A BASELINE ANALYSIS OF POACHING IN CHIQUIBUL NATIONAL PARK

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Master of Science

Fisheries and Wildlife

ABSTRACT

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Illegal hunting of wildlife, also known as poaching, in Chiquibul National Park (CNP) may be contributing to decreasing wildlife populations. Management strategies are limited due to a lack of information on the extent of poaching and motivations of poachers. The objectives of this research are to assess the extent of poaching, to address Guatemalan border community residents' understanding of wildlife in CNP and what animal species are targeted by hunters, and to investigate factors affecting poaching in CNP and Guatemalan border residents' perceptions about poaching in CNP. These objectives were addressed by (1) synthesizing information found in CNP Ranger field notebooks and reports, (2) interviewing Guatemalan border community residents, and (3) interviewing authorities in Guatemala and Belize. Guatemalan border community residents perceived a lower level of poaching in the CNP than CNP rangers, but both thought that poaching has decreased over the years. CNP rangers considered poaching to be a danger to wildlife in the area, and they thought that wildlife numbers have suffered due to poaching. This research demonstrated little support for the hypothesis that legal regulations and the enforcement of regulations are factors that contribute to whether respondents view other community members as contributing to poaching. However, the subsistence needs of hunters and their families is an important factor affecting residents' decision to poach. When subsistence was included in a logistic multivariate regression with legal regulations, regulations lost significance and subsistence was highly significant. Subsistence needs appear to be worth the risk of being caught poaching by authorities.

ACKNOWLEDGMENTS

Foremost, I would like to express my sincere gratitude to my advisor, Professor Mark Axelrod, for his guidance and support. His expertise was invaluable in completing my studies and thesis. In addition, I would like to thank my committee members Dr. Meredith Gore and Dr. Daniel Kramer for their input on this thesis research.

Finally, I greatly appreciate the assistance of Friends for Conservation and Development, the mayors' offices in Poptún and Melchor de Mencos, and the Comisión Nacional de Áreas Protegidas (CONAP) for their assistance in conducting the interviews in Guatemala and Belize and for giving me access to reports related to Chiquibul National Park.

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ABBREVIATIONS

CNP = Chiquibul National Park

FCD = Friends for Conservation and Development

CONAP = Comisión Nacional de Áreas Protegidas

INTRODUCTION

Worldwide, hunting, habitat loss, and fragmentation are the primary threats to biodiversity, and one-third of all mammals and birds are threatened with extinction due to hunting (Grey-Ross et al. 2010). Studies have shown that illegal hunting, also known as poaching, is a common occurrence and threatens native wildlife (Grey Ross et al. 2010, Bórquez et al. 2009, Bassett 2005, Robinson and Bennett 2004). Poaching is partially due to human population growth, which is causing an unsustainable demand for natural resources (Liu et al. 2011).

Scholars have explored a variety of motivations for poaching. These motivations include subsistence, stress and boredom caused by unemployment, recreation, cultural significance, commercial gain, trophy poaching, and disagreement with regulations or rebellion against authorities (Grey-Ross et al. 2010, Muth and Bowe 1998). Muth and Bowe supported the importance of cultural significance in their statement, "Poaching often is embedded in subcultural webs of meaning that involve tradition, ethnic heritage, individual and social identities, and other socio-cultural factors." Therefore, in addition to addressing environmental education, regulation and enforcement, and/or alternative food or income sources, the cultural aspect must be understood and addressed (Grey-Ross et al. 2010).

Statement of purpose

Identifying trends in illegal resource use allows researchers and managers to adapt management practices to a changing situation (Gavin et al. 2009). Successful conservation activities can be

informed by identifying local attitudes and hunting motivations (Brown-Nunez and Jonker 2008, Eliason 1999). Studies involving the extent and circumstances surrounding poaching in CNP, Belize's largest protected area, are almost nonexistent (Meerman 2005, Salas and Meerman 2008). In 2007, FCD, a Belizean nonprofit organization, entered into an agreement with the Belize Forest Department to co-manage patrols and conservation programs in CNP (Salas and Meerman 2008). This thesis research responds to a key thematic area of the CNP Management Plan, which recommends a proactive approach for understanding the conditions of the natural resources in the park through research and monitoring. Specifically, this research examines encroachment and poaching in CNP, which is located in Belize, by Guatemalans in border communities. The purpose of this baseline research is (1) to assess the extent of poaching, (2) to address Guatemalan border community residents' understanding of wildlife in CNP and what animal species are targeted by hunters, and (3) to investigate factors affecting poaching in CNP and Guatemalan border residents' perceptions about poaching in CNP.

Information on illegal resource use is necessary to evaluate the efficiency of management and conservation programs and to design new deterrence programs. In addition, it is imperative if irreversible impacts are to be avoided. This thesis study fills an important void in research in CNP. To protect biodiversity in CNP, we need to know what species are being illegally used; the magnitude, prevalence, and frequency of collection; the characteristics of the collectors and their incentives (Gavin et al. 2009, Muth and Bowe 1998). This is the first research to provide baseline information on these factors, and the first to describe poaching activities according to CNP rangers, Guatemalan government officials, and Guatemalan border community residents.

These multiple perspectives give a well-rounded view of poaching in CNP and give valuable input on where to begin to address the problem.

Study area

Created in 1995, CNP is the largest protected area in Belize at nearly 107,000 hectares (Meerman 2005, Salas and Meerman 2008). It comprises 29% of protected land in the country and nearly 5% of Belize's land area. The Belize Ministry of Natural Resources and Environment prohibits extraction of natural resources and hunting in CNP (Salas and Meerman 2008). A Level II World Conservation Union (IUCN) protected area, CNP is considered "[a] natural area of land […] designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations; (b) exclude exploitation or occupation inimical to the purposes of the area; and (c) provide foundation for spiritual, scientific, educational, recreational, and visitor opportunities all of which must be environmentally and culturally compatible (Meerman 2005, Salas and Meerman 2008)."

CNP is contiguous with other protected areas in Belize and Guatemala. Together with the Chiquibul Forest Reserve and the Caracol Archaeological Reserve in Belize, they are known as the Chiquibul Forest. Because CNP is contiguous with the protected area Reserva de la Biósfera Montañas Mayas/Chiquibul in Guatemala, CONAP, a Guatemalan government agency, also is an important stakeholder[1] in the protection of this key biodiversity region (Salas and Meerman 2008). Combined with other protected areas in Guatemala and Mexico known as the

[1] In this study, a stakeholder is defined as any person who affects or is affected by a situation either directly or indirectly.

Chiquibul/Maya Mountains Key Biodiversity Area or La Selva Maya, the CNP forms a critical piece of the Biological Corridor linking the three countries (Salas and Meerman 2008).

Seventeen different ecosystems, variants of broadleaf forests with differing levels of humidity, elevation levels, and substrate types, make the Chiquibul Forest home to a wide variety of biodiversity and many rare species, including the jaguar, ocelot, margay, scarlet macaw and Baird's tapir. Six-hundred sixty-two plant species have been identified in the Chiquibul Forest. Knowledge of the number of faunal species is less complete; however, the Biodiversity and Environmental Resource Data System of Belize (BERDS) lists nearly 7,000 faunal species (Salas and Meerman 2008).

Belize-Guatemala border situation

The border between Guatemala and Belize was established in 1859 by Guatemala and Britain, and has long been disputed (United States Department of State 1961). Therefore, the 45 km border between Guatemala and the CNP has been a source of tension between the two countries. Guatemalans regularly cross the border to clear land for agriculture, extract timber, poach wildlife, and cut xaté. Xaté is the leaf of certain types of *Chamaedorea* palms used in the global floral industry (Bridgewater et al. 2006). According to The World Conservation Union (IUCN), approximately 75% of *Chamaedorea* are threatened. The IUCN considers three of the 12 species under threat. Robberies of tourists near Caracol Archaeological Reserve and plundering of Mayan archeological sites in Belize recently has added to border tension (Bridgewater et al.

2006). Tension has resulted in a strained relationship between the two countries and greater difficulty in enforcing conservation laws (Chan 2008).

According to FCD, it is easier to regulate bordering resources when two countries have cordial relations, the same laws, and a common language (FCD, personal communication). Historically, Belize and Guatemala have not met these criteria - leading to a lax regulation of resources within the CNP. Land grabbing and speculation has increased in Guatemala, leading to an expansion of communities within the Chiquibul-Montañas Mayas Biosphere Reserve in Guatemala, followed by growth across the border into protected areas in Belize (Chan 2008).

Threats facing CNP

According to FCD, xaté harvesting by Guatemalan border communities is considered the largest threat to the CNP. In the last ten plus years, FCD believes that local migration, poverty, and a better xaté market has led to a significant increase in xaté harvesting in the CNP (Chan 2008). It is common for xaté trading companies to contract residents of border communities to collect xaté leaves. Because xaté is a multi-million dollar enterprise for Guatemala (selling the leaves to markets internationally), xaté leaves are heavily exploited. Therefore, natural xaté populations are decreasing, and people must travel to more and more remote areas, such as the Chiquibul National Park, to collect the leaves.

FCD believes that people who engage primarily in xaté harvesting also poach wild animals. Research has reported anecdotal notes of increased incidence of hunting within Chiquibul

associated with xatero activity and observations of carcasses of protected animals in xatero camps by the study authors (Bridgewater et al. 2006). The first reports of Guatemalans illegally entering Belize to harvest xaté were in 1972. As of 2008, FCD estimated that between 1,500 and 2,000 people were working inside the Chiquibul Forest Reserve and National Park. Authorities implicate xateros in the reduction of wildlife populations, and FCD states that animal populations are visibly reduced (Chan 2008).

Poaching pressure is thought to be heaviest near the Belize-Guatemala border (Salas and Meerman 2008). Authorities believe that wild animals are poached mainly for food by Guatemalans already in the park for the purpose of gathering xaté leaves, but animals also may be poached for commercial sale in Guatemala (Perez 2009). Anecdotal evidence from rangers and researchers note that large mammals, such as currasow, crested guan, ocellated turkey, white-lipped peccary, collared peccary, paca, red brocket deer and white-tailed deer, are being poached. Poaching wild animals has been shown to reduce wildlife populations internationally, potentially leading to the widespread loss of larger forest wildlife, known as empty forest syndrome, and changing the forest structure by eliminating seed dispersers (Kelly 2003, Salas and Meerman 2008, Sheil and Van Heist 2000). CNP rangers and managers fear that this could occur in CNP. For example, peccaries were abundant in Chiquibul Forest 15 years ago, but ranger patrols have not recorded any sightings since they began in 2006 (Perez 2009).

