mitos y cuentos en torno al jaguar, he aquí uno de ellos: Mi abuelo me contó que un día el tlacuache estaba comiendo zapotes, cuando el jaguar se lo topó, le saludó y le preguntó: - qué comes? El tlacuache le contestó: - estoy comiendo zapotes, quieres?

El jaguar aceptó, entonces el tlacuache le aventó varios zapotes sabrosos, directo a la boca abierta del jaguar, pero por maldad le lanzo uno que estaba verde y se le atoro, el jaguar cayó al suelo. El tlacuache al ver esto, huyó.

Otra vez, el tlacuache estaba recargado en una gran roca, cuando llego de nuevo el jaguar, le saludó y le preguntó: - que haces?

Eltlacuache le respondió: - estoy deteniendo esta roca y llevo varios días aquí, porque si no la detengo se va a caer y moriremos todos, me ayudas?

El jaguar se quedó pensando y viendo tan cansado al tlacuache, aceptó. El tlacuache le dio las gracias y le dijo que iba a tomar un descansito. El tlacuache se fue. El jaguar estuvo varias horas deteniendo la roca y al ver que el tlacuache no regresaba, decidió soltarla y correr rápido para que no le cayera.

Al ver que no pasaba nada, se sintió burlado nuevamente por el tlacuache y enojado se fue a buscarlo. Lo encontró en la entrada de la cueva de un armadillo, cuando el tlacuache vio venir al jaguar tan enojado, se metió corriendo, pero el jaguar alcanzo a agarrarle la cola. El tlacuache que ya estaba muy adentro se escapo; sin embargo, el jaguar con sus garras le arañó.

Por eso, que el tlacuache tiene la cola pelada.

*Cuento Chinanteco (Sr. Xenón Canseco Martínez)

nuestra naturaleza

miecorregión