

# Exploring the interactions of wildlife and rural communities in Carara National Park, Costa Rica

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by  
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## Abstract

Park officials at Carara National Park, Costa Rica, face considerable challenges. They believe poaching has become a significant threat to the park's biodiversity and that their enforcement measures, largely due to limited funds, are inadequate. Through family-level interviews in six communities surrounding Carara National Park, this study aims to understand the dynamics of poaching by identifying animals at risk of poaching and identifying communities to target future enforcement measures. Interviews inquired about interactions with wildlife, perceived populations of wildlife, sale of wildlife, opinions towards hunting, and observed hunting activities. Summary statistics, CART modeling and probit regressions are used to analyze the data. Results indicate hunting is not prevalent in terms of the number of families that hunt. However, these families can still have significant impacts on wildlife populations with poaching occurring for both subsistence and market-oriented reasons. Two potential community sets are identified as areas to target enforcement. Based on the number of reported families engaging in hunting, enforcement should be targeted in Bijagual and Tárcoles. However, exploring truthfulness through CART and probit regression analysis indicates enforcement should be targeted in El Sur and La Hacienda. Ultimately, future enforcement measures will be determined by Carara officials. Although potential target communities are identified and management practices such as ecotourism and community-based management are potentially viable avenues for reducing poaching, the park faces considerable challenges for enforcement due to its limited financial capabilities.

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## Introduction

Nestled close to the Pacific Ocean in a transitional ecological zone, Carara National Park (Carara) is home to high levels of biodiversity (SINAC 2010). However, officials at Carara fear poaching is threatening this abundant diversity of wildlife (Personal correspondence, Adrian Acre). Although hunting is widely recognized as a historical activity necessary for subsistence (Chardonnet et al. 2001), protected areas, like Carara, are increasingly pressured by poaching which has been identified as a significant threat to biodiversity worldwide (Robinson and Bodmer 1999). Carara is bordered by many small communities along semi-developed roads rounding the back of the park and a main highway along the front, allowing individuals to illegally and anonymously access the park and its resources. With a small enforcement staff, Carara officials believe they have been unable to effectively control poaching and fear the problem is worsening. Done in conjunction with the School for Field Studies, this study aims to evaluate hunting practices in communities surrounding Carara National Park, specifically by identifying animal species commonly subjected to extraction, determining communities to target enforcement measures, and understand the impact poaching can have on income levels in the communities.

## Background

### History of Costa Rica

Costa Rica is known for its rich biodiversity (Chase et al. 1998), protecting approximately four-percent of the known global biological diversity (Obando 2008). Now recognized worldwide as a leader in environmental conservation and environmental policies (Silva 2003, Myers 2001), Costa Rica's national parks serve as a model for other countries on how to maintain biodiversity in the tropics (Boza 1993). However, Costa Rica's environment plan was not always so robust. After suffering from massive deforestation throughout the 1900s (Silva 2003, Sánchez-Azofeifa et al. 2003) from agricultural conversion (Chase et al. 1998), Costa Rica revised its approach. With the creation of the National Park Service in 1970 and the merger of numerous environmental bodies, forming SINAC

(National Systems of Conservation Areas) in 1994, Costa Rica now hosts numerous conservation areas, with public and private reserves now accounting for roughly 26% of its total terrestrial area (Sánchez-Azofeifa et al. 2003, SINAC 2010).

## **Carara National Park**

Carara National Park was initially established as a biological reserve in 1978 but due to high tourism demand became a national park in 1998 (SINAC 2010). Located in the Puntarenas and San José provinces, Carara (9° 45' 22"N, 84° 36' 27" W) borders the Tárcoles River to the south and the Costanera Sur highway (and Pacific Ocean) to the west (Laurencio and Malone 2009). Spanning 5,242 hectares, Carara is characterized by its unique ecosystem composition. Blending the tropical dry forests of the north with wet tropical forests from the south (Laurencio and Malone 2009), this park embodies a variety of landscapes from seasonal flooding to old growth forests, creating a transitional zone home to a higher species richness than surrounding areas (Laurencio and Malone 2009, Madrigal and Grayum 2002). According to SINAC, Carara is a biological island that represents the last remaining transitional forest in Costa Rica (SINAC 2010), therefore making conservation especially crucial.

## **Theoretical Framework**

### **Protecting biodiversity in tropical forests**

Tropical forests are the richest ecosystems on Earth, in terms of biodiversity (Butler & Laurance 2008, Munasinghe 1992). Concerns over the rise of deforestation and loss of biodiversity and ecological services over the last century have led to the establishment of protected areas including national parks, biological reserves, and others (Tobias and Mendelsohn 1991, Stenger et al. 2009). Most countries have realized the importance of the environment and the impacts environmental degradation can have on economic development (Munasinghe 1992). Although one of the main goals of national parks is to protect and preserve biodiversity, several factors, including enforcement issues and park size constraints, contribute to the failure to maintain high levels of

diversity (Brashares et al. 2001, Chase et al. 1998). An even greater challenge for parks, specifically in developing countries, is a lack of monetary support. Such parks are notoriously understaffed and underfunded, causing a general sense that parks are ineffective at protecting biodiversity and are incapable of preventing illegal activities (Bruner et al. 2001). Although Bruner et al. (2001) found parks to be “surprisingly effective” at protecting biodiversity despite financial issues, the level of enforcement found in parks was inadequate to prevent illegal activities.

Even with enough funding, difficulties inherently exist within national park systems to preserve biodiversity. Brashares et al. (2001) found extinction rates in West African national parks to be highly correlated to the size of the park. If a park does not allow a large enough area for flora and fauna to disperse, food may become scarce, organisms may be unable to maintain population levels and become locally extinct, and the genetic diversity of organisms can be compromised. The proximity of human populations can also adversely affect biodiversity, especially under conditions where locals participate in illegal activities within park boundaries, including logging and poaching, which exacerbate the ability of wildlife to survive (Brashares et al. 2001).

### **The influence of hunting on biodiversity**

Deforestation is already a well documented factor affecting biodiversity loss in tropical forests (Butler and Laurance 2008, Chardonnet et al. 2001, Silva 2003, Bulte and Damania 2005), but less understood is the interaction between biodiversity and bushmeat. Traditionally hunted for human consumption (Bowen-Jones et al. 2003, Robinson and Bodmer 1999), tropical forests serve as a source of food and resources to local communities (Carrillo et al. 2000, Robinson and Bodmer 1999, Knapp et al. 2010). In addition, bushmeat can provide additional benefits including being a significant protein source for rural, subsistence based communities (Bowen-Jones et al. 2003, Milner-Gulland et al. 2003), and a rare and luxury good for urbanites (Bowen-Jones et al. 2003). In areas of abundance, bushmeat could actually be cheaper than domesticated animal meat (Chardonnet et al. 2002).

Although bushmeat hunting is historically acknowledged as sustainable, the sustainability of hunting in present times has been questioned (Robinson and Bodmer 1999) due to changes in the pressures for subsistence hunting and the more recent popularity of bushmeat as a commercial good. Kühl et al. (2009) report hunting to be the second most important driver of biodiversity loss, behind habitat loss. Rural population densities have risen significantly, causing increased pressure on forest communities and forest resources, thus affecting the sustainability of hunting within such communities (Robinson and Bodmer 1999). In addition, with commercial bushmeat becoming increasingly popular, especially as a luxury good in urban markets, the economic incentives for hunting have increased. Bushmeat can generate significant income, which can be a strong motivator for the persistence of hunting (Bowen-Jones et al. 2003, Chardonnet et al. 2001, Bulte and Damania 2005).

Bushmeat consumption in tropical countries can be extensive, enough to penetrate national parks and other protected areas. Increased pressure on animal populations for food and income can lead to increased levels of poaching. The sustainability of animal populations is already a cause for concern and uncontrolled hunting and poaching is leading to concerns over the integrity of biodiversity, specifically within national park boundaries (Bowen-Jones, et al. 2003, Chardonnet et al. 2002). Species abundance is affected by hunting and overhunting in forests has contributed to local extinctions throughout the tropics (Carrillo et al. 2000). With hunting rates throughout the tropics already much greater than sustainable levels, hunting has become a major threat to biodiversity and to communities who rely on bushmeat for subsistence (Milner-Gulland et al. 2003, Bowen-Jones et al. 2003, Quiros 2008, Robinson and Bodmer 1999).

### **Economic valuation of the environment**

Many environmental services or products do not have explicit economic values because they fall outside of the formal market, either as part of informal economies or externalities (Silva 2003, Munasinghe 1992, Stenger et al. 2009). Where neoclassical economics fails to account for such services (Hall et al. 2000, Ferraro et al. 2010), environmental valuation serves to fill in the disparity

between the market and the environment (Stenger et al. 2009, Nunes and van den Bergh 2001). Environmental valuation can trace the effects of socioeconomic decisions on the environment (Munasinghe 1992) to explore the value of environmental services. Wildlife or environmental sites are often classified by the different use values it serves. *Direct values* include consumptive use, which does not fall within the market and would embody tourism or subsistence hunting, and productive use, or using goods and services from the forest for commercial benefit such as food production or raw materials (Stenger et al. 2009, Chardonnet et al. 2002). Productive use can include the legal and illegal markets. *Indirect values* of wildlife include non-consumptive use such as scientific research, option value (keeping the options of wildlife available in the future), and existence value which is associated with ethics and pleasure derived from knowing some type of wildlife exists (Chardonnet et al. 2002, Jacobsson & Dragun 2001, Richardson & Loomis 2009, Munasinghe 1992, Stenger et al. 2009).

Although non-monetary values of wildlife are widely recognized as a necessary approach beyond classical economic theory throughout the scientific community (Flores p.27), debate exists over what these values actually mean. Economists and ecological scientists view value differently, as economists tend to look for a monetary equivalent of a good or service while ecologists typically value “intrinsic worth” (Freeman p.8). Some researchers believe values hold an inherent bias due to the anthropocentric nature of determining value, which can ultimately lead to underestimation of values (Loomis 2000, Tobias and Mendelsohn 1991, Godoy et al. 1993, Bernard et al. 2009). In addition, non-monetary values may not always positively reflect the resource. Negative values associated with wildlife, such as casualties, invasive species, and agricultural pests, are rarely considered in studies (Chardonnet et al. 2002). Therefore, any sort of economic valuation is an imperfect measure of the complete value of an environmental product (good or service).

## **Valuation methods**

The origins of non-market valuation begin with Hotelling’s travel demand estimates (1949) and willingness to pay studies from Ciracy-Wantrup (1962) (Stenger et al. 2009). The travel cost

method is used to create a demand function for visiting a site, operating under the assumption that the users of the site obtain utility and value from the site's use (Tobias and Mendelsohn 1991, Cooper et al. 2002, Boyle p.260, Menkhaus and Lober 1996). An indirect, revealed preference method which bases its valuation off of actual costs (Loomis 2000), the travel cost method explores the willingness to pay of visitors to reach a specific site as an indicator of the public's value of the site (Munasinghe 1992). The traditional travel cost method deals exclusively with single purpose, single destination trips as multiple destination trips can pose methodological problems (Munasinghe 1992), and therefore alternative methods to determine travel costs can be explored. Quiros (2008) approaches the travel cost method as a summation of costs incurred for going to an environmental site. Although this method is not widely used, it could act as a substitute for indicating tourist willingness to pay for a visiting a site that is part of a multiple destination trip.

Chocheba and Langford (1978) point out some issues with the travel cost method: it does not directly value wildlife and instead is the value of an activity, and substitute sites must be considered to effectively evaluate wildlife. The travel cost method also does not perform a complete sample as not all parties travel to the site, a nearly impossible inconsistency to correct (Cooper et al. 2002).

Contingent valuation also serves as an important valuation method where the researcher aims to discover an individual's willingness to pay or willingness to accept changes in the environment (Richardson and Loomis 2009) and can be used to explore existence value or passive use value (Stenger et al. 2009). Three types of contingent valuation exist: 1) dichotomous choice where the respondent says yes or no to a predetermined willingness to pay bid; 2) payment card in which the respondent selects their maximum willingness to pay based on a set of available options and; 3) open-ended where the respondent states their maximum willingness to pay.

Valuation estimates can greatly vary across experimental groups. To explore the breadth of valuation studies, following is a small sampling of those that exist within Costa Rica. To begin, travel cost estimates by Menkhaus and Lober (1995) averaged a consumer surplus of \$1,150 per person for

the Monteverde Cloud Forest Reserve, with the total value of ecotourism in Costa Rica by United States residents to be \$68 million. Tobias & Mendelsohn (1991) found a consumer surplus for Costa Rican visits to the Monteverde Cloud Forest Reserve to range from \$97,500 to \$116,200 per year. Bienabe & Hearne (2006) conducted a willingness to pay experiment for ecotourism and found the average value respondents were willing to pay for a “1 level” increase in the protection of scenic beauty was \$0.25 per month for Costa Ricans and \$3.36 as a single contribution for foreign tourists. Chase et al. (1998) found an average willingness to pay of \$22 to \$25 for entrance fees to three of Costa Rica’s national parks. Echeverria et al. (1995) found an average willingness to pay of \$118.76 for Costa Ricans and \$137.41 for foreigners, with an aggregate of \$37 million from all visitors to protect the Monteverde Cloud Forest’s biological reserves. For Tapantí National Park, Bernard et al. (2009) estimated the value of the park’s ecological services to key stakeholders to be \$2.5 million per year. Hearne and Salinas (2002) explored willingness to pay for three aspects of Braulio Carrillo National Park. They found an average willingness to pay of \$1.01 for Costa Ricans and \$1.54 for foreigners for greater information about the park on trails and in the visitor’s center and \$2.00 and \$2.11 for Costa Ricans and foreigners, respectively for better views from the park.

Although these methods may sound direct, they are wrought with imperfections. Basing economic value on preferences and behavioral observations is problematic due to lack of complete information, income constraints, and determining relevance for public policy decisions (Freeman p.13-14). To begin, contingent valuation exists in a hypothetical market (Chocheba and Langford 1978, Munasinghe 1992) where respondents may not easily accept operating within (Samples et al. 1986). In addition, respondents’ actual cash willingness to pay has been found to exceed their stated willingness to pay by two or more in some cases (Loomis 2000). Unless the valuation process is clear and participatory, data may be inaccurate (Loomis 2000) and the accuracy of the respondents’ bids depends on how much information they are provided (Samples et al. 1986). Zero bids also pose a problem, for they may represent true zero bids or protest bids and are thus sometimes excluded from data sets (Samples et al. 1986). The existence of a substitute will decrease willingness to pay

and by reminding respondents of the existence of substitutes, the efficiency of estimates will increase (Loureiro and Ojea 2008). Samples et al. (1986) does suggest limiting information available to the respondent, accepting their ignorance of the subject, and providing only enough information about the good to create a realistic market situation. Although this method would in turn create its own limitations, economic valuation must be realized for its imperfections but also its vast uses.

Problems surrounding the valuation of wildlife also are inherent in valuation methodology. Godoy et al. (1993) recommends sampling methods be stratified and should cover seasonal variations and warns that information provided by informants is often incorrect. Poor data will lead to inaccurate results, but in events where data is scarce, results can serve as tools for decision makers (Cooper et al. 2002). Respondents' responses can be influenced by any information given throughout the survey or interview process and the amount of information provided can also alter results (Samples et al. 1986). To adjust for such problems, careful survey development and sampling methods must be employed.

## **Evaluating poaching**

Dealing with issues of poaching within protected areas poses a complex problem. Poaching is a largely unrecognized contributor to economies as it is considered an informal activity (Bowen-Jones et al. 2003, Chardonnet et al. 2002). It has taken time for wildlife to be economically valued in the scientific community (Chardonnet et al. 2002) and the economic value of extracted wildlife has not been explored much in literature (Godoy et al. 1993). The majority of forest valuation studies focus on recreation (Stenger et al. 2009), possibly because poaching is an illegal activity and thus can be an extremely sensitive issue among respondents (Knapp et al. 2010). However, many studies do exist for evaluating poaching activities, whether that means determining the prevalence of poaching or economically valuing poached wildlife. Next, a handful of studies evaluating various aspects of poaching are reviewed.