Hypothesized factors affecting the poaching situation in CNP

The main objective of this thesis research was to investigate factors affecting poaching in CNP and Guatemalan border residents' perceptions about poaching in CNP. Researchers in other locations have implicated regulatory uncertainty, which includes a lack of awareness of regulations and the view that regulations are not enforced, and subsistence as factors affecting whether people choose to poach.

1) Regulatory uncertainty

I hypothesize that regulatory uncertainty surrounding hunting in CNP affects whether Guatemalan community residents poach wildlife. Regulatory uncertainty could mean that residents either are not aware that hunting is illegal or they are aware that it is illegal but do not think that the law banning hunting is enforced. This lack of awareness can potentially affect behavior because residents cannot comply with laws that they are not aware of or do not understand. The difference between compliance due to the actual presence and enforcement of laws and how the laws are perceived can be referred to as the difference between objective and perceptual deterrence. In this theory, the perception of risk is an adequate condition to not commit the act. On the other hand, if the regulations are not strict enough or are not enforced, the perceived lack of risk is an adequate condition to commit the act (Erickson et al. 1977).

Hunting is illegal in CNP. However, the legality of hunting may not affect whether hunting occurs because people may be unaware of the law. Research in other areas has promoted raising

public awareness of wildlife laws for conservation purposes, and the studies demonstrated that people may say they were poaching because they were ignorant of the law or uneducated about the scope of the regulations (Lee et al. 2005, Xiang et al. 2009, Eliason 2003). To determine if there is a similar lack of awareness in Guatemalan border communities regarding the law prohibiting hunting in CNP, this study asked residents about their knowledge of the hunting prohibition.

A study in Mexico demonstrated two factors that are more important in determining poaching levels than whether poaching is legal: the subsistence needs of the hunters and hunters' perception of the consequences of poaching (Bórquez et al. 2009). The latter indicates that enforcement of a hunting ban is important. Guatemalan hunters may weigh the benefits of entering Belize, such as acquiring xaté leaves to sell and food for subsistence, against the risk of being caught. This cost-benefit analysis is part of the rational choice theory of crime. This theory states that an offender may risk breaking a law after considering his or her personal situation as well as situational factors. His or her personal situation may include things such as a need for food or money, and situational factors may include how many park rangers are protecting an area and the difficulty of traveling to the area. The rational choice theory highlights that crime is not random, but it serves a specific purpose. In this theory, the risk of being caught and punished is important to consider (Guerette et al. 2005). Keane et al. highlighted the importance of enforcement by showing that decreasing enforcement leads to an increase in poaching incidents (Keane et al. 2008).

Many developing countries lack the resources to enforce wildlife protection laws. Therefore, wildlife regulations are ineffective in protecting vulnerable species (Rowcliffe et al. 2004, Grey-Ross et al. 2010). Many developing countries rely on voluntary compliance, which is largely assumed to not occur without enforcement (Rowcliffe et al. 2004, Grey-Ross et al. 2010). For example, a study in the Democratic Republic of Congo found that the level of protection of large mammals did not affect hunters' prey choices (Rowcliffe et al. 2004). In addition, studies in South Africa and Mexico found that a small minority of poachers are caught and prosecuted (Bórquez et al. 2009, Grey-Ross et al. 2010). The authors of the South Africa study concluded that "[s]tricter laws and punishment for crimes against wildlife may begin to dissuade perpetrators if they are caught. Therefore…police and conservation officers must cooperate and form a strong and consistent security presence that will deter potential illegal hunting (Grey-Ross et al. 2010)." Another researcher stated that compliance may be related to the probability of being detected and the severity of the punishment (Keane et al. 2008). Although the crime may not be for subsistence reasons, studies in other fields have shown that an increase in severity of the punishment reduces the incentive to commit a crime (Leader-Williams and Milner-Gulland 1993).

2) Subsistence needs

Secondly, I hypothesize that subsistence needs affect whether Guatemalan community residents choose to poach in CNP. Studies in other locations have demonstrated subsistence as a motivation to poach (Bassett 2005). In a study in South Africa, researchers found that poverty affected the frequency of poaching. This study noted "overwhelming evidence" that people hunt

for subsistence and economic reasons. Most people who the researchers interviewed were unemployed and earned less than 500 ZAR (US $71.30) per month. The researchers were aware of the need to educate people about poaching, but they thought it would be difficult to address without also alleviating poverty. Therefore, they advised that programs aimed to alleviate poverty might also lead to a decline in poaching (Grey-Ross et al. 2010).

In another study on illegal abalone fishing in Mexico, fishermen acknowledged the existence of regulations, but they felt forced to take the risks necessary to provide for their families. The fishermen thought that their needs were of greater legitimacy than the regulations. Researchers found that hunters weigh the risks of being caught poaching against the potential earnings. Because abalone poaching is perceived as very profitable and the risk of being caught is very low, poaching is appealing (Bórquez et al. 2009).

According to FCD, both Belizean and Guatemalan authorities believe that the destruction of the forests in north-eastern Guatemala and in Belize is due to socioeconomic circumstances. Poverty is thought to be fueling the expansion of Guatemalans into Belize, but socioeconomic information has not been reported. Authorities believe that Guatemalans enter CNP for the economic activity of cutting xaté leaves. While in the forest, xateros are believed to hunt mostly for subsistence and sell some meat for commercial purposes.

METHODS

This research triangulated three methods to achieve its objectives, and each method addressed the three objectives. Triangulation is a mixed-methods approach that addresses objectives using at least two methods. It adds trustworthiness and depth to a study, and it is used as a tool for validating data through comparing findings from different study approaches (Mcvilly et al. 2008). I used triangulation in this study in order to attempt to validate, understand, and provide trustworthiness to each separate study approach. I collected data in Belize and Guatemala May - June 2010.

1. Review of ranger reports

FCD Rangers have patrolled CNP since December 2006, and they have kept notes on evidence of hunting camps, the frequency of sighting hunters, and the number of arrests of hunters (Perez 2009). These notes were compiled in a Threat Reduction Assessment in June 2007, quarterly reports in 2008 and 2009, and in special multi-agency patrol reports. The reports were helpful to investigate illegal activity because they provided information on the extent of documented Guatemalan border community residents' involvement in poaching and other illegal activities. The reports document ranger patrol activities, sightings of trespassers' camps, arrests, sightings of trespassers, interactions with Guatemalan officials, and thoughts on illegal activities occurring in CNP. I read the reports after the formation of the interview questions for the Guatemalan community residents and the authorities. Therefore, the content of the reports did not affect the content of the questions. Formulating the questions prior to reading the reports is important for the validity and reliability of this research because it does not allow rangers views to affect the interview questions.

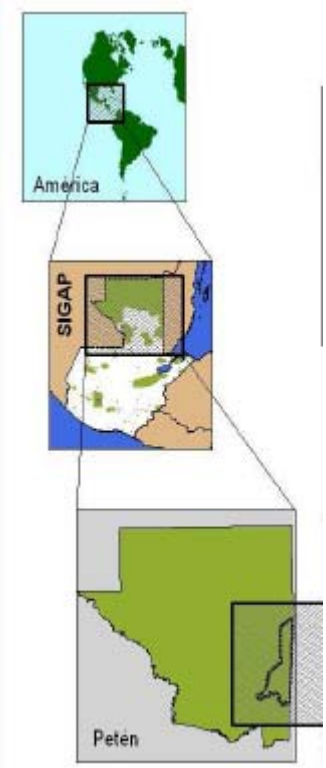
2. Community resident interviews in Guatemala border towns

I interviewed 10 residents from each of five communities along with one community leader in each community. Only one household declined to participate in this research. I identified residents opportunistically by walking up to homes, and all interview respondents were at least 18 years of age. For community representativeness, I attempted to visit homes throughout communities and not all within the same area of the community. An attempt was made to ensure gender representativeness by interviewing at least four women in each community. I identified the community leaders by inquiring within the communities since community leadership often was informal.

This research is considered baseline research because it provides a first step to understanding the poaching situation in CNP and Guatemalan border community perspectives. In in-depth interviews, a small sample size (such as 10 residents in each community) may be sufficient for a baseline research when the same topics and responses emerge from the interviews (Boyce and Neale 2006). Future studies with larger sample sizes would be better equipped to make generalizations within and across communities. This limitation's effects were minimized by drawing information from multiple sources (interviews of different stakeholders and ranger reports). In addition, the effects were minimized by sampling in five established border communities, which is not an insignificant number in this small area. (Figure 2 shows the five sampled communities among communities that were not visited.)

I interviewed residents in the communities of Centro Maya, Las Flores, Sacul Arriba, El Naranjon, and Monte Los Olivos. I chose these communities due to their proximate location to

the Belize border, their relative length of establishment as opposed to other, newer communities that have sprung up along the border, their identification by both FCD and Guatemalan government officials as being involved in activities in Chiquibul, and their accessibility. All of the communities were located in the Department of Petén in Guatemala. Figure 1 shows the department of Petén in Guatemala. Figure 2 shows the locations of the communities interviewed.



(Consejo Nacional de Areas Protegidas (CONAP 2004)

Figure 1: Guatemala map. The green and white area in the middle box is Guatemala. The bottom box is the Department of Petén. The highlighted area in the bottom box borders CNP. For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this thesis.

(Mayor's office of Poptún no date)
Figure 2: Locations of communities interviewed in Petén, Guatemala. The line represents the Guatemala-Belize Border. A is the location of Melchor de Mencos, and B is the location of Poptún. The numbers are the locations of the communities interviewed:

1. Las Flores;
2. Sacul Arriba;
3. Centro Maya;
4. El Naranjon; and
5. Monte Los Olivos.

A limitation of this research is the representativeness of the data. There are no maps of the communities that I was visiting. Therefore, to choose which houses to visit in each community I had to rely on what I could visually see of the communities and what community residents told me about the boundaries of the community. In addition, the communities I chose to visit were relatively established communities, relatively accessible, and identified by Belize and Guatemalan authorities as being involved in activities in Chiquibul. I expect that interviewing more accessible households and communities biased the results towards people less likely to poach. On the other hand, I expect that interviewing more established communities and communities identified by authorities biased the results towards people more likely to poach.

The representativeness of the data is supported by the high response rate; only one household that I approached refused to participate in this research.

I conducted the interviews in Spanish with the aid of an interpreter who spoke both Spanish and K'chie', the native language of many of the residents of the border communities. If the community resident did not speak Spanish, then I conducted the interview through the interpreter in K'iche'. Interview questions were both open and closed-ended. Open-ended questions serve to prevent the questions from influencing the responses as much as possible (Liu et al. 2011). I used open-ended questions to better understand the respondents' perspective to elicit more honest responses than from close-ended questions. Open-ended questions addressed residents' knowledge of wildlife in CNP, what animals were hunted in CNP, the importance of CNP to residents, hunting punishments, and the relationship of residents with authority figures. Closed-ended questions addressed poaching activities and frequency, the prohibition of hunting, and socio-demographic characteristics.

