The Effects of Hunting on the Jaguar Prey Populations in *Parque Nacional Alto Chagres*

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1. Introduction

1.1 Background Information

1.1.1 Concerning jaguars

The jaguar (*Panthera onca*) is part of the carnivorous feline family. It is the largest cat in the Americas and its distribution extends from the south of the United States to the north of Argentina (Guggisberg 1975, as Cited in Quigly 1992). In Panama, the jaguar is present throughout the Atlantic slope from Bocas del Toro to Darien. Recently, there has been a large increase in fragmentation of forest and expansion of human activities into the undisturbed forest occupied by the jaguar (Azevedo 2008). This poses a serious threat to the viability of jaguars and the existence of the jaguar corridor through Panama.

In Central America the jaguar population was found to exist in 33% of its former range and 75% of the populations were found in reduced numbers (Swank and Teer 1989). The risk of losing corridors between refuges and habitats means the risk of losing genetic diversity and safe migration paths (Quigly 1992). According to the Caso et al (2011) the jaguar has gone from a status of vulnerable to one of near-threatened in the last 30 years, meaning that it is less endangered. However, this does not imply that the jaguar is out of harm's way, its existence and that of its ecosystem is still in great threat and of concern.

1.1.2 Host Organization: SOMASPA

La Sociedad Mastozoologica de Panama is a non-profit organization dedicated to the study of and education regarding biodiversity, specifically the ecology and conservation of mammals. It was founded in 2000 when a group of scientists and researchers was formed to deal with the large number of endangered mammal species and the lack of action to mitigate this. SOMASPA, works toward developing projects that contribute to education as well as the expansion of conservation efforts of jaguars and the habitats of numerous mammals including the jaguar.

Specifically regarding jaguars, SOMASPA contributes to the monitoring of both its ecology and conservation status. Its jaguar project objectives are to:

1. Determine the distribution and abundance of feline species in protected areas of Panama
2. Determine their diet, periodic behavioral activity, and the use of their habitat
3. Identify the main dangers for the jaguar and other felines

These objectives are met through locating tracks, fecal matter and remains of prey, installing trap cameras, and conducting interviews in communities adjacent to jaguar habitats. Since the year 2005, SOMASPA has been dedicated to researching the distribution of the jaguar and tapir in Panama. This study is taking place mainly in the Area de Conservacion *Alto Chagres* and Parque Nacional Darien. The study involves gathering data on the distribution, behaviour, and conservation of the jaguar and tapir in the areas of study. SOMASPA is currently investigating the availability of the jaguar's

natural prey, their change in density over time, and the interaction with hunters and ranchers.

In addition, SOMASPA collaborates with PANTHERA, the organization that introduced the idea of creating a jaguar corridor throughout the Greater American continent. The corridor attempts to address the problem of jaguar decline. As noted by Simberloff and Cox (1992), corridors between refuges provide a means of alleviating pressures of genetic loss and demographic uncertainty. SOMASPA plays a critical role in promoting and maintaining the jaguar corridor and habitats in Panama.

1.1.3 Jaguar prey and hunting

Jaguars are currently threatened due to three main reasons: habitat loss and fragmentation, direct hunting and the lack of natural prey (Caso et al. 2011). The abundance of the jaguar's natural prey including the armadillo, deer, wild boar, peccaries, paca, tapir and agouti, has declined and this decline affects jaguars throughout their range (SOMASPA 2012).

Much of this decline is attributed to the hunting by communities adjacent to the jaguar's habitat and the conversion of habitat to pastures. In Panama, similar to much of Latin America, wild game populations are reduced to meet the subsistence needs of campesinos (Samudio 2009). Although much of the hunting in these areas is only for subsistence, there is also a vast amount of hunting for profit via trophy animals, as well as for ornamental, medicinal, and commercial uses (Schwartzman 2000). In poor rural communities, hunting is an activity that is used to meet food requirements not met through agriculture. As rural areas increase in population and become increasingly

modernized, the efficiency of hunting increases and therefore so does the pressure on wild game and protected areas (Schwartzman 2000). This increased hunting pressure affects the jaguar's main prey and therefore the health and stability of the jaguar population.

1.1.4 The Tapir – Prey of the Jaguar

The tapir, *Tapirus bairdii*, is found throughout the south of Mexico, Central America and reaches all the way to Ecuador. The tapir's habitat includes rainforests, low mountane forest, deciduous forests and grasslands or marsh areas (Castellanos et al. 2011). The tapir is an important large animal of prey for the jaguar but whose population is at risk (Polisar et al. 2003). The population of tapirs in Panama is continually declining according to IUCN with less than an estimated 1000 individuals existing today. This decline, over 50% of the population in the last 33 years, is due to habitat fragmentation, habitat destruction and high hunting pressure (Castellanos et al. 2011). This has led to the current endangered status of the tapir (Castellanos et al. 2011). The low reproductive rate of the Tapir, a 13-month gestation and a two-year rearing of a single offspring, is a factor that contributes to its population decline (Castellanos et al. 2011). The decline of the tapir is a reflection of the situation faced by many of the jaguar's prey today.

1.1.5 Jaguar-human conflict

It is possible that the decline in the jaguar's natural prey has led to the depredation of alternative prey such as livestock. Cattle and other livestock are now a more readily available prey for the jaguar (Quigly 1992). Poor animal husbandry leaves livestock

vulnerable to jaguar attacks, particularly among calves and cattle that are left to graze by bordering forests (Azevedo 2008). The depredation of livestock has led to a conflict between humans and jaguars leading to actions such as the hunting of jaguars to protect farms. Jaguars are frequently shot on-sight, despite laws against this (Nowell and Jackson 1996). People view the jaguar as a pest species that, in order to secure economic stability, needs to be removed.

1.1.6 Importance of Conserving the Jaguar

Top predators, such as the jaguar, are useful indicators of biodiversity and ecosystem health. In addition, they strongly influence different trophic levels and may also directly cause a high level of biodiversity by making resources more readily available to other species (Sergio 2008). Top predators are used in conservation as umbrella species meaning their protection results in the protection of many other animal and non-animal species within their range (Sergio 2008).

1.2 Specific Focus

1.2.1 Goals and Objectives

The overarching goal of our project is to facilitate conservation of the jaguar and to better understand the human-animal interactions in order for both humans and jaguars to live together in harmony. Specifically, our project aims to understand the role of hunting of the jaguar's prey and how it may impact the number of jaguar attacks on farms and hence the killing of those jaguars in order to defend the farm. The goal is to identify

areas of hunting, the extent of hunting in each area and which animals are hunted. This data could then be compared to previous research in the area that identified locations where jaguar attacks were occurring. Furthermore, this project seeks to provide possible solutions to help mitigate this problem.

The product of this project will comprise of a report for our host organization, SOMASPA, which outlines and summarizes all of our interactions and interviews in *Alto Chagres*. The report will include graphs, maps, photos, and charts as well as an analysis of our results to summarize the information gained from the interviews. In addition, a pamphlet draft will be made that can be distributed to the community of study that explains the issue, important findings of our project and recommendations.

1.2.2 Questions

1. Is there pressure on the jaguar's prey in the study area?
    a. In what areas does hunting occur? To what extent?
    b. Which animals are being hunted?
2. Does pressure on the jaguar's prey affect the number of jaguar attacks on farms near areas of high hunting pressure?

1.2.3 Hypotheses:

We predict that there will be areas where hunting puts pressure on the prey of the jaguar. We then hypothesize that the farms closest to these areas of pressure will be more likely to suffer jaguar attacks.

2. Methodology

2.1 Study site

This project is based out of the village of *Nuevo Tonosi* which is located on the Caribbean side of Panama between two national parks: *Parque Nacional Portobello* and *Parque Nacional Alto Chagres*. East of the historic coastal town of *Portobello*, *Nuevo Tonosi* is home to many farmers and cattle ranchers generally known as campesinos or *ganaderos*.

Parque Nacional Alto Chagres is a critical region for Panama's jaguar conservation program. It is located just to the East of the Panama Canal, which serves as a major hindrance to the jaguar corridor (Leigh 1999). As such, the jaguar habitat is fragmented and the integrity of the corridor is impeded.

In 2007, it was estimated that the area had a density of 3 jaguars/100km^2 (SOMASPA 2012). This density however has been characterized by PANTHERA and ANAM as lower than necessary for the conservation of the jaguar and the maintenance of strong ecosystem interactions (SOMASPA 2012). The presence of the many farms in close proximity to the jaguar has perhaps perpetuated the scarcity of the jaguar. The juxtaposition and at times the superposition of the habitats of human and jaguar populations also result in economic problems for the campesinos. In the communities located in *Parque Nacional Portobello* there have been 166 reported deaths of domestic animals due to pumas and jaguars between 1985 and 2009 (SOMASPA 2012). The study site is implicated in the human-jaguar conflict and can benefit from the new knowledge this study can bring to this issue.

2.2 Interviews

2.2.1 Study Population

The study population comprised 34 interviewees who live in or near four main villages: *Nuevo Tonosi*, *San Antonio*, *La Linea* and *Nombre de Dios*. Interviews were either conducted at the interviewee's house in one of these villages or they were conducted at their *finca* (farm or ranch), many of which are located in the *Parque Nacional Alto Chagres* (Appendix IV). For a full description of the study population see table 1 below.

Table 1. Characteristics of Study Population

Age (average)	51 years old
Sex	97% Male 3% Female
Household size	4 people on average
Occupation	66% Agriculture/Ranching 6% Retired 6% Government workers 6% Manual Labour 16% Other (carpenter, homemaker, storeowner)
Ethnicity	91% Panamanian 6% Indigenous (Bugle) 3% Columbian 3% Congolese
Religion	80% Catholic 9% Baptist Witness 6% Evangelical 6% Indigenous belief system

2.2.2 Use of Local Knowledge

The first half of the interviews was carried out with the assistance of a local guide. In this way, we were able to create a "strategic alliance" that is said to be beneficial when there are "geographical and technological constraints" in a project (Rosenkopf and Almeida 2003). A partnership with local members is also described as a "useful mechanism for knowledge acquisition and learning," which was the fundamental reason for partnering with a local guide (Rosenkopf and Almeida 2003). Working with a guide served as useful means to integrate into the community. This method was used to help avoid possible reluctance and skepticism as issues of regulation surround hunting in this area of Panama. The guide's presence and her confidence in the study cultivated a sense of security among participants in light of this sensitive topic. Her role provided insight to cultural norms and direction to those contacts having specific knowledge of hunting and animal abundances in the forest. Furthermore, she was able to help organize interviews, which is difficult in these communities because the men are frequently unavailable as they work out of town or in the forest.

2.2.3 Snowball Sampling

For the second half of the interviews, participants were identified through snowball or chain referral sampling techniques. These techniques involve a subject providing the contact information of the next subject who then provides the contact information of another subject and so on (Atkinson and Flint, 2001). This sampling method is particularly useful when the "focus of study is on a sensitive issue" or when the target population is difficult to reach or "hidden" (Biernacki and Waldorf 1981, Atkinson

and Flint 2001). Atkinson and Flint (2001) describe the main value of this form of sampling as "a method for obtaining respondents where they are few in number or where some degree of trust is required to initiate contact." The hunters in the study population are relatively few and wish to remain anonymous because they could be reprimanded for their actions.

The validity of results from snowball sampling has been assessed and it has been concluded that it is an effective way to conduct studies and can produce in-depth results (Atkins and Flint 2001). One of the main challenges of chain-referral sampling is that prior knowledge of the target group is needed to initiate the sampling process (Atkins and Flint, 2001). This study was able to effectively initiate the chain-referral sampling through the guide who facilitated this process by providing the researchers with a list of personal contacts who were hunters and could be of assistance in each community. Upon entrance into each community, the researchers were able to locate these contacts who, not only were able to provide valuable information in the form of a personal interview but were also able to refer them to friends or community members who similarly had "in-depth knowledge of the forest."

2.2.4 Ethical Considerations

In following the McGill University Code of Ethics, all participation in this study was voluntary and informed consent was obtained from all participants. Before beginning any interview the participants were fully explained the purpose of the study, what would be required of them and their rights to stop the interview at any time or to skip any question. Voluntary oral consent was gained and a written copy of the oral consent form

can be found in (Appendix X). Furthermore, all participants remain anonymous, identified only by an interview number. Participants were also asked for their consent to have a GPS point taken at the site of the interview and were informed of how the GPS point would be used. Again it was made clear that this was voluntary and the point would remain anonymous.

2.2.5 Interviews

Each interview lasted about 15 to 45 minutes and was composed of three parts. The first part gained general information on the participant and the community in which they lived. The second part sought to understand the food sources of each participant including their hunting practices. Finally, the last part inquired about animal sightings, indicators and attacks. A full version of the questionnaire can be found in Appendix I-III.

In order to carry out these interviews effectively, a number of steps had to be taken. Firstly, the behaviour of the researchers was critical in developing a sense of comfort among the participants. The researchers were honest, friendly and professional in order to cultivate trust and indicate respect. The researchers had to also follow cultural norms that contributed to this sense of trust including accepting food or drink as well as saying buenas and asking permission before walking onto private property. Of course all the interviews were carried out at the convenience of the participant whether it was at their house, workplace or the local cantina or *fonda*.

