



Poaching, rural communities and tourism development: A case study in Costa Rica

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Abstract

Although the establishment of national parks aims to protect biodiversity, several factors, including poaching, severely hinder this goal. This study aims to assess the extent of poaching around a national park and understand the community's reliance on wildlife for wealth generation. A total of 264 interviews were conducted to households in six communities around Carara National Park between June and November of 2009. Interviews inquired about interactions with wildlife, sale of wildlife, opinions and observed hunting activities. Although the number of families that hunt is relatively small, these families can still have significant impacts on wildlife populations with poaching occurring for both subsistence and market-oriented reasons. In total for the six species evaluated, we estimated 5,208 animals being hunted/extracted on an annual basis; a number substantially higher to the 31 animals seized by park officials during the 2004-2008 period. Furthermore, the estimated annual commercial value of hunting/extracting was approximately sixfold to the resources invested by the park into wildlife protection. Thus, with low-income communities surrounding the park, the incentives for poaching are evident; however, the potential economic impact to the park and the communities in terms of tourism revenues should warrant attention to this situation.

Keywords: economic valuation; illegal hunting; national parks; poaching; tourism.

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1. Introduction

Poaching is widely recognized as a historical activity necessary for subsistence (Chardonnet et al., 2002), yet has more recently become a significant threat to biodiversity across the world (Ervin, 2003). With tropical forests serving as the richest ecosystems on earth, touting the highest levels of biodiversity (Butler and Laurance 2008; Munasinghe, 1992), the risks associated with poaching are of increasing worry. Concerns over the rise of deforestation and the loss of biodiversity and ecological services over the last century have led to the establishment of protected areas such as national parks and biological reserves (Stenger et al., 2009; Tobias and Mendelsohn, 1991). 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 of maintaining 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 financial 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.

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); therefore, it has taken time for wildlife to be economically valued in the scientific community (Chardonnet et al., 2002). Thus, the economic value of extracted wildlife has not been studied much and its economic impact on protected areas, biodiversity, and local economies, is largely unknown.

Carara National Park (Carara) officials believe poaching is becoming more prominent and is occurring within the park’s boundaries at increasing levels (Personal correspondence, Adrian Arce, Director of Research at Carara). With unknown individuals accessing the park and an enforcement staff of just five officers, Carara officials are unsure of the extent of poaching. Between 2004 and 2008 there were 26 seizures of poached animals, totaling 31 animals. With this number of seizures occurring over five years, poaching is either occurring less than anticipated or Carara’s ability to prevent poaching is extremely limited.

The objectives of this study are to assess the extent of poaching and its corresponding economic valuation, and understand the park and community’s reliance on wildlife for wealth generation. In order to fulfill the mission of protecting biodiversity, national park officials must understand the extent of poaching and the reasons behind its occurrence. We hope this study will provide valuable information to Carara’s officials to aid in developing a strategy to reduce poaching within the park. We also hope this study sheds some light on the ongoing challenges faced today by national parks and protected areas, providing an innovative methodological approach for the economic assessment of poached species. In the following section we provide a theoretical review of the influence of hunting on biodiversity, particularly within national parks, and a review on economic approaches to valuing poaching. The methodological procedure is then explained, followed by results and its implications. Finally, we provide some conclusions on the convergence of development and conservation.

2. Theoretical background

2.1. The influence of poaching on biodiversity

Deforestation is already a well-documented factor affecting biodiversity loss in tropical forests (Butler and Laurance, 2008; Chardonnet et al., 2002; Silva, 2003), but less understood is how the consumption of wildlife, or “bushmeat,” can affect biodiversity. Tropical forests act as a source of food and resources to local communities (Carrillo et al., 2000; Robinson and Bodmer, 1999) with species serving as a traditional food source (Bowen-Jones et al., 2003). Bushmeat can serve as both a significant protein source for rural, subsistence-based communities (Bowen-Jones et al., 2003; Milner-Gulland and Bennett, 2002), and a rare and luxury good for urbanites (Bowen-Jones et al., 2003).

Although bushmeat hunting has historically been 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, the more recent popularity of bushmeat as a commercial good, and continual habitat loss. In this regard, rural population densities have risen significantly, causing increased pressure on forest communities and forest resources (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., 2002). The need of hunting for subsistence or hunting for profit varies across cultures and nations, but is an important distinction for managing animal populations.