In the questions, the generic term "forest" was used to refer to CNP to avoid confusion. Because people within the communities refer to CNP using different names, using the term CNP could have resulted in confusion. CNP is the only forest near the communities interviewed. A list of questions for community residents are available in Appendix A.

The subject matter of the questions was sensitive, addressed illegal activities, and could have caused a lack of reliability in respondents' answers. Because the questions regarded an illegal activity, poaching, respondents who were aware that it was illegal may have been defensive in their answers. If someone knew that poaching was illegal, he or she may have been more likely

to respond that community residents did not poach, even if they knew they did, and, therefore, biased the results. This limitation was addressed by asking if community residents hunted before asking if hunting was prohibited. These questions were separated by six other questions, and I asked direct and indirect questions related to hunting and a prohibition on hunting. For example, I asked the importance of the forest, whether community residents enter the forest, who enforces any regulations regarding hunting, and if there are any penalties for hunting. Finally, I explained to respondents before the interview that I was a student, not associated with the governments of Belize or Guatemala, and that I did not know their names and could not use the information that they gave me against them. My interpreter did the same.

Additional ways this study increased the reliability of the answers included a comfortable setting allowing a more open atmosphere (Bell et al. 2007); the illegal activity in question could be considered "an everyday reality, embedded in local cultural values, rather than ethically wrong or a source of shame," making residents less reluctant to talk about it with a researcher (Bell et al. 2007); and community resident interviews refrained from addressing individuals' direct poaching activities. Instead, the questions addressed community activities. This framing of the interview questions, which indirectly asked about poaching activities in CNP, also could be a limitation of this research. Because the questions asked respondents about activities of community residents instead of their own activities, the socio-demographic information and answers to other questions cannot be attributed to poachers or non-poachers. However, because the questions referenced an illegal activity, it was advantageous to not directly question community residents about their own activities in order to increase the reliability of the answers. Other studies have questioned

residents about activities of other people in their communities due to a reluctance of respondents to report on their own illegal activities (Liu et al. 2011).

3. Interviews with CNP Rangers (Belize) and the mayors of Poptún and Melchor de Mencos, Guatemala

I interviewed four rangers who patrol CNP and are employed by FCD. I also interviewed one Institute of Archeology ranger. The Institute of Archeology is a Belize government agency dedicated to the preservation of cultural and archaeological sites (Institute of Archaeology no date). This ranger patrolled Caracol, the largest Maya archaeological site in Belize, which is encircled by CNP.

Poptún and Melchor de Mencos are the largest Guatemalan cities near the communities interviewed and Belize. I interviewed the mayors of each city because they were active in surrounding community matters and resource use, they were aware of border activities, and they were engaged by FCD. Finally, I spoke with local CONAP employees about CNP management.

I conducted interviews informally in a semi-structured fashion in the interviewees' workplaces. I recruited the interviewees opportunistically. The FCD rangers and the CONAP employees interviewed were working at the time that I was present. I interviewed authority figures on each side of the border in order to have representative points of view.

The interview instrument used both closed and open-ended questions. Open-ended questions addressed the authority figures' relationships with officials on the opposite side of the border and

with Guatemalan community residents, animals present in and poached in CNP, reasons for poaching, and regulations regarding poaching. Closed ended-questions addressed the presence and frequency of poaching. I asked the questions in English in Belize and in Spanish in Guatemala. A list of questions for authority figures are available in Appendix B.

4. I analyzed the hypothesized factors affecting the poaching situation in CNP: (1) regulatory uncertainty, and (2) subsistence needs. The analyses in this section use nonparametric logistic regressions to analyze these factors because the outcome variables, including whether community residents hunt, whether hunting is prohibited, and whether hunting is for subsistence, are dichotomous. Therefore, the residuals follow a logistic distribution rather than a normal distribution. Table 1 lists the explanatory variables in this research.

Table 1: Explanatory variables in this research

Variable	Shortened Variable Name
how many years the respondent lived in the community	Community years
years of formal education	education
respondent's knowledge of a hunting ban	hunting prohibited
respondent's knowledge of a hunting ban and enforcement	hunting ban enforced
whether respondents thought hunting was for subsistence	subsistence
whether respondents stated that community residents hunt	residents hunt
whether respondents thought residents would accept an economic alternative to hunting	alternative
Gender	--
Age	--
Income	--
Number of children	--
Resident of El Naranjon	El Naranjon
Resident of Las Flores	Las Flores
Resident of Monte Lost Olivos	Monte Los Olivos
Resident of Centro Maya*	Centro Maya

* Sacul Arriba was omitted from the regressions because its inclusion resulted in perfect correlation with the outcome. Only three respondents in Sacul Arriba stated that community members hunt, compared to eight or nine in each of the other communities.

I used the socio-demographic characteristics gender, community years, age, and education as control variables in all regressions. I chose the variables gender, community years, and age based on differences that I noticed during the interviews. Men tended to be more inclined to talk about poaching and be aware of poaching activities. People in more established communities and older individuals appeared to know more about poaching. I chose to include the variable education because previous research demonstrated that it may influence level of support for environmental policies (Bonita and McFarlane 2005).

Income was omitted because it was highly positively correlated with education, and it was more difficult for respondents to quantify than education. It also was highly negatively correlated with community years, as was education. I also omitted the variable number of children because it was highly positively correlated with age. The number of children and education were highly negatively correlated. These correlations and omissions affect confidence in this research's findings because it is possible that the relationship between the included variable, such as education, and the outcome variable, such as hunting prohibited, may actually be due to the omitted variable, in this case income. Table 2 lists Pearson's correlation coefficients from STATA.

I used subsistence, hunting prohibited, hunting ban enforced, and residents hunt as explanatory variables. Pearson's correlation coefficients for these variables also are listed in Table 2. Hunting prohibited is omitted from Table 2 because it is a component of the variable hunting ban enforced (hunting ban enforced is composed of residents who thought that hunting was prohibited and the prohibition was enforced). Subsistence and residents hunt perfectly correlated.

In addition, both were negatively correlated with gender and education. Hunting ban enforced was positively correlated with gender.

Table 2: Pearson's correlation coefficients of variables used in this research

	Income	Education	Community years	Age	# of children
Income	1.0000				
Education	0.8185	1.0000			
Community years	-0.8459	-0.7145	1.0000		
Age	0.0456	-0.1581	0.0229	1.0000	
# of children	-0.2061	-0.4913	0.2228	0.9126	1.0000
Gender	-0.0029	-0.1304	0.1295	-0.0261	0.1401
Hunting Ban Enforced	0.1241	0.0761	-0.0367	0.2949	0.2910
Subsistence	-0.4363	-0.5410	0.2658	0.0604	0.1180
Residents hunt	-0.4363	-0.5410	0.2658	0.0604	0.1180
Alternative	0.1689	0.0161	-0.2406	-0.1695	-0.0189

Table 2 continued: Pearson's correlation coefficients of variables used in this research

	Gender	Hunting Ban Enforced	Subsistence	Residents hunt
Hunting Ban Enforced	0.4303	1.0000		
Subsistence	-0.5164	-0.2222	1.0000	
Residents hunt	-0.5164	-0.2222	1.0000	1.0000
Alternative	0.3105	0.1336	-0.3563	-0.3563

(1) First, I ran a multivariate logistic regression that analyzed hunting prohibited on residents hunt. The purpose of this regression was to determine if hunting prohibited significantly affected residents hunt when the variables gender, education, community years, and age were controlled for. Using this regression, I then used CLARIFY software to simulate community members' likely responses to the question of community hunting when their awareness of hunting prohibitions changes. I also compared the results of this regression to the results of a multivariate logistic regression that analyzed whether residents hunt based on respondent's knowledge of enforcement. This regression controlled for the same variables. I ran this additional regression in order to determine if the inclusion of enforcement changed the results.

I also explored enforcement by discussing residents' answers to open ended questions about the nature of the different relationships among parties involved. For example, interviews with community residents asked about their relationship with Belizean officials; interviews with Belizean officials asked about their relationship with Guatemalan officials and community residents; and interviews with Guatemalan officials asked about their relationship with Belizean officials and community residents.

(2) In order to determine the relationship between subsistence and the occurrence of poaching as well as determine the strength of the findings about hunting prohibitions and enforcement, I ran a multivariate logistic regression including the variable subsistence. The independent variables were subsistence, gender, education, community years, age, and hunting prohibited. The variables hunting prohibited and hunting ban enforced were not included in the same regression because hunting prohibited is a component of the variable hunting ban enforced. In addition,

using this regression, I simulated how community residents would respond to whether hunting was for the purpose of subsistence and whether community members hunt using CLARIFY software.

This research also indirectly analyzes whether residents poach for subsistence reasons by exploring if community residents would accept an alternative economic activity that would negate the need to poach. This research tests the assumptions that if residents poach for subsistence reasons, they would more likely accept an alternative economic activity, and if residents do not poach for subsistence reasons, they may think that an alternative economic activity would not replace poaching. The likelihood of acceptance of an economic alternative is tested by analyzing the responses of residents who said that other community residents would or would not be interested in an economic alternative to poaching.

BACKGROUND

Community Information and Poaching Involvement

The communities ranged in size from approximately 47 families in Centro Maya to 144 families in Las Flores. Sacul Arriba had 86 families, El Naranjon had 90 families, and Monte Los Olivos had 120 families. The average family size of my interview sample ranged from 6.5 in Sacul Arriba to about 8.5 in Las Flores.

Flores was the most recently settled community, and the average number of years residents in my interview sample had lived in Flores was 14.3 years. Sacul Arriba was the longest settled

community, and the average number of years residents in my interview sample lived there was 30 years. Table 3 lists the average number of years respondents resided in each community.

Table 3: Average number of years respondents resided in each community

Average years in community:	
Flores	14.3
Naranjon	19.7
Maya	23.8
Olivos	20.9
Sacul Arriba	30.0

Table 4 shows the number of respondents of each age, income, and education level. It also lists the number of children of respondents. At 2.5 years, Sacul Arriba had the highest median education, followed by El Naranjon (2 years), Las Flores (1 year), and Centro Maya and Monte Los Olivos (both with 0.5 years). However, income followed a different pattern. The median annual income per household for Las Flores was nearly 1100 Quetzales (approximately U.S. $137.50), followed by Centro Maya at 1000 Q (approximately U.S. $125), and Sacul Arriba with about 500 Q (approximately U.S. $62.50). El Naranjon and Monte Los Olivos both had a median annual income per household of $0.00. All of the communities primarily engaged in agriculture for subsistence; therefore, they were not reliant on income for food. However, it appears that the residents who reported no monetary income sell some of their crop harvest periodically to purchase necessities.