Secondly, particular attention was paid to the speech used in interviews. To gain a particular piece of information, specific phrasing of the question was used so that it reflected the way in which rural Panamanians describe situations. For example, rather

than only asking how far away the best hunting area was located, participants were also asked how long does it take to get there by foot. By choosing the appropriate phrasing of the question the subjects were able to understand the questions and provide the most accurate information possible. Another way in which special attention was given to the speech used in interviews is in the terminology chosen. Certain words such as *carne* have a specific meaning in Panama. These words had to be clarified for the context of the interview questions or substituted with other words so that accurate results could be achieved. For example, *carne* generally means meat in Spanish however it also specifically means beef. When asking how much meat was consumed in the household each week it was important to indicate that the question referred to all types of meat from different animals.

Terminology was also of utmost importance in discussing the animals of the jungle. In addition to knowing the Spanish name of each animal it was essential to know the colloquial name for them where, for example, the jaguar is more commonly known as *tigre* and the tapir is more commonly known as *macho de monte*. To further improve understanding between the researchers and participants, a sheet with the photos of a variety of animals present in the jungle was shown to participants so they could visually identify the animals they wished to describe.

2.2.6 GPS

A Garmin eTrex Legend HCx, was used to obtain GPS points for interviews, sightings, attacks, tracks, and hunting observations. Consent was always taken before obtaining any points. The points were taken by taking the waypoint average for 30

seconds. Software ArcGIS (ESRI 2011) was used to demonstrate the information spatially in the form of maps (appendices IV-VII).

2.3 Mammal Census

To supplement the information gained through interviews regarding mammal abundance and hunting pressure, a line-transect mammal census was also conducted. The mammal census was intended to further assess the ecosystem status of the jaguar and its prey, identifying its presence and if so, its relative abundance. The line-mammal transect was carried out as a pilot study for SOMASPA to provide an indication as to whether the area is a good monitoring site so they can possibly expand the current area of jaguar monitoring in *Alto Chagres*. In addition, by establishing transects, it is possible that future researchers will be able to carry out more studies in this area allowing results to be carried out on a multi-temporal scale. Line-transect mammal censes are a well-recognized method to survey large mammals in the tropical rainforest (Thoisy et al. 2008). Furthermore, large mammals are commonly used as indicators of ecosystem disturbances including hunting (Thoisy et al. 2008).

Two line-transects were established in the area around the *Rio Pavos* where both a diurnal and nocturnal census was conducted along each one. This area was chosen as the study site because it is an area known to be important for jaguar crossing (Samudio. R , personal communication). Further characteristics of the two transects can be found in Table 2 below and the locations of the study sites in the map in Appendix IV. Due to the feasibility and logistical constraints, the lengths of the two transects were quite short. To provide accurate estimates of species richness and species abundance approximately 85

kilometers are needed in tropical forests (Thoisy et al. 2008). As this was only a pilot study, the goal was to just provide presence/absence data as well as simple indices of relative abundance.

Table 2. Description of Transects

	Area	**Length**	**Soil Type**	**Forest Type**
Transect 1	In the forest	750m	Clay-like	Tropical Moist Forest
Transect 2	Along *Quebrada Pavos*	1000m	Sandy	Tropical Moist Forest

For each transect, a GPS location was recorded at both its beginning and its end. The first transect followed an old hunting path that is still used occasionally by people crossing from villages on the other side of the park to the coast. Each 25m were flagged in this area. The second transect followed the stream and every 50m were flagged because the path was more obvious and there was less fear of getting lost. The two transects were walked at a slow pace (about 0.5km/hr). The diurnal surveys began around 7 a.m. and the nocturnal surveys began around 8 p.m. The same people performed all the survey in order to avoid potential bias in the ability to detect and identify individuals, their tracks and markings. Track-counts, visual sightings and animal call recognition were all included as indicators of animal presence. As such, these indicators were recorded along with their GPS location, the animal to which they belonged and other useful information (for an example of the mammal census record sheet see Appendix XI). When many tracks of the same individual were seen, this was counted as one observation. In addition, any indicators of gregarious animals were counted as one observation.

2.4 Camera Trapping

As a further method to understand the ecosystem conditions and possible threat of hunting in the *Parque Nacional Alto Chagres*, camera trapping was used. This widely accepted approach monitors the movement of all animals in a specific area through the use of motion-sensing cameras (Kays et al. 2010, Rowcliffe et al. 2008). The camera traps are non-invasive and take photos both day and night (Kays et al. 2010, Rowcliffe et al. 2008). This is an ideal method to study animals that are hard to monitor including many large felids such as the jaguar (Kays et al. 2010, Rowcliffe et al. 2008, Silver et al. 2003). The jaguar has typically been difficult to monitor due to its "cryptic nature, large home range sizes, and low population densities" (Silver et al. 2003).

This pilot study was established to complement the line-transect and to provide SOMASPA with a preliminary idea of the animals present in this area and their possible abundance. The study comprised of six cameras located along the two line-transects used in the mammal survey. Two were placed along the first transect and four along the second in areas where animal crossing seemed likely (Appendix IV) for locations of the cameras). The cameras were left in place for a total of 21 days.

3. Results

3.1 Prey Abundance

The main species of prey of the jaguar were all observed in the park (Fig. 1). The animal that was observed least was the *puerco de monte*. Interviewees stated that they have not seen them recently because the animal has gone further into the mountains and therefore is less likely to cross their path. The most observed prey was the *conejo*

pintado, having 30 out of 34 observations, with many sightings in and around villages as well. The *armadillo* and *ñeque* were the next most observed animals. In general it is possible to say that there is a presence of the jaguar's main prey yet its abundance is less clear.

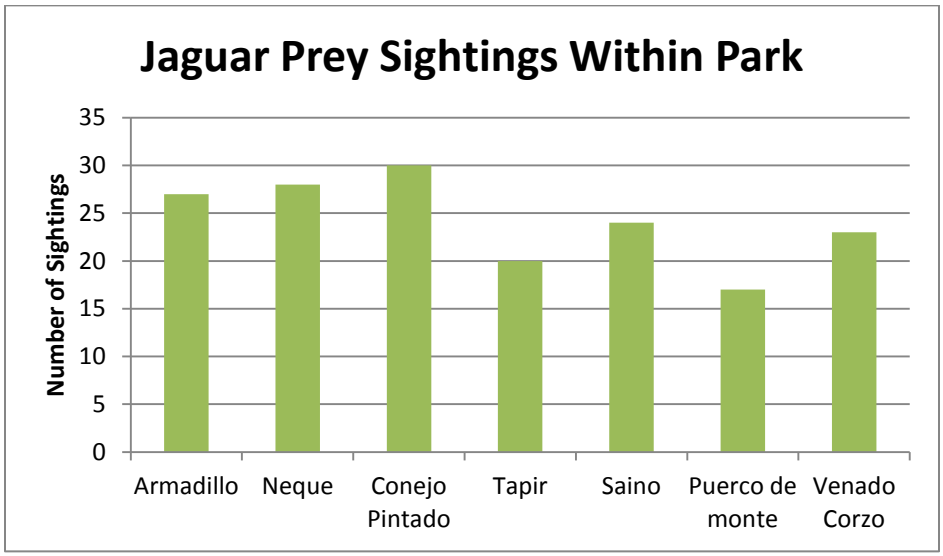


Fig. 1 The number of observations for each of the jaguar's main prey in and around the house, around the village or town center, and within the forest/park area.

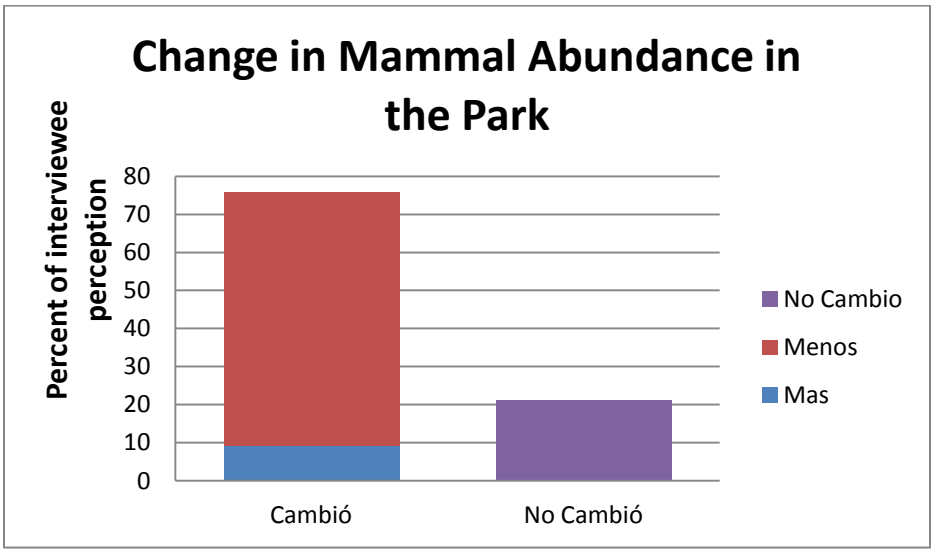


Fig. 2 Interviewees' perception on the change of mammal abundance in the park over recent years, those who thought there was change (more or less) or those who thought there to be no change.

Out of the 33 interviews, 25 thought that there was a change in the abundance of animals in the area of *Alto Chagres* while only 8 thought there to be no change in abundance (Fig. 2). Of those that said there was a change, 3 thought there were more animals while 22 thought there were less animals. The majority believed there to be less animals than in the past for various reasons such as human encroachment into forest, hunting pressure, jaguar population increase, and that they have either retreated or died from habitat loss. Those that believed the abundance to increase based it on the explanations that hunting has decreased and people have stopped entering the mountains as much as in the past therefore the mammals have been allowed to increase in population. The explanations for those that believed that there was no change was that the animals remained in the same numbers but have retreated from human presence further into the park. The main finding regarding the jaguar's main prey is that indeed there has been a change in animal abundance and that the animals are less abundant than in the recent past.

3.2 Jaguar and tapir presence

It is possible to see that the direct sightings of jaguars and jaguar tracks are spread mainly around the parks boundaries (Appendix VII). Also areas that had many jaguar sightings were *Cerro Bruja*, *Rio Indio/San Antonio*, *Rio Cascajal* and *La Linea*. All of these areas, except *Cerro Bruja*, are areas of different land use types (Appendix VII). These areas are a mix of ranches, bush and forested areas. The jaguar sightings tend to follow the corridors of forested areas toward human populations and larger areas of ranches. It is evident that the jaguars are present near human communities and that

human communities are close to the jaguar's habitat outlining the conflict. Furthermore, the presence of two jaguars was confirmed by using camera traps near *Rio Pavos* (see Appendix XII for photos). The cameras captured an adult jaguar with its young.

The majority of direct tapir sightings as well as the sightings of its tracks were found within the park with one direct sighting and 2 tracks found close to the river *Nombre de Dios* (Appendix VII). The presence of the Tapir is found deeper in the park than that of the jaguar. Furthermore the tapir's presence does not overlap particularly with jaguar sightings or with areas of human population.

3.3 Human Pressure

3.3.1 Number of Hunters

To assess the level of hunting pressure, a number of questions were asked in the questionnaire regarding hunting practices of hunters as well as perceptions of non-hunters about the occurrence of hunting in their community.

To better understand the level of hunting pressure in the national park, the table below provides various data to assess the number of hunters present in each community of study (Table 3). The minimum number of hunters describes how many people were personally identified through the interviews as being hunters living in a given community. There are 12 known hunters in *Nuevo Tonosí*, three in *La Línea* and six in *Nombre de Dios* totaling 21 hunters overall. In addition, all participants were asked to estimate the number of hunters they believed to exist in their community. The range of these estimates is presented in the table, as is the average estimate. The average estimated number of hunters was divided into two groups: estimates given by hunters and those

given by non-hunters. It is probable that hunters have a more intimate knowledge of the hunting community and can therefore give a more accurate answer to this question. When asked whether the participant felt there was a large quantity of hunters in their community, 67% of respondents in *La Línea* said 'yes' as opposed to the other communities where only 33-38% said 'yes'. The response of hunters was very strong in this regard and upwards of 67% of respondents in all communities believed there are a large number of hunters in their community. Some of the problems regarding the data of people's estimates of the number of hunters are that people have different definitions of a hunter as well as varying levels of intimate knowledge of the hunting community. What can be said for certain is the number of hunters identified through the interviews in each community.