Bushmeat consumption in tropical countries can be extensive, enough to penetrate national parks and other protected areas (Bowen-Jones et al., 2003; Macdonald et al., 2012). There is evidence of local animal extinctions throughout the tropics (Carrillo et al., 2000), becoming a major threat to biodiversity and to communities who rely on bushmeat for subsistence (Bowen-Jones et al., 2003; Milner-Gulland and Bennett, 2002; Quiros, 2008; Robinson and Bodmer, 1999).

2.2. Valuing poached wildlife

Although non-monetary valuation of wildlife is widely recognized as a necessity beyond classical economic theory (Flores, 2003, p.27), debate exists over what these values actually mean. Economists and ecologists view value differently: an economist tends to look for a monetary equivalent of a good or service whereas an ecologist typically values “intrinsic worth” (Freeman, 2003, p.8). Some researchers believe values hold an inherent bias due to the anthropocentric nature of its determination, which can ultimately lead to an underestimation of the “true value” of an environmental good (Bernard et al., 2009; Godoy et al., 1993; Loomis, 2000; Tobias and Mendelsohn, 1991). 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 good or service.

Dealing with issues of poaching within protected areas poses another layer of complexity. Poaching itself is a largely unrecognized contributor to economies due to its informal nature (Bowen-Jones et al., 2003; Chardonnet et al., 2002). This situation, in turn, has propitiated the lack of economic assessments by the scientific community (Chardonnet et al., 2002). 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).

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 a method of creating policy recommendations. Through surveys in three villages, they estimated that the admittance of poaching across households varied between the villages from 3% to 13%. Kuhl et al. (2009) explored poaching of saiga in the Soviet Union and, like Knapp et al. (2010), used household based interviews to collect data on demographics, attitudes of the individual, and income sources. 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.

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 the personal opinions and general awareness of the impact of poaching on the sustainability of animal populations (Milner-Gulland and Bennett, 2002). However, there are several challenges to consider when conducting a wildlife evaluation. For example, 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). In addition, respondents' answers 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.

2.3. Costa Rica's park system and the effects of poaching

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. Tourism in Costa Rica accounts directly for approximately 5% of the gross domestic production (GDP) each year during the last decade (WTTC, 2012). This has placed a great deal of pressure for continued economic development on national parks to balance the economic advantages of tourism with conservation goals (Chase et al., 1998).

The struggle between economic vitality and conservation appears in many aspects of the park system (Sanchez-Azofeifa et al., 2003). Like many developing countries, Costa Rica has limited resources to finance it (Chase et al., 1998). Poaching by local communities is a problem of great concern, and although hunting within national park boundaries is illegal (Wildlife Conservation Law No. 7317), such activities are difficult to monitor and enforce with limited funds. Thus, our understanding of how effective protected areas are in preventing poaching is actually incomplete (Gaston et al., 2008).

3. Methodology

3.1. Study site

Carara National Park was initially established as a biological reserve in 1978 but due to high tourism visitation it was re-categorized as a national park in 1998 (SINAC, 2010). Tourism increased from 10,230 visitors in 1990 up to 27,546 in 2010, peaking around 44,000 in 1994. Located in the Puntarenas and San José provinces, Carara borders the Tárcoles River to the south and the Costanera Sur highway (and Pacific Ocean) to the west (See Figure 1). 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, this park embodies a variety of landscapes from seasonal flooding to old growth forests, creating a transitional zone home to higher species richness than surrounding areas (Laurencio and Malone, 2009; Madrigal and Grayum, 2002).

3.2. Data collection

Data was collected mainly from three different sources: households within surrounding communities, tourists visiting the Park, and secondary data provided by park officials. In order to design the questionnaire administered to households, we interviewed park officials and a former hunter of the area to obtain information of which communities to assess, species most frequently hunted, and tips to address people on this sensitive subject. Final interviews were administered to locals in six rural communities. Four communities (A, B, C, and D) border Carara's western edge (*back of the park*) and two (E and F) are located along the main road leading to Carara (*front of the park*). Questions were administered in a door-to-door structured interview covering interactions with wildlife, perceived populations of wildlife, sale of wildlife, and opinions towards hunting and observed hunting activities. Prior to the interview, respondents were informed about the objectives of the study, how we intended to use the data, and how their anonymity was ensured. Sizes of the communities varied although all were relatively small and a complete sample was attempted in each community. Data was collected between June and November 2009. A total of 264 interviews were conducted.