Table 4: Interview questions and community residents' responses to socio-demographic questions

Question with answers	Number of respondents
Age	
19-29	14
30-39	15
40-49	7
50-59	6
60-69	6
76	1
85	1
Number of children	
0-3	16
4-6	16
7-9	12
10-13	6
Annual Income	
0	24
400-800	4
1000	14
1200-2000	7
3900	1
Years of Education	
0	21
1-3	15
4-6	7
7-9	3
10-12	3
13-15	0
16-18	1

Extent of poaching

Ranger reports

I analyzed the extent of poaching in CNP using Ranger patrol reports, community resident interviews, and authority interviews. First, I used ranger patrol reports to determine the change in hunting between April 2007 and November 2009. These are the dates in which records from FCD rangers were available. The change in the number of camps used by xateros and hunters located per kilometer traveled by ranger patrols was used as a proxy to determine the change in hunting. Changes in presence of camps are an adequate measurement of poaching trends because, according to FCD, remnants of wildlife have been found in almost every camp located (Chan 2008). In addition, a study in Chiquibul reported anecdotal observations of carcasses of wildlife in xatero camps (Bridgewater et al. 2006). I used camps per kilometer as opposed to total number of camps because the distance traveled, number of rangers in a patrol, number of patrols, and percentage of the park covered differed each month. I analyzed monthly trends using descriptive analyses.

Figure 3 shows the level of hunting per month from April 2007 to November 2009. According to Figure 3, hunting appears to remain relatively stable from month to month, around 0.1 camps/km (range 0 – 0.36). The most hunting occurred in May 2009, followed by October 2009.

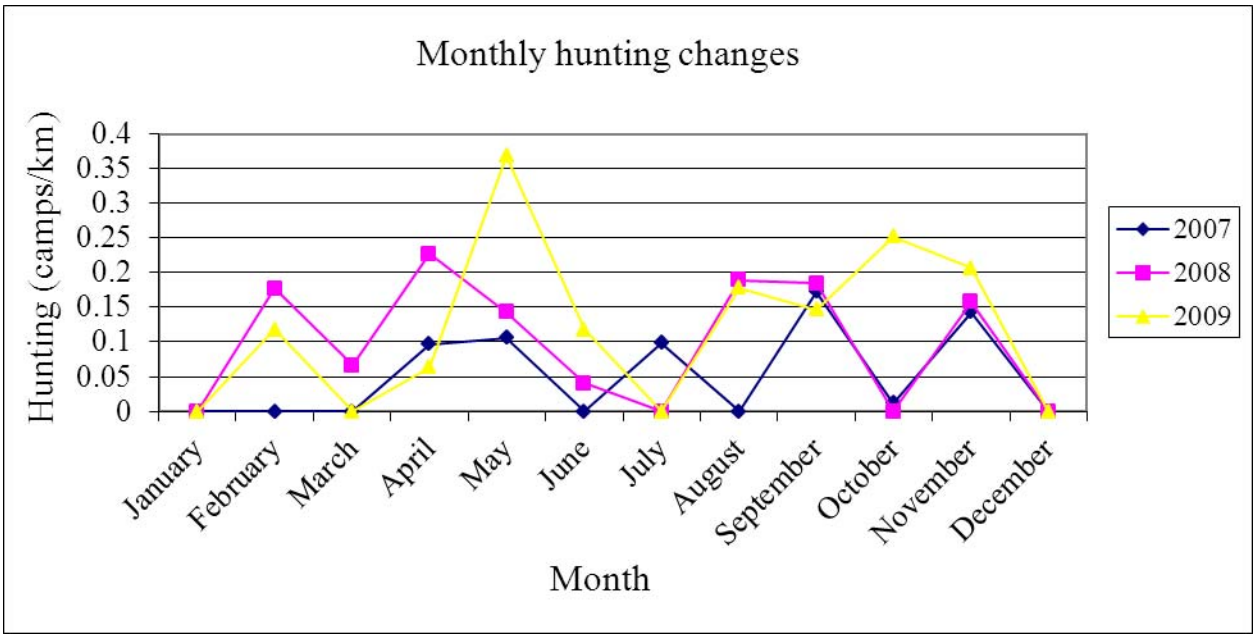


Figure 3: Level of hunting 2007 – 2009.

Figure 4 shows how the number of hunting camps per kilometer differs in the same month of the year from 2007 to 2008, and Figure 5 looks at changes between the same months in 2008 and 2009. For example, in Figure 4, the value above April on the x-axis indicates the change in camps/km from April 2007 to April 2008. The figures show the same months of different years to eliminate potential seasonal differences. The figures indicate a slight decrease in hunting in most months between 2007 and 2009. While May 2008 to 2009 and November 2008 to 2009 show the greatest increase in hunting, overall, more months from 2007 to 2008 show increases in hunting than months from 2008 to 2009. The average change in camps/km in corresponding months from 2007 to 2008 is 0.0475, and the average from 2008 to 2009 is 0.025. Therefore, the increase in hunting from 2007 to 2009 is leveling off.

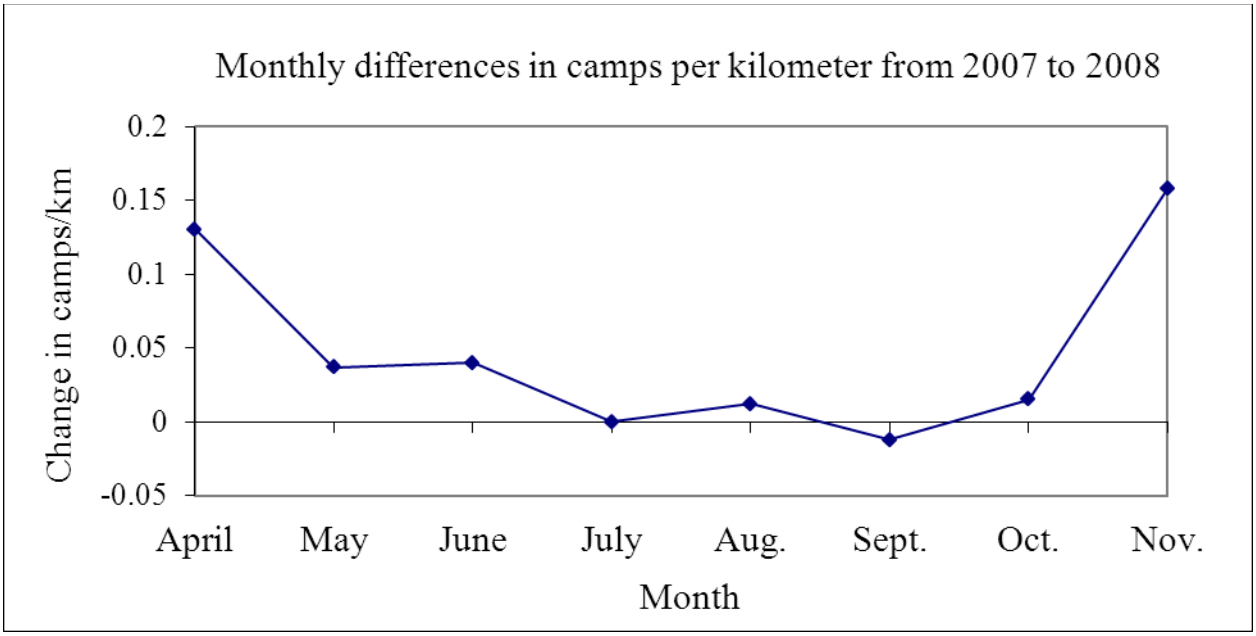


Figure 4: Increase or decrease in camps/kilometer per month from 2007 to 2008

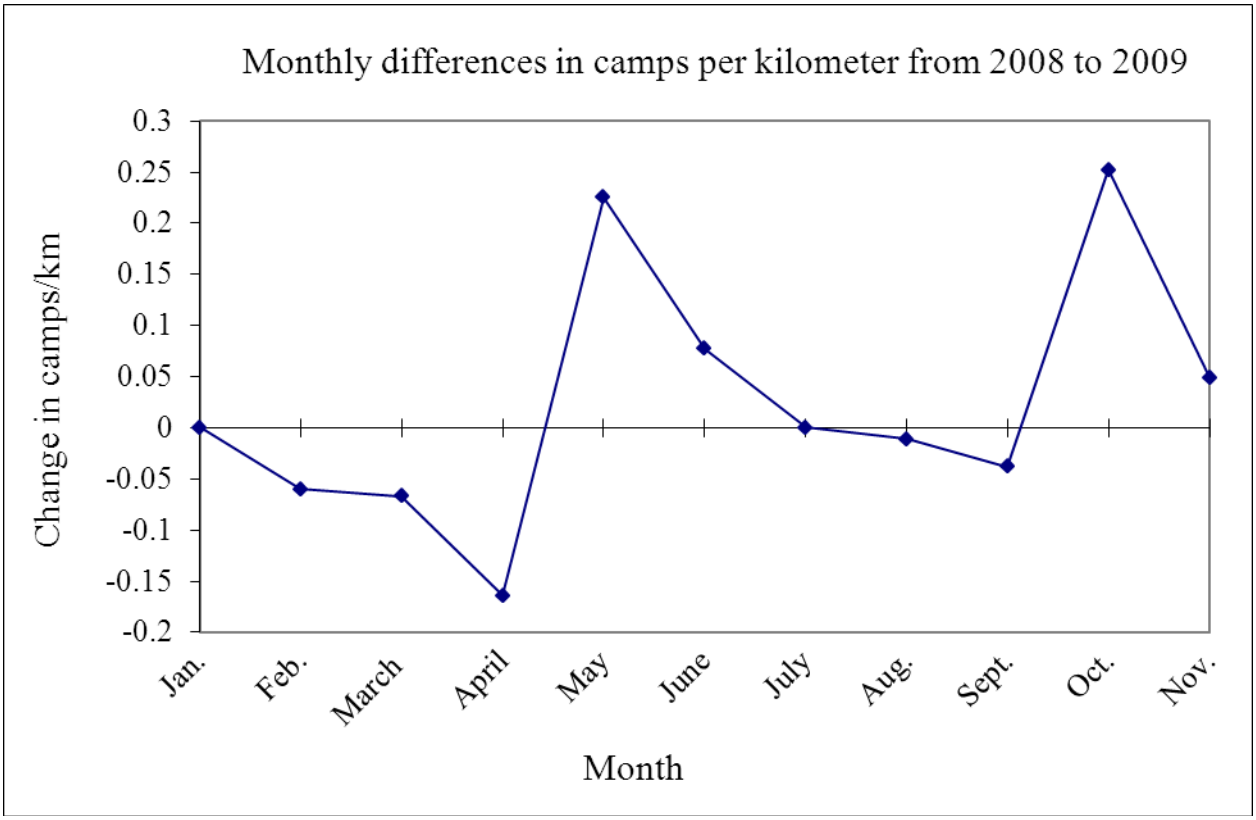


Figure 5: Increase or decrease in camps/kilometer per month from 2008 to 2009

Community resident interviews

In order to analyze Guatemalan border communities as a whole, I analyzed all five communities as one group. This allowed for a larger sample size. All residents in all of the communities interviewed stated that the forest was important, and 16 of 50 residents said that it was important for the animals and/or hunting. There were slight differences among communities. In this research, I explored differences between communities as a baseline for further research. Only one resident in El Naranjon said that the forest was important for animals/hunting, two in Las Flores, three in Sacul Arriba, four in Centro Maya, and six in Monte Los Olivos.