Knapp et al. (2010) explored the interactions of communities and poaching in the Serengeti through household interviews, looking to evaluate illegal activities based on admittance of

participating in such activities as method of creating policy recommendations. Conducting 180 surveys in three villages, Knapp et al. suggest strategies for interviewing including speaking with the head of household, focusing on household livelihood and asking about poaching activities towards the end of the survey to take advantage of any trust gained throughout the process. Admittance of poaching across households varied between three villages from 3% to 13%.

Kühl et al. (2009) explore poaching of saiga in the Soviet Union. Like Knapp et al. (2010), Kühl et al. (2009) utilize household based interviews to collect data on demographics, attitudes of the individual, and income sources. Questions concerning saiga focus on awareness of its presence, changes in population, trade, awareness of poaching activity, and attitudes towards conservation. Poaching households were identified using “key informants” from the community. Results indicate many households were aware of declining numbers and the most reported reason for engaging in poaching was unemployment and foreign market demand.

Quiros (2008) creates a valuation of the Osa Peninsula in Costa Rica through a summation of the commercial value of hunted species, the commercial value of offspring, the value of protection, and the recreational value associated with the area of wildlife extraction. This valuation does not include the additional values of biological, scientific, educational, or social and thus serves as an indicator of the economic impact of hunting.

A much simpler valuation approach than Quiros (2008), Godoy et al.’s (1993) methods include poaching through its extraction measures. Their model presumes the value of a forest is a reflection of its forest products, including wildlife, timber, and non-timber forest products, calculated through a summation of the quantity extracted multiplied by the net of the commercial price minus cost of extraction.

To gather a holistic picture of hunting activities, it is important to gather data on not only the economic valuation of poaching, but also on personal opinions and general public awareness of the impact of poaching on sustainability of animal populations (Milner-Gulland et al. 2008). Important demographics to consider include age, technology, income and information concerning consumptive

use, and measuring the monetary value of poaching through an equivalent monetary value or the willingness to pay for the product can be helpful (Godoy et al. 1993). Many hunters believe animals will always be available for use (Bowen-Jones et al. 2003), therefore gauging personal knowledge of how hunting affects biodiversity as well as personal reactions to the existence of poaching should also be considered (Gray and Kaminski 1994).

### **Using CART to explore data**

CART (Classification and Regression Trees) is a binary recursive partitioning model that develops a hierarchical structure of tree-based models, classifying predictors based on their relative importance to the dependent variable (Qian, p.217, Mehrotra and Agarwal 2009, Muñoz and Felicísimo 2004). First developed by Brieman et al. (1984), the trees create homogenous “zones” that act as a predictor of a specific response (Vayssières et al. 2000, De’ath and Fabricius 2000). Once the initial tree is generated, each tree is pruned to minimize the standard error (Vayssières et al. 2000). Some advantages of CART modeling include eliminating the necessity of making simplifying assumptions concerning the data and minimizing the effects of outliers; a disadvantage of this method concerns the nature of splits. Because the trees are dichotomous, each split separates the data into two portions. However, if one split continues to be split more, the full data set is not represented in these further splits (for example, if split into 0 and 1, further splits from 1 will not include those data points already segmented into 0) (Vayssières et al. 2000, Muñoz and Felicísimo 2004).

Non-environmental uses of CART are commonly used in exploratory data measures (De’ath and Fabricius 2000). Some of these uses have included medical diagnoses (Vayssières et al. 2000) and classifying customer attitudes of telemarketing (Mehrotra and Agarwal 2009). Not commonly used in ecological studies (De’ath and Fabricius 2000), CART modeling has more recently found applications in such studies as it easily handles continuous and discrete variables (Qian p.217). For specific uses of CART in environmental studies, see Vayssières et al. (2000), De’ath and Fabricius (2000) and Qian (p.217 – 221).

## Costa Rica's park system and the effects of hunting

Despite Costa Rica's commendable strides in conservation strategies, its parks are not without problems. Costa Rica has become a famous tourist destination, especially known for its diverse wildlife and spectacular national parks (Chardonnet et al. 2002, Chase et al. 1998). Tourism accounted for 14% of gross domestic product (GDP) for Costa Rica in 2009 (WTTC 2010), placing a great deal of pressure for continued economic development on national parks to balance the economic advantages of tourism with conservation goals (Alegria 2007, Chase et al. 1998).

The struggle between economic vitality and conservation appears in many aspects of the park system (Sánchez-Azofeifa et al. 2003). Like many developing countries, Costa Rica has limited resources to funnel into its park system (Chase et al. 1998). Poaching by local communities is a problem of great concern; hunting within national park boundaries is illegal (Wildlife Conservation Law No. 7317), but such activities are difficult to monitor and enforce with limited funds. Questions of biological integrity also arise. Mario Boza (1993), a founder of Costa Rica's park system, states a long-term goal of the park system is to expand only parks greater than 20,000 hectares in size, as any expansion of smaller parks would have little effect on the preservation of biodiversity.

Carrillo et al. (2000) tested species abundance between two protected areas with different hunting restrictions (a national park versus a forest reserve). Results indicated that species preferred by hunters were less abundant throughout the forest reserve and more abundant in the national park, but still at risk. Qualified as a well-protected area, and a "best case scenario" for protection, Carrillo et al. (2000) warn that the overexploitation of wildlife in Costa Rica's protected areas is an urgent issue. In addition, wildlife is often present around homes and communities. In a survey of wildlife in households in Costa Rica, about one quarter of the respondents indicated they had wildlife in their homes (Drews 1999). Even so, there is not much data for Latin America on bushmeat hunting or the commercial aspect of hunting (Chardonnet et al. 2002).

## Research Objective

Carara's park officials believe poaching is becoming more prominent and is occurring within the park's boundaries at unsustainable levels (Personal correspondence, Adrian Arce). With a limited enforcement staff of five officers, Carara officials are unsure the extent of poaching and where to target enforcement measures. From 2004 to 2009, there were only twenty-six seizures of poached animals, totaling 31 animals. The majority of the animals seized were paca (*Cuniculus paca*), accounting for 12 animals or 39-percent of the total. Other animals seized (in order of number seized) include white-tailed deer (*Odocoileus virginianus*), scarlet macaw chicks (*Ara macao*), collared peccaries (*Pecari tajacu*), and crested guan (*Penelope purpurascens*). With such a small number of seizures over a five-year span, poaching is either occurring less than anticipated or Carara's ability to prevent poaching is extremely limited. Noted as a particularly unsettling event, officials discovered the peccaries from a 2005 seizure already marinating (Personal correspondence, Adrian Arce). Although animals used for meat are found slaughtered, officials still believe such seizures are small successes. See Appendix 3 for documentation of a seizure of a paca occurring in July 2009.

To better evaluate the relationship between seizures and enforcement, Adrian Arce, the Director of Research at Carara, provided information on capital spent for enforcement for Carara in 2008. There are five people working in enforcement and the yearly salary for an enforcement officer is \$8,551 USD. Acre estimated costs associated with enforcement to be \$4,219 per year for fuel, using two vehicles valued at \$17,103 each, with other equipment totaling an estimated annual cost of \$3,800. Assuming 30% depreciation on the vehicles, the total amount of capital spent on enforcement within Carara was \$49,065 in 2008. However, in 2008 there were only seven seizures of animals, bringing into question the effectiveness of translating funds into results. With such a low level of seizures, there are three possible conclusions. First, Carara officials may be extremely effective at preventing poaching; perhaps the seven violations were the only ones to occur. Second, Carara officials are overestimating the extent of poaching and inaccurately believe they are

ineffective at preventing poaching. And third, Carara officials are actually ineffective at preventing poaching.

Arce identified the animals he believes to be most at risk of poaching and/or local extinction, with the top four (in order of anticipated risk) listed as the paca, white-tailed deer, collared peccary, and scarlet macaw. Additional animals of concern include two avian species: the crested guan and yellow-bellied seedeater (*Sporophila nigricollis*). Four of these animals are used for meat: the paca (known throughout Latin America for its tenderness of meat [Chardonnet et al. 2001]), the white-tailed deer, the collared peccary, and the crested guan. Two avian species are extracted as pets: the scarlet macaw, which is popular in the exotic animal black market, and the yellow-bellied seedeater, a more localized household pet.

It is important to note that these species were identified as vulnerable to population loss in Carara, but not necessarily throughout the rest of the world. To clarify, based on the IUCN's Red List of Threatened Species, which identifies species at risk of extinction, all six identified animals are listed as "Least Concern."

The goal of this study is to understand the extent of poaching through three main objectives:

1. Identify communities to target enforcement.
2. Identify animals to target enforcement.
3. Understand the impact poaching can have on income levels in the communities.

These objectives will be explored through various measures including:

1. General demographic indicators of each community.
2. Summary data on market aspects of poached animals.
3. Perform exploratory data measures through CART modeling to determine potential variables yielding admitting of hunting.
4. Use results from CART to develop probit models to explain admittance of hunting across all communities.

For Carara to improve management of its animal populations, officials must understand the extent of poaching in the park and the reasons it occurs. The ultimate goal of this study is to develop knowledge to aid in the mitigation of illegal activities and preserve Carara's unique biodiversity.

## Methodology

Interviews were administered to residents of six communities (Appendix 2). Four communities, Bijagual, El Sur, La Hacienda, and Las Delicias, border Carara's western edge. Quebrada Ganado and Tárcoles are located along the main road leading to Carara. Nine groups of two to three students administered door-to-door structured interviews, to heads of households, covering interactions with wildlife, perceived populations of wildlife, sale of wildlife, opinions towards hunting and observed hunting activities. Following Knapp et al. (2010) interviews began with general demographic information and respondents were asked about poaching at the end of the interview. To help respondents identify animals, flipbooks with illustrations of the animals were used (Appendix 4). Sizes of the communities varied although all were relatively small. A complete sample was attempted in each community. However, due to time constraints, repeat visits were not always attempted for empty homes. Data for El Sur, La Hacienda, and Las Delicias were collected between June 25 and June 28, 2009; data for Bijagual were collected between July 31 and August 2, 2009 and; data for Quebrada Ganado and Tárcoles were collected between November 19 and November 24, 2009. A total of 252 interviews were conducted.

Data was compiled using Microsoft Excel and analyzed in Stata IC 11 and R. Prices were converted from colones to USD using the World Bank's World Development Indicators official exchange rate, averaged for 2008 (526.24 colones per one U.S. Dollar).

## Results

### Demographic statistics

*Respondents and gender.* Of 252 respondents (Table 1), the majority of the interviews were conducted in Quebrada Ganado (44.8%). The next highest shares of responses were in Bijagual