Travel expenses from 99 tourists were also collected with a short survey at the park's visitor center after tourists had the chance to hike around it. Tourists were also asked to gauge the importance of wildlife in influencing their decisions to visit the park on a 1 to 5 ordinary scale. Finally, we interviewed a park official and reviewed some records in order to estimate the annual investments executed in park protection.

3.3. Data analyses

Household data was explored through general demographic indicators of each community and calculations were made about the market of poached animals. The commercial value (CV) of species hunted was calculated using the following formula: $CV = \Sigma(F \cdot I \cdot P)$, where F=number of hunting families, I=the number of individual animals hunted per species per hunting family, and P=the average price sold/bought for each

species across all communities. Data was compiled and analyzed using Microsoft Excel and JMP statistical software. Prices were converted from colones (Costa Rican currency) to U.S. dollars using the World Bank's World Development Indicators official exchange rate, averaged for 2008 (526.24 colones per one U.S. Dollar). Tourists' travel expenses and their importance of wildlife were calculated as aggregated. For annual protection investments we included labor cost, depreciation of vehicles, fuel, and others items such GPS devices, binoculars, computers, ammunitions. Detailed calculations are explained below.

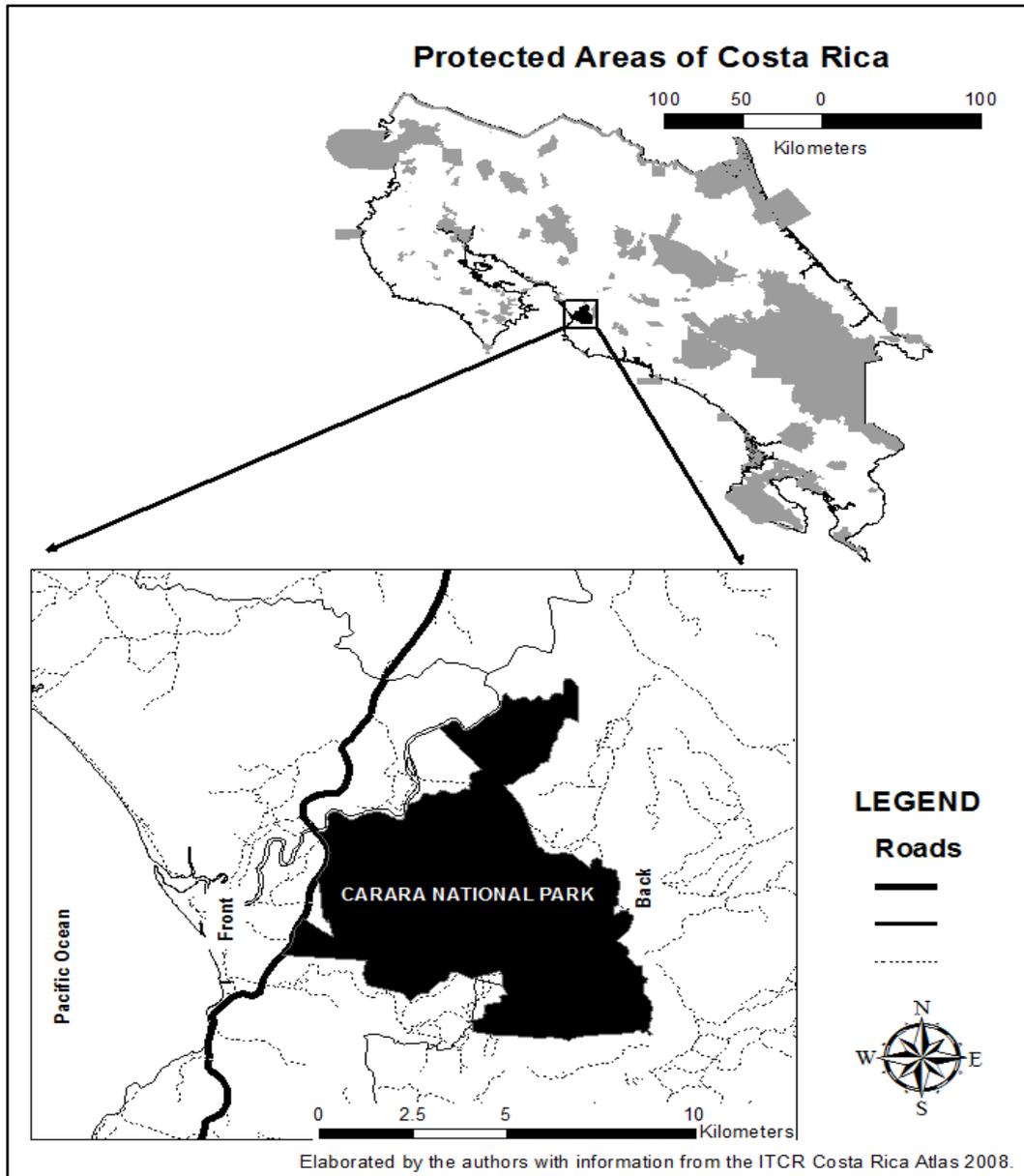


Figure 1. Protected areas of Costa Rica and study site

4. Results

4.1. General demographics

In total, information was used from 264 respondents. These collections represent response rates (in descending order) of 66.7% for Community B, 42.4% for Community D, 39.9% for Community E, 39.6% for Community A, 39.3% for Community C, and 22.2% for Community F based on total number of houses inhabited according to information provided by the local Department of Health. The gender spread was 66.7% female versus 33.3% male. Differences in the male and female ratio could be due to the traditional nature of the communities, with many women serving as homemakers. Overall, average monthly income for all six communities is about \$463 per month or \$5,553 per year. Average income varies drastically among communities. Two communities have average incomes below the total average of \$5,553 and the other four communities demonstrate higher wealth, although still below the national nominal GDP per capita of \$6,484 for that year (BCCR, 2009). In general, education levels are low throughout the communities with the majority of respondents (62.2%) indicating a primary education level or lower. Variation in education levels also differs across communities.