Forty-four out of 50 residents stated that people in their communities enter the forest. Thirty-seven respondents stated that people entered fairly frequently, with only five stating infrequently. The length of time people remain in the forest ranged from hours to 15 days. This time-frame is consistent with the amount of time needed to travel to CNP.

Thirty-eight out of 50 residents responded that people in their communities hunt in the surrounding forests. Thirty-five residents stated that the hunting frequency was low (less than 20 community residents hunted), and five residents said the frequency was high (more than 20 community residents hunted). The discrepancy between the number of respondents who stated that community members hunt and the number of respondents who gave a hunting frequency can be explained by two respondents who stated that people do not hunt, but in the later question, they stated a hunting frequency. Everyone who talked about hunting frequency in Sacul Arriba, Monte Los Olivos, Naranjon, and Las Flores said that hunting frequency was low. One person in Las Flores said that it is high in other places. All five who said it was high lived in Centro Maya.

FCD reported that Monte Los Olivos and Las Flores have higher rates of incursion into CNP. However, residents of these two communities stated that hunting frequency is low. On the other hand, five Centro Maya residents reported hunting frequency as high. One possible explanation for this discrepancy is that Centro Maya is located closer to other villages than Monte Los Olivos and Las Flores. Residents may have more contact with people in other communities and be more aware of the activities of people in other communities.

Thirty-three out of 50 community residents stated that hunting frequency has decreased in recent years because animal populations had decreased, animals had moved further into the forest due to habitat destruction, hunting was prohibited, there was an increased risk of being caught in Belize, or people were busy with other work. One person in each of Naranjon, Centro Maya, and Monte Los Olivos said that hunting frequency had increased in previous years. Nine residents thought that hunting frequency had not changed over the years. This information corresponds with data in CNP Ranger reports, as indicated in Figures 3 and 4 which show a slight decrease in hunting change rates in most months between 2007 and 2009.

Authority interviews

All four CNP rangers and the mayors of Poptún and Melchor de Mencos stated that people in Guatemalan communities bordering Belize enter CNP and poach wildlife across the border. They said that crossing the border into CNP is a common practice that is harming the forest. They were extremely concerned about the effects of the destruction of the forest. The mayors commented, “wildlife habitat is being limited” and “people are hunting to feed themselves.”

However, the mayors believed the level of hunting was low, and they were more concerned about the effects of the destruction of the forest on water sources. CNP rangers mentioned strong concerns about xaté extraction and the loss of native wildlife. They were aware of what species were thought to be declining or had declined in CNP, such as brocket deer and white-lipped peccary, and said they kept an eye out for these species.

All Belize rangers believed that poaching rates were relatively high in the CNP. They considered poaching a grave danger to wildlife in the area, and they believed that wildlife numbers suffered due to poaching. However, most rangers agreed with community residents that poaching has decreased over the years due to a decline in wildlife numbers and greater enforcement.

Understanding of wildlife in CNP and species poached

Ranger reports and authority interviews

Ranger reports focused on the declining numbers of species of concern. Information on wildlife species focused on observational notes about species such as the peccary, scarlet macaws, and jaguar. The reports demonstrated xatero activity and hunting in CNP using these species.

According to FCD, their 2008 patrols noticed less wildlife than what was recorded in 2000. For example, since the beginning of patrols in 2006 to 2008, rangers did not record sightings of any white lipped peccary. However, sightings of herds of peccaries were recorded in 1993. As

further evidence of poaching, wildlife appeared to be more prominent in areas where poaching would be less common, such as where firearm sounds would be more noticeable (Chan 2008).

In 2006, George Hanson, the Enforcement Program Officer for the Belize Forest Department, wrote a report about the present xaté situation in Belize (Hanson 2006). He stated that a 2005 operation in Chiquibul found evidence of white-lip and collared peccary hunting and consumption of monkeys at abandoned camp sites. He also stated that in 2005, Guatemalans cutting xaté (xateros) killed over 20 wild turkeys at Las Quevas Research Station, which were all that lived at the station. Finally, he noted the decline of jaguars' prey base due to xatero hunting. It resulted in problems with jaguars preying on domestic animals, looking for food in the streets of cities and communities, and coming into contact with humans. Between February and May 2006, 15 jaguars were killed for preying on domestic animals and entering communities.

This limited observational information demonstrates the harmful effects poaching could be having on key species in CNP. It indicates a need for studies in the area to quantify wildlife numbers in order to determine the effects of poaching on species beyond observational data.

Community resident interviews

-Hunted species

Many community residents also were aware that wildlife populations were decreasing. Twenty-four out of 50 residents said that populations of all species in the area were decreasing due to hunting and habitat destruction. Residents stated that community residents hunt tepezcuintle (Agouti/Cuniculus paca, a large rodent), white-tailed deer, wild pigs (peccary and coche de

monte), pizote (coatimundi, a member of the raccoon family), armadillos, smaller deer (cabrito), and birds such as turkey and pajuil. Monte Los Olivos residents mentioned the greatest variety of species hunted; residents mentioned all of the above species.

Together, all 50 respondents listed 21 different animal species, and 14 of those animals also were listed as being hunted. The names of animals are included here as listed by residents. Figure 6 shows the most commonly listed hunted species.

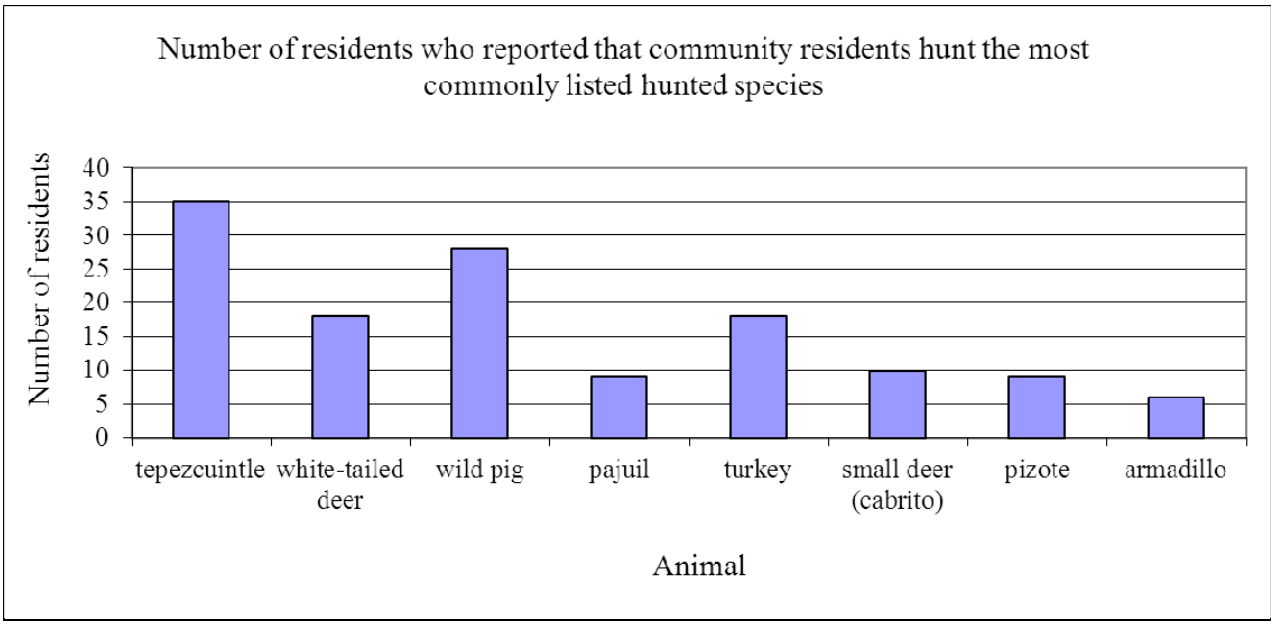


Figure 6: The most commonly listed hunted species by community residents

Some residents stated that they knew that certain species were declining in number yet continued to be hunted. However, generally it was not the same people that stated that a species was in decline and the species was hunted. For example, 32 people stated that tepezcuintle were hunted and 10 people said that tepezcuintle were declining in the forest. Only four residents stated that tepezcuintle were disappearing yet continued to be hunted by community residents. Likewise, 19 residents said white-tailed deer were hunted, 11 residents stated that white-tailed deer were

declining, and four stated both. Finally, 13 residents stated that peccary were hunted, five stated that they were declining, and two stated both.

The fact that most residents who stated that certain species were declining in number were not the same people who said that that the species were hunted could suggest need for wildlife conservation education in the area. Some of the species that residents said were hunted are known to be of concern, which also suggests a need for wildlife conservation education. Most of the populations of white-tailed deer in Central America are declining, and most of the subspecies statuses are unknown (Gallina and Lopez Arevalo 2008). The status of peccary in the area also is questionable. White-lipped peccary is listed by the IUCN as near threatened due to habitat loss and over-hunting. Its range has been significantly reduced in Central America (Reyna-Hurtado et al. 2008). According to the IUCN, the status of the collared peccary also should be monitored due to habitat destruction and potential for over-hunting (Beck et al. 2008). Finally, the IUCN lists tepezcuintle as of least concern, but it notes that hunting for bushmeat is a major threat (Queirolo et al. 2008). In addition, as mentioned above, the Enforcement Program Officer for the Belize Forest Department noted in a report that jaguars were preying on domestic animals as a result of a decline of jaguars' prey base due to xatero hunting. Jaguars will normally prey on large or medium-size wild animals such as tepezcuintle instead of domestic animals unless there is an insufficient supply of wild animals (Foster et al. 2010).

-Non-hunted species

When I asked community residents what animals were present in CNP, respondents mentioned species that were not listed as hunted less frequently than animals who are hunted. Mentioning

hunted species more frequently suggests that residents were more aware of game species than non-game species or that residents were knowledgeable about hunting and it was a well-known activity within the communities. Only seven animals were listed by residents as living in the forests but were not mentioned when asked what animals were hunted. Table 5 shows the most commonly mentioned non-hunted species.