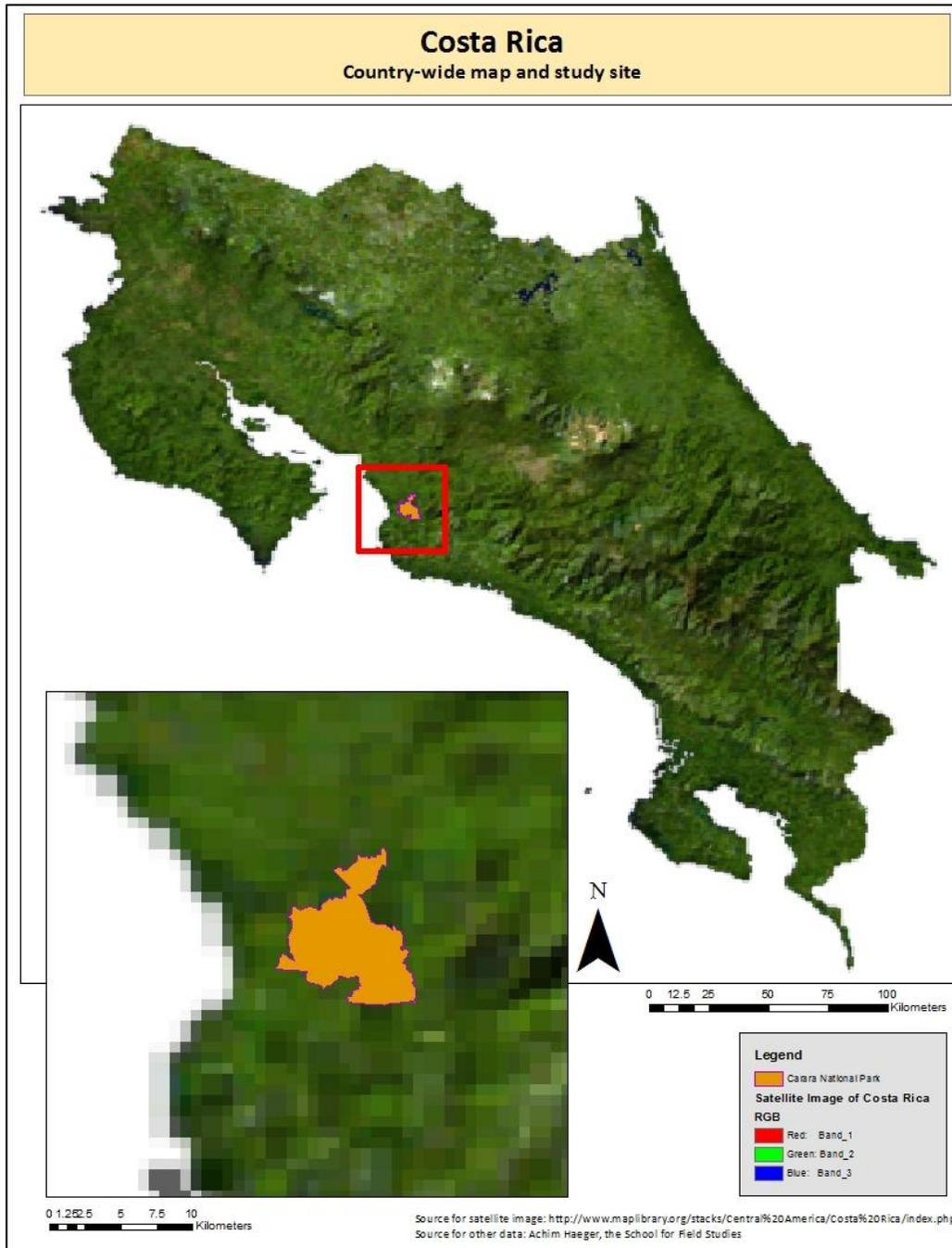


Figure 1. Costa Rica and Carara National Park

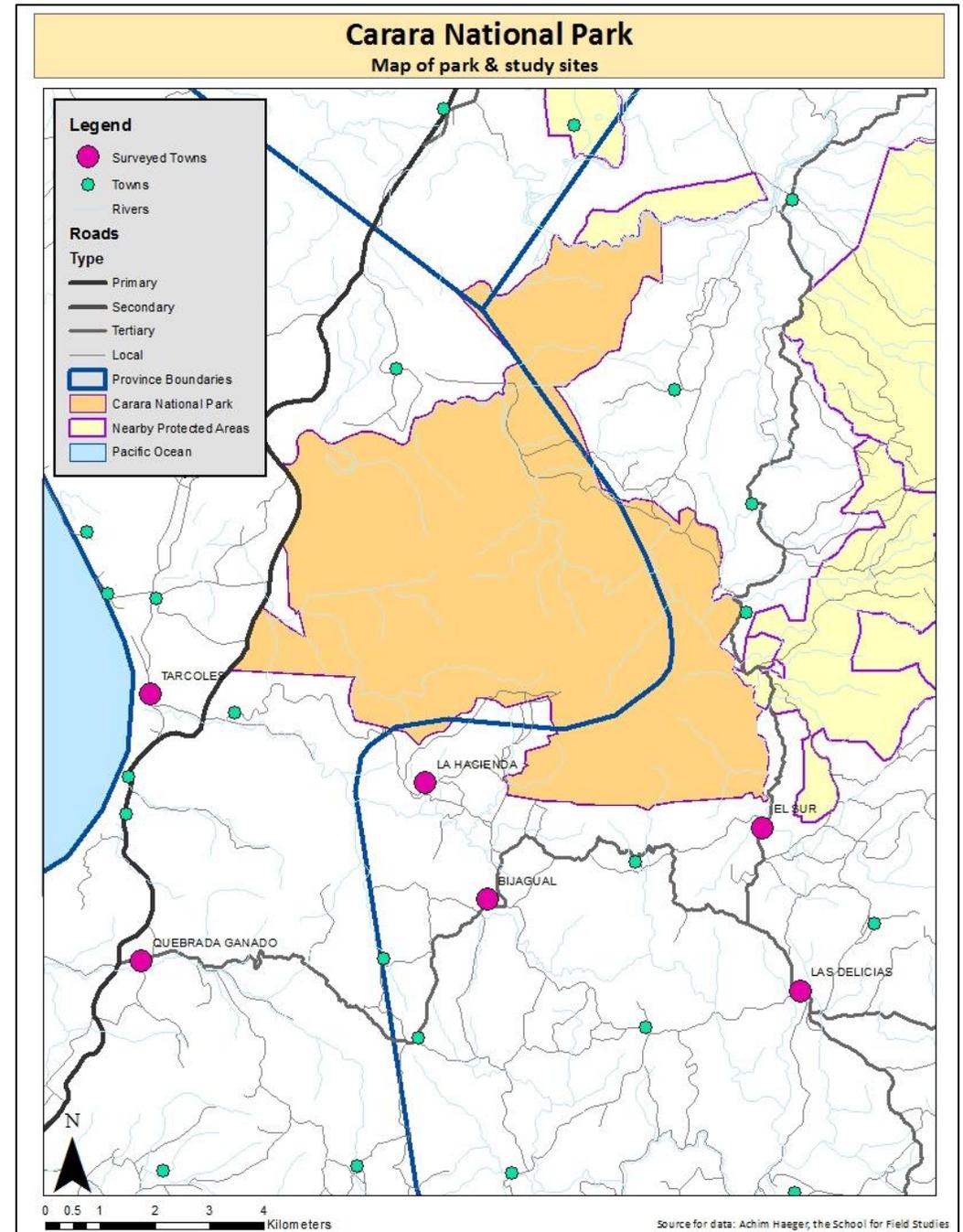


Figure 2. Map of park and study sites.

(19.8%) and Tárcoles (17.9%). Three communities each took under ten-percent of the share: Las Delicias (8.3%), El Sur (4.8%) and La Hacienda (4.4%). There were 168 female respondents and 84 male respondents; this gender spread is 66.7% female versus 33.3% male. The split of female to male respondents varies across communities. Over 60% of respondents are female in Las Delicias, Bijagual, Quebrada Ganado, and Tárcoles. The ratio of female to male is greater in El Sur and La Hacienda. La Hacienda is the only community with more male respondents (54.6% male, 45.4% female). Differences in the male and female ratio could be due to the traditional nature of the communities as many women serving as homemakers; therefore, males may have been at work while females remained at their homes.

<b>Community</b>	<i>Number of respondents</i>	<i>Share of total respondents (%)</i>	<i>Male (%)</i>	<i>Female (%)</i>
<i>Las Delicias</i>	21	8.3	23.8	76.2
<i>El Sur</i>	12	4.8	41.7	58.3
<i>La Hacienda</i>	11	4.4	<b>54.6</b>	45.4
<i>Bijagual</i>	50	19.8	22.0	78.0
<i>Quebrada Ganado</i>	113	<b>44.8</b>	36.3	63.7
<i>Tárcoles</i>	45	17.9	35.6	64.4
<i>All communities</i>	252	100.0	33.3	66.7

Table 1. Distribution of respondents and gender.

*Income.* Overall, average monthly income for all six communities is about \$463 per month or \$5,553 per year (Table 2). Average income varies drastically among communities. Two communities have average incomes below the total average of \$5,553: Las Delicias at \$2,208 and El Sur at \$4,452. The other four communities demonstrate higher wealth, with La Hacienda at \$6,228, Bijagual with \$5,590, Quebrada Ganado at \$6,251, and Tárcoles with \$5,722. Quebrada Ganado and Bijagual represent the largest communities surveyed and those closest to a main highway, which could correlate to higher income levels. La Hacienda's results do include an inconsistency. Although the maximum income in La

Hacienda is close to Quebrada Ganado and Tárcoles, La Hacienda has only eleven responses. One reported income was much higher than the other respondents, affecting average results. Removing this value from the calculation would reduce La Hacienda’s average income to \$3,459, making it the second lowest average income for the six communities.

<b>Community</b>	<i>Average income</i>	<i>Average monthly income</i>	<i>Median</i>	<i>Minimum</i>	<i>Maximum</i>
<i>Las Delicias</i>	\$2,202	\$184	\$1,596	\$342	\$6,841
<i>El Sur</i>	\$4,454	\$371	\$3,991	\$456	\$13,682
<i>La Hacienda</i>	\$6,222	\$519	\$4,560	\$1,140	<b>\$22,803</b>
<i>Bijagual</i>	\$5,590	\$466	\$4,560	\$456	<b>\$22,803</b>
<i>Quebrada Ganado</i>	\$6,251	\$521	\$5,587	\$570	<b>\$22,803</b>
<i>Tárcoles</i>	\$5,722	\$477	\$4,560	\$1,140	\$19,155
<i>All communities</i>	\$5,553	\$463	\$4,560	\$342	\$22,803

Table 2. Summary statistics for income.

**Education.** Throughout the communities, education level is low with the majority of respondents (62.2%) having a primary education or lower (Table 3). However, the variation in education levels differs across communities. Although primary education accounts for the greatest percentage of respondents in all communities, two-thirds or more of respondents have a primary education in El Sur and La Hacienda. In addition, El Sur has the highest level of university-educated respondents, at 16.7%, which is double that of El Sur’s secondary-educated respondents. Quebrada Ganado has the highest level of respondents with a secondary education at 36.6%.

<b>Community</b>	<i>None (%)</i>	<i>Primary (%)</i>	<i>Secondary (%)</i>	<i>University or higher (%)</i>
<i>Las Delicias</i>	19.1	57.1	19.0	4.8
<i>El Sur</i>	8.3	<b>66.7</b>	8.3	<b>16.7</b>
<i>La Hacienda</i>	9.1	<b>72.7</b>	9.1	9.1
<i>Bijagual</i>	20.0	44.0	24.0	12.0
<i>Quebrada Ganado</i>	8.1	48.2	<b>36.6</b>	7.1
<i>Tárcoles</i>	20.0	40.0	28.9	11.1
<i>All communities</i>	13.6	48.6	28.7	9.2

Table 3. Distribution of responses for education levels.

*Age.* The average age of all respondents is 40 years, with the variation on average age ranging from 37 to 48 years (Table 4). This result is expected as surveys were administered to heads of households, which logically falls into the middle-aged category. In all of the communities, the age of the head of household had a wide range, with the youngest head of household being 18 years old (in Bijagual, Quebrada Ganado, and Tárcoles) and the eldest being 84 years old (Quebrada Ganado).

<b>Community</b>	<i>Average age (years)</i>	<i>Median</i>	<i>Minimum</i>	<i>Maximum</i>
<i>Las Delicias</i>	42	41	23	70
<i>El Sur</i>	47	44	22	70
<i>La Hacienda</i>	48	56	21	83
<i>Bijagual</i>	44	41.5	<b>18</b>	78
<i>Quebrada Ganado</i>	37	35	<b>18</b>	<b>84</b>
<i>Tárcoles</i>	39	36	<b>18</b>	82
<i>All communities</i>	40	38	18	84

Table 4. Summary statistics for age.

*Occupation.* A vast array of occupations is cited among respondents. Both the occupation of the respondent and his or her spouse is reported. Female occupations range from bartender to accounting assistant. However, the majority of females (69.6%) are homemakers. The second most

reported occupation for a female is student at 4.9%, followed by house cleaner at 2.5%. Male occupations range from painter to honey maker with most men working in agriculture (28.2%) followed by work in business (10.0%), mechanics (7.7%) and construction (6.5%).

*Family size.* The average size of a family in all communities is four individuals (Table 5). Values are rounded to the half-person to account for slight variation across communities. Bijagual is the only community with an average family size lower than four. The largest families reported include ten individuals, found in Las Delicias and Tárcoles. Summary statistics for all six communities do not yield much variation. Therefore, “% with > 4 members” is included in Table 5 to add an additional dimension of the spread of family size between communities. Results indicate respondents in Las Delicias have the smallest family sizes while respondents in Tárcoles have the largest family sizes.

<b>Community</b>	<i>Average family size</i>	<i>% with &gt; 4 members</i>	<i>Minimum</i>	<i>Maximum</i>
<i>Las Delicias</i>	4	<b>23.8</b>	1	10
<i>El Sur</i>	4	41.7	1	7
<i>La Hacienda</i>	4	36.4	2	7
<i>Bijagual</i>	3.5	26.5	1	7
<i>Quebrada Ganado</i>	4	33.0	1	9
<i>Tárcoles</i>	4	<b>42.2</b>	1	10
<i>All communities</i>	4	33.2	1	10

Table 5. Summary statistics for family size.

*Years in the community.* Two indicators are represented in Table 6 to address years spent in the community. The first indicator is the total number of years spent living in the community. Values shown are rounded to the half year. The second indicator, “% of life spent in the community,” was generated to control for variations in age. Calculated by dividing the age of the respondent by his or her reported years living in the community, this indicator provides a percentage of life spent in the community which can prove more insightful into determining how invested an individual is to the

community. On average, respondents generally spent about half of their lives in their respective communities, but variation was great with minimums staying close or at zero and maximums always reaching 100%.

<b>Community</b>	<i>Years in community</i>	<i>% of life spent in community</i>	<i>Minimum (% of life)</i>	<i>Maximum (% of life)</i>
<i>Las Delicias</i>	17.5	47.1	1.1	100
<i>El Sur</i>	22	45.2	2.8	100
<i>La Hacienda</i>	28	<b>65.4</b>	0.0	100
<i>Bijagual</i>	25	58.3	3.6	100
<i>Quebrada Ganado</i>	22	59.8	0.5	100
<i>Tárcoles</i>	19	52.5	2.7	100
<i>All communities</i>	22.0	56.7	0.0	100

Table 6. Distribution of responses for years spent in the community.

*Household pets.* The majority of respondents (63.1%) said they own domestic animals (Table 7). Across all communities, 20.3% own wild animals. In three communities, over 25% of respondents owned wild animals (Las Delicias, La Hacienda, and Bijagual). In three communities, (Bijagual, Quebrada Ganado, and Tárcoles) respondents believed it was more common to have wildlife in homes than actual results indicate.

<b>Community</b>	<i>Own domestic animals (%)</i>	<i>Own wild animals (%)</i>	<i>Believe it is common for people to have wild pets in their homes (%)</i>
<i>Las Delicias</i>	57.1	<b>28.6</b>	19.0
<i>El Sur</i>	66.7	8.3	8.3
<i>La Hacienda</i>	81.8	<b>27.3</b>	27.3
<i>Bijagual</i>	74.0	<b>28.0</b>	<b>39.6</b>
<i>Quebrada Ganado</i>	60.2	14.3	<b>32.1</b>
<i>Tárcoles</i>	55.6	24.4	<b>46.7</b>
<i>All communities</i>	63.1	20.3	33.7

Table 7. Distribution of responses for household pets.

## Environmental education indicators

Respondents were asked to rate their level of agreement for two statements relating to environmental education, two statements regarding their observations of wildlife in the community, and one representing their feelings towards Carara's presence. Agreement levels are categorized as agree, neutral, or disagree.

Overall, the environmental education indicators tend to yield the belief that residents around Carara do possess environmental knowledge. However, even with perfect knowledge of the impacts of various activities on the environment, knowledge may not directly translate into environmentally sound behavior because of personal motivations in deviating from such behavior. These motivations could include complying with social norms, historical activities, or pressure from peers. However, some individuals may be motivated by a personal desire to hunt or, if hunting is not a social norm, a need to deviate from what is expected.

*Response to "I enjoy living near Carara National Park."* Although Carara has been under some level of protection since 1978, the dynamics surrounding its existence could be positive or negative (Table 8). Results indicate the vast majority (91.2%) of respondents enjoy living near Carara, with 100.0% of Bijagual's respondents enjoying its proximity. El Sur has the highest level of disagreement at 16.7%; with twelve respondents in El Sur, two respondents disagreed with the statement.

Response to “I enjoy living near Carara National Park”	Agree (%)	Neutral (%)	Disagree (%)
Las Delicias	95.2	0.0	4.8
El Sur	83.3	0.0	<b>16.7</b>
La Hacienda	90.9	0.0	9.1
Bijagual	<b>100.0</b>	0.0	0.0
Quebrada Ganado	87.3	10.9	1.8
Tárcoles	93.2	4.5	2.3
All communities	91.5	5.7	2.8

Table 8. Distribution of agreement levels to “I enjoy living near Carara National Park.”

*Response to “Hunting can substantially reduce wildlife populations.”* Overall, respondents agreed with the statement, with the minimum level of agreement being 54.5% for La Hacienda (Table 9). El Sur had the highest level of agreement at 91.7%. Las Delicias and La Hacienda had the highest levels of disagreement, at 33.3% and 36.4% respectively.

Response to “Hunting can substantially reduce wildlife populations”	Agree (%)	Neutral (%)	Disagree (%)
Las Delicias	57.2	9.5	<b>33.3</b>
El Sur	<b>91.7</b>	0.0	8.3
La Hacienda	<b>54.5</b>	9.1	<b>36.4</b>
Bijagual	82.0	6.0	12.0
Quebrada Ganado	72.3	2.7	25.0
Tárcoles	80.0	2.2	17.8
All communities	74.5	4.0	21.5

Table 9. Distribution of agreement levels to “Hunting can substantially reduce wildlife populations.”

*Response to “Wildlife populations are as high today in my community as they were 10 years ago.”* On average, communities did *not* agree with the statement (62.9%), meaning they perceive wildlife populations to be *lower* today than ten years ago (Table 10). However, there was variation within the communities. In Las Delicias, the majority of respondents (52.6%) agreed with the

statement; therefore, Las Delicias residents may not be observing reductions in wildlife populations. The highest levels of disagreement were in Bijagual and Quebrada Ganado, at 71.4% and 67.3% respectively.

<b>Response to “Wildlife populations are as high today in my community as they were 10 years ago”</b>	<i>Agree (%)</i>	<i>Neutral (%)</i>	<i>Disagree (%)</i>
<i>Las Delicias</i>	<b>52.6</b>	10.5	36.9
<i>El Sur</i>	45.5	9.0	45.5
<i>La Hacienda</i>	30.0	10.0	60.0
<i>Bijagual</i>	18.4	10.2	<b>71.4</b>
<i>Quebrada Ganado</i>	24.3	8.4	<b>67.3</b>
<i>Tárcoles</i>	27.3	13.6	59.1
<i>All communities</i>	27.1	10.0	62.9

Table 10. Distribution of agreement levels to “Wildlife populations are as high today in my community as they were 10 years ago.”

*Response to “Decreasing habitat has reduced wildlife populations near my community.”* Most respondents (79.6%) agreed with the statement (Table 11). Tárcoles had the highest level of agreement with 88.62%. The average level of disagreement for this statement was 14.8% and all but one community (El Sur) had disagreement levels under 20%.