Table 3. Number of hunters by region

Community	Min. Hunters	Range	Average Estimated Hunters	Estimated Hunters by Non-Hunters (avg.)	Estimated Hunters by Hunters (avg.)	People who think there is a large no. of hunters in community (%)
Nuevo Tonosí	12	3-15	7	4	10	38% (75% of hunters)
La Línea	3	3-5	4	5	3	67% (100% of hunters)
Nombre de Dios	6	5-20	12.5	5	20	33% (67% of hunters)
Total	21	3-20	23.5	14	33	46% (81% of hunters)

3.3.2 Hunting intensity

To better understand the current hunting pressure, hunters were asked when they last hunted (Fig. 3). Of the known hunters, the majority, 41%, last hunted sometime within the last year. Another 23% of respondents said their last excursion was about two

weeks to one month ago and finally 36% of hunters had gone hunting within the last 2 weeks. It must be noted however that the answers of those who stated the last time they hunted was within the last year were generally quite elusive. It seemed that these respondents did not feel comfortable giving a specific answer so the results here are not necessarily very accurate. They could be interpreted as being the maximum amount of time that has elapsed since the last hunting trip and it is likely that many of the respondents in the 1 month to 1 year category could actually fall into more recent categories.

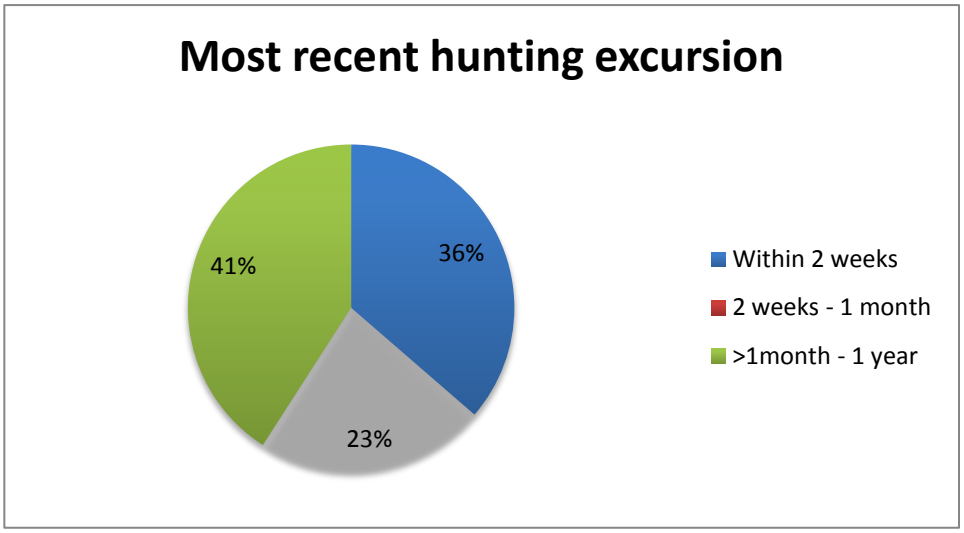


Fig. 3 Summary of when a hunter's last hunting trip occurred, by category

Another question that was asked to gain a better understanding of the current hunting intensity was how frequently people hunt (Fig. 4). Of the known hunters, 17% are hunting at least once per week. Another 44% are hunting approximately every two to four weeks. Those who hunt approximately three to six times per year comprise 26% of the known hunters and 13% only hunt about once per year.

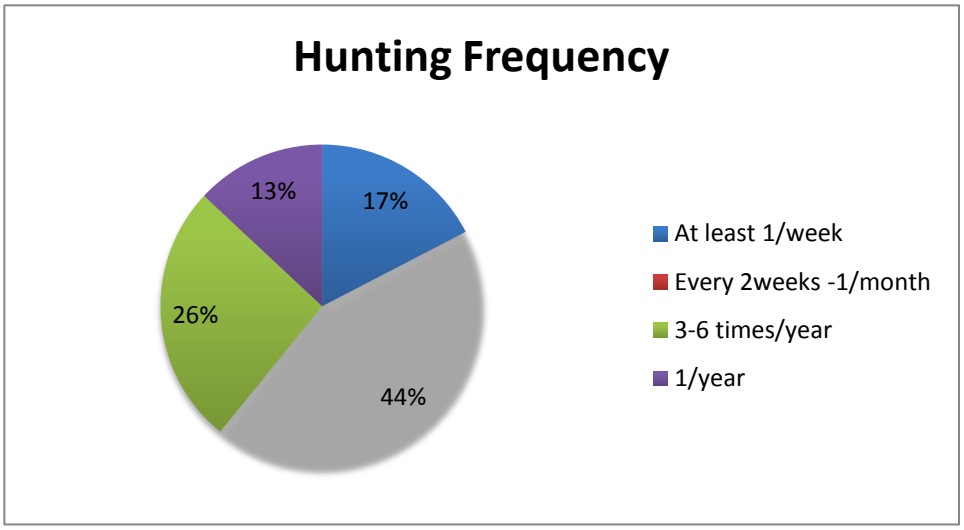


Fig. 4 The frequency with which hunters go hunting, by category

3.3.3 Animals hunted

Respondents who were hunters were asked which species they hunted (Fig. 5). *Conejo pintado* was the most frequently mentioned game species with 100% of hunters stating they hunted it. The *ñeque* and *saíno* were the next most frequently hunted animals with about 70% of respondents hunting them. Large mammals such as the tapir, *venado corzo* and *puerco de monte* were the least frequently mentioned by hunters.

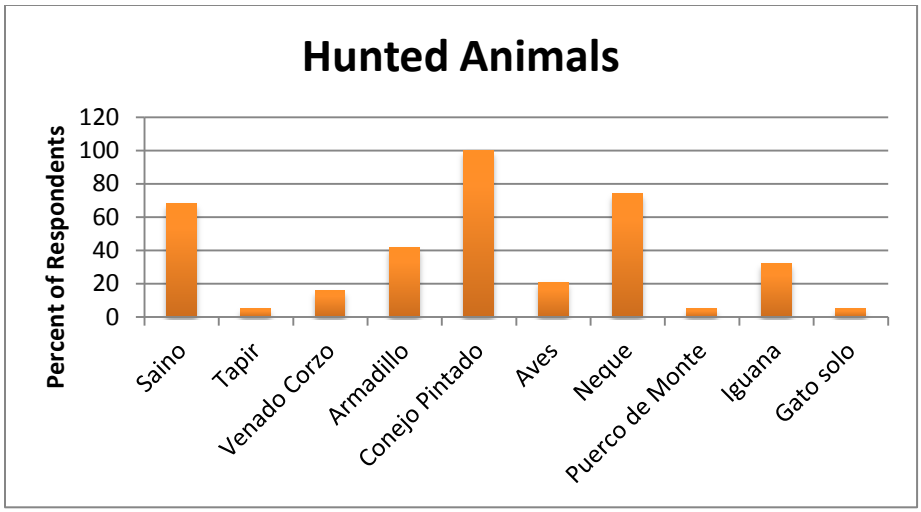


Fig. 5 Frequency of animals hunted by percent of respondents

In addition, interviewees were asked to list their top three hunting preferences (Fig. 6). The majority of hunters listed the *conejo pintado* as being their top preference. Subjects often described this being their first choice because it is very prevalent and is very calm so it is easy to hunt. The majority of subjects responded that their second choice would be the *saíno* because of its "rich meat."

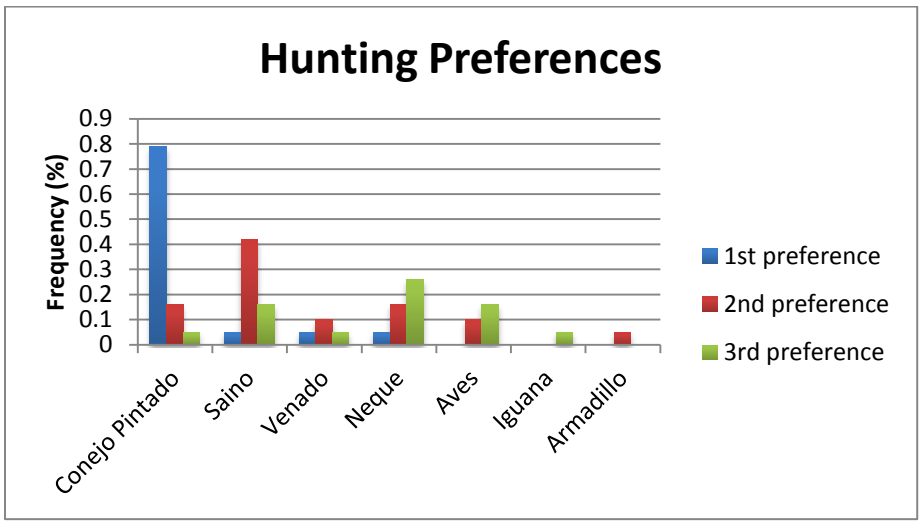


Fig. 6 Top hunting preferences by animal

3.3.4 Reasoning

Of the respondents who do not hunt or hunt very infrequently, there were a number of common themes that arose. Among this group, 23% said it was because they were too old and if they were younger they would continue to hunt. All of the respondents who described this as the reason for their discontinuation of hunting were from *Nuevo Tonosi*. 23% also said they simply do not enjoy hunting or going into the mountains. Another reason many people do not hunt is simply because they do not have time for it and this was represented by 23% of the respondents in this category. This sentiment of having no time to hunt was dispersed fairly evenly across the communities suggesting that people are tending to work paid jobs that are long hours or are located far away from the home. Furthermore, a group of subjects comprising 23% of those who do not hunt described that they do not hunt now because the animals are few and far away. Finally, 18% of these respondents do not hunt only because they cannot have firearms due to the law that is enforced and associated price. Of those who felt the law inhibited their ability to hunt, 67% were from *Nombre de Dios* and through observations and other comments made by subjects it was clear that either the authorities are stricter about this law in *Nombre de Dios* or the community is simply more afraid of its consequences.

The entirety of respondents who do hunt said they hunt for food. A small minority, 13%, said they hunt for sport and not a single person admitted to hunting to sell their game. It is probable that the hunters felt the need to tell us they hunt only for food to justify their actions considering hunting is illegal. At the same time, in interviews with non-hunters it was discussed that people in the communities were buying wild game from

hunters. It is likely then that some of the hunters interviewed were not truthful about their actions or those people who are selling their game were not interviewed. Another reason for hunting that was discussed with some hunters towards the end of the interviews was its cultural importance. One hunter even explained that he hunts because "it is something to do with the family that brings us together."

3.3.5 The State of Hunting as an Indicator of Animal Populations

When asked if hunting had changed over the last few years only 4% said it had improved and 24% said there was no change (Fig. 7). The vast majority, 72%, of respondents described hunting as being worse compared to previous years. Of those who thought hunting had worsened, 63% explained this was the case because the animals had gone further into the forest. In addition, 21% explained that hunting was worse because there were fewer animals present in the forest. Another 16% spoke about how more *fincas* have been established in the forest and this has increased the pressure on animals and made hunting more difficult. Finally, 16% described hunting being worse now because more people were hunting in the area.

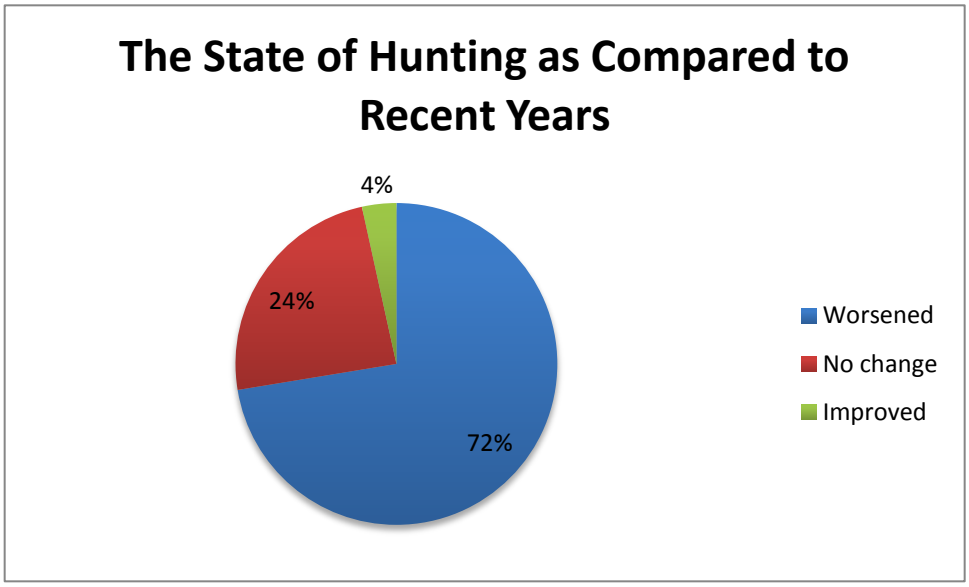


Fig. 7 How hunting has changed in the last few years

3.3.6 Consumption

Another way to gain a deeper understanding of the pressure on wild animals is to examine meat consumption. The table below provides an idea of the average amount of meat consumed in each community (Table 4). Throughout the interviews meat was frequently described as being "very expensive." It was also clear in speaking to these communities that meat plays an important cultural role.