We also calculated “percentage of life spent in the community” by dividing the age of the respondent by his or her reported years living in the community. This indicator can prove more insightful into determining how invested an individual is to the community. In general, respondents spent about half of their lives in their respective communities (56.7% on average for all communities with a range from 45.2% for Community B and 65.4% for Community C) with no significant differences across the six communities (Kruskal-Wallis $X^2=4.41$, $df=5$, $p\text{-value}=0.49$) nor between those located in the back or front of the park (Mann-Whitney $X^2=0.35$, $df=1$, $p\text{-value}=0.55$).

4.2. Attitudes towards hunting

As presented in Table 1, hardly any respondents believed “*It is always OK*” to hunt (1.2%). Community F had the largest percentage of respondents (13.3%) stating “*It is okay to hunt as long as no species are threatened by extinction*”; however, this community also had the largest proportion of those against hunting or extracting animals, with 73.4% stating “*It is never OK.*” All communities had at least 50% of respondents state “*It is never OK,*” which is an interesting insight to consider towards the social view of hunting. By comparing differences in attitudes toward hunting between communities located in the back (A, B, C and D) and front (E and F) of the park, a trend appears which indicates the communities towards the front of the park are less in favor of hunting or extracting animals (Pearson $X^2=7.979$, $df=4$, $p\text{-value}=0.092$).

Table 1. Distribution of responses to “How do you feel about other people hunting or extracting animals in your community?”

Response to “How do you feel about others hunting or extracting animals in your community?”	It is always OK (%)	It is okay as long as no species are threatened by extinction (%)	It is okay as long as it is for subsistence (%)	I am indifferent to it (%)	It is never OK (%)
Community A	0.0	9.5	23.8	0.0	52.4
Community B	0.0	8.3	8.3	16.7	66.7
Community C	0.0	0.0	18.2	18.2	63.6
Community D	0.0	10.0	16.0	6.0	66.0
Community E	2.7	9.8	8.0	3.6	67.0
Community F	0.0	13.3	11.1	2.2	73.4
All communities	1.2*	10.0	11.9	4.8	66.5

^a The percentage difference is made by those who preferred not to respond; n=249.