<b>Response to “Decreasing habitat has reduced wildlife populations near my community”</b>	<i>Agree (%)</i>	<i>Neutral (%)</i>	<i>Disagree (%)</i>
<i>Las Delicias</i>	80.9	0.0	19.1
<i>El Sur</i>	58.3	0.0	<b>41.7</b>
<i>La Hacienda</i>	81.8	9.1	9.1
<i>Bijagual</i>	76.0	6.0	18.0
<i>Quebrada Ganado</i>	79.5	7.1	13.4
<i>Tárcoles</i>	<b>88.6</b>	4.6	6.8
<i>All communities</i>	79.6	5.6	14.8

Table 11. Distribution of agreement levels to “Decreasing habitat has reduced wildlife populations near my community.”

*Response to “Diversity of wildlife is important for the environment.”* Communities are not differentiated for summary statistics of this statement because only one respondent disagreed (Table 12). This strong level of agreement concerning biodiversity indicates general environmental knowledge is persistent throughout communities and respondents understand the importance of biodiversity.

<b>Response to “Diversity of wildlife is important for the environment”</b>	<i>Agree (%)</i>	<i>Neutral (%)</i>	<i>Disagree (%)</i>
<i>All communities</i>	<b>99.6</b>	0.0	0.4

Table 12. Distribution of agreement levels to “Diversity of wildlife is important for the environment.”

## Hunting dynamics

*Attitudes towards hunting.* Hardly any respondents believed “*It is always OK*” to hunt (1.2%) (Table 13). Tárcoles had the largest percentage of respondents stating “*It is okay as long as no species are threatened by extinction,*” at 13.3%; however, these respondents also had the largest proportion of those against hunting or extracting, with 73.4% stating “*It is never OK.*” All communities had at least 50% of respondents state “*It is never OK,*” which provides valuable insight into community values of wildlife and view towards hunting.

<b>Response to “How do you feel about others hunting or extracting animals in your community?”</b>	<i>It is always OK (%)</i>	<i>It is okay as long as no species are threatened by extinction (%)</i>	<i>It is okay as long as it is for subsistence (%)</i>	<i>I am indifferent to it (%)</i>	<i>It is never OK (%)</i>	<i>Prefer not to respond (%)</i>
<i>Las Delicias</i>	0.0	9.5	<b>23.8</b>	0.0	<b>52.4</b>	<b>14.3</b>
<i>El Sur</i>	0.0	8.3	8.3	<b>16.7</b>	66.7	0.0
<i>La Hacienda</i>	0.0	0.0	18.2	<b>18.2</b>	63.6	0.0
<i>Bijagual</i>	0.0	10.0	16.0	6.0	66.0	2.0
<i>Quebrada Ganado</i>	<b>2.7</b>	9.8	8.0	3.6	67.0	8.9
<i>Tárcoles</i>	0.0	<b>13.3</b>	11.1	2.2	<b>73.4</b>	0.0
<i>All communities</i>	1.2	10.0	11.9	4.8	66.5	5.6

Table 13. Distribution of responses to “How do you feel about other hunting or extracting animals in your community?”

*Reasons for hunting.* Based on conversations with Adrian Acre (Director of Investigation) and Antonio, a former hunter and one of Carara’s current tour guides, five “reasons” are given to determine why people engage in hunting or extraction activities. “*Sell or trade*” had the highest proportion of responses, averaging 62.7% across communities (Table 14). “*Subsistence*” averaged 39.7% across communities; however, “*Subsistence*” was cited by over 50% of respondents in Las Delicias, El Sur and La Hacienda. This variation could indicate these communities, located at the rear of the park, may depend more on subsistence than communities closer to the more developed highway (Quebrada Ganado and Tárcoles). Yet, “*Sell or trade*” was cited more often than “*Subsistence*” in every community except La Hacienda. Perhaps market influences are more at play in the community than subsistence-based reasons. “*Other*” was also an available choice. Some of the additional reasons cited include: 1) to eat (three responses); 2) to own them (two responses); 3) for fun (two responses); 4) lack of education (two responses); 5) to kill them; 6) they like it; 7) poor education; 8) for lack of protection; 9) to be destructive; 10) ignorance and; 11) to make more money.

Response to “Why do you think people hunt or extract animals?”	<i>Sport (%)</i>	<i>Tradition (%)</i>	<i>Sell or trade (%)</i>	<i>Subsistence (%)</i>	<i>No particular reason (%)</i>
<i>Las Delicias</i>	28.6	33.3	<b>81.0</b>	<b>71.4</b>	4.8
<i>El Sur</i>	33.3	25.0	<b>75.0</b>	50.0	8.3
<i>La Hacienda</i>	<b>45.5</b>	18.2	63.6	<b>72.7</b>	0.0
<i>Bijagual</i>	28.0	<b>6.0</b>	58.0	42.0	8.0
<i>Quebrada Ganado</i>	46.9	25.7	57.5	30.1	5.3
<i>Tárcoles</i>	28.9	15.6	<b>68.9</b>	35.6	8.9
<i>All communities</i>	37.7	20.2	62.7	39.7	6.3

Table 14. Distribution of responses for “Why do you think people hunt or extract animals?”

*Estimates of number of hunting families.* In order to gauge the prevalence of hunting, a question on the survey asked respondents to estimate the number of families who participate in

hunting activities in their respective community. These estimates will yield valuable information for estimating how many animals are hunted or extracted in each community. To develop a holistic picture of how prevalent hunting is within communities, looking at the proportion of families who engage in hunting is important. Local officials provided information on the total number of inhabited homes in the communities. Results (Table 15) indicate hunting occurs most often, in terms of number of families that hunt, in Bijagual and Tarcoles, with 6.9 and 6.7 families, respectively. However, based on percent of the total community, it appears hunting is most prevalent in Las Delicias and Bijagual, with 6.4% and 5.9% of the community engaging in hunting, respectively.

<b>Community</b>	<i>Average number of families reported as hunting</i>	<i>Total number of families in community</i>	<i>Estimated percent of families that hunt in community</i>
<i>Las Delicias</i>	3.4	53	<b>6.4</b>
<i>El Sur</i>	0.3	18	1.7
<i>La Hacienda</i>	1.0	28	3.6
<i>Bijagual</i>	<b>6.9</b>	118	<b>5.9</b>
<i>Quebrada Ganado</i>	3.9	283	1.4
<i>Tárcoles</i>	<b>6.7</b>	203	3.3
<i>All communities</i>	22.2 (total)	703	3.2

Table 15. Estimates of the number of families engaging in poaching activities.

## Animal-related variables

*Crested guan.* The crested guan was most often seen in El Sur, Las Delicias, and La Hacienda (Table 16). Quebrada Ganado and Tárcoles do not see the crested guan as much, which was expected as those two communities are along the main highway at the front of the park. For all communities, 32.5% reported seeing less of the crested guan in 2009 (the year data collection occurred) than in the previous year, indicating respondents did not observe declines in population numbers. On average, 5.0% of respondents reported the crested guan was for sale, indicating it is not a prevalent animal within the market. Following this point, there were only four reported sale prices for the crested guan, ranging from zero (El Sur, La Hacienda, Bijagual and Tárcoles) to two responses (Las Delicias and Quebrada Ganado). An average of 14.3% of respondents reported the crested guan is hunted; the average number hunted or extracted per family per month is 0.3, based on 119 observations.

<b>Crested Guan</b>	<i>Seen near home in the last year (%)</i>	<i>Seen less this year than last year (%)</i>	<i>Is the animal for sale? (% yes)</i>	<i>Median price reported</i>	<i>Seen this animal hunted or extracted? (%)</i>	<i>Average # hunted or extracted per family per month</i>
<i>Las Delicias</i>	52.4	33.3	18.8	\$48	19.1	0.8
<i>El Sur</i>	91.7	25.0	8.3	-	16.7	0.9
<i>La Hacienda</i>	45.5	60.0	9.1	-	9.1	0.8
<i>Bijagual</i>	52.0	40.7	2.8	-	20.0	0.2
<i>Quebrada Ganado</i>	19.5	19.2	3.9	\$29	8.9	0.1
<i>Tárcoles</i>	15.6	42.9	2.4	-	20.0	0.3
<i>All communities</i>	32.5	32.6	5.0	\$29	14.3	0.3

Table 16. Distribution of responses for crested guan-related variables.

*Yellow-bellied seedeater.* Respondents from El Sur report seeing the yellow-bellied seedeater the most (91.7%); all other communities had less than 70% of respondents reporting sightings of the yellow-bellied seedeater (Table 17). On average, the respondents did not see less yellow-bellied

seed eaters in 2008 than 2009. When asked whether the yellow-bellied seedeater was for sale, percentages saying yes varied between communities, ranging from 60.0% (Las Delicias) to 14.4% (Quebrada Ganado). With overall low reports of sale with an average of 25.7%, the yellow-bellied seedeater may be sold in only a few of the communities. The median price reported is \$38 based on 21 observations for the cost, ranging from zero in El Sur to six in Tárcoles and Quebrada Ganado. Reports of the yellow-bellied seedeater being extracted from the forest are all under 50%, with an average of 27.0%. The average number of yellow-bellied seed eaters extracted per month is 1.7 across all communities, based on 117 observations ranging from three to 57 between communities.

<b>Yellow-bellied seedeater</b>	<i>Seen near home in the last year (%)</i>	<i>Seen less this year than last year (%)</i>	<i>Is the animal for sale? (% yes)</i>	<i>Median price reported</i>	<i>Seen this animal hunted or extracted? (%)</i>	<i>Average # hunted or extracted per family per month</i>
<i>Las Delicias</i>	66.7	35.7	60.0	\$15	47.6	3.8
<i>El Sur</i>	91.7	8.3	16.7	-	41.7	3.3
<i>La Hacienda</i>	54.6	16.7	18.2	\$48	27.3	1.3
<i>Bijagual</i>	62.0	23.3	37.8	\$76	28.0	3.0
<i>Quebrada Ganado</i>	45.1	40.8	14.4	\$67	19.3	1.1
<i>Tárcoles</i>	64.4	33.3	29.3	\$21	31.1	1.1
<i>All communities</i>	56.4	31.2	25.7	\$38	27.0	1.7

Table 17. Distribution of responses for yellow-bellied seedeater-related variables.

*Scarlet macaw.* The scarlet macaw is viewed quite often in all communities, with 100% of the respondents from Las Delicias, El Sur, La Hacienda and Bijagual seeing them (Table 18). Most respondents did not see less in 2008 than in 2009, indicating the scarlet macaw is well established in the communities. When asked if the scarlet macaw was for sale, on average 31.3% said it was, with a range of 20.4% (Bijagual) to 54.65% (La Hacienda). There are 48 total observations for price points of a scarlet macaw and the median cost is \$190, ranging from \$105 to \$285. On average, 43.0% of respondents said

the scarlet macaw was extracted with an average of one macaw extracted per hunting family per month, based on 105 observations.

<b>Scarlet macaw</b>	<i>Seen near home in the last year (%)</i>	<i>Seen less this year than last year (%)</i>	<i>Is the animal for sale? (% yes)</i>	<i>Median price reported</i>	<i>Seen this animal hunted or extracted? (%)</i>	<i>Average # hunted or extracted per family per month</i>
<i>Las Delicias</i>	100.0	30.0	50.0	\$285	47.6	0.5
<i>El Sur</i>	100.0	16.7	41.7	\$285	50.0	2.0
<i>La Hacienda</i>	100.0	10.0	54.6	\$143	36.4	1.0
<i>Bijagual</i>	100.0	18.4	20.4	\$105	42.0	0.1
<i>Quebrada Ganado</i>	98.2	12.8	21.5	\$285	37.3	0.9
<i>Tárcoles</i>	97.8	27.9	50.0	\$124	55.6	1.7
<i>All communities</i>	98.8	18.2	31.3	\$190	43.0	1.0

Table 18. Distribution of responses for scarlet macaw-related variables.

*Collared peccary.* On average, 40.4% of respondents have seen the collared peccary around their home during the past year. Of those respondents, 38.0% have seen less in 2008 than in 2009 (Table 19). Sale of the collared peccary is not frequent, with an average of 24.4% of respondents reporting it is for sale. The median price reported is \$38; with 19 observations, the median price ranged from \$29 to \$72 across communities, with anywhere from zero observations (La Hacienda) to five observations (Las Delicias). Over half of the respondents reported the collared peccary is hunted (53.6%), although there is a lot of variance among communities, ranging from 8.3% to 74.0% of respondents. An average of 2.4 collared peccaries are hunted per family per month, based on 117 observations.

<b>Collared peccary</b>	<i>Seen near home in the last year (%)</i>	<i>Seen less this year than last year (%)</i>	<i>Is the animal for sale? (% yes)</i>	<i>Median price reported</i>	<i>Seen this animal hunted or extracted? (%)</i>	<i>Average # hunted or extracted per family per month</i>
<i>Las Delicias</i>	57.1	53.3	33.3	\$29	57.1	2.7
<i>El Sur</i>	58.3	33.3	25.0	\$38	8.3	1.3
<i>La Hacienda</i>	54.6	60.0	9.1	-	27.3	1.3
<i>Bijagual</i>	68.0	30.3	39.5	\$48	74.0	8.8
<i>Quebrada Ganado</i>	27.0	35.7	18.5	\$72	50.5	1.5
<i>Tárcoles</i>	26.7	40.0	23.3	\$29	55.6	1.5
<i>All communities</i>	40.4	38.0	24.4	\$38	53.6	2.4

Table 19. Distribution of responses for collared peccary-related variables.

*Paca*. The paca was identified by Adrian Acre as the animal most at risk of poaching. About half of the respondents reported seeing the paca near their homes in the past year (45.6%) and have seen less in 2009 than 2008 (50.9%) (Table 20). Over half report the paca is for sale (56.6%), ranging from 43.4% (Quebrada Ganado) to 86.4% (Bijagual). The cost of a paca is based on 88 observations and the median reported price for all communities is \$57, which is also the median price for El Sur, Quebrada Ganado and Tárcoles. Most respondents (74.1%) report the paca is hunted, garnering the largest percentage of respondents reporting hunting across all of the animals in question. The average number hunted per family per month is 4.4 paca, which is based on 121 observations, ranging from zero to 30 in the six communities. Overall, the paca has more observations contributing to its evaluation of hunting and sale than any of the other animals, which may confirm officials' fears concerning the how much the paca is hunted.

<b>Paca</b>	<i>Seen near home in the last year (%)</i>	<i>Seen less this year than last year (%)</i>	<i>Is the animal for sale? (% yes)</i>	<i>Median price reported</i>	<i>Seen this animal hunted or extracted? (%)</i>	<i>Average # hunted or extracted per family per month</i>
<i>Las Delicias</i>	47.6	64.3	73.7	\$81	71.4	3.7
<i>El Sur</i>	75.0	40.0	66.7	\$57	50.0	6.1
<i>La Hacienda</i>	36.4	66.7	45.5	\$76	54.6	2.8
<i>Bijagual</i>	72.0	56.8	86.4	\$65	86.0	12.0
<i>Quebrada Ganado</i>	34.5	44.7	43.4	\$57	74.1	3.3
<i>Tárcoles</i>	37.8	43.8	51.2	\$57	73.3	2.7
<i>All communities</i>	45.6	50.9	56.6	\$57	74.1	4.4

Table 20. Distribution of responses for paca-related variables.

*White-tailed deer.* Data on the white-tailed deer varies across communities. The percent of respondents who have seen white-tailed deer around their homes in the past year varies, with an average of 45.2% for all communities ranging from under 30% (La Hacienda and Quebrada Ganado) to 100% (El Sur) (Table 21). On average, 48.6% of respondents have seen less deer in 2009 than in the previous year, but results encompass a wide range from 31.3% (Las Delicias) to 64.3% (Tárcoles). Reported sale of white-tailed deer also has a wide spread, from 18.2% (La Hacienda) to 60.0% (Las Delicias), with an average of 30.8%. The median price reported is \$61 across the communities, but there are only nine observations for price indicating the price is not a robust estimate. An average of 57.8% of respondents report the white-tailed deer is hunted or extracted, with a range of 18.2% (La Hacienda) to 80.0% (Bijagual). The wide range of responses between communities for these variables may indicate a lack of consistency concerning hunting behavior; hunting white-tailed deer may not be prevalent in communities like La Hacienda, where there are low reported percentages of sale and hunting. The average number of deer reported as hunted per family per month is 1.8, which is based on 110 observations.

