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Exploring Long Term Patterns of Wildlife Use In Two Afroecuadorian Communities of Northwestern Ecuador

Tese de Mestrado em Ecologia (especialização em Ecologia Aplicada), orientada pelo Prof. Estebán Suarez (Universidad de San Francisco de Quito, Ecuador) e pelo Prof. José Paulo Sousa (Universidade de Coimbra) e apresentada ao Departamento Ciências de Vida da Faculdade de Ciências e Tecnologia da Universidade de Coimbra

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ABSTRACT

The use of natural resources by rural communities is one of the principal sources of food and income in rural areas. Subsistence hunting is a very common, dynamic and complex practice that depends on a diverse array of ecological, social, cultural and economic factors. Under current conditions, subsistence hunting is often unsustainable and can lead to depletion or local extirpation of wild species, having direct consequences on local communities and overarching impacts on ecological integrity. Despite its well-documented importance and impacts, questions still remain concerning the way in which the use of wild animals as food changes in the complex social and ecological settings in which it occurs. In this thesis we use a case study of two Afroecuadorian communities from North-western Ecuador to assess the long-term (24 years) changes in the patterns of wildlife use and their potential relationship with the socio-economic transformation experienced in the region.

The amount of collected biomass is quite small suggesting that wildlife is no longer a very important source of protein, however it can be important in the diet contributing to the diversification of the local diet. Most of the hunting in these communities is opportunistic and the majority of events occur near the farms. The use of traditional trapping system is still present and provides an alternative source of protein while helping in the protection of crops. Increased dependence in external sources of food was found as well as an increase in the number of sources of external protein, showing that the use of fauna as a source of food is not as important as it was in the past. Economic activities in form of agriculture and mining are the major source of income on the area, and supply the cash needed to purchase food from external sources.

Keywords

Hunting patterns, Fishing patterns, wildlife-use, Diet, Economic factors.

RESUMO

A utilização de recursos naturais pelas comunidades rurais é uma das principais fontes de alimento e de rendimento em áreas rurais. A caça de subsistência é uma prática muito comum, dinâmica e complexa que depende de um conjunto diversificado de factores ecológicos, sociais, culturais e económicos. Nas condições atuais, a caça de subsistência torna-se muitas vezes insustentável e pode levar à diminuição ou extinção local de espécies selvagens, tendo consequências diretas sobre as comunidades locais e impactos na integridade ecológica dos ecossistemas. Apesar da sua importância e os seus impactos estarem bem documentados, permanecem ainda questões sobre o modo como o uso de animais selvagens como alimento se pode alterar de acordo com os complexos contextos sociais e ecológicos em que esta prática ocorre. Nesta dissertação usamos um estudo de caso de duas comunidades Afroecuatorianas de noroeste do Equador para avaliar as mudanças a longo prazo (24 anos) nos padrões de uso da vida selvagem como alimento e sua potencial relação com a transformação socioeconómica ocorrida na região.

Os resultados mostram que a quantidade de biomassa animal caçada é bastante pequena, o que sugere que os animais selvagens já não são uma fonte muito importante de proteína sendo, no entanto, importantes na dieta local ao contribuir para a sua diversificação. A maior parte das atividades cinegéticas nestas comunidades é oportunista e a maioria dos eventos ocorrem perto das fazendas. O uso do sistema tradicional de captura (armadilhas tradicionais) ainda é utilizado e fornece uma fonte alternativa de proteína ao mesmo tempo ajuda na proteção de culturas. No entanto foi detetado um aumento da dependência em fontes externas de alimentos, incluindo um aumento do número de fontes de proteína externa, o que indica que a utilização da fauna como fonte de alimento não é tão importante como no passado. Atividades económicas como a agricultura e exploração mineira são agora a principal fonte de rendimento destas comunidades, fornecendo o rendimento necessário para a compra de alimentos a partir de fontes externas.

Keywords

Padrões de caça; Padrões de pesca; Uso da vida selvagem; Dieta; Fatores económicos.