Table 4. Amount of meat consumed by region

Community	Average amount of meat/week/household (lbs/wk/house)	Average amount of meat/week/person (lbs/wk/person)
Nuevo Tonosí	13.2	3.7
San Antonio	14.3	4.8
La Línea	6.9	2.1
Nombre de Dios	18.1	4.0
Total average	13.1	3.6

Furthermore, all participants were asked to list the wild animals they ate if they did so. 74% of participants stated they eat wild animals and the animals eaten can be viewed in the chart below. The pattern closely resembles the Figure of the wild animals hunted (Fig. 8). The major difference is that iguana is described much more frequently in the discussion surrounding food consumption rather than that of hunting. This is because obtaining iguana for a meal is not considered hunting but rather trapping or simply an animal that one stumbles upon by chance. Another possible reason for this difference is that there was bias in the question because when participants were asked to indicate those animals they hunted, they were provided with a diagram of animals to facilitate the process.

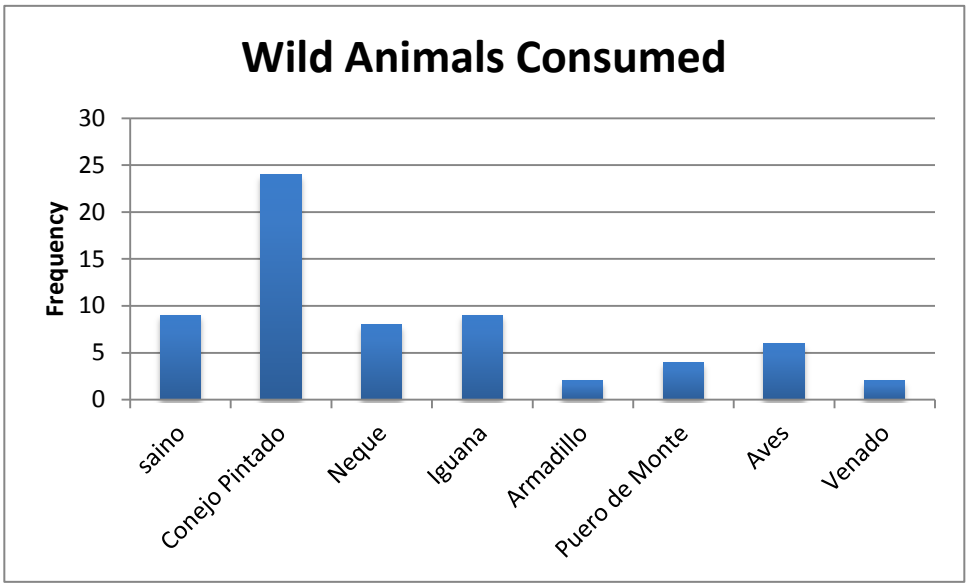


Fig. 8 Frequency of wild animals consumed by respondents

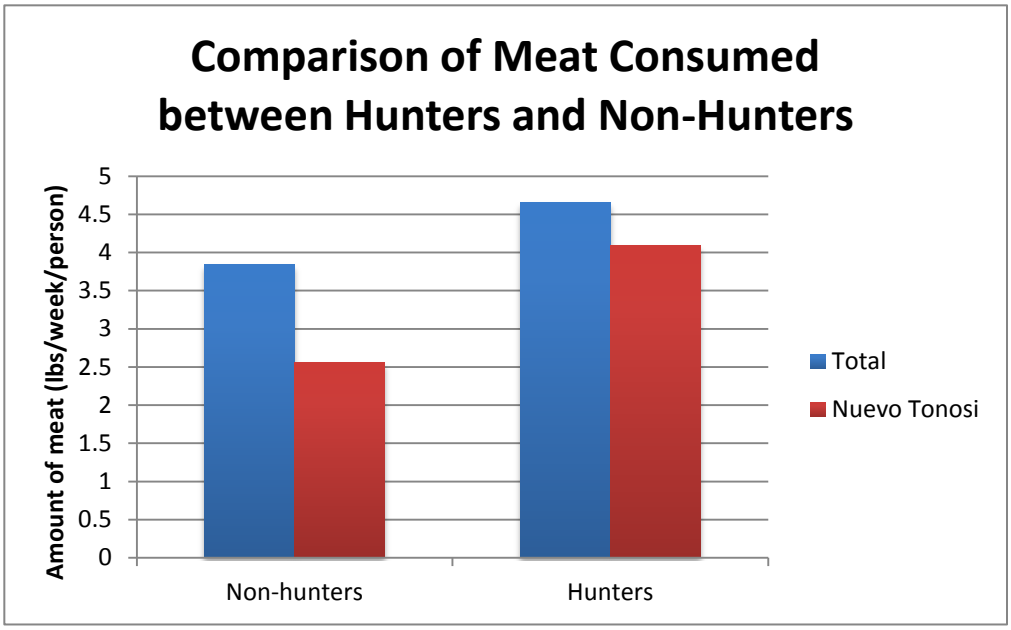


Fig. 9 A comparison of the amount of meat consumed by hunters and non-hunters

The figure above illustrates the discrepancy between the amount of meat consumed between hunters and non-hunters (Fig. 9). The average meat consumed among all participants is shown in blue and it was found that there is no statistically significant relationship between hunting and amount of meat consumed ($p= 0.36$). A comparison between the amount of meat consumed between hunting and non-hunting households was also made for the community of *Nuevo Tonosi* because it is the community for which there is the most robust data and the most hunters. On average, non-hunting households eat 2.6 lbs/week/person and hunting households eat 4.1 lbs/week/person. Once again this relationship was not found to be statistically significant ($p=0.33$). Interestingly, the majority of non-hunters comprising 60% of this group stated they do not eat wild animals while 40% do (Fig. 10).

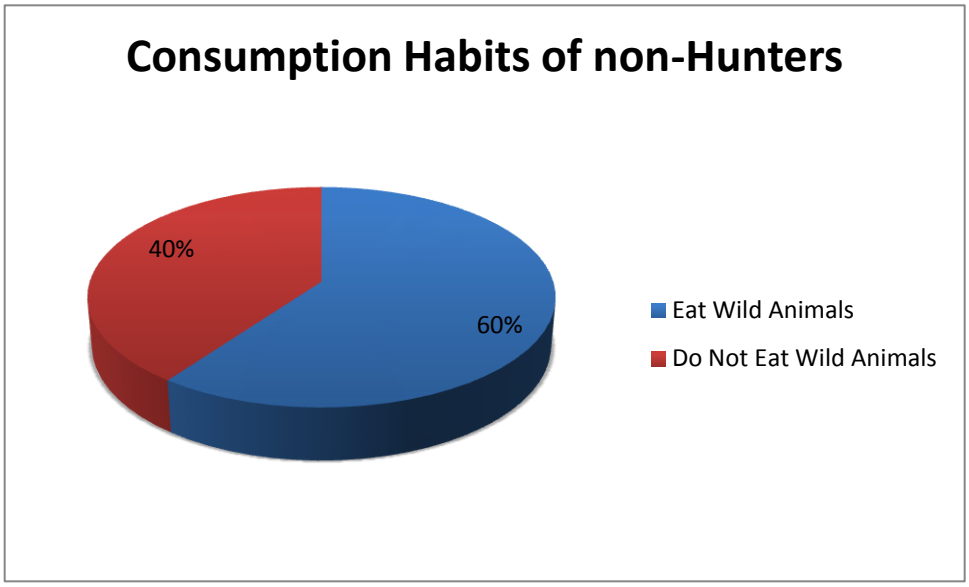


Fig. 10 The consumption habits of non-hunters

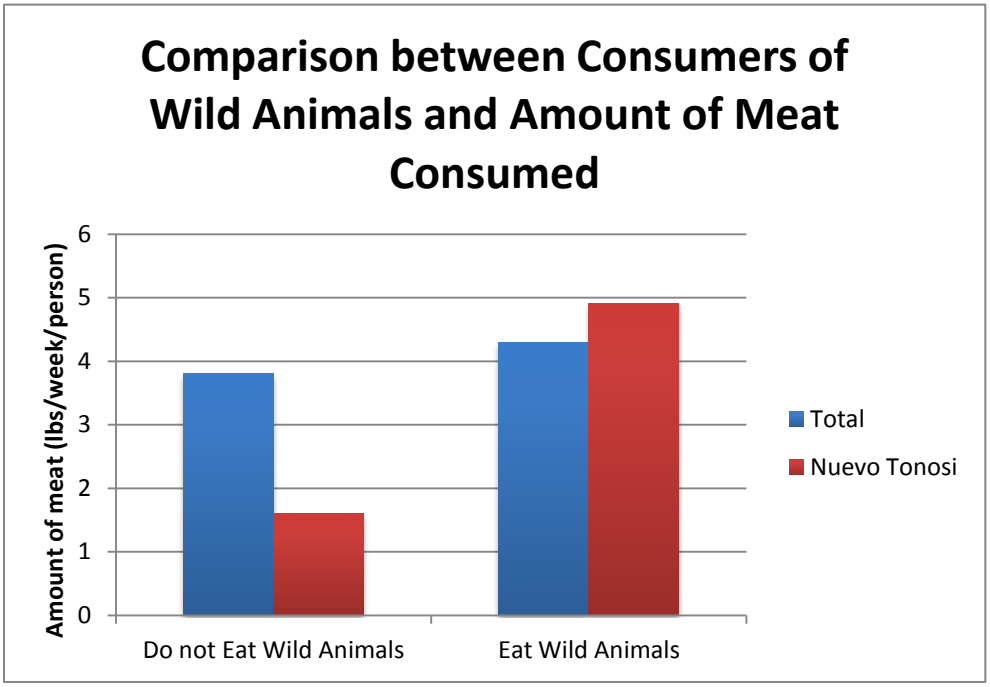


Fig. 11 A comparison of both the entire study population and specifically citizens of *Nuevo Tonosi* between the amounts of meat consumed between those who eat wild meat and those who do not eat wild meat

The figure above represents a comparison between people who eat wild animals and those who do not and difference in the amount of meat consumed per week per person (Fig 11). The average meat consumed of all the participants is depicted in blue with those eating wild animals consuming an average of 4.3 lbs/week/person whereas those who do not eating any wild animals only consumed 3.8 lbs/week/person. This relationship however was not found to be statistically significant (p=0.37). The same comparison of groups was made within the sampled population in Nuevo Tonosi. Here those who do not eat wild animals only eat an average of 1.6 lbs/week/person whereas those who do eat wild animals eat 4.9 lbs/week/person. This relationship was not statistically significant (p= 0.07).

3.3.7 Spatial distribution of hunting

A number of hunting areas were identified (see map in appendix V). By far, the region with the highest hunting pressure is the one including *Cerro Bruja* and *Rio Cascajal*. In this area, 20 identified hunters hunt. As a second area of high pressure is the hunting zone that includes *Rio Nombre de Dios* and *Quebrada Brazo de Tigre*. This area is subject to the hunting of four known hunters. Once again, these numbers represent minimums as information regarding hunters is difficult to obtain.

3.4 Perception of jaguar

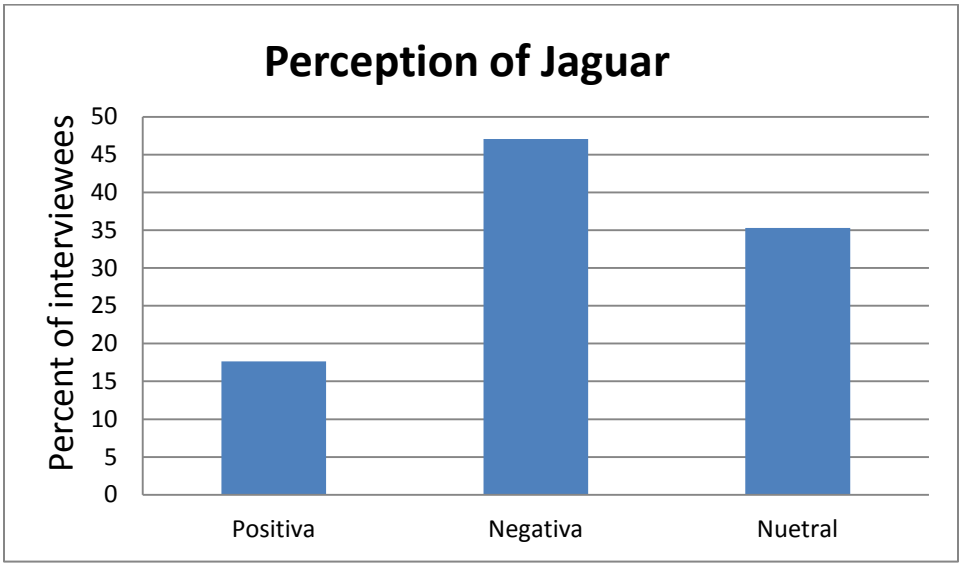


Fig. 12 Perception of the jaguar among participants

For the most part the perception of the jaguar is negative where approximately 47% of participants expressed a negative attitude towards the jaguar (Fig. 12). 35 % of interviewees have a neutral opinion while 18% have a positive opinion. The majority of the negative perceptions are based on interviewees or neighbors having large economic loss and the feeling of helplessness to protect themselves and their food source because of government regulation or economic situation (Table 5). Reasons for the neutral perception of the jaguar include an acknowledgement of both positive and negative attribute of the jaguar. For example, people in this category explained that the tiger is a beautiful creature but at the same time causes people economic harm. Another opinion expressed was that the jaguar is not an aggressive animal but rather one trying to cope with humans encroaching into its habitat. The people with a neutral opinion of the jaguar had little to no incidents of jaguar attacks. The positive attitude was based on the idea that people were not educated to live harmoniously with the jaguar and that it has a right to

exist. The people expressing positive attitudes also stated any negative opinions and experiences with the jaguar are a result of people's lack of autonomous action and their reliance on the government to fix their problems.