<b>White-tailed deer</b>	<i>Seen near home in the last year (%)</i>	<i>Seen less this year than last year (%)</i>	<i>Is the animal for sale? (% yes)</i>	<i>Median price reported</i>	<i>Seen this animal hunted or extracted? (%)</i>	<i>Average # hunted or extracted per family per month</i>
<i>Las Delicias</i>	85.7	31.3	60.0	\$63	76.2	3.4
<i>El Sur</i>	100.0	41.7	58.3	\$76	58.3	2.7
<i>La Hacienda</i>	27.3	50.0	18.2	-	18.2	1.3
<i>Bijagual</i>	74.0	52.9	36.8	\$57	80.0	5.3
<i>Quebrada Ganado</i>	26.6	48.3	23.2	\$52	40.2	0.6
<i>Tárcoles</i>	31.1	64.3	24.4	\$54	77.8	1.4
<i>All communities</i>	45.2	48.6	30.8	\$61	57.8	1.8

Table 21. Distribution of responses for white-tailed deer-related variables.

*Admittance of hunting.* An important aspect of this study is to determine where Carara should focus enforcement measures. To aid in this objective, an *admit* variable was generated: if the respondent admitted that any of the animals surveyed was hunted, they were assigned a 1; other respondents were assigned a 0. The *admit* variable can be seen as a measure of truthfulness. Hunting occurs *at some level* in the communities and through personal experience while out in the field, it was clear there was a strong negative stigma surrounding the discussion of poaching throughout the communities. Throughout surveying, some respondents become agitated and resistant to completing the interview once poaching questions were asked. Therefore, given these experiences, the *admit* variable may help to uncover some community dynamics not apparent in other aspects of the interview and will hopefully provide additional insight for Carara officials when determining how best to move forward with enforcement. It is important to clarify that admitting hunting occurs can indicate a hunter or a person with close relations to hunters but can also indicate respondents unaware of hunting activities. However, observations of truthfulness in communities can provide indicators for targeting enforcement based on this assumption that non-admittance is untruthful and untruthful communities

are more likely to be associated with illegal activities. Table 22 indicates the share of respondents admitting hunting occurs for the *admit* variable and for each of the six animals in question.

<b>Community</b>	<b>Admit (all) (%)</b>	<b>Crested guan (%)</b>	<b>Yellow-bellied seedeater (%)</b>	<b>Scarlet macaw (%)</b>	<b>Peccary (%)</b>	<b>Paca (%)</b>	<b>White-tailed deer (%)</b>
<i>Las Delicias</i>	<b>85.7</b>	19.1	47.6	57.6	57.1	71.4	76.2
<i>El Sur</i>	66.7	16.7	41.7	50.0	8.3	50.0	58.3
<i>La Hacienda</i>	63.6	9.1	27.3	36.4	27.3	54.6	18.2
<i>Bijagual</i>	96.0	20.0	28.0	42.0	74.0	86.0	80.0
<i>Quebrada Ganado</i>	83.2	8.9	19.3	37.3	50.5	74.1	40.2
<i>Tárcoles</i>	88.9	20.0	31.1	55.6	55.6	73.3	77.8
<i>All communities</i>	85.3	14.3	27.0	43.0	53.6	74.1	57.8

Table 22. Distribution of responses for admittance of poaching.

*Determining market value and hunting prevalence across communities.* Table 23 summarizes the cumulative results across communities for the six animals included in this study. Two measures help determine market value of animals: 1) the number of respondents reporting the animal was for sale and 2) the cost of the animal. As stated earlier, median values for the price of the animal are used to better eliminate outlier responses. The third measure, the percentage admitting hunting, can provide indicators of prevalence of hunting throughout all of the communities including which animals are hunted or extracted most often. Based on the results, the paca is hunted the most (74.1% of respondents say it is hunted), followed by the white-tailed deer (according to 57.8% of respondents), collared peccary (53.6% of respondents), scarlet macaw (43.0% of respondents), yellow-bellied seedeater (27.0% of respondents), and crested guan (14.3% of respondents). The ranking of the animals by percent admitting hunting is synonymous with Adrian Acre’s ranking of animals of most concern; this parallel indicates that Carara officials have a good idea of what is occurring within the parks boundaries and are aware of their own limitations in enforcement.

Looking at the percent of respondents admitting sale can help determine which animals hold a strong market presence and which do not. Respondents admitted the paca was for sale the most (56.6%) followed by the scarlet macaw (31.3%), white tailed deer (30.8%), yellow-bellied seedeater (25.7%), collared peccary (24.4%), and crested guan (5.0%). Based on these results, it is safe to assume the crested guan is not often sold in the market.

<b>Animal</b>	<i>Percent admitting sale(%)</i>	<i>Market value(\$)</i>	<i>Percent admitting hunting (%)</i>
<i>Crested guan (Penelope purpurascens)</i>	5.0%	\$29	14.3%
<i>Yellow-bellied seedeater (Sporophila nigricollis)</i>	25.7%	\$38	27.0%
<i>Scarlet macaw (Ara macao)</i>	31.3%	\$190	43.0%
<i>Collared peccary (Pecari tajacu)</i>	24.4%	\$38	53.6%
<i>Paca (Cuniculus paca)</i>	56.6%	\$57	74.1%
<i>White-tailed deer (Odocoileus virginianus)</i>	30.8%	\$61	57.8%

Table 23. Sale, value, and hunting results for the six animals.

### **Analysis of admittance**

The primary goal of this study is to determine specific communities for Carara officials to target enforcement measures to best combat poaching. To begin, an initial look is given to the relationship between the *admit* variable and each community. This relationship was established through general pair-wise correlations and indicates initial communities to consider throughout the rest of the analysis. Of the six communities, three were statistically significant in their relationship to *admit*. These three communities are El Sur (10% level), La Hacienda (5% level) and Bijagual (5% level). El Sur and La Hacienda have negative coefficients, indicating a tendency towards non-admittance; Bijagual has a positive coefficient, indicating a tendency towards admittance.

CART is next utilized as an exploratory method to determine potential variables affecting admittance across communities. As a second level of analysis, probit regression models are used to determine the statistical significance each predictor has on the dependent variable (Table 24).

Following are seven trees used to determine the importance of variables on admittance. Trees were generated for the admittance of each of the six animals, as well as the general *admit* variable defined above. Variables used to determine admittance are age, gender, educational level, community, percent of life spent in the community (*yrscomm\_perc*), responses to two of the environmental indicator statements (*I enjoy living near Carara National Park* and *Hunting has little impact on wildlife population*), responses to “*How do you feel about others hunting or extracting animals in your community?*” (now referred to as the “*OK hunt*” variable), and whether the respondent has pets in his or her home. Community is indicated numerically; the code for the communities is as follows: 1 – Las Delicias; 2 – El Sur; 3 – La Hacienda; 4 – Bijagual; 5 – Quebrada Ganado and; 6 – Tárcoles.

For probit analyses, categorical data is treated differently (due to variations between Stata IC 11 and R). Because *OK hunt*, community code, and education are categorical data, one category was eliminated from the regression. Las Delicias (community code 1) was removed because it represents the community closest to the average percentage of admittance (the overall average was 85.3% and in Las Delicias, 85.7% of respondents admitted hunting occurred). From *OK hunt*, the response that it is never OK to hunt is removed as it represents the polar response among the selection. For education, primary is eliminated as the highest share of respondents fell into this category (40%).

*Admit variable.* Based on the standard error, the admit tree was pruned to six branches (Figure 1). For respondents who admitted hunting occurred for *any* of the animals, the most important factor determining admittance were responses to the *OK hunt* question. This primary split provides an 8.53% reduction in prediction error. However, if *yrscomm\_perc* had been the primary split, the

reduction in prediction error would have been 8.06%. The similarity of prediction errors indicates both variables are important for classifying admittance.

At the primary split, the response “*Prefer not to respond*” for the *OK hunt question* classified non-admitters. The second split in the tree concerns community code. If the respondent lived in El Sur, La Hacienda, Quebrada Ganado or Tárcoles, they were likely not to admit hunting occurs, leaving Las Delicias and Bijagual as communities admitting hunting. The third split indicates that respondents living in their communities for less than 5.6% of their lives tended not to admit hunting occurs. Community code appears a second time, further classifying the four non-admitting communities into a terminal node with El Sur and La Hacienda not admitting hunting. This division leaves Quebrada Ganado and Tárcoles to be further split by the *OK hunt* question, which appears in the tree for its second time. The responses of *OK hunt* appear again with “*It is OK as long as no species are at risk of extinction*” and “*It is never OK*” segmented into non-admittance. The final split for the admit tree is percent of life spent in the community, also appearing for its second time, with those spending under 51.5% of their lives in the community not admitting hunting.

The results of CART modeling are best understood as a systematic guide to determining admittance by focusing on the terminal nodes. Following the branches, respondents who do not admit hunting occurs are classified as follows:

1. Individuals responding “*Prefer not to respond*” to the *OK hunt* question.
2. Individuals living in El Sur, La Hacienda, Quebrada Ganado, and Tárcoles under 5.6% of their lives.
3. Individuals living in El Sur and La Hacienda who have lived in these communities over 5.6% of their lives.

- Individuals living in Quebrada Ganado and Tárcoles for less than 5.2% of their lives and responded with *It is OK as long as no species are at risk of extinction* or *It is never OK* to the *OK hunt* question.

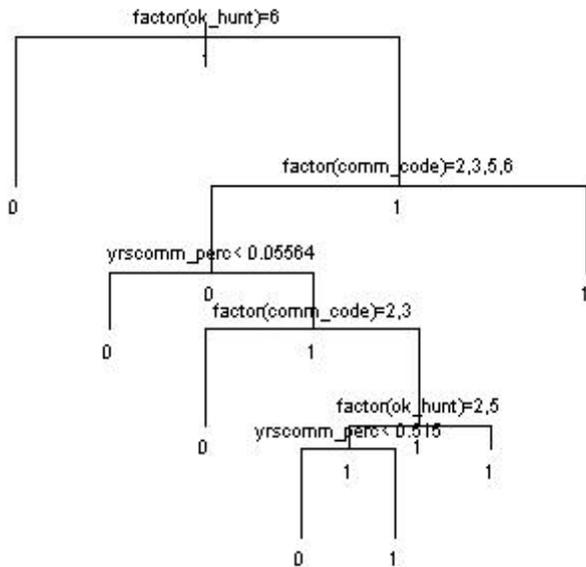


Figure 3. CART model for the *admit* variable.

As a second step to the evaluation of admittance, the three predictors appearing in this tree became the dependent factors in a probit regression (Table 24). El Sur was significant at 10% and La Hacienda was significant at 5%; both of the coefficients are negative. These results indicate that significantly more respondents from El Sur and La Hacienda do not admit hunting than from the average community, Las Delicias (negative indicates closer to zero). This result confirms the fourth split of the tree, where these two communities are separated to a terminal node as not admitters. The third branch of the tree, percent of life spent in the community, was significant at the 10% level; with a positive coefficient, individuals living in the community longer tend to admit hunting occurs. For the *OK hunt* question, which appeared as the first and fifth branches of the tree, the response *“Prefer not to respond”* was significantly different from those who said hunting was never OK at the 1% level with a negative coefficient. . The constant is significant at 1% and the pseudo-R<sup>2</sup> is 13.8%.

*Crested guan admittance.* For the crested guan, the *OK hunt* question is revealed as the most important variable, with responses of *"It is okay as long as no species are threatened by extinction," "I am indifferent to it"* and *"Prefer not to respond"* characterizing non-admittance (Figure 2). Using *OK hunt* as the primary split reduces prediction error by 13.1%; age served as the alternative split, which would have provided an 11.1% reduction in prediction error. Consequently, age appears as the second split in the tree, with respondents under 22.5 years not admitting the crested guan is hunted. Gender is the third split, indicating females do not admit; the fourth split concerns percent of life spent in the community, with those spending under 26.5% of their life in the community not admitting to hunting. The final division seen in this CART model is community code, with respondents from La Hacienda, Bijagual and Quebrada Ganado not admitting hunting of the crested guan.

The classifications of non-admittance are as follows:

1. Individuals responding *"It is okay as long as no species are threatened by extinction," "I am indifferent to it"* or *"Prefer not to respond"* to the *OK hunt* question.
2. Individuals younger than 22.5 years who responded *"It is always OK," "It is OK as long as it is for subsistence,"* or *"It is never OK"* for the *OK hunt* question.
3. Females living in their respective communities under 26.5% of their lives who are older than 22.5 years and responded *"It is always OK," "It is OK as long as it is for subsistence,"* or *"It is never OK"* for the *OK hunt* question.
4. Females living in La Hacienda, Bijagual, and Quebrada Ganado who have lived in their respective communities over 26.5% of their lives, are older than 22.5 years, and responded with *"It is always OK," "It is OK as long as it is for subsistence,"* or *"It is never OK"* for the *OK hunt* question.

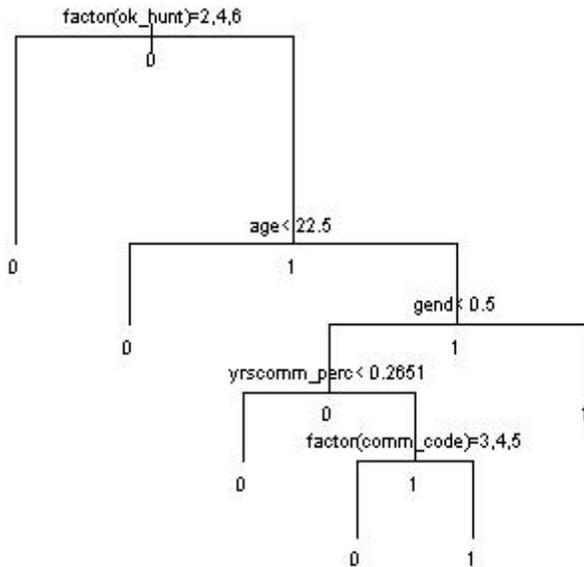


Figure 4. CART model for crested guan admittance.

The probit results indicate gender returns a statistically significant result, at the 1% level (Table 24). With a positive coefficient, males tend to admit the crested guan is hunted. Quebrada Ganado is significant at 5%; with a negative coefficient, this result indicates respondents from Quebrada Ganado do not say the crested guan is hunted. The response *“It is okay as long as no species are threatened by extinction”* is the only statistically significant response in this regression concerning the *OK hunt* question. Two factors from *OK hunt* are omitted from the analysis as they predict failure perfectly. The constant is significant at the 5% level and the pseudo- $R^2$  is 11.5%.

*Yellow-bellied seedeater admittance.* The main factor for admittance of extraction of the yellow-bellied seedeater is community code, which splits in an interesting manner (Figure 3). Terminal nodes for non-admittance are seen on both sides of the community code split; therefore, results for this CART model require a two-part interpretation. Community code as the primary split reduces prediction error by 3.9%; the second option for the primary split was percent of life spent in the community, which would have provided a reduction of 3.4% in prediction error, and interestingly, does not appear in the resulting CART model. Quebrada Ganado is the only community classified to the left side of the primary

split; gender occurs as the second split for the left side indicating females tend not to admit the yellow-bellied seedeater is extracted. Age is the third split, with respondents (males) over 44 years saying the yellow-bellied seedeater is extracted. On the right side of the initial split, which includes all communities except Quebrada Ganado. Age comes through as the second split for the left side, with those younger than 20.5 years not admitting the yellow-bellied seedeater is extracted. Age also represents the third and fourth splits here, which can be condensed to classify respondents younger than 48.5 years and older than 34.5 years as non-admitters of yellow-bellied seedeater extraction.