INTRODUCTION

Hunting of wild animals by local people is one of the most controversial among the many ways in which humans interact with wildlife (Robinson and Redford 1991). On one hand, wildlife hunting can provide a substantial amount of animal protein, thus contributing to the food security of rural communities across the world (Nasi et al. 2008, Sarti et al. 2015). Moreover, wildlife hunting frequently plays a crucial role in the culture and social interactions of many rural or indigenous groups (Morsello et al. 2015). On the other hand, under current conditions, subsistence hunting is often unsustainable and can lead to depletion or local extirpation of wild species, with overarching impacts on ecological integrity (Dirzo and Miranda 1990, Ghanem and Voigt 2013). Despite its well-documented importance and impacts, questions still remain concerning the way in which the use of wild animals as food changes in the complex social and ecological settings in which it occurs. More specifically, additional information is needed about the relationship between changes socio-economic conditions and the long-term patterns of wildlife use. This information is seldom available, as long-term monitoring of hunting practices is difficult and time-consuming. In this context, in this thesis we use a case study of two Afroecuadorian communities from North-western Ecuador to assess the long-term (24 years) changes in the patterns of wildlife use and their potential relationship with the socio-economic transformation experienced in the region.

The hunting of wildlife constitutes one of the biggest threats for a large number of species (Bennett et al. 2002). At the same time, this practice has a crucial role on the diet of rural populations and the decline of game species can have a significant impact on human health (Golden *et al.* 2011), emphasizing the relation between subsistence hunting and human wellbeing. This is one of the reasons why wild-meat is considered determinant for food security not only if is directly obtained by hunting, but also if is obtained through different forms of trade (Nasi et al. 2008; CPW 2014). However, the relative importance of hunting as a source of food is probably dynamic, and might change rapidly according to the social, economic and ecological dynamics of a region (Stearman 2000).

Previous studies have shown that increased accessibility of rural communities and their connection to local markets can lead to changes in the purpose of hunting from subsistence to commercial hunting, with dramatic consequences for local wildlife (Franzen and Eaves 2007, Suárez et al. 2009, Suárez et al. 2012). Similarly, urbanization and increased connectivity can result in a “nutrition transition”, or the change from a traditional diet based on wild products, to a more westernized diet. As shown in parts of the Colombian Amazon (Van Vliet *et al.* 2015), local people are increasingly dependent on domestic and industrial sources of animal protein, can experience a poorer nutritional balance than that provided by wild meat. Moreover, this study suggested that this dependency on “external” sources of protein makes people reliant on the availability of cash and compromises their food security. From this perspective, even though the use of wild animals as food can lead to depletion of wild species, dependency on industrial food can also result in socio-economic or health problems among local communities (Popkin 1994). This and other studies that have reported changes in diet of rural communities call for attention on the nature of nutrition transitions and their potential impacts on food security and ecological integrity (Blackwell et al. 2009; Arnold et al. 2011).

The circumstances that lead to changes in the patterns and motives of wildlife use are complex. In Gabon, for example, wealth levels of rural families directly affected the amount of wildlife consumed (Wilkie *et al.* 2005). Similarly, a survey among four lowland Amerindian groups suggested that consumption of wild meat and fish was strongly dependent on the prices of protein alternatives, but also on the wealth of the households (Wilkie and Godoy 2001), while cultural attitudes were a better predictor of wildmeat consumption than economic variables among rural families in the Colombian and Brazilian Amazon (Morsello et al. 2015). However, to our knowledge, there are few studies that offer a retrospective view on the long-term patterns of subsistence hunting by local communities and their relationship with changing socio-economic and environmental conditions. This information is critical in terms of understanding the interaction between local communities and wildlife and providing guidelines for improving its ecological and social sustainability.