4.3. Reasons for hunting

We presented respondents with four “reasons” why they thought people engage in hunting or extraction activities. The analysis indicates that “*Sell or trade*” is the most prevalent reason, averaging 63.4% across communities (Table 2). “*Subsistence*” averaged 39.7% across communities; however, there were significant differences in stated reasons between front and back of park communities (Pearson $X^2=10.21$, $df=3$, p -value=0.017). It is evident that those communities in the back of the park rely more on hunting for subsistence compared to those in the front (32% vs. 20%). Hunting as a sport was cited as the second most important reason in the front communities (26.3% vs. 18.6%). Yet, “*Sell or trade*” was cited more often than “*Subsistence*” in every community except for Community C. Among the “*Other*” reasons why hunting took places included: to own them (as pets), for fun, lack of education, and for lack of protection. We found that 19.7% of the surveyed households had wildlife animals in their house as pets at some point in time.

4.4. Estimates of quantity of hunting families and hunting prevalence per species

In order to gauge the prevalence of hunting, a question asked respondents to estimate the number of families who participate in hunting activities in their respective communities. These estimates yield valuable information for estimating how many animals are hunted or extracted in each community. Average results range from 0.27 families in Community B to 7.73 in Community F, with significant differences across communities (Kruskal-Wallis $X^2=45.30$, $df=4$, p -value = 0.001). With the information provided by local officials on the total number of inhabited homes in these communities, we were able to estimate the percentage of families that hunt based on average numbers. You may find in Appendix A the details for all communities. It appears that hunting is most prevalent in Community D and Community F, respectively; however, for our follow-up calculations, we considered it appropriate to use the median values for number of hunting families per community in order to minimize the effects of outliers. Using this estimate, in two communities this estimate yields no hunting families; the remaining communities have between 3 to 5

families engaging in hunting, for a total of 16 hunting families. Also shown in Table 3 is the average number of animals hunted per hunting family per month by community for each species evaluated. We aggregated the estimates across communities to obtain totals. As suspected by park officials and the former hunter interviewed, paca is the species most frequently hunted, with about 145 individuals extracted per month across all hunting families. The paca is followed by the yellow-bellied seedeater (~104) and the collared peccary (~85). In total for the six species, we estimated 434 animals being hunted/extracted on a monthly basis (5,208 per year), a number astonishingly higher when compared to the 31 animals seized by park officials between 2004 and 2008.

Table 2. Distribution of responses for “Why do you think people hunt or extract animals?”

Response to “Why do you think people hunt or extract animals?”	Sport (%)	Tradition (%)	Sell or trade (%)	Subsistence (%)	No particular reason (%)
Community A	28.6	33.3	81.0	71.4	4.8
Community B	33.3	25.0	75.0	50.0	8.3
Community C	45.5	18.2	63.6	72.7	0.0
Community D	28.0	6.0	58.0	42.0	8.0
Community E	45.5	25.2	58.5	30.1	5.7
Community F	31.2	16.7	70.8	35.4	8.3
All communities	37.7	20.4	63.4	39.2	6.4

^a Respondents were able to select more than one reason

Table 3. Estimate of median number of hunting families per community, and average number of animals hunted per hunting family per month by community for each species evaluated

Community	Median number of hunting families	Crested guan	Yellow-bellied seedeater	Scarlet macaw	Collared peccary	Paca	White-tailed deer
Community A	3	8.6	17.7	2.8	10.7	12.0	4.0
Community B	0	0	0	0	0	0	0
Community C	0	0	0	0	0	0	0
Community D	5	4.5	56.3	3.5	57.0	86.3	22.5
Community E	4	4.7	19.2	10.3	9.3	14.8	11.0
Community F	4	7.0	11.2	11.2	8.2	31.9	9.3
All communities (aggregate)	16	24.9	104.3	27.9	85.1	145.1	46.8

4.5. The commercial value of poaching

Table 4. Estimation of total monthly market value of poaching activities for species assessed in all six communities