Following the branches, respondents who do not admit hunting occurs are classified as follows:

1. Females from Quebrada Ganado.
2. Males over 44 years from Quebrada Ganado.
3. Individuals younger than 20.5 years from Las Delicias, El Sur, La Hacienda, Bijagual or Tárcoles.
4. Individuals older than 34.5 years but younger than 48.5 years from Las Delicias, El Sur, La Hacienda, Bijagual or Tárcoles.

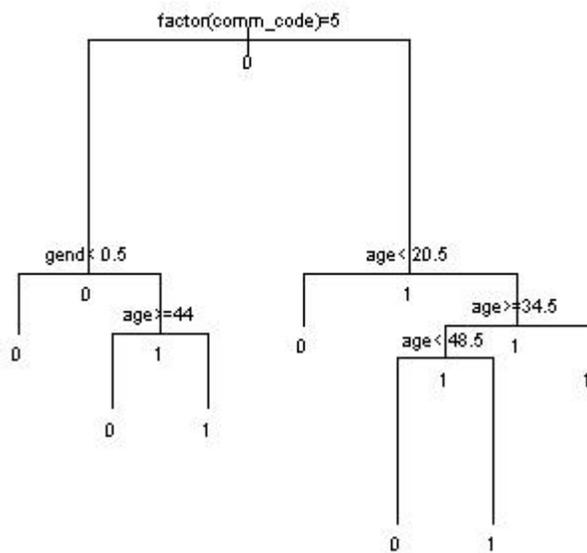


Figure 5. CART model for yellow-bellied seedeater admittance.

The probit for the yellow-bellied seedeater yields three statistically significant variables (Table 24). Gender (male) is statistically significant at the 10% level; with a positive coefficient, males tend to admit the yellow-bellied seedeater is extracted which is consistent with the second split for the left side of the CART model. Two communities return with statistically significant results: Bijagual and Quebrada Ganado at the 10% and 1% level, respectively. The significance of Quebrada Ganado mirrors the CART model, as this community represents the primary split towards non-admittance. Bijagual, on the other hand, does not appear in the CART model. The pseudo-R<sup>2</sup> for this probit is 4.4%.

*Scarlet macaw admittance.* For those respondents admitting the scarlet macaw is extracted from the park, education is the primary split with respondents with less than a university education being separated into the not admitting node (Figure 4). University educated respondents are put into a terminal node of admittance. Using education as the primary split reduces prediction error by 2.6%; community code represents the second best primary split, which would have reduced prediction error by 2.2%. Therefore, both education and community are important factors and community appears in the tree as the second branch with respondents from La Hacienda, Bijagual and Quebrada Ganado not admitting hunting occurs.

Respondents who do not admit hunting occurs are classified as:

1. Individuals from La Hacienda, Bijagual, or Quebrada Ganado who do not have a university education.

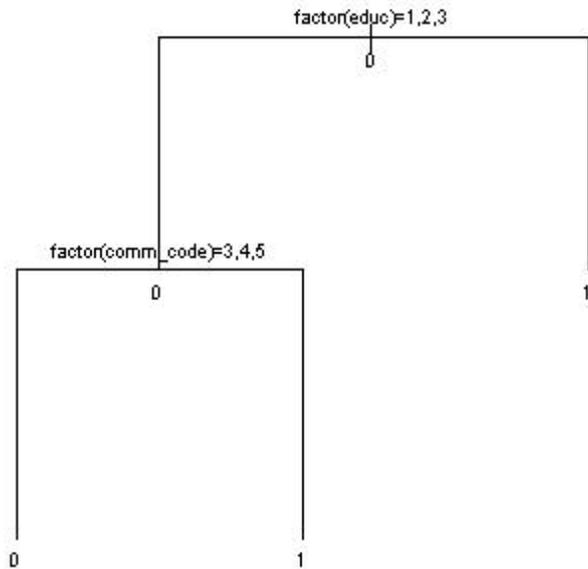


Figure 6. CART model for scarlet macaw admittance.

For the scarlet macaw admittance probit model, university education is the only statistically significant variable at the 5% level (Table 24). University education has a positive coefficient, indicating university educated respondents tend to admit hunting occurs, corresponding to the CART model. The pseudo-R<sup>2</sup> for the scarlet macaw probit is 3.0%.

*Collared peccary admittance.* The peccary admittance tree shows community code as the primary split, providing an improvement of 7.0% for prediction error. Responses to the *OK hunt* question ranked as a secondary split, and if used, would have provided an improvement of 6.6% in prediction error. Respondents from El Sur and La Hacienda do not admit hunting occurs for the collared peccary, creating a terminal node. *OK hunt* responses do appear as the second split, with “*Prefer not to respond*” being classified as another terminal node of non-admittance. The final split in the tree is percentage of life spent in the community, with individuals spending less than 3.1% of their lives in their communities not admitting hunting.

The three terminal nodes in this tree determine the following classifications for non-admittance:

1. Individuals living in El Sur or La Hacienda.

2. Individuals living in Las Delicias, Bijagual, Quebrada Ganado, or Tárcoles who responded “*Prefer not to respond*” to the *OK hunt* question.
3. Individuals living in Las Delicias, Bijagual, Quebrada Ganado, or Tárcoles who have spent less than 3.1% of their lives in their respective communities.

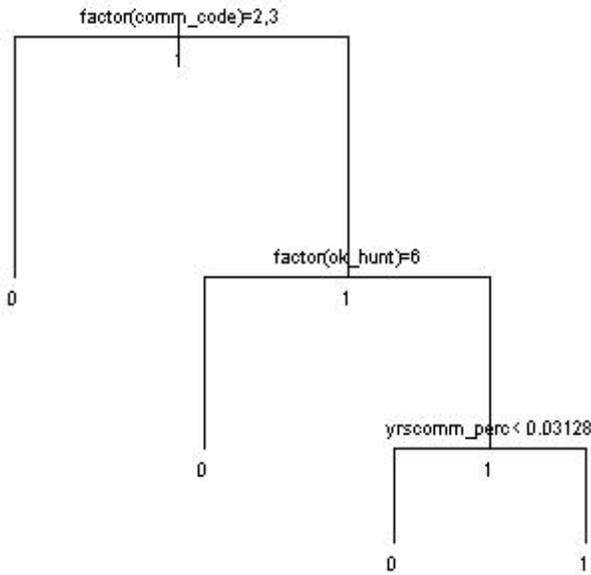


Figure 7. CART model for collared peccary admittance.

The collared peccary probit reveals several statistically significant variables (Table 24). First, El Sur and La Hacienda are both statistically significant, at the 1% and 5% levels, respectively. Both variables have negative coefficients (a tendency of non-admittance), which parallels the conclusions of the first branch of the CART model. Also mimicking the CART model, the response “*Prefer not to respond*” to the *OK hunt* question is statistically significant, with a negative coefficient, at the 1% level. In line with the third branch of the tree, percent of life spent in the community is statistically significant at the 10% level; its positive coefficient indicates a greater percent of life spent in a community yields a tendency to admit hunting occurs. The pseudo- $R^2$  for this probit is 12.0%.

*Paca admittance.* The response to the *OK hunt* question is the most important factor in determining admittance for the paca being hunted, mimicking the primary split in the *admit* tree. *OK*

*hunt* improved prediction error by 5.6%; responses to “*Hunting has little impact on wildlife populations*” would have improved prediction error by 3.9% if used as the primary split, indicating the *OK hunt* variable is a better predictor of admittance. This primary split classifies “*Prefer not to respond*” as a terminal node for non-admittance. Community code appears as the second branch in the tree, with El Sur and La Hacienda appearing as a terminal node for non-admittance. The final split in the tree focuses on responses to “*Hunting has little impact on wildlife populations,*” which are levels of agreement to the statement (disagree, neutral and agree). If individuals felt neutral or agreed with this statement, they were classified in a terminal node of non-admittance.

Non-admittance can be classified as follows:

1. Individuals responding “*Prefer not to respond*” to the *OK hunt* question.
2. Individuals from El Sur and La Hacienda with any response other than “*Prefer not to respond*” to the *OK hunt* question (at this point, all individuals from El Sur and La Hacienda are classified as non-admitters).
3. Individuals who felt neutral or agreed to the statement “*Hunting has little impact on wildlife populations*” who live in Las Delicias, Bijagual, Quebrada Ganado, or Tárcoles and responded with anything but “*Prefer not to respond*” to the *OK hunt* question.

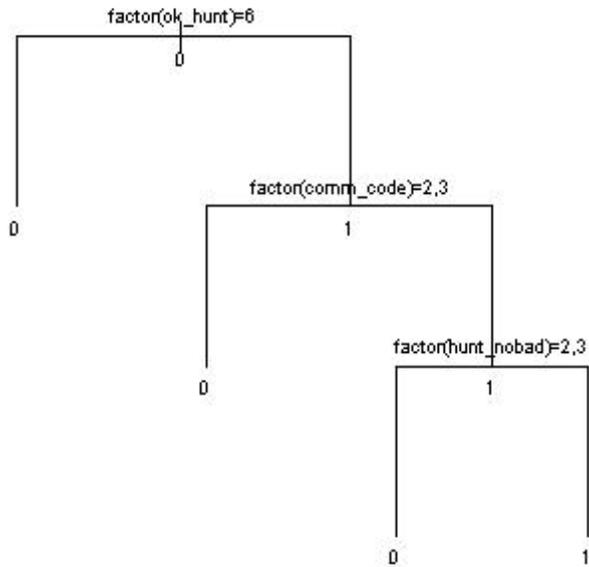


Figure 8. CART model for paca admittance.

The first segment of the CART tree reveals “*Prefer not to respond*” as an indicator of non-admittance. The probit regression reveals this response as statistically significant at the 1% level (Table 24); with a negative coefficient, the probit results coincide with the CART model. For the second split, CART recognizes El Sur and La Hacienda as non-admittance predictors; the probit reveals El Sur to be significant at the 10% level. La Hacienda is not statistically significant. Mimicking the third split of the CART model, both neutral and agree responses to “*Hunting has little impact on wildlife populations*” are statistically significant, with negative coefficients, at the 10% level. The constant is significant at the 1% level and the pseudo- $R^2$  is 8.9%.

*White-tailed deer admittance.* White-tailed deer admittance is strongly characterized by community code with members of El Sur, La Hacienda, and Quebrada Ganado not admitting. The long branches for this primary split indicate the strength of community code as a classification predictor and ultimately did not require the tree to be pruned. By classifying the white-tailed deer admittance variable by community, the error is improved 20.2%. For those respondents not admitting, age appears as the next split, with those older than 29.5 years not admitting. Agreement levels to “*Hunting has little impact*

on wildlife population” appears as the final split in the tree with respondents who felt neutral or agreed with the statement not admitting.

Classifications for non-admittance are:

1. Individuals over 29.5 years who live in El Sur, La Hacienda, or Quebrada Ganado.
2. Individuals agreeing or feeling neutral to the statement “Hunting has little impact on wildlife population” who are under 29.5 years and live in El Sur, La Hacienda, or Quebrada Ganado.

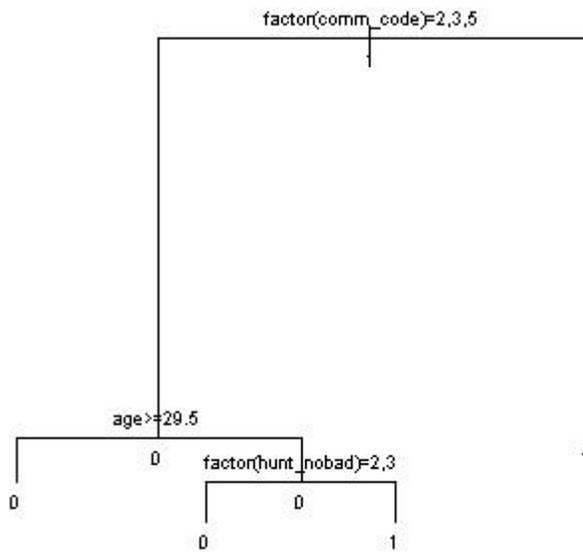


Figure 9. CART model for white-tailed deer admittance.

With community acting so strongly in prediction of admittance with the white-tailed deer’s CART model, it is not surprising find the statistical significance within community variables (Table 24). La Hacienda and Quebrada Ganado are statistically significant at the 1% level; their negative coefficients indicate these communities tend not to admit hunting occurs. Bijagual, which is also in the CART model, is not statistically significant. None of the other predictors in the CART model is significant predictors in the probit. The constant is significant at 1% and the pseudo-R2 for this probit is 14.2%.

*Conclusions.* By using the data and classification trees from the CART models, probit models can be used to determine the influencing characteristics on admittance and whether these independent

	Admit	Crested guan	Yellow-bellied seedeater	Scarlet macaw	Peccary	Paca	White-tailed deer
Intercept	1.155 *** (0.445)	-1.163 ** (0.382)	0.0216 (0.367)	-0.075 (0.285)	0.197 (0.329)	0.936 *** (0.357)	1.213 *** (0.420)
Percent of life spent in the community	0.574 * (0.301)	0.268 (0.307)			0.408 * (0.237)		
Age (years)		0.006 (0.007)	-0.002 (.006)				-0.007 (0.007)
Male		0.674 *** (0.225)	0.309 * (0.185)				
No education				-0.052 (0.253)			
Secondary education				-0.005 (0.195)			
University education				0.604 ** (0.294)			
El Sur	-1.098 * (0.577)	-0.234 (0.569)	-0.250 (0.461)	-0.020 (0.457)	-1.834 *** (0.618)	-0.891 * (0.499)	-0.634 (0.503)
La Hacienda	-1.379 ** (0.581)	-0.951 (0.685)	-0.684 (0.497)	-0.329 (0.481)	-1.074 ** (0.516)	-0.732 (0.511)	-1.703 *** (0.552)
Bijagual	0.306 (0.547)	-0.107 (0.402)	-0.570 * (0.336)	-0.189 (0.330)	0.205 (0.362)	0.211 (0.404)	-0.044 (0.399)
Quebrada Ganado	-0.437 (0.444)	-0.797 ** (0.395)	-0.931 *** (0.315)	-0.306 (0.304)	-0.329 (0.332)	-0.011 (0.350)	-1.094 *** (0.356)
Tárcoles	-0.282 (0.494)	-0.224 (0.407)	-0.538 (0.342)	0.162 (0.335)	-0.271 (0.361)	-0.062 (0.389)	-0.002 (0.396)
Hunting is always OK	omitted	0.709 (0.78)			-0.594 (0.776)	-0.100 (0.776)	
No risk extinction (hunting OK)	0.038 (0.363)	-0.856 * (0.490)			0.302 (0.289)	0.069 (0.319)	
Subsistence (hunting OK)	0.433 (0.416)	-0.332 (0.336)			-0.060 (0.261)	-0.025 (0.286)	
Indifferent (hunting OK)	0.648 (0.610)	omitted			0.059 (0.405)	0.212 (0.435)	
Prefer not to respond (hunting OK)	-1.096 *** (0.381)	omitted			-1.636 *** (0.543)	-1.044 *** (0.383)	
Neutral (hunting has little impact on wildlife populations)						-0.566 * (0.304)	-0.269 (0.300)
Agree (hunting has little impact on wildlife populations)						-0.395 * (0.220)	-0.237 (0.210)
Pseudo R <sup>2</sup>	13.8%	11.5%	4.4%	3.0%	12.0%	8.9%	14.2%

\*\*\* (\*\*, \*) indicates significance at the 1% (5%, 10%) level

Table 24. Regression results based on CART models.

variables significantly affect admittance. Within the regression results, various variables held significance; most often seen throughout the regressions was a statistical significance of certain communities with La Hacienda, El Sur, and Quebrada Ganado each being significant in three of the seven regressions. The response “*Prefer not to respond*” to the *OK hunt* question held significance in three of the seven regressions. Each of these statistically significant variables had negative coefficients, indicating a tendency towards non-admittance. Percent of life spent in the community and male were both statistically significant in two of the regressions, with positive coefficients. Not surprisingly, attitudes towards hunting and community connection (expressed in percent of life lived there) would play an important role one’s admittance of hunting, whether they do not believe it is right to poach from Carara or they feel more connected to the community and thus want to preserve its natural surroundings. Conversely, community connection could also be viewed as those who have not spent much time in the community may only live there (possibly temporarily) to hunt animals from Carara. In addition, it is important to note that animals with overall low admittance rates (specifically the crested guan and yellow-bellied seedeater, with admittance of 14.3% and 27.0%, respectively) can influence the CART results by making data divisions increasingly generalized. This result would speak to an exploitation of local resources by outsiders. Although regressions were completed for all six animals, the *admit* variable appears to be the best indicator of admittance. Holding one of the highest pseudo  $R^2$  (13.8%) and having four statistically significant variables, using information of admittance across all animals provides the most information about overall admittance, and therefore overall hunting behaviors. The next step to the analysis is to use the results from CART to develop a series of probit models to explain admittance of hunting across all communities.