The Afroecuadorian communities that live in the Cotacachi Cayapas Ecological Reserve (CCER) and its buffer area, in Northwestern Ecuador, offer a striking example of the complex relationships that often connect human well-being and the conservation (or lack thereof) of wildlife. Having arrived in the region approximately 462 years ago, Afroecuadorians developed an intricate subsistence system that includes hunting of large and medium sized mammals and birds, fishing, and farming. Additionally, these communities use a traditional trapping system that provided a significant source of protein from at least seven species of rodents and marsupials, and also had a role in the protection of crops (Suarez *et al.* 1995).

Although, comprehensive evaluations are still lacking, it has been suggested that this trapping system might have become even more important as other sources of protein (fish and large mammals) are depleted (Suarez *et al.* 1995). Moreover, the large socio-economic and environmental changes that this region has experienced could have altered the relationships of local families with their forests. On one hand, certain pressures have increased, especially in the form of artisanal mining, and expansion of the agricultural frontier. On the other hand, conservation opportunities have also emerged through the development of eco-tourism initiatives, and conservation incentives such as the Socio-Bosque Program, a state-subsidized initiative that provides economic resources to communities that conserve their forests (Lobo 2015; WCS 2015). Despite the importance of these changes, there is little information on how they might affect the patterns of wildlife use in the region, a factor that remains critical for the conservation of the biodiversity in the CCER, an area that is also considered a regional biodiversity hotspot. From this perspective, a reevaluation of the patterns of wildlife use in this region could offer new insights into the mechanisms that affect the relationships between wildlife conservation and the wellbeing of local communities.

By revisiting the patterns of wildlife use by two Afroecuadorian communities studied by Suárez *et al.* (1995) in this study we offer a retrospective view on the

potential changes in subsistence hunting among these communities and their relationships with the socio-economic and environmental dynamics in this region. More specifically, the objectives of this thesis are: i) to assess potential long-term (25 years) changes in the patterns of wildlife hunting and use in two Afro-Ecuadorian communities, ii) to discuss the way in which these changes relate to the socio-economic changes that this region has experienced during the last two decades. We expect a change in wildlife use and therefore diets of both communities as a result of the changes in the socio-economic dynamics of the region occurring over the last 25 years. To elaborate the socio-economic changes mentioned here included the onset of new economic activities as well as intensification of present ones, increase in connectivity and access to markets. Ultimately, our goal is to use these communities as a case study to discuss the way in which socio-economic dynamics can alter the relationship between local people and wildlife.

STUDY AREA

The study conducted in this thesis was performed between February 28th and June 20th, 2016 in Esmeraldas province, Eloy Alfaro County, in northwestern Ecuador. This area corresponds to the buffer zone of the lower part (<500 m) of the CCER, a 246,638 ha protected area that represents the last continuous remnant of Tropical Lowland Forest of the Pacific coast of Ecuador. The study site experiences mean temperatures of 24 °C, the relative humidity is always greater than 90% and precipitation levels range between 2000 and 4000 mm/yr (MAE 2007).

Two Afroecuadorian communities (Figure 1) were chosen, one in the Luis Vargas Torres Parrish, in the Santiago River (Playa de Oro), and the other in the Telembí Parrish, in the Cayapas River (San Miguel). Both communities are predominately inhabited by Afroecuadorians, descendants of the first settlers that established in this region in the 1500's, and currently represent at least 87% of the total population of this area. The remaining population is mostly represented by members of the Chachi indigenous group who share this landscape but for the most part live in their own settlements, with limited interaction with Afroecuadorian communities.