Table 5 Examples of opinions regarding the jaguar

Negative	Neutral	Positive
• The jaguar is an enemy to all humans • It eats all our potential food in the forest as well as our livestock. • Need to kill them • They take away our economic security • The government does not let us protect our livelihood.	• A beautiful but dangerous animal • Not naturally aggressive, we just are living in its habitat • Just trying to exist, if it does not hunt livestock there is no problem • It poses no danger to humans only the livestock they put in front of the forest	• It is beautiful and does not pose any threat • Has a right to survive • We can live harmoniously if we were educated how • It is not the jaguars fault but our own

3.5 Perception of parks

When asked the question of "what do you think of national parks and protected areas", the attitudes varied as follows with 56% (19) positive, 24% (8) neutral, and 20% (7) negative (Fig.13). The arguments for each attitude position varied (Table 6). Generally people who lived inside or bordering the park had neutral or negative views as they are affected more by the Park's legislation. The general opinion for the negative-

perception interviewees was that it limits their livelihood and access to resources while the government does nothing to help the people affected by the park. The general sentiment from the neutral-perception interviewees was that it is great to protect nature but they do not see any benefit in terms of their livelihood. The positive-perception group had a better understanding of the ecosystem interactions and their importance for human survival as well as an appreciation for the intrinsic value of the park. Overall the majority of the people enjoy living close to the park and are in accord with having protected areas however many dislike the current management. Numerous community members desire changes in the current management system that take into account the interests of the people living in and near parks such that they can benefit both themselves and, through a better understanding, the nature around them.

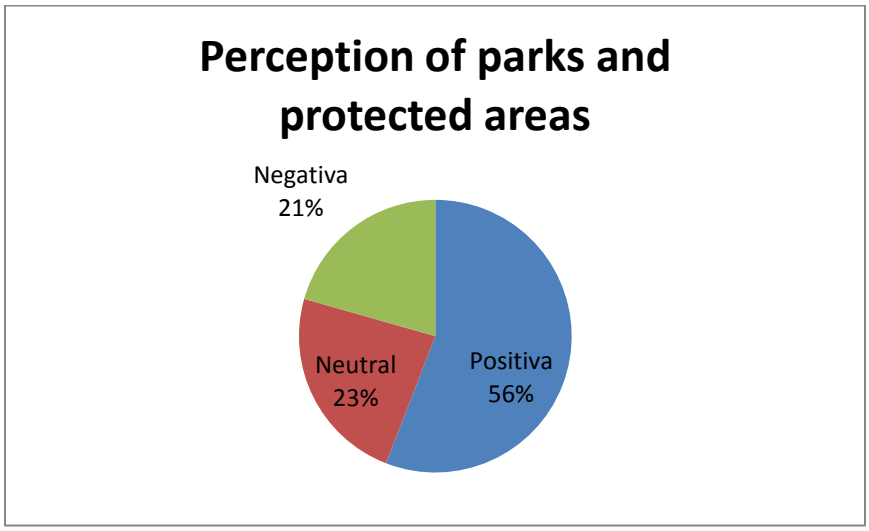


Fig. 13 Perception of parks and protected areas by category

Table 6 Examples of opinions regarding parks and protected areas

Negative	Neutral	Positive
• We are unable to extract resources that we should have the right to • We only have laws and there is no attempt to educate us why they are there and why we should follow them • Does not respect the people who were there before the park • Take away our livelihood and keep us poor	• Good to conserve these areas but they do not help anyone • They are good yet ANAM does not actually protect it, it only sets up boundaries and laws. • Good but they affect the people living close to and inside the park, something needs to be done about this • Lack of Park workers	• It is great for the nature • We need to conserve our ecosystems for ourselves and the future • Provides homes for animals such as the tapir which we have not seen for a long time • Allows animals to grow that we can eat • It is beautiful • People do not understand its importance and therefore we need to limit their use of it • Good so that people do not turn it into another Los Santos

4. Discussion

4.1 Prey Abundance

4.1.1 Main jaguar prey

It is clear that the people in *Alto Chagres* believe that most of the jaguar's main species of prey are present. Although the prey is present, we were unable to obtain a clear idea of their abundance or spatial distribution. This leaves many questions unanswered and a need for future quantitative studies on the abundance of jaguar prey. This being said we were able to gather some qualitative information regarding the spatial distribution

and abundance of some of the prey. A fair number of interviewees noted that many mammals have gone further into the park and people need to go further to hunt or to see animals that used to be common closer to the town centers.

Animals such as the *saino*, *puerco de monte*, *venado corzo*, and the tapir are thought to have retreated. This implies a number of possible explanations. Firstly, there may have simply been a decline in populations for natural reasons. Secondly, there has been an actual migration of the animals in response to unsustainable hunting pressure and increased habitat loss. Thirdly, the jaguar population has increased in numbers and has put a larger pressure on its prey's population. The final possibility is that it could be a combination of these explanations.

Another point of interest is that of the results from the mammal census conducted near *Rio Pavos*. Particularly, a high relative abundance of the jaguar's main prey was not found and those animals that were identified were those that are smaller in size such as the armadillo and conejo pintado. Although our census was preliminary and not extensive, its results coupled with the interviewees opinion that the animals have either decreased in abundance or have gone further in the park suggests that the lack of prey in this area may be perpetuating the jaguar-*ganadero* conflict. Additionally, with the numerous attacks in the specific region there is clear evidence that there is a lack of available prey for the jaguar (Appendix VI). This pattern is thought to be repeated throughout areas where the land cover changes from forest to ranches or to areas of human populations yet there is less data to support this.

In addition to this, the area in question is surrounded heavily by farmland possibly creating a biological island and increasing fragmentation of the boundary with the park.

As Andrén (1994) discusses, fragmentation affects the abundance and distribution of organisms in a landscape. This may be another explanation why the prey of the jaguars is not present. This may be valuable information for those attempting to mitigate the conflict and implement conservation methods in *Alto Chagres*. It is possible to conclude that habitat fragmentation is responsible, in part, for the low mammal viewed in these areas.

4.1.2 Tapir as an example

In particular the tapir's abundance is thought to have changed drastically since recent years. Interviewees who have resided in the area for more than 25 years have informed us that the tapir's abundance has greatly decreased and that now it is very rare to see one. At one time they used to be present in huge densities close to human populations. Now they believe that viewing a tapir is extremely rare, and that one needs to go farther in the park to encounter them. This being said, it was possible to see traces of the tapir (Appendix VII) mostly deep inside the park confirming peoples reports but there were also a few sightings in more populated areas. The fact that sightings can now be seen close to human populations could mean that there is an increase in the abundance of tapirs or migration. Migration may be due to increased predation of jaguars inside the park and the tapir's avoidance behavior. At the same time, it is still clear that the tapir and other prey's abundances have been affected in the last years by human presence, loss and fragmentation of habitat, and, of more interest, hunting.

4.2 Jaguar Presence

Jaguars are undoubtedly present throughout the park boundaries and as well in forested areas around farmland and human populations, such as *La Linea*. The jaguar seem to be exiting the park either in search of food or simply maintaining their territory, which can span anywhere from 25 to 86 km depending on the sex of the jaguar and other regional factors (Brock 1963).This notion is supported by the reports of increased jaguar attacks and sightings in the last years. The people of *La Linea* and *Nombre de Dios* believe that the populations have increased as ANAM has made stricter laws on the killing of jaguars and its prey. As previously mentioned, we have confirmed the presence of a jaguar and it's young (Appendix XI) in the area of *Quebrada los Pavos*. We can safely say that the jaguar is present through *Alto Chagres* and that it is either migrating more into areas of human presence because of territorial issues or rather because it is in search of food and its prey abundance has changed.

4.3 Hunting

4.3.1 Current state of hunting

It was very difficult to assess the current level of hunting due to its legal status. People were therefore reluctant to identify themselves as hunters and reluctant to identify other members of their hunting community. In addition, those who were willing to identify themselves as hunters were still at times uncomfortable giving clear answers to specific questions regarding their hunting habits including their frequency of hunting, the

last time they went hunting, how they use the animals they hunt and where specifically they go to hunt. Despite this, there are still a number of conclusions that can be drawn from these results. At the same time, based on the difficulties in obtaining truthful information, the results presented in this document can serve as a minimum level of hunting pressure.

The physical presence and intensity of hunting can be characterized in a number of ways. The number of hunters that are present in the area is not terribly large however there is still a substantial group that exists (table 3). The largest number of identified hunters was in *Nuevo Tonosi*. It was also determined that the area of highest hunting pressure was around *Cerro Bruja* and *Rio Cascajal,* which are located close to the village of *Nuevo Tonosi* (Appendix V). It is logical that the village supplying the most hunters would be closest to the region of highest hunting activity especially because all of the hunters go by foot to their hunting location. The estimated number of hunters given by hunters was highest in *Nombre de Dios* but this is perhaps because due to an error in judgment or a much larger hunting community in the village than the number of identified hunters in interviews suggests. There may indeed be many more hunters in *Nombre de Dios* however this is simply based on the size of the town in comparison with *Nuevo Tonosi*. In this study only about a half-dozen people were interviewed in *Nombre de Dios* therefore further investigation is required to make more solid claims and to understand the hunting situation there. Finally, 81% of all hunters believe there is a larger number of hunters in their community suggesting that the hunting community is greater than has been thought (table 3).

An interesting point to note is that a much greater proportion of participants from La *Linea* believed there to be a "large number of hunters in their community" than any of the other communities. It was the community with the lowest number of identified hunters as well as the lowest number of estimated hunters across the board. Perhaps there is an inflated perception of hunting in this village or perhaps there were many hunters living there in the past. It may also just be that people were unwilling to identify themselves or that the sample size was too small to gain an accurate picture of the number of hunters in the area. It should be noted that the communities of *La Linea* and *Nombre de Dios* but especially the later explained relentlessly that in recent years the authorities had become stricter regarding hunting. This was one reason why 18% of respondents said they no longer hunted: they could not afford the gun licenses. Because of the stricter regulations, hunters in these communities may have also been more afraid to speak to us about their involvement in hunting.

In terms of individual hunting intensity, the consensus is that people tend to hunt every couple of weeks (fig. 4). Only 17% hunt more frequently than this. The majority, 44% go every two to four weeks. This is in line with what participants explained as a normal workweek. The people of these communities typically work six days a week and long hours each day. In general, hunters said they go hunting whenever they can, which meant whenever they were not working. This typically translated into them determining their frequency to be about every two or three weeks.

4.3.2 Animal consumption as an indicator of hunting

There may be several factors to explain why there is no statistically significant difference in the amount of meat consumed by hunters and non-hunters (fig. 9). One possibility is that the people interviewed are economically secure and can afford to buy meat. This seems unlikely though considering the vast number of subjects who complained about the price of meat. Another possible explanation could be that the non-hunters are lying about their involvement in hunting or where their food comes from. This seems a likely option because 60% of non-hunters are still eating wild animal meat (Fig. 10). It is true that these people could be obtaining this meat from community members who raise wild animals for sale however this did not seem common in this area based on the time spent in the various communities. Other possible ways these subjects could be obtaining wild meat is by buying wild game from hunters. When asked, all hunters denied ever selling their game but this may have simply been to protect themselves from legal consequences. Finally, the subjects who are eating wild animals could have lied to us and are actually hunters but are afraid of being revealed to the authorities and therefore refuted any involvement in hunting. If those who were characterized as non-hunters but eat meat were either they themselves hunters or buying wild meat from hunters, it would imply a greater level of hunting pressure in the area.

4.3.3 Hunting pressure on animals

The largest amount of hunting pressure seems to be on the conejo pintado. It was described as both the most commonly hunted and widely eaten animal (Fig. 5, 8). *Sainos* and *neques* were also described very frequently as being hunted and eaten. The *saino*

may possibly be at risk because despite some people elaborating that there were many *sainos* in the forest, it had only been seen by as many people as had seen the *venado corzo*, which was described as being quite rare (Fig. 1). There are a number of large mammals such as the *venado corzo* (*venado cola blanca* not found in this area), *puerco de monte* and tapir that do not seem very threatened by hunting. This however seems as though it is a result of their low abundance rather than a lack of desire to hunt these animals. When describing their top hunting preferences, hunters explained that they preferred to kill the conejo pintado primarily because it was just so easy to hunt due to its high numbers and calm behaviour. The fact that hunters are mostly killing small animals including *conejo pintados* and *neque* is somewhat worrisome because hunters tend to prey on large animals such as the tapir first and once they are driven to local extinction they move on to smaller animals (Milner-Gulland and Bennett, 2002). This may therefore suggest that previous years of hunting has already caused major population declines. The question of one's preferred animals to hunt also does not take into account those animals that hunters would like to hunt but are not present. This may be an interesting question to help understand what the hunting pressure would be like on these animals if their populations were to increase.