Table 5: Non-hunted species most commonly listed by community residents

Species	Number of residents
Monkeys	16
Parrots (including scarlet macaw)	11
Serpents	3
Raccoons	2

Most residents failed to mention that jaguar and scarlet macaws live in the surrounding area. Jaguars are one of the most studied species in the area (Sanderson et al. 2002, Kelly 2003). They also are considered an "umbrella" species because they require large territories that also protect habitat for many other species by default (Kelly 2003). Yet only 13 of 50 people mentioned that jaguar lived in the forest. A more striking example of the lack of awareness of rare species is that only four residents specifically stated that scarlet macaws live in the forest even though the species is extremely rare yet relatively prominent in the area (seven more residents mentioned parrots in general). Scarlet Macaws are considered Endangered on the World Conservation Union (IUCN) Red List and classified under Appendix I of the Convention on International Trade in Endangered Species (CITES) (Renton 2006).

RESULTS AND INTERPRETATION

Regulatory uncertainty: residents unaware of a ban on hunting

Community resident interviews

Twenty-nine out of 50 residents were knowledgeable that hunting is prohibited. An additional three, all of whom lived in Las Flores, said that hunting is not prohibited, but selling the meat of hunted animals is prohibited. Multivariate logistic regressions tested the effect of respondents' knowledge of a hunting ban on whether they thought community residents hunted. When community was excluded from the regression, the regression explained nearly 25% of the variation in residents hunt. When community was included, nearly 40% of the variation was accounted for.

Table 6 shows that significant variables affecting residents hunt include gender and hunting prohibited. Men were more likely to say that community residents hunted than women. However, when I controlled for community, only hunting prohibited is significant. In this case, respondents' residence in Centro Maya and Monte Los Olivos significantly affected how they responded to whether community residents hunt. In both communities, nine out of 10 residents stated that community residents hunt, but only two in each community said that hunting was prohibited.

Interview responses indicate that residents who said that community residents did not hunt were more likely to be aware that hunting was prohibited. According to CLARIFY simulation results, residents who stated that hunting was not prohibited were about 33 percent more likely to say that community residents hunt than residents who stated that hunting was prohibited (Table 7). I

based the simulation results on Table 6's logistic regression. The results show the magnitude of influence of hunting prohibited on the outcome variable residents hunt.

Table 6. Logistic regression coefficients for variables' effects on the dependent variable view that community residents hunt

	View that community residents hunt, not controlling for community	Standard Error	View that community residents hunt, controlling for community	Standard Error
hunting prohibited	-2.103*	1.223	-2.351*	1.389
gender	-1.504*	0.834	-1.113	1.054
education	-0.111	0.114	-0.055	0.138
community years	-0.054	0.051	0.044	0.073
age	0.011	0.028	0.012	0.045
Las Flores	-	-	1.705	1.913
Centro Maya	-	-	2.567**	1.277
Monte Los Olivos	-	-	3.249**	1.588
Constant	4.557	2.226	0.121	3.597
Pseudo R^2	0.238		0.384	
Observations	49^		40^^	

* p <0.10
** p < 0.05
*** p < 0.01
^ One observation was dropped because the respondent did not know if hunting was prohibited or not.
^^El Naranjon's 10 observations were dropped because its inclusion perfectly correlated with the outcome.

Table 7: Simulation results: magnitude of influence of hunting prohibited on residents hunt

	Mean probability that residents hunt	Standard error
Hunting is prohibited	0.694	0.102
Hunting is not prohibited	0.923	0.084

Because I found that hunting prohibited was a significant factor affecting residents hunt, I analyzed factors that could affect whether a respondent thought that hunting was prohibited. In a multivariate logistic regression where hunting prohibited was the outcome variable, with all variables in Table 8 except for community controlled for, education and community years are significant (Table 8). The more years residents lived in the community, the more likely that they were to respond that hunting was prohibited.

When community is included, slightly more variation is explained. When community is controlled for, only education remains significant. In addition, the community Las Flores is significant; only two residents of this community stated that hunting was prohibited.

Table 8. Logistic regression coefficients for variables' effects on the dependent variable residents' knowledge of hunting

	Knowledgeable that hunting is prohibited, not controlling for community	Standard Error	Knowledgeable that hunting is prohibited, controlling for community	Standard Error
gender	-0.021	0.807	-0.488	0.865
education	0.351**	0.139	0.336**	0.146
community years	0.146***	0.052	0.084	0.061
age	-0.025	0.026	-0.017	0.028
Las Flores	-	-	-3.079*	1.715
El Naranjon	-	-	-1.412	1.642
Centro Maya	-	-	-0.339	1.440
Monte Los Olivos	-	-	-1.133	1.356
Constant	-2.455	1.869	-0.052	2.544
Pseudo R^2	0.311		0.385	
Observations	49^		49^	

* p <0.10
** p < 0.05
*** p < 0.01
^ One observation was dropped because the respondent did not know if hunting was prohibited or not.

The above regression indicates education is a significant factor in determining whether respondents were aware of a hunting ban. Residents who reported a higher level of education were more likely to say that hunting was prohibited. Higher awareness of the law among those with higher educations is consistent with other studies that have demonstrated that people with higher levels of education are more concerned about the environment and more likely to support environmental policies (Bonita and McFarlane 2005). Therefore, they may be more likely to be aware of a law protecting the environment.

Regulatory uncertainty: hunting ban not enforced

Twenty-six of 50 respondents stated that hunting was prohibited and the prohibition was enforced. Only three residents thought that the hunting prohibition was not enforced. Therefore, the groups hunting prohibited and hunting ban enforced were almost identical, and I obtained very similar results when the same regression as above was run with the variable hunting ban enforced instead of hunting prohibited. Like hunting prohibited, the variable hunting ban enforced is significant in a regression with the outcome variable residents hunt.

Multivariate logistic regressions tested the effect of the variable hunting ban enforced on the outcome variable residents hunt. Table 9 shows that significant variables affecting residents hunt include gender and hunting ban enforced. However, when community is controlled for, neither is significant.

Table 9. Logistic regression coefficients for variables' effects on the dependent variable view that community residents hunt

	View that community residents hunt, not controlling for community	Standard Error	View that community residents hunt, controlling for community	Standard Error
hunting ban enforced	-1.686*	0.961	-1.603	1.090
gender	-1.521*	0.821	-1.414	0.897
education	-0.106	0.113	-0.061	0.123
community years	-0.061	0.049	0.007	0.063
age	0.012	0.028	0.015	0.034
Las Flores	-	-	1.233	1.671
El Naranjon	-	-	2.334	1.620
Centro Maya	-	-	2.160	1.200
Monte Los Olivos	-	-	2.714	1.482
Constant	1.167**	0.048	0.996	2.873
Pseudo R^2	0.235		0.339	
Observations	50		50	

* $p < 0.10$
** $p < 0.05$
*** $p < 0.01$

Unlike in the hunting prohibited regression where the variable hunting prohibited was significant when community was controlled for, the variable hunting ban enforced was not significant when community was controlled for. Therefore, there were differences in views on enforcement of a hunting ban among communities. Communities closest to the Belize border, Las Flores and Monte Los Olivos, had the smallest percentage of residents who responded that the hunting ban was enforced. These communities also had the greatest percentage of respondents who stated that residents in the community hunted, and the hunting ban was not enforced.

Because it was found that hunting ban enforced was a significant factor affecting residents hunt, I analyzed factors that could affect whether a respondent thought that hunting was prohibited and that the prohibition was enforced. In a multivariate analysis where the outcome variable was hunting ban enforced and community was controlled for, only education was significant (Table 10). Residents with more years of education were more likely to state that a hunting ban was enforced. Again, this demonstrates the importance of education in these communities.

Table 10. Logistic regression coefficients for variables' effects on the dependent variable residents' knowledge of hunting and view that a hunting ban is enforced

	Knowledgeable that hunting is prohibited and the prohibition is enforced, not controlling for community	Standard Error	Knowledgeable that hunting is prohibited and the prohibition is enforced, controlling for community	Standard Error
gender	0.436	0.748	0.120	0.838
education	0.322***	0.124	0.279**	0.135
community years	0.115**	0.045	0.030	0.057
age	-0.0.15	0.024	-0.009	0.027
Las Flores			-3.505**	1.664
El Naranjon			-2.926*	1.507
Centro Maya			-0.557	1.391
Monte Los Olivos			-2.264*	1.345
Constant	-2.767	1.775	0.919	2.550
Pseudo R^2	0.245		0.370	
Observations	50		50	

* p <0.10
** p < 0.05
*** p < 0.01

Enforcement measures reported by community residents and authority figures

Forest rangers and Guatemalan government officials reported that there was a relationship developing between Guatemalan and Belizean authorities to tackle enforcement of not only hunting laws in CNP but also expansion into the park, xaté extraction, and other resource use. However, this relationship was in its infancy. CNP rangers thought the law was weak in Belize. They reported that it was difficult to enforce and ineffective because the Belizean government often chooses not to prosecute poachers. Therefore, they did not think that enforcement was effective in deterring Guatemalan community residents from entering the park. They stated that they often encountered the same people in CNP repeatedly. Therefore, deterrence was weak in CNP.

Enforcement methods consisted of both formal and informal measures. It is important to keep in mind that because poaching often accompanies other illegal activities, such as xaté extraction, the enforcement measures discussed may not be just for poaching. Formal measures listed by community residents included going to jail and forfeiting your guns and hunted animals. Many residents mentioned that the law was only applied in Belize. When questioned about hunting penalties, four out of five community leaders only mentioned punishment in Belize.

Rangers reported that it was sometimes necessary to enforce deterrence measures that were not in their mandates because poaching cases often were not pursued by the Belize government and because there was a lack of cooperation with Guatemala in enforcing the regulations. Informal measures included beatings; authorities taking possession of xaté, weapons, and dead animals;

and being sent back to Guatemala. During interviews in Guatemalan communities, residents corroborated this information without prompting.

Enforcement of poaching regulations in CNP has increased since ranger patrols began in December 2006, and this may be partly responsible for the decrease in hunting over the years. As the rational choice theory suggests, hunters could be weighing the costs and benefits of poaching, and, if other variables are controlled for, as the risk of being caught increases, their likelihood to engage in poaching decreases.

The informal and formal enforcement measures indicated by both community residents and authority figures demonstrate a lack of consistency in enforcement. The measures do not indicate that there is a strong, fair, and consistent punishment for poaching. CNP rangers thought that regulations were not strong enough to discourage poaching. The lack of strong enforcement and penalties may be affecting residents' decision to poach. Alternatively, subsistence concerns may drive residents' decision to poach despite penalties.