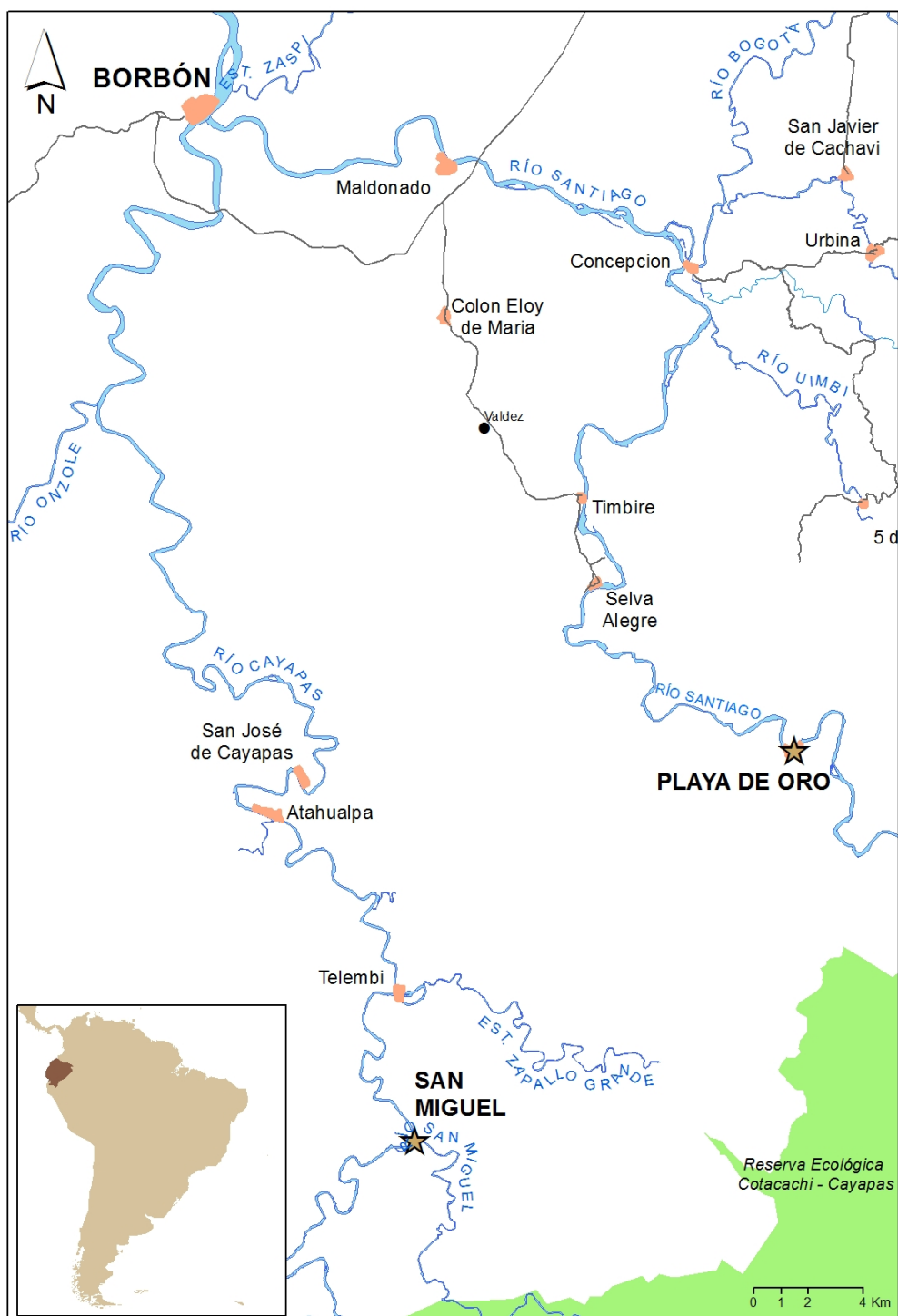


Figure 1: Map of the lower portion of Cotacachi- Cayapas Ecological Reserve and its buffer zone in northwestern Ecuador. Stars indicate the two communities where the study was conducted.

Community of San Miguel

This community is located in the Cayapas River (Figure 3) and was founded approximately 101 years ago. San Miguel is home to 200 inhabitants (40 families) and includes 1,928 hectares of communal lands. The main economic activities in this area are small-scale agriculture and logging. According with the INEC, 2010 poverty levels by unsatisfied basic needs in this community is 100%.



Figure 3: Map of San Miguel and its surroundings. Dots without name are hunting events of medium and big mammals, usually located close to farms; most of the activities are carried close to the river. Dots whit names represent all de communities located in the area, the star indicate the community of San Miguel where the study was conducted.