4.3.4 Hunting as an indicator of ecosystem health

A striking 72% of respondents felt that the hunting conditions had worsened in recent years (Fig. 7). The vast majority of which explained that this was the case because the animals were fewer and farther away. Some went further describing how the

increasing number of *fincas* established in the park was putting pressure on the animal populations. They were described as eliminating habitat areas of the animals as well as frightening the animals by their human presence. Furthermore, 23% of non-hunters explained that the reason they do not hunt is because the animals are so far away and difficult to find, as there are few.

4.4 Attacks – conflict

In the last year there have been 15 attacks of felids on farms in the area of study, 13 of which were by jaguars and two by pumas. This is quite a high number especially since the density of jaguars in *Parque Nacional Alto Chagres* is only 3 jaguars/100km^2 (SOMASPA 2012). It is possible that these attacks are amplified by hunting but it is difficult to determine this for certain. In general, the attacks have all occurred within or bordering areas of hunting except for a grouping of attacks around San Antonio. Most of our data was collected along trails that are both used by ranchers and hunters to access the ranch and hunting areas. This may explain the overlap in values. Also, the farms that had attacks are simply the farms located farther into the forest and the park. Because these farmers are living within the jaguar's natural habitat, they would simply be more likely to have contact with the jaguar. However because of the robustness of our data it is possible to say that there is an interaction between hunting pressure and jaguar attacks. With the exception of the San Antonio attacks, our hypothesis that more attacks would occur on *fincas* situated within or neighboring areas of high hunting, is supported by the spatial distribution of the attacks and hunting areas (Appendix VI). All the attacks occurred at farms within or nearby hunting areas. At the same time, where *Cerro Bruja* is

by far the area of highest hunting pressure and with many *fincas* located along the *Rio Cascajal,* only three attacks occurred in this area. This leads us to question whether hunting is really driving the farm attacks. On the other hand it is possible that the impacts of this hunting have driven the jaguar to other areas in search for food in response to perceived danger or increased human presence. This may perhaps explain why there were a number of attacks around San Antonio. The jaguar may have been pushed towards this area for lack of food and took advantage of the fact that there is a high density of farms there providing a large food supply. Another possibility is that the forest is well connected up to the area where the fincas around *San Antonio* are found and therefore they are simply located within the jaguar habitat, which makes them more likely to suffer attacks.

The idea that the jaguar has been driven eastwards could not only be a result of the hunting pressure on *Cerro Bruja* but also the killing of jaguars in the area. In general, the subjects in *Nuevo Tonosi* and along *Rio Cascajal* described the number of attacks as having decreased in recent years because of the elimination of many jaguars in the area. In contrast, the participants in La Linea expressed concern that the number of attacks in the area had increased. This can be attributed to the number of jaguars killed in each region. Through anecdotal accounts from various members it was made clear that those in the *Nuevo Tonosi-Rio Cascajal* region are both more intent on killing jaguars and more experienced at killing them than the other communities. Farmers in this area have killed jaguars in the past and even this year, two out of the three attacks resulted in the death of the jaguar. This may also explain why despite such a high hunting pressure in the area there are comparatively few attacks on farms.

It must be noted that a very large number of jaguars were killed in the entire study area within the last year (Appendix VI). It must also be reiterated that the density of jaguars in the park is only 3 jaguars /100 km^2 whereas the normal average density for a healthy jaguar population was found to be 6 / 100 km^2 (SOMASPA 2012). The fact that five jaguars were killed in the last year is therefore extremely important. There seems to be a dire problem along the park limits where humans and jaguars meet. Furthermore if the rate of jaguar elimination was, per say, constant throughout the populated areas of *Alto Chagres* much of the jaguar population would be decimated. This information gives an indirect indicator of the jaguar mortality as well as the conservation status of the jaguar in *Alto Chagres*. The data now provides spatial information of the overlap of hunting pressure, prey abundance and, jaguar attacks in the last year. This may be of use for those who want to provide educational programs about the effects of hunting and jaguar attacks, park managers, and those who want to further monitor the area.

4.5 Perceptions

4.5.1 Jaguars

People's attitudes highly influence the effective management or treatment of conservation issues, especially those that are involve conflicts within their daily lives (Zimmerman et al.2005). Most interviewees had a negative perception (47%) of the jaguar in Alto Chagres and as a consequence are less likely to conserve the jaguar (fig. 12, table 5). To mitigate this conflict and promote jaguar conservation it is believed that the most widely held attitude of the community is the most important (Zimmerman et al. 2005). It was also found that ranchers with negative attitudes towards the jaguar are more

likely to persecute them. It is clear that there is a majority negative attitude in *Alto Chagres* mostly because there is a lack of knowledge about alternatives and the importance of large carnivore conservation. With only loss associated with the conservation of jaguars it will be difficult to implement any effective conservation methods or management techniques without first changing the attitudes of the communities.

4.5.2 Parks

In the case of parks and protected areas, the majority of people felt that parks and protected areas were great yet lacked proper management and a strong relationship with the people (fig. 13, table 6). Many interviewees were unaware of basic ecosystem services provided by protecting large tracts of nature and other benefits and reasons associated with conservation. Instead their attitude depended more on their personal perception of the park. For example one interviewee felt that the park was limiting his natural right to use nature for sustenance and trade. Another interviewee states "Parks are great, we need to conserve them to protect nature from ourselves for future generations".

It is vital to note the general lack of education regarding parks and natural areas. Our target group was people who knew the forest the best in their community and the knowledge obtained from our data suggests that much education is needed so that the park and the people can build a stronger relationship. To add to this, people feel the park management, ANAM, does very little to inform people and educate them but rather makes laws and assumes people will follow them. Yet clearly in *Alto Chagres* this is not the case. In our mammal census we found direct evidence of hunting in the form of a

shotgun shell and pictures of hunters on our trap cameras about 0.25 km away from an ANAM sign that states the regulations of the park.

In order to make respectable changes to the conservation of both the jaguar and parks in general, people's education and community attitude should be a high priority and is key for both jaguars and parks in Alto Chagres.

4.6 Issues, difficulties and recommendations for future studies

There were a number of difficulties involved in carrying out this study and the following provides a description of these difficulties and possible solutions for future studies. One of the major problems, as discussed earlier, was the sensitivity of the topic. This severely hindered our ability to obtain accurate results. We suggest in the future using more indirect methods to assess the level of hunting. This could be in the form of very indirect questions being asked to interviewees or it could be in the form of a different kind of study. Possible options might include doing a kitchen inventory with the woman of the household to gain a better understanding of the types of meat consumed in the communities. Another possibility would be to do a hunter census in the forest to assess the quantity and frequency of hunters in a given area. Finally, a more extensive survey of all food sources in the communities including grocery stores, *tiendas, fondas* and restaurants could be carried out.

The second main difficulty that was encountered in doing this study was the issue of working with a guide. There are a number of benefits of working with a guide that are described above (2.2.2 Use of local knowledge) however there were also a number of disadvantages. Some of these included the guide often giving her opinion in interviews

and providing leading answers to participants. Another issue with the guide is that their knowledge may be limited to certain areas. To avoid this, we recommend using multiple guides, each with good knowledge of their area and the people in it. In many instances our guide held back our research because of her unwillingness or unavailability. Using multiple guides would have many advantages and also helps networking in different communities. To avoid problems of the guide interfering with the scientific method it is important that the methodology be thoroughly discussed with them before beginning the study.

We suggest that in a similar study in the future, a representative sample be taken. In this area and for this topic it is certainly possible to carry out a representative sample. Doing so would give a better idea of the relative amount of hunting occurring in each community. The sample should not only include a representative number of people from each community but also an equal number of hunters and non-hunters. This way, the two groups could be appropriately compared. Furthermore, more questions can be included in the interviews to gain important information from non-hunters. For example, those non-hunters who described eating wild meat should also be asked where and how they obtain this meat. Also to note, all participants should be asked if they raise wild animals or buy animals that had been raised by someone.

Finally, it is critical that future studies allot time to field-test their questions before beginning official interviews. This would allow the interviewers to ensure that the questions are being asked appropriately using colloquial language and that the questions are posed in such a way that respondents are can give accurate information.

One part of the interview that we would have changed had we field-tested our questions was the use of the animal diagram. This sheet had a number of pictures of animals on it that comprised the most important prey of the jaguar and acted as a visual aid during interviews. The disadvantage of using this was that people tended to heavily rely upon it and would only give answers based on the animals illustrated on the sheet. In the future, it would be better to provide a more extensive animal sheet to avoid this problem. Another such case where this would have been useful was the use of a map to describe areas. There are many available maps such as those provided by the Smithsonian Tropical Research Institute GIS lab of all the information about the study area that if we had viewed previous to beginning the study would have made the spatial information much more valuable as well as our facility of navigating the landscape. We highly recommend reviewing these detailed maps of the area and bringing them along to interviews.

Finally, a persistent issue in this study was that of ethical consideration. As in all studies it is fundamental that subjects are given adequate information regarding the study before agreeing to participate. With hunting being such a sensitive topic in these communities it was critical that subjects were appropriately informed in a way that would both allow them the opportunity to make an informed decision but also in a way that would not hinder them from answering truthfully. We advise future researchers in this area of study to maintain a commitment to honesty but perhaps spend more time in the communities to integrate into the community and gain acceptance. This way a stronger bond between the community members, researchers and involved organizations can be

created facilitating the mitigation of this conflict and the implementation of conservation efforts.

4.7 Recommendations

As previously mentioned, the most effective way of implementing conservation strategies would be shifting the current focus from laws and regulations to putting more energy toward education and environmental awareness including topics about the use of flora and fauna. This allows conservation policies and movements to be supported by independent and empowered individuals (Zimmerman et al. 2005, Campbell et al. 2011). Through educating ranchers and community members the voluntary and/or self-reinforcing mechanisms will have the potential to change the attitude, regulations and conflict altogether in *Alto Chagres*. This can be done in participatory workshops, talks and presentations with ranchers while other programs could be used in schools with children. A positive attitude toward both the park and jaguars accompanied by the feeling of choice and empowerment may lead to the community becoming more receptive to conservation efforts.

Another proven method of specifically avoiding problems on ranches entails a more conscious animal husbandry. As Azevado (2007) found, animal husbandry affects the risk of predation in specific areas. A suggestion for large amounts of people dealing with large carnivore-livestock conflict is to provide simple changes to the current on ranch-methods (Ogada et al. 2003). For example, simple changes have reduced the risk of jaguar depredation in Venezuela (Hoogesteijn 2005). In many cases our interviewees were intrigued about what they could do to protect themselves and about alternatives. The REDD program, reducing of emissions from deforestation and forest degradation in

developing countries, is also becoming of interests to locals and for future researchers going into the area providing contact information would be extremely beneficial. REDD can aid in bridging the gap between humans and nature and while benefiting both, protected both (Nepstad et al. 2007). The local MIDA, the ministry of agriculture, office has much potential to help the people but their sentiment is that farmers do not want to learn. Instead of changing tactics they seem to give up and fulfill only their basic duties. There is a large potential for the both the *ganaderos* and MIDA to benefit from each other, their area and the nature around them.

5. Conclusion

5.1 Specific Questions*:*

The first question sought to answer whether or not there was pressure on the jaguar's prey. Through this study it was determined that there is indeed pressure on the prey of the jaguar in *Alto Chagres*. Although generally all of the species of the jaguar's prey are present throughout *Parque Nacional Alto Chagres*, it seems apparent that they have declined in numbers. This study has also helped assess the role hunting plays in the pressure on jaguar prey. The main animals being currently hunted are the conejo pintado, the saino and the neque however this may support the theory that previous hunting pressure has eliminated much of the large mammals in this area. In addition, this study determined the areas of hunting pressure which seem to border on the park limits and especially include *Cerro Bruja* and *rio Cascajal*. Although we were able to find the main areas of hunting , it was difficult to determine the extent of which hunting occurs. Additional quantitative studies are required to better address this question.

It is obvious that hunting places a pressure on the jaguar's prey and this may be responsible for jaguar attacks yet the complexity of this relationship is so that the situation is still unclear. In some instances jaguar attacks have decreased in areas of heavy hunting, such as *Nuevo Tonosi*. This is explained by the large number of eliminated jaguars in the area. A more intensive study regarding the relationship between prey abundance and jaguar attacks is needed. Despite this, it is still possible to say that hunting affects jaguar's prey and that this results in jaguar attacks. The exact relationship in areas of high hunting pressure is unclear as more robust spatial data is needed for analysis.

5.3 Final statement

Jaguars are clearly affected by the human pressures in this study area, which include both hunting and presence of *fincas* within the forest and specifically the park. Further data is needed to quantify these relationships but the general conflict is understood and a number of actions can now be taken. For any effective means of jaguar conservation to be carried out in this area, a substantial amount of education is needed in order to change the current attitudes and empower farmers and community members to make autonomous informed decisions without relying on the government. Even though there is much work to be done in this regard, the situation looks promising because education can only increase and we have clear evidence of future generations of jaguars and a change in generational values.