Subsistence

In accordance with CNP rangers' observations, among those who think a hunting ban is enforced, approximately 65% still believe that hunting takes places. Twenty-eight percent of all respondents stated that residents hunt despite the enforcement of a hunting prohibition (Table 11). According to the rational choice theory, the people who continue to poach are weighing the costs

and benefits of poaching, and they must have a strong motivation for poaching that outweighs the risk of punishment. Researchers have identified subsistence as a motivation to poach.

Table 11: Percent of respondents in each community and their views on whether residents hunt and whether a hunting ban is enforced

	Residents do not hunt	Residents hunt
Hunting ban not enforced	4	46
Hunting ban enforced	22	28

Subsistence appeared to affect whether residents stated that people in their communities hunted. All residents but one who reported that people in their communities or in nearby communities hunted said that the purpose was to consume the animals. When the variable subsistence is included in the regulatory uncertainty multivariate regressions run in the previous section, it trumps the role of a hunting prohibition across all of the communities (Table 12). In addition, the regressions now explain a much larger amount of the variation in responses to residents hunt, and even more variation is explained when community is controlled for.

Table 12. Logistic regression coefficients for variables' effects on the dependent variable view that community residents hunt. Values in parentheses indicate the values when the subsistence variable was excluded from the regression.

	View that community residents hunt, not controlling for community	Standard Error	View that community residents hunt, controlling for community	Standard Error
subsistence	5.085***	1.438	5.229***	1.613
gender	-1.621 (-1.521*)	1.464 (0.821)	-1.749 (-1.414)	1.750 (0.897)
education	-0.041 (-0.106)	0.210 (0.113)	-0.007 (-0.061)	0.254 (0.123)
community years	-0.043 (-0.061)	0.082 (0.049)	0.007 (0.007)	0.108 (0.063)
age	0.024 (0.012)	0.054 (0.028)	0.024 (0.015)	0.062 (0.034)
hunting ban enforced^	-1.965 (-1.686*)	1.794 (0.961)	-1.731 (-1.603)	2.465 (1.090)
Las Flores	-	-	2.083 (1.233)	4.035 (1.671)
El Naranjon	-	-	2.262 (2.334)	2.923 (1.620)
Centro Maya	-	-	2.143 (2.160)	1.899 (1.200)
Monte Los Olivos	-	-	2.879 (2.714)	2.589 (1.482)

Constant	0.109 (1.167**)	4.090 (0.048)	-3.034 (0.996)	5.698 (2.873)
Pseudo R^2	0.673 (0.235)		0.712 (0.339)	
Observations	50 (50)		50 (50)	

* p < 0.10
** p < 0.05
*** p < 0.01
^ When hunting ban enforced is replaced with hunting prohibited, results are nearly identical.

According to CLARIFY simulation results, residents were nearly four times more likely to state that people in their communities hunt when they stated that the purpose of hunting was for subsistence reasons (Table 13). I based the simulation results on Table 12's logistic regression. Table 13's results show the magnitude of influence of subsistence on the outcome variable residents hunt. The regression and simulation results suggest that people who hunt for subsistence purposes may be willing to face possible punishment. The results also suggest that when alternative livelihoods are available, community residents may place more importance on the legality of hunting and the enforcement of a hunting ban.

Table 13: Simulation results: magnitude of influence of subsistence on residents hunt

	Mean probability that residents hunt	Standard error
Hunting is for subsistence	0.953	0.060
Hunting is not for subsistence	0.245	0.191

Based on the above information, it is important to explore what those who indicate subsistence as the reason for hunting have in common. The variables education and community years

significantly affected whether community residents thought that hunting was for subsistence purposes (Table 14). Those with a lower level of education were slightly more likely to think that community residents hunted for subsistence purposes. However, neither variable is significant when community is controlled for. The communities El Naranjon and Monte Los Olivos communities, the two communities with a median annual income of $0.00, have significant coefficients. Nine out of 10 respondents in each of these communities stated that hunting was for subsistence purposes. Eight out of 10 residents stated this in Centro Maya and in Las Flores. Only four out of 10 respondents stated this in Sacul Arriba.

Table 14. Logistic regression coefficients for variables' effects on the dependent variable view on hunting for subsistence purposes

	View on hunting for subsistence, not controlling for community	Standard Error	View on hunting for subsistence, controlling for community	Standard Error
gender	-0.714	0.458	-0.653	0.494
education	-0.108*	0.062	-0.088	0.067
community years	-0.048*	0.025	-0.019	0.033
age	0.003	0.016	0.002	0.018
Las Flores	-	-	0.825	0.832
El Naranjon	-	-	1.371*	0.802
Centro Maya	-	-	1.009	0.636
Monte Los Olivos	-	-	1.346*	0.793
Constant	2.309**	1.164	0.784	1.524
Pseudo R^2	0.138		0.228	
Observations	50		50	

* p <0.10
** p < 0.05
*** p < 0.01

Lack of alternatives

The amount of interest in an economic alternative to replace hunting also suggests that poaching is for subsistence purposes. More residents were interested in alternative economic activities than those who were not. Ten residents stated that they do not think that an alternative economic activity would eliminate hunting. One person in Las Flores, one in Sacul Arriba, three in Monte Los Olivos, two in Centro Maya, and three in Naranjon said that people enjoy hunting or hunting was customary, and, therefore, their communities would not accept alternatives. Some respondents also mentioned that hunting was only secondary to xaté collection, and, therefore, the alternative activity would need to replace xaté collection.

Muultivariate logistic regressions to determine what would affect residents' acceptance of an alternative did not result in any significant variables (Table 15). In addition, both regressions explain very little of the variation in alternatives. Therefore, it is difficult to say what would affect community residents' level of acceptance. However, simulation results suggest a potential connection with hunting prohibition (but do not show significance).

According to simulation results, the variable hunting prohibited increases the likelihood that a community resident would want an alternative to poaching (Table 16). The results show the magnitude of influence of the variable hunting prohibition on the outcome variable acceptance of an economic alternative. Controlling for other variables, residents who stated that hunting was prohibited were nearly 40 percent more likely to say that community residents would accept an alternative than residents who stated that hunting was not prohibited. I based the simulation

results on Table 15's logistic regression. The results suggest that residents might prefer to have other opportunities that do not conflict with the law. As discussed above, poachers may think that they do not have another choice than breaking the law due to the need to provide for themselves and their families.

Table 15. Logistic regression coefficients for the effect of explanatory variables on the dependent variable acceptance of an economic alternative to hunting

	Accepting of an alternative, not controlling for community	Standard Error	Accepting of an alternative, controlling for community	Standard Error
gender	-0.580	0.954	-0.069	1.163
education	0.000	0.138	-0.018	0.188
community years	-0.046	0.058	-0.038	0.077
age	-0.004	0.034	0.022	0.043
hunting prohibited	0.839	1.185	1.709	1.477
Las Flores	-	-	1.514	2.468
El Naranjon	-	-	0.445	2.245
Centro Maya	-	-	-1.272	2.321
Monte Los Olivos	-	-	0.550	1.921
Constant	1.141	2.328	-1.075	3.992
Pseudo R^2	0.051		0.103	
Observations	23^		23^	

* p <0.10
** p < 0.05
*** p < 0.01
^ Only 23 community residents responded to this question because other respondents did not know if other residents would accept an alternative, responded that residents did not hunt (and therefore there would be no need for an alternative) or did not understand the question. It is possible that respondents who did not understand the question would have stated that community residents would accept an alternative economic activity to poaching.

Table 16: Simulation results: magnitude of influence of the variable hunting prohibition on the outcome variable acceptance of an economic alternative

	Mean probability of acceptance of an alternative	Standard error
Hunting is prohibited	0.655	0.158
Hunting is not prohibited	0.474	0.161

DISCUSSION

This research is considered a baseline study because it provides a first step to understanding the poaching situation in CNP and Guatemalan border community perspectives. In in-depth interviews, a small sample size may be sufficient for a baseline research when the same topics and responses emerge from the interviews (Boyce and Neale 2006). As demonstrated, the same topics and responses to questions arose in Guatemalan border community interviews.

Consistent responses suggest that community residents answered questions honestly. When interview questions discuss sensitive matters or illegal activities, researchers may assume that they have elicited honest responses when respondents are willing to share information and expand on answers beyond what was required by the questions or when responses are largely consistent among residents and between communities (Liu et al. 2011). In this research, responses to interview questions were largely consistent and many respondents gave more information than the question required, suggesting that respondents answered the interview questions honestly.

This research overwhelmingly indicates that the forest is important to people in Guatemalan border communities, but hunting appears to be less important. Because some consider hunting a byproduct of xaté collection, it may be perceived as a less important forest activity. While rangers agreed with Guatemalan community residents that poaching has decreased in recent years, they thought that poaching frequency was still high. It is possible that CNP rangers are more aware of the activities in the park as a whole, and this is why they report poaching frequency as higher than community residents do. While community residents are aware of their communities' and possibly neighboring communities' activities, rangers see the impact of communities along the entire border. Therefore, they may report a higher frequency of poaching than community residents.

However, both community residents and authority figures agreed that hunting decreased in recent years. While the decrease in hunting could be for a variety of reasons, it could be due to the start of ranger patrols in 2007. Other studies demonstrate the importance of enforcement by showing that decreasing enforcement leads to an increase in poaching incidents (Keane et al. 2008). However, the lack of cooperation of Belize and Guatemalan officials may affect their ability to consistently enforce hunting regulations. To effectively deter poaching, conservation officers must "cooperate and form a strong and consistent security presence (Grey-Ross et al. 2010)." Authorities comments on enforcement highlight the need for both sides to work together to develop and enforce consistent hunting regulations.

The perception of a decrease in hunting in recent years also could be due to the belief that animal populations have decreased. Therefore, the benefits of poaching had declined. The view held by

both community residents and authority figures that poaching had decreased in recent years due to declining animal populations is a large conservation concern. Often the effects of over-hunting on livelihoods are noticed secondarily to the ecological impact of poaching (Bowen-Jones et al. 2003). Therefore, wildlife populations may have significantly declined before there is a noticeable effect on overall poaching success. A study in Central and West Africa showed that "individual species most vulnerable to hunting can become locally and regionally extinct even though the impact on the livelihoods of those people involved in the bushmeat trade may be small (Bowen-Jones et al. 2003).

The awareness of hunted wildlife species as opposed to non-hunted species may hint at the prevalence of hunting or the hunting culture in the communities. It also suggests a need for wildlife education in the area. In addition, the lack of awareness of rare non-hunted species in Guatemalan border communities highlights the need for wildlife education in the area. Because there are a variety of rare species of international concern in CNP, it should be a priority to disseminate knowledge about these species in local communities as well as to gather information about these species from local people. Some researchers consider education a worthwhile conservation strategy, more so than restricting human access to nature (Bonita and McFarlane 2005). This research suggests a need for wildlife education in CNP, especially because ranger patrols and regulations have demonstrated that restricting Guatemalan access is difficult.