### **Developing the model**

The data from CART revealed specific variables to focus on when developing a larger probit model to explain admittance of hunting among the six communities (Table 25). The model is developed

by adding additional variables to test how changes in the independent variable set affect significance. The first specification (1) includes only the *admit* variable as the dependent variable and five communities as predictors (as mentioned earlier, Las Delicias is removed from this categorical data set). None of the communities yields significance. Two communities have positive coefficients (Bijagual and Tárcoles) while the rest have negative coefficients. This result indicates that although there is not a statistically significant difference in admittance in these communities compared with Las Delicias, Bijagual and Tárcoles respondents tend to admit more than Las Delicias respondents do and the other communities (El Sur, La Hacienda and Quebrada Ganado) tend to admit less. Specification (2) adds in percent of life spent in the community, age, gender, and monthly income. Percent of life in the community is statistically significant at the 5% level and has a positive coefficient meaning the greater percent of one's life spent in the community indicates a greater admittance rate; this result is consistent with the CART results and probit for the *admit* tree. Specification (3) adds in education level; specification (4) includes the total number of people in a family, and the responses of "It is never OK" for the question "How do you feel about others hunting or extracting animals in your community?" As with specification (2), percent of life spent in the community is the only significant variable in both specifications (3) and (4), at the 5% level. The final specification (5) adds in one response for five of the environmental indicator questions asked in the interview. The addition of these variables increases the pseudo  $R^2$  from 15.5% to 32.2%, a significant increase in the level of prediction of the model compared with the other specifications. Four variables are significant in this final model. First, percent of life spent in the community continues to be statistically significant, but its level of significance is improved to 1%. Two communities now appear significant: Bijagual and Tárcoles, at 5% and 1% respectively. Both have positive coefficients, indicating, as mentioned before, these respondents tend to admit more than Las Delicias' respondents. Finally, respondents feeling neutral to the statement "Wildlife populations are as high today in my community as they were 10 years ago" tend not to admit hunting occurs.

	Specification (1)	Specification (2)	Specification (3)	Specification (4)	Specification (5)
Intercept	1.067 *** (.338)	0.372 (0.631)	0.601 (0.663)	0.794 (0.752)	0.941 (1.006)
El Sur	-0.637 (0.505)	-0.687 (0.600)	-0.807 (0.610)	-0.769 (0.616)	0.195 (0.806)
La Hacienda	-0.719 (0.514)	-0.868 (0.669)	-0.918 (0.681)	-0.885 (0.683)	-0.708 (0.833)
Bijagual	0.683 (0.467)	0.784 (0.618)	0.939 (0.652)	0.959 (0.658)	2.050 ** (0.924)
Quebrada Ganado	-0.106 (0.366)	-0.220 (0.473)	-0.160 (0.482)	-0.123 (0.592)	0.389 (0.585)
Tárcoles	0.153 (0.419)	0.167 (0.571)	0.240 (0.577)	0.310 (0.592)	1.432 * (0.826)
Percent of life spent in the community		1.009 ** (0.406)	1.003 ** (0.424)	0.989 ** (0.427)	1.481 *** (0.567)
Age (years)		0.005 (0.012)	0.004 (0.013)	0.005 (0.013)	-0.004 (0.016)
Male		0.216 (0.329)	0.261 (0.338)	0.254 (0.340)	-0.163 (0.402)
Monthly income		0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
No education			-0.579 (0.448)	-0.575 (0.459)	-0.968 (0.602)
Secondary education			-0.328 (0.350)	-0.334 (0.351)	-0.740 (0.458)
University education			0.239 (0.556)	0.230 (0.558)	0.550 (0.829)
Total number in family				-0.031 (0.087)	-0.095 (0.122)
Hunting is never OK				-0.191 (0.300)	-0.407 (0.392)
Disagree with "Hunting can substantially reduce wildlife populations"					-0.378 (0.405)
Neutral to "Wildlife populations are as high today in my community as they were 10 years ago"					-1.166 ** (0.481)
Disagree with "Decreasing habitat has reduced wildlife populations near my community"					-0.551 (0.478)
Disagree with "I enjoy living near Carara National Park"					0.145 (0.801)
Agree with "Hunting has little impact on wildlife populations"					0.631 (0.456)
Pseudo R <sup>2</sup>	6.1%	13.2%	15.3%	15.5%	32.2%

\*\*\* (\*\*, \*) indicates significance at the 1% (5%, 10%) level

Table 25. Generalized probit models for *admit*.

## The economic impact of hunting on the communities

It is important to note the impact poaching can have on a household. As stated earlier, the average family income across communities was \$463 per month. If one family sold one paca at the median price of \$57, the sale would contribute to 12.3%, on average, of monthly household income. This percentage is greater for communities with lower incomes; in Las Delicias, where residents had an average monthly income of \$184, selling one paca per month would on average account for 31% of monthly income. Selling a scarlet macaw chick at \$190 would account for 41% of the average monthly income across communities; however, in Las Delicias, the sale of one scarlet macaw chick would contribute 103% of the average monthly income. Based on the impact the sale of one animal can have on monthly income, it is easy to draw conclusions on how poaching and selling wildlife is justified amongst households. Specifically within communities characterized by lower income levels, as the sale of just a few animals can significantly supplement income, providing strong monetary incentives to participating in poaching. However, based on the percentage of families reported as engaging in poaching, 3.2% across all communities, the monetary incentives may not be a strong motivator when deciding whether to poach.

Although it is certainly important to assess how prevalent hunting is within the communities, the number of families alone is not the only indicator to consider. If each of these hunting families hunts a significant number of animals, wildlife populations can still be compromised regardless of whether or not only a handful of families engage in poaching. Following is a general summation table to develop an aggregate estimate of the number of animals hunted or extracted from Carara per month. The aggregate numbers of animals were calculated by taking the average number of animals reported as hunted per family per month for each community and multiplying that by the average number of hunting families in each community.

Table 26 below indicates the aggregate number of animals hunted or extracted per month. However, these estimates are not extremely robust. The interview asked how many animals were hunted per family per month, but could have been subjected to confusion. Respondents may have thought of the total number hunted per month for everyone in the community or considered the total number per year for each family. Under either of these circumstances, the estimates are likely exaggerated. However, if respondents understood the question and had sufficient information about hunting activities, the estimates below can provide valuable information to park officials on which animals are being hunted the most across communities. In line with officials predictions, the paca is hunted the most with an estimated 131 paca killed per month across the six communities.

<b>Community</b>	<i>Average number of hunting families</i>	<i>Crested guan</i>	<i>Yellow-bellied seedeater</i>	<i>Scarlet macaw</i>	<i>Collared peccary</i>	<i>Paca</i>	<i>White-tailed deer</i>
<i>Las Delicias</i>	3.4	0.8	3.8	0.5	2.7	3.7	3.4
<i>El Sur</i>	0.3	0.9	3.3	2.0	1.3	6.1	2.7
<i>La Hacienda</i>	1.0	0.8	1.3	1.0	1.3	2.8	1.3
<i>Bijagual</i>	6.9	0.2	3.0	0.1	8.8	12.0	5.3
<i>Quebrada Ganado</i>	3.9	0.1	1.1	0.9	1.5	3.3	0.6
<i>Tárcoles</i>	6.7	0.3	1.1	1.7	1.5	2.7	1.4
<i>All communities (aggregate)</i>	22.2	7.6	47.6	18.9	87.5	131.0	62.0

Table 26. Aggregate estimations of the number of animals hunted or extracted per month across all communities.

## Limitations

Several limitations exist within this study concerning data collection techniques. Surveys were not administered randomly; surveys were, however, attempted at most or all households in the community to try to gather a complete sample. For cases where the house was empty, repeat visits

were occasionally, but not always, attempted. This caveat can skew results, yielding a sample that is not representative of the entire community.

Although inhabited home numbers were provided, based on experience in the field, many homes seemed abandoned. During fieldwork, it appeared complete samples were obtained in El Sur and La Hacienda. Therefore, the accuracy of the census data is unknown.

Next, limitations remain inherent in data itself. This study is static, representing one period; it does not attempt to dynamically assess changes in behavior, opinions, or wildlife over time (Godoy et al. 1993). Second, respondents to surveys were not obligated to tell the truth and given the delicate nature of this study probing into poaching, honesty is not expected throughout the data (Godoy et al. 1993). I try to adjust for this by generating the *admit* variable, although this variable is not a perfect measure of honesty or hunting prevalence. In addition, the *admit* variable may not correctly classify hunters, but as there was no question on the survey directly asking respondents' own hunting behavior, it serves as a proxy for generating some type of indicator relevant to poaching.

Additional inconsistencies can exist within the analyses. Leaving exogenous variables out of regression analyses will affect results. As already indicated, a variable for hunters would be integral for future study of the communities. In addition, El Sur has an ecologically friendly program (Eco-Sur) in its community; the influence of such a program on environmental knowledge, indicators, and beliefs could influence El Sur's results. Finally, although poaching from Carara is illegal, there are three other biological reserves near the park: the Fernando Castro Cervantes area (191 hectares), Cerros de Turribares (2,868 hectares), and Surtabal (136 hectares). Although all questions on the survey are asked in relation to Carara National Park, it is not unlikely hunters are utilizing these other protected areas for poaching. Therefore, the aggregate numbers of animals hunted or extracted from Carara may not entirely represent illegal activity and there is a chance some animals are taken from these adjacent protected areas and not Carara.

Despite the vast array of limitations within this study, data of this sort is the *first and only* kind of data existing for Carara and these communities. Although results may be imperfect, they can provide basic indicators and recommendations for what is happening in Carara and where officials should target enforcement measures.

## Discussion

### The importance of hunting within the community

Hunting is an important activity throughout the communities. Although hunting was most likely subsistence based in the past, the current dynamics surrounding hunting indicate the animals can serve in both subsistence and market based atmospheres. The crested guan, collared peccary, and white-tailed deer are likely used mostly for subsistence reasons given the low number of price observations. The yellow-bellied seedeater, scarlet macaw, and paca are more market-oriented animals, each with a high level of respondents citing they are for sale and have a market price. As mentioned earlier, there are three adjacent protected areas to Carara. Poaching can certainly occur within these areas and although such activities may still be illegal, such activities fall outside of the jurisdiction of Carara.

### Targeting enforcement

Although Carara officials have successfully identified the most important animals to monitor, information on the six communities can help determine which communities need stronger enforcement measures. Determining this is not extremely straightforward, although various indicators can help identify communities. Based on number of families reported as engaging in hunting alone, Bijagual and Tárcoles are identified as primary communities to target enforcement, with 6.9 and 6.7 families on average hunting (Table 15). El Sur and La Hacienda have the lowest level of hunting families, with a reported average of 0.3 and 1.0 families, respectively. However, when looking at truthfulness through the *admit* variable, at face value El Sur and La Hacienda appear to be the least truthful, representing the lowest levels of admittance at 66.7% and 63.6%, respectively (Table 22). On the other hand, Bijagual and

Tárcoles appear as the most truthful communities, with the two highest admittance rates of 96.0% and 88.9%, respectively. Looking further into the issue of truthfulness, the CART results reveal El Sur, La Hacienda, and Quebrada Ganado as the most important communities in which to target enforcement, each showing statistically significant and negative results in three of the seven probit regressions (Table 24). For the general probit model, Bijagual and Tárcoles were the only statistically significant communities, both with positive coefficients, indicating a tendency towards admittance and truthfulness. The results above appear to be contradictory conclusions. The number of hunting families indicates Bijagual and Tárcoles are communities in which to target enforcement; however, these communities are the also the most truthful communities. Through the CART and probit models, El Sur and La Hacienda appear to be the communities in which to target enforcement, based on low levels of truthfulness, but also have the lowest reported number of families engaging in poaching. There are a few possible conclusions based on these results:

1. Respondents in all communities are truthful in admitting hunting and reporting the number of families engaging in hunting.
2. Respondents in El Sur and La Hacienda are showing contradictory conclusions because they are hiding the occurrence of hunting in both truthfulness and the reported number of hunting families.
3. Respondents in Bijagual and Tárcoles are showing contradictory conclusions because they are overestimating the level of hunting in their communities, due to exogenous factors including, but not limited to, a lack of accurate knowledge or a desire to please the interviewer by admitting hunting.

Because the results above are not conclusive, determining where to target enforcement will become a judgment call for Carara's park officials to make. Looking at admittance rate, the number of reported families, and additional aspects, such as location, officials will be able to use these results in

conjunction with their personal experiences and perceptions of the communities to identify which set of communities, if any or all, to target future enforcement measures.

Although anecdotal, throughout my field experience in conducting this research, there are some potentially important additional factors to include in the analysis. As mentioned above, El Sur and La Hacienda present the two communities in which to target enforcement based a lack of truthfulness through the *admit* variable and the CART and probit models. These communities are both located along the semi-developed roads, are essentially isolated, and are the two communities located closest to the park's boundaries. These communities were also the two smallest communities surveyed; 12 surveys were conducted in El Sur (which had 18 inhabited homes) and 11 were conducted in La Hacienda (with a reported 28 inhabited homes). Curiously, El Sur is the community that presents the most eco-friendly image; El Sur has an EcoSur program, used to promote environmental education and sustainability throughout their community. However, El Sur residents candidly spoke of the presence of outsiders entering their community and illegally accessing their authorized Carara park trail to hunt. Therefore, El Sur may appear in this rating because the residents *observe* hunting occurs, although actual residents may not engage in such activities and may have answered questions in accordance to experiences with fellow community members and not outsiders. La Hacienda also presents an interesting case. In La Hacienda, an expatriate from the United States resides with a rehabilitation area on his property for paca seized from hunters. Although information provided by this respondent is anecdotal, he did declare many residents in La Hacienda were hunters, with homes in the community as just temporary hunting quarters. Therefore, these communities do certainly present communities in which to target enforcement, although El Sur's problem may be an issue of intruders rather than residents.

To speak to the other set of communities, Bijagual and Tárcoles are the two largest communities surveyed. Tárcoles is located along the main highway and is located at the front of the park, near its entrance. Its location may make it more difficult to access the park, as officials tend to spend the

majority of their time in this area. Bijagual is located closer to the rear of the park, but among the four communities in that vicinity, is closest to the main highway. Although location is certainly not a clear indicator of hunting activities, it may influence behavior based on what individuals believe they can get away with.

This analysis determines two sets of communities Carara officials should consider for targeting enforcement; however, it is important to qualify that individual behavior, rather than classifications among entire communities, may be the best avenue when identifying enforcement. Based on the probit model developed for exploring *admit* across all communities, percent of life spent in the community is statistically significant in every specification it is included in. The predominance of this predictor in admittance indicates targeting enforcement to new individuals in the communities could be a successful avenue.