Appendix I: General questionnaire

Formulario General

1. Básicos

1) Numero de entrevista
2) Fecha:
3) Lugar:
4) Entrevistador:
5) GPS N __ __ - __ __ __ __ W __ __ - __ __ __ __ (numero de punto: _____)
6) Teléfono 8) Nombre de finca:
7) Correo electrónico: 9) Numero de casa:

2. Información personal

1) Tiene cuantos años (su edad)_____ 4) Lengua_____
2) Sexo: masculino☐ femenino:☐ 5) Origen cultural_____
3) 6) Religión_____
Trabajo(s)_____

3. Casa

1) Jefe de casa Si ☐ No☐
2) Relación con el jefe de casa_____
3) Cuantas personas por casa _____
4) Hace cuanto tiempo que vive aquí_____
5) Donde vive antes de aquí_____
6) Tiene otra casa Si ☐ No☐ 7) Donde_____

4. Pueblo

1) Cuantos casas_____
2) Cuantos personas por casa_____

3) Infraestructura

☐ Escuela ☐ Iglesia ☐Mercado ☐Centro de Salud ☐ Oficina de gobierno

A**ppendix II: Food, Hunting and Park Questionnaire**

Formulario sobre la comida

1. Comida general

1) ¿Que hace para obtener comida y donde?

☐Pescar☐Cazar☐agricultura ☐ recolectar en bosque☐supermercado ☐ cría

2) ¿Donde hace eses actividades para obtener comida?
Pescar:
_____
Cazar: _____
Agricultura: _____
Recolectar: _____
Ganador: _____

3) ¿Cuantos kilogramos de carne entre en la casa cada semana?_____
¿De que animales?_____
_____
_____

4) Animales silvestres Si☐ No☐
¿Cuales son? _____
_____
_____

2. Caceria

1) ¿Hace la cacería? Si☐ No☐

Si no

1) Sino, ¿porque? _____
2) ¿Cree que muchas personas practican la cacería? Si☐ No☐
¿Cuantos en su pueblo? _____
¿Cuantas en su casa? _____

3) ¿Donde cree que la mayoridad de personas cazan?
_____

Si

1) ¿Porque caza?

☐ Comida☐deportiva ☐para vender ☐otro_____

2) ¿Cuando fue el último vez? _____
3) ¿Con qué frecuencia caza? _____
4) ¿Durante cuánto tiempo cazan cada vez? _____

5) ¿Que equipo utiliza?
☐Perros☐ Trampas ☐Rifle ☐ Otro_____

6) ¿Que especies caza?

7) ¿Que son sus animales que prefiere cazar?
1) _____
2) _____
3) _____

8) ¿Donde caza regularmente?_____
¿Cuantos kilómetros de aquí a este lugar?_____
¿En que dirección?_____
¿En el parque?_____
¿Como llega allá?_____
¿Cuanto tiempo es necesario para ir allá?_____
¿Que animales son máscomún en este lugar?_____
9) ¿La cacería es mejor o peor que los últimosaños?☐mejor☐ peor☐no cambia

¿Porque?_____

10) ¿Ha visto un cambio en la abundancia de los animales? ☐Si ☐No
Mas o Menos?_____

3. Tapir/Jaguar

1. ¿Ha visto estos animales cerca de su finca/parque/pueblo? Cambio en abundancia?

Finca/Casa Pueblo Parque

Tapir

1) ¿Ha visto el tapir?
¿Dónde?
¿Cuándo?
Sexo ☐masculino ☐ femenino ☐ no sabe

Tamaño/ ¿que largo?_____
¿Cuantos en el grupo?_____

2) ¿Ha visto huellas del tapir?☐Si ☐ No (FOTO)

¿Dónde?
¿Cuándo?

Jaguar/ Tigre

1) Ha visto el tigre?
Dónde?
¿Cuándo?
Sexo ☐masculino ☐ femenino ☐ no sabe

Tamaño/ ¿que largo?_____
¿Cuántos ?_____

2) Ha visto huellas del tigre?☐Si ☐ No (FOTO)

¿Dónde? _____
¿Cuándo? _____
¿Tamano? _____

3) Habían ataques aquí en su finca?☐Si ☐ No

¿Dónde?
¿Cuándo?
¿Que animal fue atacado?_____
¿Que animal estuvo atacando? ☐jaguar☐puma

¿Que pasa cuando hay un ataque?_____

4) ¿Hay mas o menos ataques ahora que los últimos anos? ¿Porque?

4) ¿Cual es su percepción del tigre? _____

5) ¿Que piensa de los parques nacionales? _____
_____

6) ¿Esta interesando en losactividades alternativos y programas educacional sobre esta tema?
_____
_____
_____

4. Ayuda

1) ¿Conoce a alguien que hace la cacería?
¿Piense que quiera hacer esta investigación?

2) ¿Cuando es lapróxima vez que va a cazar?
¿Podemos ir con usted?

Appendix III: Direct observation of hunting or signs of hunting

Formulario de encontrar algo de la caceria

1. Básicos

1) Tiene cuantos años (su edad)_____
2) Sexo: masculino☐ femenino:☐
3)
Trabajo(s)_____
__
4) ¿Dónde
vive?_____

2. Anímale

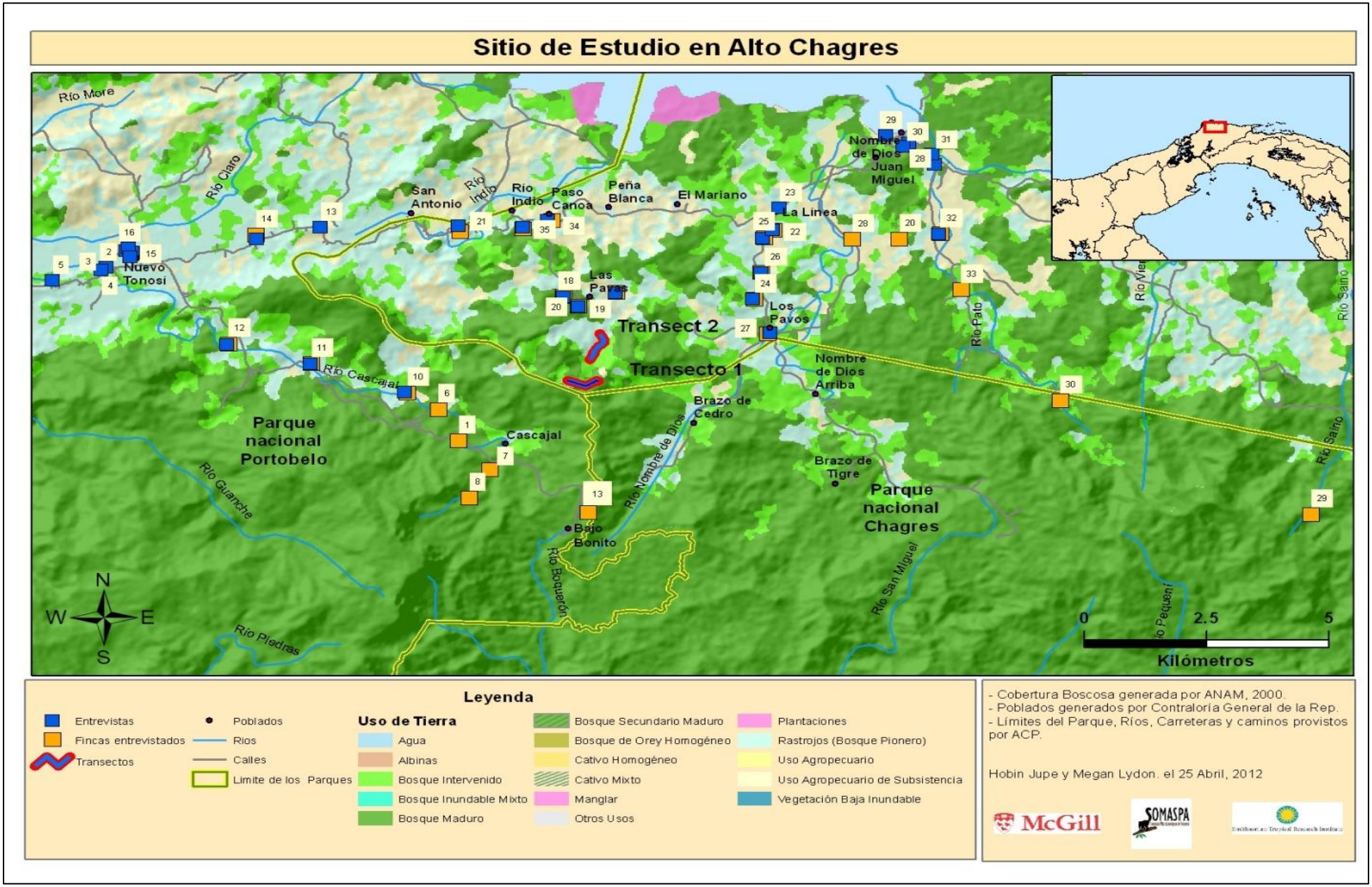
1) ¿Dónde en el pueblo encontró el animal?
_____
3) ¿Como lo mato?
_____
4) ¿Con que tipo de equipo?
_____
5) ¿Dónde lo mato?
_____
6) ¿Tipo de animal?
7) Sexo del animal: masculino☐ femenino:☐ No sabe ☐
8) Peso/tamaño:
_____
9) Edad:
_____
10) ¿Usted planifico cazar a este animal?
_____
11) ¿Por qué razón, y que va a hacer Ud. con ese animal?
_____

3. Observaciones

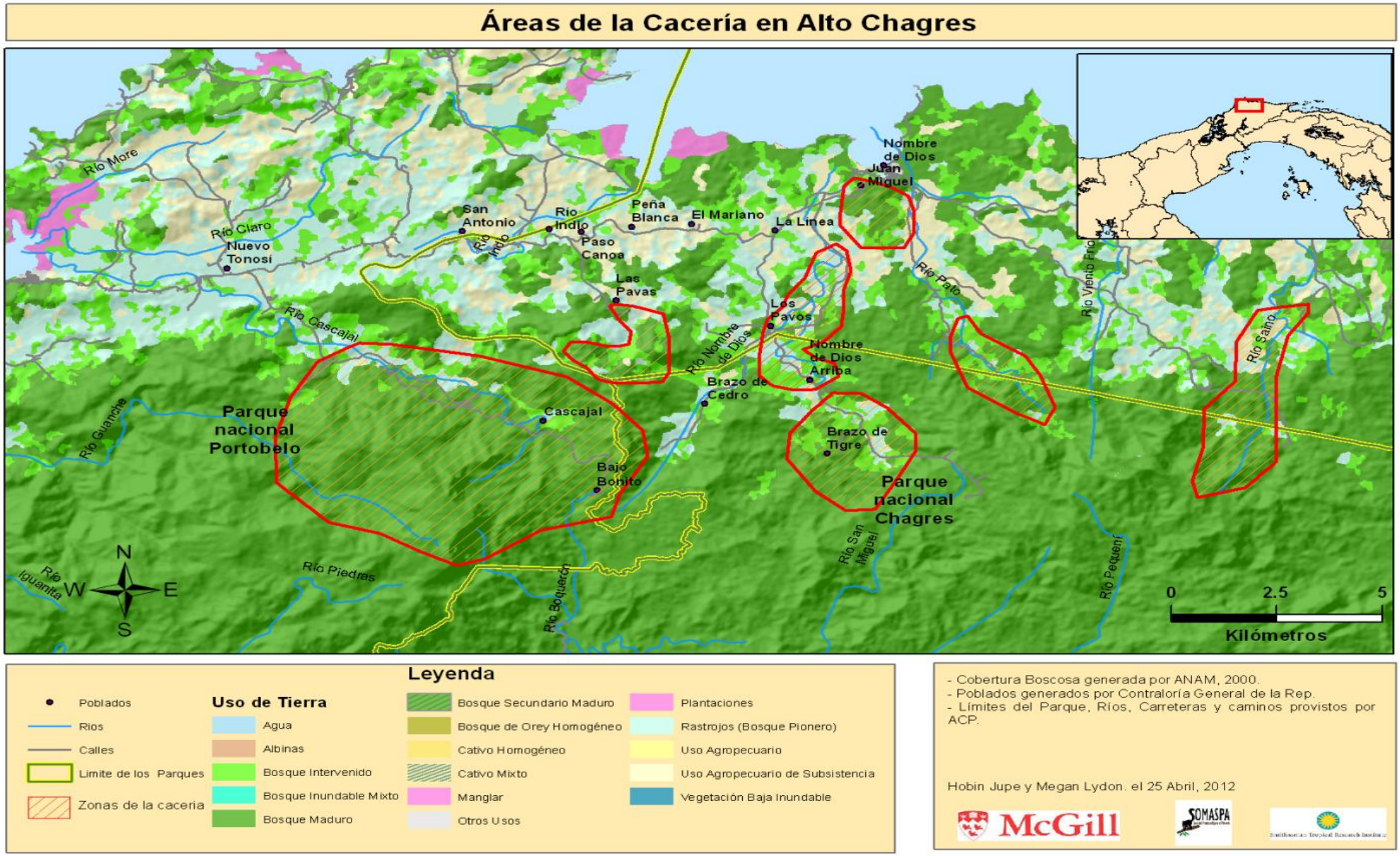
1) ¿Qué actividad estaba haciendo la persona entrevistada?
_____