Species	Number of animals hunted per month for all communities	Avg. Commercial Value (\$)	Total Commercial Value extracted monthly (\$)
Crested guan (<i>Penelope purpurascens</i>)	24.9 (6%)	29	720.9 (3%)
Yellow-bellied seedeater (<i>Sporophila nigricollis</i>)	104.3 (24%)	38	3,962.60 (16%)
Scarlet macaw (<i>Ara macao</i>)	27.9 (6%)	190	5,291.50 (22%)
Collared peccary (<i>Pecari tajacu</i>)	85.1 (20%)	38	3,233.40 (13%)
Paca (<i>Cuniculus paca</i>)	145.1 (33%)	57	8,268.40 (34%)
White-tailed deer (<i>Odocoileus virginianus</i>)	46.8 (11%)	61	2,855.40 (12%)
TOTAL	434 (100%)	-	\$ 24,332.30 (100%)

The monthly commercial value of poaching totaled \$24,332.30 for all six communities across all six species evaluated (See Table 4). Because of its hunting prevalence, pacas represent the largest percentage of total value hunted/extracted (34%) followed by scarlet macaws (22%), given its high market value per individual. With the exception of the crested guan, which only represents about 3% of total value extracted, the other three species represent each between 12 and 16% of the total commercial value hunted/extracted. On a yearly basis, the hunting/extraction value totals \$291,988, about sixfold compared to our estimated amount of money invested into protection, which totaled about \$53,000 per year. This result was calculated using the formula: $PV = \Sigma(L+dV+F+O)$, where PV=Protection value, L=Labor cost, dV = Depreciation of vehicles, F = Fuel, and O=Others, which includes items such GPS devices, binoculars, computers, ammunitions, etc. This information was provided by park officials and the detailed calculations can be found in Appendix B.

4.6. Tourism revenue and wildlife

With the aid of a survey administered to 99 tourists, we estimated a series of travel expenses in order to assess the potential economic impact that hunting/extraction of wildlife could have on the area. We used a simple equation where the total tourists expenses or recreational value was the sum of the entrance fee, lodging, food and the services of a guided tour. As shown in Table 5, these values were calculated separately for foreign and national tourists given their distinct consuming behavior. The entrance fee is a constant \$10 for foreigners and \$2 for nationals. Lodging per person was determined by multiplying the provided cost of

lodging for one night by the number of nights the tourists stayed overnight near Carara, and then dividing by the number of adults in their party.

The cost of food, used in a similar Costa Rican study (Quiros, 2008), was estimated at \$40/day/person for foreigners and \$20/day/person for nationals. And finally, the price for a tour guide is \$40/person for foreigners as specified by the Association of Guides of the Central Pacific Region (ASOGUIPACE, Personal Communication, June 15 2009). This price was multiplied by the percentage of foreigners who used this service (zero nationals said they were going to enter the park with a guide). To account for all visitors, the average prices per person for a single trip to Carara were multiplied by the total number of visitors to Carara National Park per year (total visitors to Carara in 2009 were 20,677 foreigners and 6,325 nationals). In order to account for the importance of wildlife in influencing tourist visitation, this subtotal was multiplied by the percentage of people who consider wildlife as “somewhat important” or “very important” (i.e., 4 or 5 on a 1-5 importance ordinary scale) as a reason to attend the park (i.e., 91% for foreigners and 95% for nationals).

Thus, the estimated annual value of these expenditures incurred by tourists of Carara National Park totaled \$2,370,060. Notice that the value due to entrance fees only accounts for 8.5% of the total, whereas lodging and food accounts for the majority of the expenses.

Table 5. Estimated annual value of tourists expenses while traveling to Carara National Park

	Average \$/foreigner ¹	Average \$/national	Total \$ Foreigners/ year	Total \$ nationals/ Year	Total expenditures (\$)
Entrance fee	10.00	2.00	206,770.00	12,650.00	219,420.00(8.5%)
Lodging	54.60	12.40	1,128,757.43	78,113.75	1,206,871.18(46.5%)
Food	40.00	20.00	827,080.00	126,500.00	953,580.00(36.7%)
Guided tour	10.40	-	215,040.80	-	215,040.80(8.3%)
<i>Subtotal</i>	<i>115.00</i>	<i>34.40</i>	<i>2,377,648.23</i>	<i>217,263.75</i>	<i>2,594,911.98</i>
% wildlife	0.91	0.95	-	-	-
Total			\$2,163,669.89	\$206,400.56	\$2,370,060.45(100%)

¹Only a fraction of people used the services of lodging, and a guided tour, so the average cost per person was multiplied by the percentage of the people who answered yes to using these services. For foreigners, the coefficient was 0.44 for lodging and 0.26 for guided tour. For nationals, the coefficient was 0.19 for lodging and zero for guided tour.