METHODS

To gather information on wildlife use, diet and basic socio-economic characteristics of each community, semi structured interviews were performed with 60 families in Playa de Oro (85.7% of the total population), and 33 families in San Miguel (82.5% of the total population). During these interviews information was gathered about i) hunting practices and frequency, ii) frequency of daily consumption of items of local or external origin, and iii) type and quantities of selected items that contribute to the family's assets (*e.g.* motor boat, TV set, refrigerator) (Appendix I). Additional interviews with community members helped us to gather additional information on the transportation system to and from each community, prices of external food items, and relative importance of activities such as farming, mining, and tourism

Hunting information gathered through interviews was complemented with direct records of hunted animals that were registered by the researchers, or by a community member that was hired to assist during the study and facilitate a better communication between researchers and the community. This information allowed us to estimate harvested biomass, identity of the game species, hunting areas, and the techniques used to capture different species. The fauna was divided in four categories: Medium to large sized mammals, small mammals, reptiles, and fish and crustaceans. The biomass of each group was calculated and reported for each community. In order to compare between communities and due to the differences in the number of families a correction was applied to the biomass, and we report this information as Kg/family/month. The number of families corresponds of the number of households that participated in the study and not to the total number of families in the communities.

As an important portion of the protein intake of these communities used to come from small mammals captured with a traditional trapping systems (Suárez *et al.* 1995, 1997), during this study we also collected information about types of traps used, setting locations, the number of traps per trapping line, trapping time,

number of weeks that traps were closed as well as the types of baits used were recorded. This information was qualitatively compared with the results reported by Suarez *et al.* (1995), to assess potential changes in hunting intensity and techniques through time. In addition to the interviews, visits to trapping lines of several hunters were performed with the owner. During these visits the following information for each animal captured was recorded: local Spanish name; scientific name; weight (g); head, tail, body and hind foot lengths (mm); general habitat type. The trapping effort and outcome of complete trapping periods were recorded and the efficiency of this hunting system was estimated. Comparison of the animals that are commonly hunted in the present with those which were hunted 20 years ago give us a sense of potential changes in the populations, a proxy measure of the sustainability of this practice over the last two decades.

As our objective was to assess if socio-economic factors could explain differences in wildlife use patterns through time and between communities, we complemented our data with information about the assets of the families, adapting the methodology proposed by Wilkie *et al.* (2006). A list of items was created consisting of specific appliances such as telephone, television, freezer and motor boats (Appendix I). During interviews we confirmed if each family owned these items and, using regional prices, we transformed this information into an estimate of the relative wealth of the families, and the mean relative wealth of the communities. This information was complemented with data on the type of house (timber vs concrete/bricks) where they live. Finally, we obtained information about the cost of basic food and cooking products in the communities and in the most important market on the area (Borbón) and analyzed the differences in the cost of these products to assess if the economic burden of consuming external food items was different between communities.

The different information gathered was treated in different ways, in the majority of the cases graphical representation (figures of percentages or frequency) were created, and comparative results in term of percentages or proportions were performed. Wilcoxon test, a non-parametric statistical test, was performed to

compare the frequency of consumption of diet items between communities, and the information of the relative wealth of the families between communities.

RESULTS

For medium and large mammals, the most popular hunting technic was the gun trap, which was the only technique used in San Miguel for this type of hunting. In Playa de Oro, 50% of the medium and large mammals were hunted with this method, while 37% were shot directly by a hunter, and 13% were killed with a machete. For small mammals 92% of the animals were killed using small mammal log-fall traps, while 8% were captured with artisanal live traps. Regarding fishing arts, most of the captures registered in San Miguel (68%) were carried out with an artisanal trap for crayfish and fish called “catanga”, while the remaining 32% was captured with conventional technics like hooks and nets. In Playa de Oro, 28% of the fishing events were carried out with two different types of traditional traps (Proceso and Corral), whereas the rest of the captures were done with conventional technics. Photos of the most used traps are available on Appendix II.