Observaciones:_____
_____

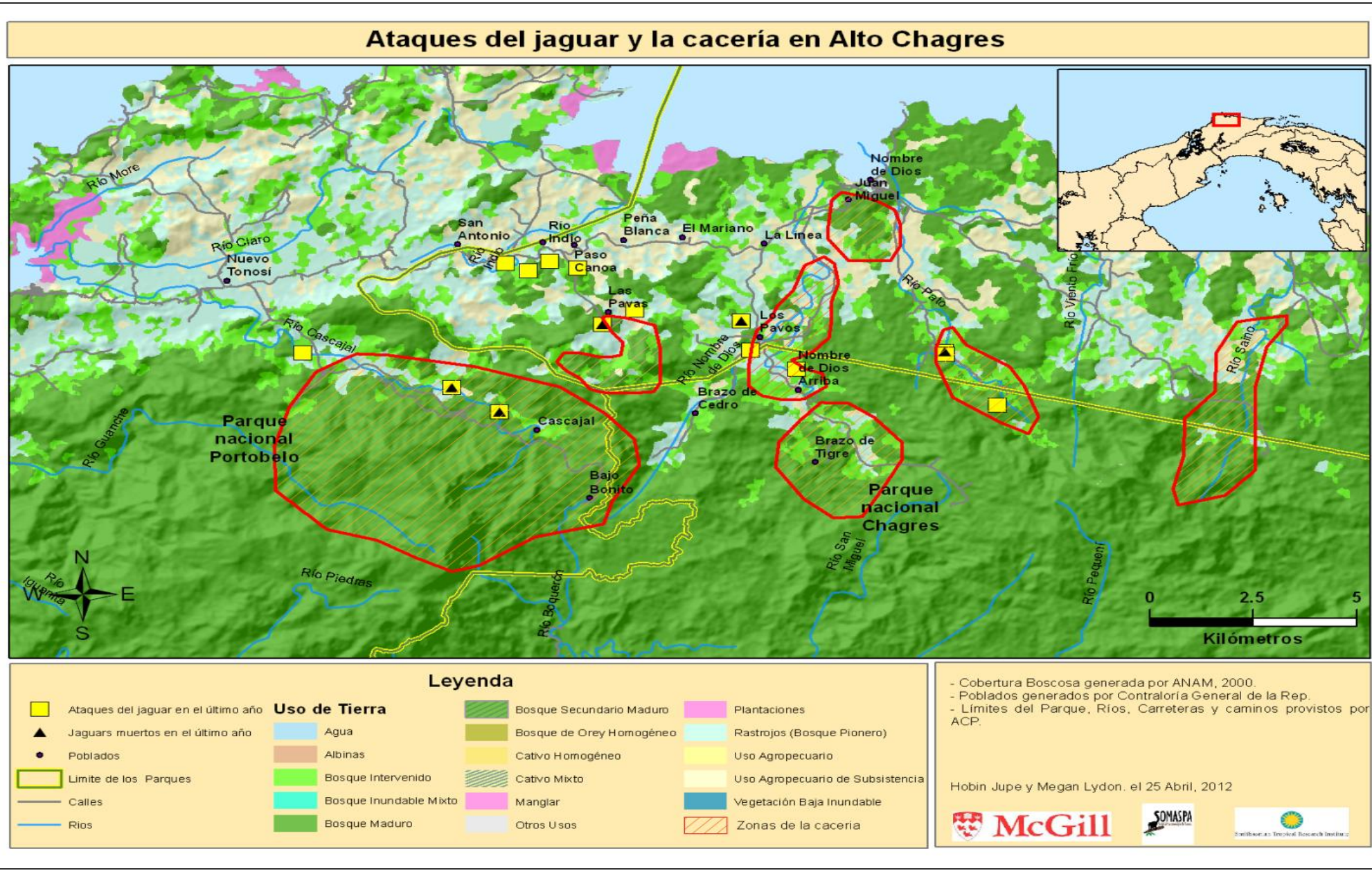
Appendix IV: Map of Study Sight



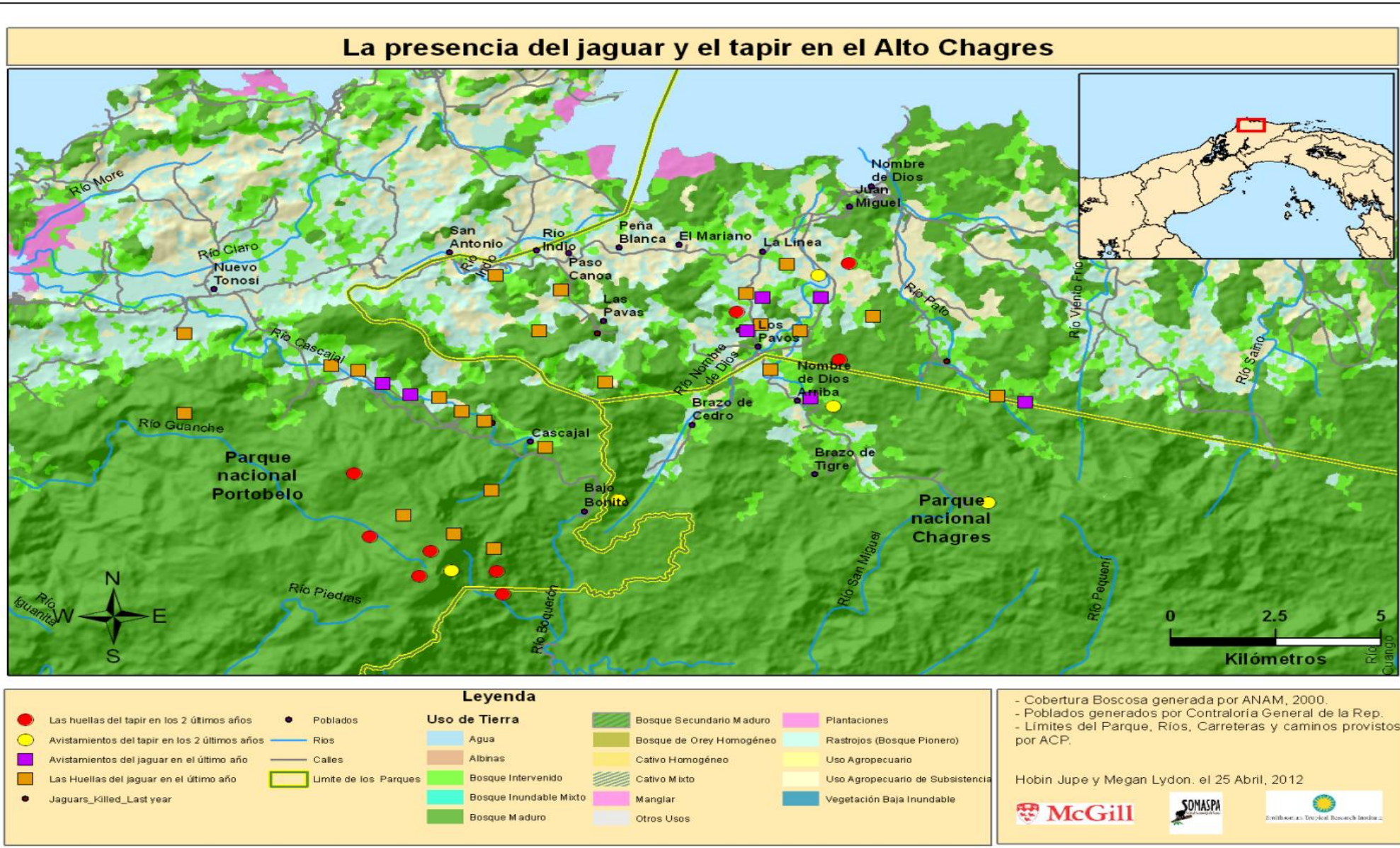
Appendix V: Map of general hunting areas in Alto Chagres



Appendix VI: Map of hunting areas and jaguar attacks in Alto Chagres



Appendix VII: Map of the presence of Jaguars and Tapir in Alto Chagres



Appendix VII Budget

Activity	*Unit Cost ($)*	*Total Cost per person ($)*
Round trip ticket to Nuevo Tonosí (per person)	10	(4 trips x 2) 40
Food (2$/breakfast, 2.5$ lunch, 2.5$/dinner)	7	(17 days x2) 120
Rental of room in Nuevo Tonosí (per night, per bed)	5	(15 nights x2) 75
Service of a guide in the field (per day)	10-15	(4days) 45
Transportation to farms for interviews • Pick up truck taxi (per day)	5	(10 days) 50
Transportation to SOMASPA office	3	(10 trips x2) 30
Film Development	10	5
Photocopies		10
Cell phone minutes		10
Binding of projects		2
Total Cost per person		**390**

Appendix VIII working days spent on project

Days worked (8hour day excluding breaks, transportation, and lunch)	**Days**
Days worked in Panama City	20
Days Spent in the SOMASPA Office	6
Days Spent in Field	17
Total	43

Appendix IX: Mammal census observation sheet

HOJA DE DATOS DE CENSO POR INDICIOS EN TRANSECTOS LINEALES PARA PRESAS DEL JAGUAR Y OTRAS ESPECIES DE INTERES

PARQUE NACIONAL CHAGRES, *ALTO CHAGRES*, PANAMA. 2012

Transect: 1	Observadores: Megan, Hobin , Eric	Horainicio: 7:12 am Hora final:
Fecha: 23 de Marzo de 2012	Climainicial: Rainy top of mountain slope, path littered with leaves, Muddy	Clima final:

Nombre de la especie	Tipo de rastro o indicio detectado	Obs.directa de la sp.	Numero de individuos	Numero del GPS	Estrato del bosque	Actividad del animal	Otrasobservaciones

Appendix X: Consent form

Formulario de Consentimiento

Investigaciones que necesitan la participación de humanos requieren el consentimiento de los participantes. La Universidad de McGill cree que todos los individuales tienen el derecho a esto respecto. Entonces ese acuerdo entre el investigador y el participante es obligatorio.

_____

Mi participación en ese investigación significa estoy de acuerdo de contestar preguntas sobre el tema de las presas del tigre. Yo doy mi permiso de usar lo que he dicho en la entrevista y mi lenguaje corporal para hacer conclusiones en esta investigación. Entiendo que no voy a recibir dinero por mi participación. Comprendo que voy a quedar anónimo y los resultados serian usado solamente para razones académicas. Cuando firma este documento libero mis derechos a este material.

Entiendo que no necesito contestar una pregunta si yo decido y puedo parar la entrevista en cualquier momento.

Finalmente, puedo obtener mas información de los investigadores Hobin Jupe y Megan Lydon o su supervisor a la Sociedad Mastozoologica de Panamá.

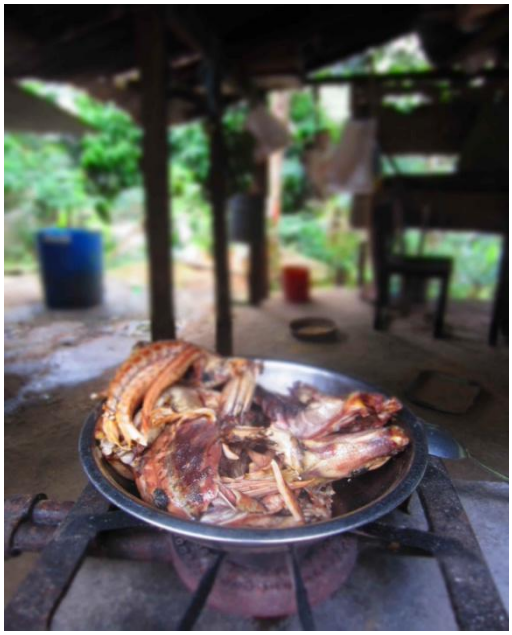
Firma: _____

Fecha: _____

Nombre (escribe con letra de molde por favor): _____

Appendix XI: Photos from the field

Picture 1. Saino skin



Picture 2. Iguana for lunch

Picture 3. Jaguar Skull

Picture 4. Jaguar teeth

Picture5. Gunshell found in transect

Picture 6. Oposum track

Picture 7. Puma track

Picture 8. Hobin taking GPS

Picture 9. Fair in Nuevo tonosi

Picture 10. Hobin doing a transect

Picture 11. Hobin at Fair

Picture 12. Megan at Fair

Appendix XII: Jaguar photos from trap camaras

Picture 1. Jaguar and its young in *Quebrada Las Pavas,. Alto Chagres*

Picture 2. Jaguar and its young in *Quebrada Las Pavas,. Alto Chagres*

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