This study supported the hypotheses that regulatory uncertainty surrounding hunting in CNP and subsistence needs affect whether Guatemalan community residents choose to poach in CNP. Community residents who either were knowledgeable about the prohibition of hunting or were

knowledgeable and thought the prohibition was enforced were less likely to respond that community residents hunted. Because the group of respondents who thought hunting was prohibited and the group who thought a hunting ban was enforced were nearly identical, it is not possible to differentiate whether it is the presence of the hunting ban or its enforcement which is affecting how residents responded to whether community residents hunted. However, the results still show that regulatory uncertainty, either being that residents are not aware of the law or that it is not enforced, is a factor affecting whether respondents stated that people in their communities hunted.

However, there is limited support for the regulatory uncertainty hypothesis. Regulatory uncertainty is a complicated variable because it was indirectly analyzed (residents were not asked about their own activities, but activities of the community), and regulatory uncertainty directly addressed an illegal activity. In the same series of questions, residents were asked if hunting was prohibited and if people in their communities hunt. It is possible that people who said that hunting was prohibited were more likely to respond that community residents did not hunt, even if they knew that they did. Therefore, the regulatory uncertainty variable needs further study.

Subsistence was a more significant factor affecting poaching than regulatory uncertainty. When subsistence was included in the regression with regulatory uncertainty, regulatory uncertainty lost significance and subsistence was highly significant. The logistic regression including the subsistence variable explains a large amount of the variation in how residents responded to whether community residents hunt. Subsistence is one of the common reasons that researchers

have found that people poach, and one of the ten categories of motives for poaching identified by Muth and Bowe (Muth and Bowe 1998).

Subsistence needs appear to be worth the risk of being caught. However, community residents stated that poaching rates had declined recently in part because benefits had decreased due to decreasing wildlife populations and risks had increased due to increased enforcement. Guatemalan hunters appear to be weighing the benefits of entering Belize against the risk of being caught. This cost-benefit analysis and the change in poaching rates alongside the change in situational factors support the rational choice theory of crime. Because the risk of being caught in CNP has increased with increasing enforcement, the situational factors have changed, and Guatemalan community residents stated that poaching behaviors changed. This situational analysis is in accordance with one of the rational choice theory's highlights: that crime is not random, but it serves a specific purpose. In the Guatemalan border communities, as in other locations nationwide, reducing poverty and providing alternative incomes may change the personal situation of those engaged in the activity and reduce the motivation to poach (Bassett 2005).

This research suggested that many Guatemalan community residents may be willing to refrain from entering CNP and poaching if there are economic alternatives. In the communities, alternative economic activities would help people provide for themselves and their families, alleviating the need to illegally enter CNP, cut xaté, and poach. This research also suggested that the existence and enforcement of hunting laws may have a greater effect after alternative economic activities are available. Therefore, authorities and community residents have the

important, yet challenging task of determining what types of activities would be sustainable, economical, and profitable.

The ten residents who did not think that an alternative economic activity would eliminate hunting demonstrated reasons other than subsistence that people may poach in CNP. Recreation and tradition are other oft cited reasons for poaching, and the statements of these ten individuals support these reasons for poaching. Their reasons for poaching, tradition and recreation, are supported by similar studies in the literature (Grey-Ross et al. 2010, Muth and Bowe 1998).

The purpose of a baseline study is to provide new data on a specific problem or a specific location that has not been studied before. This research suggests that hunting is well-known in the CNP area but declining; that subsistence needs, and possibly secondarily, the prohibition and enforcement of hunting, affect poaching in CNP; and finally, that there is room for raising awareness about wildlife and hunting regulations in CNP. This research also noted reasons other than subsistence that Guatemalan community residents hunt. Finally, the research showed topical areas in which community residents and officials agreed, such as the decline of hunting in CNP in recent years, as well as areas in which they disagreed, such as the degree of hunting and the wildlife species located in CNP.

CONCLUSION AND FUTURE RESEARCH

This research provides multiple perspectives on the poaching situation in CNP and valuable input on where to begin to address the problem. Importantly, it can help park managers to better understand the perspectives and motivations of poachers. It highlighted the urgency for a comprehensive bi-national initiative to protect biodiversity in CNP, the need for economic alternatives to poaching, and room for conservation education in the Guatemalan border communities.

Due to the significance of subsistence as a factor affecting poaching and the lack of current alternatives, suggesting policies that decrease hunting without affecting livelihoods is difficult. Many often mentioned methods to increase compliance with hunting regulations or to decrease poaching are more complicated in the case of CNP management due to the illegal activity taking place in Belize by Guatemalans and the precarious border history. One method is to enforce regulations regarding specific vulnerable species, but allow hunting of other species (Bowen-Jones et al. 2003). Other methods include involving local communities in regulating hunting. This method would curtail blanket regulations against hunting in favor of working with local people to protect wildlife and conserve livelihoods (Hampshire et al. 2004). Both of these routes would be complicated without increased cooperation between Guatemalan and Belizean authorities.

Therefore, it is imperative for the successful and efficient management of CNP for authorities on both sides of the border to work together. While the feasibility of developing alternative

livelihoods to xaté collection and poaching is complicated and is not currently being researched in the communities that participated in this study, one method that could decrease poaching in the near term is conservation education. Even when researchers recognize poverty as the overwhelming reason for poaching, they still recognize the necessity for educating community residents on why wildlife needs to be protected (Grey-Ross et al. 2010). Researchers think that education programs help to persuade people that wildlife is valuable and should be protected (Liu et al. 2011). Authorities believe that poaching is threatening wildlife in CNP, but educational programs have not yet been employed to help reduce the threat. This research can help inform conservation education programs in the area and inform further research into such programs.

Further research is necessary to determine whether it was the presence of the law or the view on enforcement that would have a larger effect on respondents' view on whether others in the community hunted. Both reasons have been analyzed and found to be important in the literature. Normally, enforcement is thought to have a larger effect (Rowcliffe et al. 2004, Grey-Ross et al. 2010). However, one study showed that normative factors such a moral obligation to a law, legal legitimacy, and social acceptance, affects compliance with a law. The study highlighted the low levels of enforcement, yet high compliance, with some small fisheries regulations in Norway and Newfoundland. Because collectively the group agreed with the regulations, there was a moral decision to comply with them on behalf of the group (Keane et al. 2008). While a group mentality disagreeing with poaching was not observed in the Guatemalan communities, it is worth further exploration particularly in light of residents' claimed concern about the health of the forest.

Further research also could explore the link between hunting and xaté extraction. According to FCD and some interview respondents, hunting is thought to be a byproduct of xaté extraction. In addition, one CNP study reported anecdotal notes of increased incidence of hunting within Chiquibul associated with xatero activity and observations of carcasses of protected animals in xatero camps (Bridgewater et al. 2006). The connection between poaching and xaté extraction suggests that in order to address poaching, the significant issue of xaté extraction also would need to be addressed. Further research may make a stronger case for making xaté illegal in the market, requiring xaté suppliers to provide product information, or the need for an educational program throughout the xaté commercial chain.

Finally, further research could analyze one or more of the many other reasons for poaching, such as stress and boredom caused by unemployment, recreation, cultural significance, commercial gain, trophy poaching, and disagreement with regulations or rebellion against authorities. In addition, because the reasons for poaching are not mutually exclusive, further research must explore the relationships between different reasons (Hampshire et al. 2004).

APPENDICES

APPENDIX A: GUATEMALAN COMMUNITY RESIDENT INTERVIEW QUESTIONS

1.What community do you live in?
2.Have you lived in the community your whole life?
3. What do you do for a living?
4.How important is the forest to you, not important, important, very important, never thought about it?
5.Why is the woods important to you?
6.Who enters the woods?
7.Why would they enter the woods?
8.Does anyone in the community enter the woods?
9.How often do people in your community enter the woods?
10.Approximately how long do people who enter the woods stay each visit?
11.Why do people enter the woods?
12.What wild animals live in the woods?
13.Do any of the animals you mentioned have a small population or are disappearing from the woods?
14.Do people from your community hunt in the woods?
15.If so, is it a small number (less than 20) or large number of people (more than 20)?
16.Why do people hunt in the woods?
17.What wild animals do they hunt and why?
18.What do you think is the frequency of hunting in the woods {low, high, very high – and what do these words mean]? (by your community and in general)
19.Has the level of hunting increased or decreased Over the past five years? Ten years? (by those in this community and in general)
20. What could people in your town that hunt be offered that would make them stop hunting in Chiquibul?
21.What are the regulations surrounding hunting?
22.Who enforces the regulations?
23.What are the penalties associated with hunting in Chiquibul?
24.How much money do you earn per month?
25.How many years of school have you completed?
26.Are you married?
27.How old are you?
28.How many children do you have?
29. What is your relationship with Belize in relation to the woods?
30.Is there anything you would like to add?

APPENDIX B: AUTHORITY INTERVIEW QUESTIONS

1.What are your responsibilities as an employee of CONAP/FCD? How long have you held this position?
2.What is Chiquibul National Park?
3.How is your agency involved in Chiquibul National Park management?
4.In what ways is the park protected? What activities are not permitted?
5.Why is Chiquibul National Park a protected area?
6.How does your agency work with CONAP/FCD?
7.What wild animals live in Chiquibul National Park? Which of those have you personally seen within the past five years?
8.Of the animals that you mentioned, which ones are threatened by human activity such as hunting or habitat encroachment and why?
How do you know they are threatened? (or based on what data or whose assessment?)
9.Are there other animals that you have not mentioned that are hunted in Chiquibul National Park?
10.What do you think is the frequency of illegal hunting in Chiquibul National Park {low, high, very high – and what do these words mean]?
11.Has the level of hunting increased or decreased since you've held this position? Over the past five years? Ten years?
12.Who hunts wild animals in Chiquibul National Park
13.Why are the animals hunted?
14.What are the regulations surrounding hunting in Chiquibul National Park and who created them and enforces them?
15.What are the challenges you face in enforcing hunting regulations?
16.What are the penalties associated with illegal hunting in Chiquibul National Park?
17.Would the situation change if Chiquibul National Park was located within Guatemala? How and why?
18.Would the situation change if it was Belizeans hunting instead of Guatemalans? How and why?
19.Has your agency considered offering anything, such as money or food, to stop hunting in Chiquibul National Park? If so, what?
20.Is there anything you would like to add?
21.Is there anybody else I should talk to while I am here?

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