Between April and June 2016, a total of 42 medium and large mammals (11 species), 220 small mammals (7 species), 30 river turtles (4 species) and 676 fish (10 families) were captured in Playa de Oro and San Miguel. The most commonly hunted species were *Dasyprocta punctata* and *Cuniculus paca* among the medium–big size mammals, and *Proechymis semispinosus* and *Hoplomys gymnurus* among the small mammals (Tables 1 and 2). *Rhinoclemmys* was the most frequently captured Turtle, while Loricariidae was the family of freshwater fish with the largest contribution to the local fishery.

Table 1: Species of mammals captured during the study, number of captures, percentage, average weight, and Biomass.

Medium-Big size mammals						
species	Local name	No. Captures		% total	Weight (kg)	Biomass (Kg)
		San Miguel	Playa de Oro			
<i>Cuniculus paca</i>	Guanta	4	4	19.05	7.71	61.69
<i>Dasyprocta punctata</i>	Guatin	4	11	35.71	2.80	42.01
<i>Dasyopus novemcinctus</i>	Armadillo	3	4	16.67	5.27	36.91
<i>Tayassu pecari</i>	Saino	0	4	9.52	29.03	116.12
<i>Pecari tajacu</i>	Tatabra	0	1	2.38	11.00	11
<i>Bradypus variegatus</i>	Perico	0	2	4.76	3.00	6
<i>Choloepus hoffmanni</i>	Perico colorado	0	1	2.38	5.90	5.9
<i>Eira barbara</i>	Zorro madurero	0	1	2.38	2.21	2.21
<i>Mazama americana</i>	Venado	0	1	2.38	25.00	25
<i>Tamandua tetradactyla</i>	gonzo	0	1	2.38	2.72	2.72
<i>Potos flavus</i>	cusumbi	0	1	2.38	2.72	2.72
Total		11	31	100		312.28
Small mammals						
species	Local name	No. Captures		% total	Weight (kg)	Biomass (Kg)
		San Miguel	Playa de Oro			
<i>Proechimys semispinosus</i>	Raton liso	4	116	54.55	0.394	47.27
<i>Oryzomys caliginosus</i>	Churi negro	0	19	8.64	0.051	0.96
<i>Oryzomys alfaroi</i>	Churi blanco	0	29	13.18	0.045	1.32
<i>Didelphis marsupialis</i>	Zorra hedionda	0	4	1.82	0.454	1.81
<i>Hoplomys gymnurus</i>	Raton puyudo	0	41	18.64	0.699	28.64
<i>Oryzomys sp.</i>	Churi caniceto	0	6	2.73	0.075	0.45
<i>Heteromys australis</i>	Raton Bolson	0	1	0.45	0.056	0.06
Total		4	216	100		80.51

Table2: Species of reptiles and families of fish captured during the study, number of captures, percentage, average weight, and Biomass.

Reptiles						
species	Local name	No. Captures		% total	Weight (kg)	Biomass (Kg)
		San Miguel	Playa de Oro			
<i>Chelydra acutirostris</i>	tortugaña	0	5	16,70	4,53	22,67
<i>Rhinoclemmys sp.</i>	Tortuga	0	25	83,30	1,36	34,02
Total		0	30	100		56,69

Fish						
Family	Local name	No. Captures		% total	Weight (kg)	Biomass (kg)
		San Miguel	Playa de Oro			
Loricariidae	Guaña	47	167	31,66	0,15	32,10
Prochilodontidae	Sabalo	17	43	8,88	0,76	45,60
Bryconidae	Sabaleta	5	41	6,80	0,14	6,44
Heptateridae	Barbudo	70	22	13,61	0,21	19,32
Haemulidae	Cubo	2	4	0,89	1,59	9,54
Cichlidae	Mojarra/macho	2	23	3,70	0,14	3,50
Erythrinidae	Cagua/Chichero	25	8	4,88	0,18	5,94
Heptateridae	Picurito	1	0	0,15	0,08	0,08
Characidae	sardina	0	10	1,48	0,06	0,60
Atyidae	Camaron	149	40	27,96	0,06	11,34
Total		318	358	100		134,46

The total biomass of wildlife hunted in both communities is relatively low and amounted to less than 3 kg/month/family. However, Playa de Oro families extracted approximately 2.4 times more biomass of large mammals and 20 times more biomass of small mammals than San Miguel families.