### **Management suggestions**

As mentioned above, Carara officials face considerable enforcement challenges. Even with adequate information of poaching activities, enforcement is constrained by inadequate funding. Ecotourism is often cited as a viable activity to improve biodiversity (Isaacs 2000). An inherent feature of ecotourism is the inclusion of surrounding communities, often through community-based management (Algotsson 2006, Robinson and Bodmer 1999). However, challenges exist when integrating such management plans with existing national park regimes.

Carara National Park has engaged in some community-based management programs, most notably El Sur's EcoSur program. Through its EcoSur program, El Sur is allowed to access the park through a trail at the back of the park. However, this program operates outside of the park's system and therefore does not financially benefit the park. One could argue the existence of this program increases the environmental consciousness of El Sur and promotes an environmentally friendly attitude toward the park and its biodiversity. As demonstrated through the environmental indicator questions, El Sur

residents consistently responded to the questions in a manner consistent with environmental knowledge. However, El Sur is identified as a community in which to target enforcement; therefore the interaction of their ecotourism program and hunting issues is somewhat convoluted and should be explored further.

Exploring ways to combat poaching is a difficult issue. Education may provide more awareness of environmental issues and ultimately alter behavior, but this is a slow process met with much difficulty. For instance, integrating environmental education into primary school programs will experience a large time delay before these students are active participants in the communities. At the heart of education is the necessity of change. From the interviews, 99.6% of the respondents agreed with the statement *“Diversity of wildlife is important for the environment;”* however, this information does not directly translate into environmentally conscious behavior.

Finally, at the heart of Carara’s enforcement issues are institutional insufficiencies. As mentioned many times before, the park has an extremely tight financial budget. Despite having the best management plan, enforcement can only occur if the park can operate within its means. Perhaps the issue of poaching is outside of Carara’s control and lays more with government changes for funding and budgeting concerns.

## **Conclusion**

Officials at Carara National Park face considerable challenges when identifying the best ways to target enforcement. Although two community sets are identified in this study as areas of concern for poaching (El Sur and La Hacienda or Quebrada Ganado and Tárcoles), the park has extremely limited funding to put any recommendations in place. However, this study does provide valuable information about the communities surrounding Carara National Park. Information about these communities is scarce and developing an understanding of the dynamics in these communities concerning wildlife and hunting will give officials insight into the motivations of poaching. As seen in the data, hunting is

important in the communities for both subsistence and monetary gain; with low-income communities surrounding the park, the incentives surrounding poaching are great. However, the data indicates a small percentage of families (8.8%) actually do participate in hunting activities. The goal of this study is to provide information to Carara concerning poaching; hopefully this information can be used to successfully improve biodiversity in the park.

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## Appendix.

### Appendix 1. List of variables for analyses.

#### Variables used in statistical analysis:

admit	whether respondent admits hunting occurs (1) or not (0); respondent admitted to any of the six animals as being hunted or extracted
yrscomm_perc	percent of life spent in the community, calculated as years living there divided by age
comm_code1	Las Delicias
comm_code2	El Sur
comm_code3	La Hacienda
comm_code4	Bijagual
comm_code5	Quebrada Ganado
comm_code6	Tárcoles
age	age of respondent
gend	gender - female (0), male (1)
educ1	no education
educ2	primary education
educ3	secondary education
educ4	university education
like_park1	disagree - I enjoy living near Carara National Park
like_park2	neutral - I enjoy living near Carara National Park
like_park3	agree - I enjoy living near Carara National Park
hunt_bad1	disagree - Hunting can substantially reduce wildlife populations
hunt_bad2	neutral - Hunting can substantially reduce wildlife populations
hunt_bad3	agree - Hunting can substantially reduce wildlife populations
anis_tenyrs1	disagree - Wildlife populations are as high today in my community as they were 10 years ago.
anis_tenyrs2	neutral - Wildlife populations are as high today in my community as they were 10 years ago.
anis_tenyrs3	agree - Wildlife populations are as high today in my community as they were 10 years ago.
deforest1	disagree - Decreasing habitat has reduced wildlife populations near my community.
deforest2	neutral - Decreasing habitat has reduced wildlife populations near my community.
deforest3	agree - Decreasing habitat has reduced wildlife populations near my community.
inc_mes	monthly income in colones
ok_hunt1	it is always ok - response to How do you feel about others hunting or extracting animals in your community?
ok_hunt2	it is okay as long as no species are threatened by extinction - response to How do you feel about others hunting or extracting animals in your community?
ok_hunt3	it is ok as long as it is for subsistence - response to How do you feel about others hunting or extracting animals in your community?
ok_hunt4	I am indifferent to it - response to How do you feel about others hunting or extracting animals in your community?
ok_hunt5	it is never okay - response to How do you feel about others hunting or extracting animals in your community?
ok_hunt6	prefer not to respond - response to How do you feel about others hunting or extracting animals in your community?
pava_hunt	have you seen the crested guan hunted or extracted?
set_hunt	have you seen the yellow-bellied seedeater hunted or extracted?
lapa_hunt	have you seen the scarlet macaw hunted or extracted?
saino_hunt	have you seen the peccary hunted or extracted?
paca_hunt	have you seen the paca hunted or extracted?
deer_hunt	have you seen the deer hunted or extracted?
animals	have domestic animals (1) or don't (0)

### Variables not used in statistical analysis:

job text of job  
famtot total number of people in the family  
yrscomm years in the community  
dogs have dogs (1) or not (0)  
cats have cats (1) or not (0)  
ani\_other have other domestic animals (1) or not (0)  
wild\_ani own wild animal (1) or not (0)  
garden grow food in a garden (1) or not (0)  
gard\_wild has wildlife ever disrupted your growing activities yes (1) or no (0)  
wild\_house how common do you think it is for people to keep wildlife in their home?  
1 very uncommon, 2 uncommon, 3 common, 4 very common  
wild\_see how often do you see wild mammals around town (select one) 1 once a day,  
2 once a week, 3 once a month, 4 once every three months, 5 once every  
six months, 6 once a year  
pava\_see have you seen crested guans near your home in the past year? yes (1) or  
no (0)  
set\_see have you seen yellow-bellied seedeaters near your home in the past year?  
yes (1) or no (0)  
lapa\_see have you seen scarlet macaws near your home in the past year? yes (1) or  
no (0)  
saino\_see have you seen peccaries near your home in the past year? yes (1) or no  
(0)  
paca\_see have you seen paca near your home in the past year? yes (1) or no (0)  
deer\_see have you seen deer near your home in the past year? yes (1) or no (0)  
pava\_amt how many crested guan have you seen this year compared to the year  
before? 0 - less, 1 - about the same, 2 - more  
set\_amt how many yellow-bellied seedeaters have you seen this year compared to  
the year before? 0 - less, 1 - about the same, 2 - more  
lapa\_amt how many scarlet macaws have you seen this year compared to the year  
before? 0 - less, 1 - about the same, 2 - more  
saino\_amt how many peccaries have you seen this year compared to the year before? 0  
- less, 1 - about the same, 2 - more  
paca\_amt how many pacas have you seen this year compared to the year before? 0 -  
less, 1 - about the same, 2 - more  
deet\_amt how many deer have you seen this year compared to the year before? 0 -  
less, 1 - about the same, 2 - more  
pava\_sale is the crested guan for sale? 0 - no, 1 - yes  
set\_sale is the yellow-bellied seedeater for sale? 0 - no, 1 - yes  
lapa\_sale is the scarlet macaw for sale? 0 - no, 1 - yes  
saino\_sale is the peccary for sale? 0 - no, 1 - yes  
paca\_sale is the paca for sale? 0 - no, 1 - yes  
deer\_sale is the deer for sale? 0 - no, 1 - yes  
pava\_cost if the crested guan is for sale, how much do you think it costs  
(colones)?  
set\_cost if the yellow-bellied seedeater is for sale, how much do you think it  
costs (colones)?  
lapa\_cost if the scarlet macaw is for sale, how much do you think it costs  
(colones)?  
saino\_cost if the peccary is for sale, how much do you think it costs (colones)?  
paca\_cost if the paca is for sale, how much do you think it costs (colones)?  
deer\_cost if the deer is for sale, how much do you think it costs (colones)?  
divers\_good diversity of wildlife is important for the environment 1 - disagree, 2 -  
neutral, 3 - agree  
hunt\_nobad hunting has little impact on wildlife populations 1 - disagree, 2 -  
neutral, 3 - agree  
see\_hunt how often do you notice hunting or extracting practices in your  
community? (select one) 1 - once a day, 2 - once a week, 3 - once a  
month, 4 - once every three months, 5 - once every six months, 6 - once  
every year  
sport sport as a reason for "why do you think people hunt or extract animals?"

tradition	tradition as a reason for "why do you think people hunt or extract animals?"
sale	to sale or trade as a reason for "why do you think people hunt or extract animals?"
subsist	for subsistence as a reason for "why do you think people hunt or extract animals?"
no_reason	no reason in particular as a reason for "why do you think people hunt or extract animals?"
other	1 indicates an other response
other_txt	text for other response
hours_hunt	how long do you think the average hunter spends hunting or extracting per trip (in hours)
fam_hunt	in your community, how many families do you think hunt or extract animals from the forest?
pava_num	on average, how many crested guans do you think are hunted or extracted per family per month?
set_num	on average, how many yellow-bellied seedeaters do you think are hunted or extracted per family per month?
lapa_num	on average, how many scarlet macaws do you think are hunted or extracted per family per month?
saino_num	on average, how many peccaries do you think are hunted or extracted per family per month?
paca_num	on average, how many paca do you think are hunted or extracted per family per month?
deer_num	on average, how many deer do you think are hunted or extracted per family per month?

## Appendix 2. Community survey in English.

### SECTION I: GENERAL INFORMATION

- 1) Gender: ( ) Female ( ) Primary
- 2) Education level: ( ) 1. None ( ) 2. Primary ( ) 3. Secondary ( ) 4. University
- 3) Age: \_\_\_\_\_
- 4) Occupation or job: \_\_\_\_\_ 4b. Spouse's occupation:  
\_\_\_\_\_
- 5) Number of members in your family: \_\_\_\_\_ 5b. Name of your community:  
\_\_\_\_\_
- 6) Number of years you have lived here: \_\_\_\_\_
- 7) Monthly salary (¢/month) \_\_\_\_\_

### Section II: Household Interactions with Animals

- 8) Do you keep domestic animals in your households? ( ) NO ( ) YES
- 9) How many of the following animals do you have:  
a. Dogs: \_\_\_\_\_ b. Cats: \_\_\_\_\_ c. Others: \_\_\_\_\_
- 10) Have you ever had wildlife animals in your house? ( ) NO ( ) YES
- 11) Do you grow crops in your garden? ( ) NO ( ) YES
  - 11a. If YES, has wildlife ever disrupted your growing activities? ( ) NO ( ) YES
  - 11b. If YES, what have you done to prevent this? (*select all that apply*)  
( ) a. Put up a fence ( ) d. Kill them  
( ) b. Scare them away ( ) e. Do nothing  
( ) c. Trap them ( ) f. Other: \_\_\_\_\_
- 12) How common do you think is for people to keep wildlife animals in their houses?  
( ) 1. Very Uncommon ( ) 2. Uncommon ( ) 3. Common ( ) 4. Very Common
- 13) How often do you see wild mammals like tepezcuintle around the town? (*select one*)  
( ) a. Once a day ( ) d. Once every three months  
( ) b. Once a week ( ) e. Once every six months  
( ) c. Once a month ( ) f. Once every year

**SECTION III: INTERACTIONS WITH WILDLIFE AND CARARA NATIONAL PARK**

This section will ask you about your opinions on your interactions with wildlife in your community and with Carara National Park.

**14)** Please fill in the chart to the best of your knowledge. Select only one option per question.

Common name (scientific name)	Have you seen this near your home in the past year?		How many have you seen this year compared to the year before?			Is this animal for sale? If YES, how much do you think it costs?	
	NO	YES	LESS	ABOUT THE SAME	MORE	NO	YES
a. Pava Negra (black guan)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> : ₡ _____
b. Setillero (yellow-bellied seedeater)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> : ₡ _____
c. Lapa Roja (scarlet macaw)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> : ₡ _____
d. Sainos (collared peccary)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> : ₡ _____
e. Tepezcuittle (paca)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> : ₡ _____
f. Guatusa o Cherenga (agouti)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> : ₡ _____
h. Venado (white-tailed deer)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> : ₡ _____
i. Zorro Pelón (opossum)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> : ₡ _____
j. Other: _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> : ₡ _____

**15)** Please indicate your feelings on the following statements by **circling one of the five numbers** for each statement.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
1	2	3	4	5	a. I enjoy living near Carara National Park.
1	2	3	4	5	b. Hunting can substantially reduce wildlife populations.
1	2	3	4	5	c. Wildlife populations are as high today in my community as they were 10 years ago.
1	2	3	4	5	d. Diversity of wildlife is important for the environment.
1	2	3	4	5	e. Hunting has little impact on wildlife populations.
1	2	3	4	5	f. Decreasing habitat has reduced wildlife populations near my community.

**SECTION IV: EXTRACTION PRACTICES**

This section will ask you about practices you have observed concerning hunting or extracting animals in your community.

16) How often do you notice hunting or extracting practices in your community? (*select one*)

- a. Once a day                       d. Once every three months  
 b. Once a week                       e. Once every six months  
 c. Once a month     f. Once every year

17) How do you feel about others hunting or extracting animals in your community? (*select one*)

- a. It is always okay                       d. I am indifferent to it  
 b. It is okay as long as no species are threatened by extinction     e. It is never okay  
 c. It is okay as long as it is for subsistence                       f. Prefer not to answer

18) Why do you think people hunt or extract animals? (*select all that apply*)

- a. Sport                       d. Food or Subsistence  
 b. Tradition                       e. For no particular reason  
 c. To Sell or Trade                       f. Other: \_\_\_\_\_

19) How long do you think the average hunter spends hunting or extracting per trip? \_\_\_\_\_ hours

20) In your community, how many families do you think hunt or extract animals from the forest?  
 \_\_\_\_\_ families

21) Please fill in the chart to the best of your knowledge. Select only one option per question.

Common name ( <i>scientific name</i> )	Have you seen this animal hunted or extracted?		On average, how many _____ do you think are hunted or extracted per family per month?
	NO	YES	NUMBER OF ANIMALS
a. Pava Negra (black guan)	<input type="checkbox"/>	<input type="checkbox"/>	_____
b. Setillero (yellow-bellied seedeater)	<input type="checkbox"/>	<input type="checkbox"/>	_____
c. Lapa Roja (scarlet macaw)	<input type="checkbox"/>	<input type="checkbox"/>	_____
d. Sainos (collared peccary)	<input type="checkbox"/>	<input type="checkbox"/>	_____
e. Tepezcuintle (paca)	<input type="checkbox"/>	<input type="checkbox"/>	_____
f. Guatusa o Cherenga (agouti)	<input type="checkbox"/>	<input type="checkbox"/>	_____
h. Venado (white-tailed deer)	<input type="checkbox"/>	<input type="checkbox"/>	_____
i. Zorro Pelón (opossum)	<input type="checkbox"/>	<input type="checkbox"/>	_____
j. Other: _____	<input type="checkbox"/>	<input type="checkbox"/>	_____

Appendix 3. Documentation of a paca seizure occurring in July 2009. Source of material: Adrian Acre.



Appendix 4. Flipbook illustrations used during interviewing.



Saino  
(Collared Peccary)



Setillero  
(Yellow-Bellied Seedeater)



Tepezcuintle  
(Paca)



Venado  
(White-Tailed Deer)



Lapa Roja  
(Scarlet Macaw)



Pava Negra  
(Black Guan)