5. Discussion

The results indicate that hunting does play an important role throughout the communities, although the nature of that role varies to encompass both hunting and conservation-minded families. Although hunting in Carara may have traditionally been subsistence based, 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 given their low level of observations for market price. The scarlet macaw, paca, and yellow-bellied seedeater are more market-oriented animals, each with a significant level of respondents citing they are for sale and have a market price. 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. This is the case for valuable species like the scarlet macaw, in which population's numbers were recently classified as being in a critical state (Vaughan et al., 2005; Vaughan, 2006).

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%, of monthly household income. This percentage is greater for communities with lower incomes; in Community A, 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. Based on the impact the sale of one animal can have on monthly income, it is easy to draw conclusions on why the poaching and selling of wildlife is practiced in the area and is often justified amongst households. Specifically within communities characterized by lower income levels, 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 across all communities, the monetary incentives may not be a strong motivator when deciding whether to poach. We suspect this has to do with the strong legal framework of the county, and the high levels of environmental concern among Costa Ricans.

Furthermore, direct park income through visitors' entrance fees for the year 2009 was estimated at \$219,420. Given that the majority of visitors indicated wildlife was important in influencing their decision to visit Carara National Park, it would be critical for park management to pay close attention to such situations, in particular when iconic species such the scarlet macaw have an important "market" price. This potential problem will not only affect the park, but many of the surrounding businesses that depend on tourists such tour operators, lodges, guides, and restaurants, especially when the revenue generated by these activities is substantially higher (i.e., \$2,150,640) compared to that from hunting/extraction activities (i.e., \$291,988).

Among the potential solutions to address this situation, the park could establish a better surveillance program. Given the park's lack of financial resources, this might need to come from other sources, such as third-party donations. Tourists could be important contributors, since they are willing to pay in addition to their entrance fee for protecting wildlife. Another potential solution is to use the commercial value estimated here as an proxy amount to include in a Payment for Environmental Services, where locals living around the park would be compensated for conserving the biodiversity of Carara National Park. In theory this would provide monetary compensation to the landowners around the park and discourage the need or incentive for hunting (Pagiola et al., 2004).

6. Conclusions

This study provides valuable information about the dynamics of a park and its surrounding communities concerning wildlife and hunting. For low-income communities surrounding the park, the incentives for poaching are great. Although the data indicates only a small percentage of families actually do participate in hunting activities, the total number of species poached and the resulting market value is substantial. The economic impacts for the park and surrounding communities in terms of tourism revenue merit the attention to fix this situation. This study elucidates that despite the significant efforts done thus far to protect biodiversity through national parks, there is still a critical need to integrate the communities' goal of development with the parks' goal of conservation. Alternative schemes such as Joint Forest Management (Nielsen and Treue, 2012) or Community Forest Management (Bray, 2013) might contribute more efficiently to this goal.

7. Appendices

Appendix A. Estimates of the number of families engaging in poaching activities

Community	Total number of families in community	Average number of families reported as hunting	Median number of families reported as hunting	Estimated percent of families that hunt in community based on average
Community A	53	3.42	3	6.4
Community B	18	0.27	0	1.7
Community C	28	1.0	0	3.6
Community D	118	6.9	5	5.9
Community E	283	4.0	4	1.4
Community F	203	7.73	4	3.3
All communities	703	23.32 (total)	16 (total)	3.2

Appendix B. Estimates of monthly and annual amount of money invested by the National Park on protection (information provided by park officials)

Itemized expenses	Monthly value (\$)	Annual value (\$)
Total salary of 5 park rangers	3,563.00	42,756.16
Value of 6.66% depreciation of 2 official vehicles ¹	189.83	2,277.99
Fuel cost	351.60	4,218.61
Other expenses (binoculars, GPS, PC, ammunitions)	316.71	3,800.50
Total	4,421.11	53,053.30
¹ Official duty free price of official vehicles is \$17,102.		

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