Table 3: Biomass obtained by community on the different groups of fauna and correction for family in each community.

	Biomass San Miguel (kg)	Biomass Playa de Oro (Kg)	Biomass San Miguel (Kg/month/family)	Biomass Playa de Oro (kg/month/family)
Medium-big mammals	57.87	254.42	0.58	1.41
Small-mammals	1.58	78.93	0.02	0.44
Reptiles	0	56.70	0.00	0.31
Fish	52.35	82.11	0.53	0.46
Total	111.79	472.16	1.13	2.62

In terms of the heterogeneity of the game species hunted in each community (Figure 4) Playa de Oro used a more diverse group of animals, in which the largest biomass contribution is accounted for by medium and large sized mammals, while reptiles, freshwater fish and small mammals contributed between 12 and 17% of the biomass. In contrast, in San Miguel, large and medium sized mammals had a similar biomass contribution as in Playa de Oro,

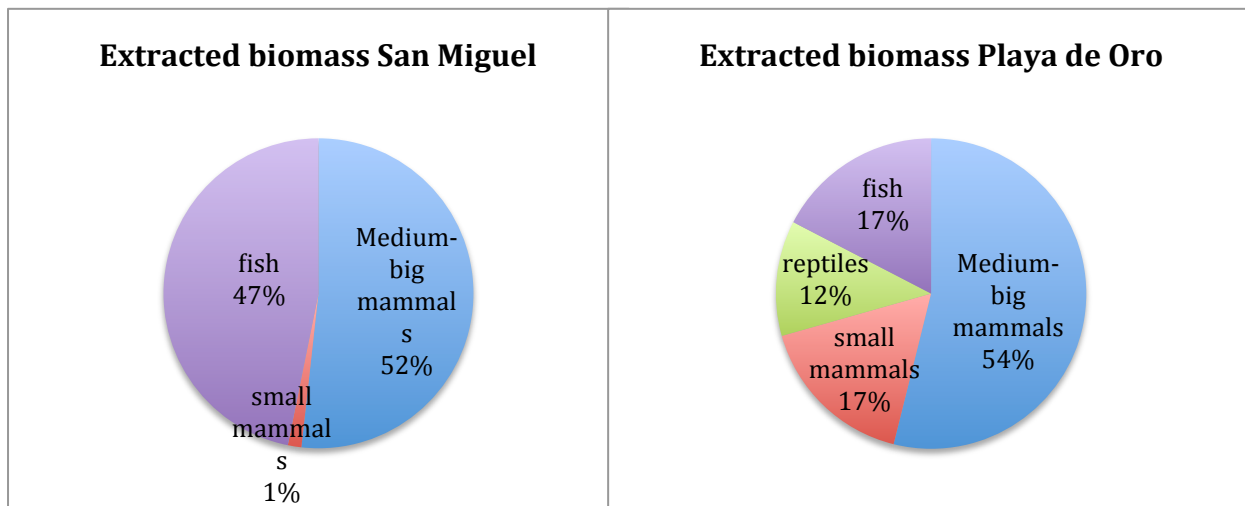


Figure 4: Percentage of biomass of different groups of fauna captured or hunted in the two study communities

but freshwater fish were almost as important, while small mammals had a negligible contribution (Figure 4). River turtles were only reported in Playa de

Oro and they contributed 12 % of the total biomass of hunted animals in this community.

Compared to the 1990's, we found important changes in the patterns of small-mammal hunting in the study communities. More specifically, in the first study, five types of traps were described, while only two of them were recorded in this thesis (Figure 5).

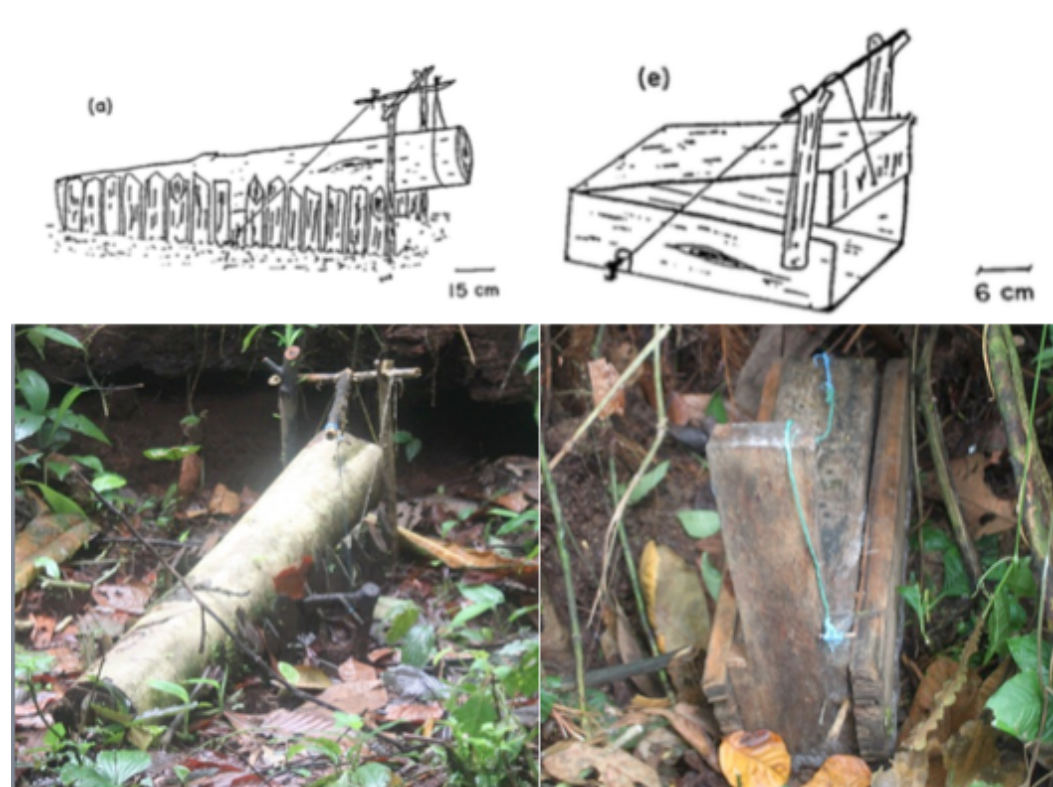


Figure 5: Types of traditional traps that are still present in the study communities.

In the same period, the number of traps per trap line decreased by 10%, while the number of days that the traps were open decreased by 48%. Similarly, the number of days in which traps are closed was also reduced by 63.2 %, suggesting that the frequency of use between hunting periods have increased (Table 4). Additionally, in Playa de Oro, 85% of the families have traps and 29.51% are using the system frequently, while the other 55.49% use the system occasionally. In San Miguel only 8.82 % of the families are using traps and they do it occasionally.

Table 4: temporal comparison of the trap systems taking in to account: number of traps per trap line, number of days that the traps are open, number of days traps are closed, knowledge of the traditional names of the part of the traps, well established trap lines, types of traps used, and types of baits used.

	Past	Present
# traps/ trap line	19.64(±27.22)	17.61(±10.51)
# dais trap open	6.00(±4.08)	3.11(±1.24)
# days traps are closed	39.9(±18.11)	14.69(±7.29)
Names used for trap parts	yes	yes
Maintain well-established trap lines	yes	yes
Use live and dead weight traps	yes	yes
Use large dead traps	yes	no
Use various baits for dead weight traps	yes	yes

In this study seven species of small mammals were captured with the traditional trapping system while 11 species were recorded in the 1990's. *P. semispinosus* is still the most common species hunted with this system, representing more than half of the individuals that where captured during the study (54.55%), a very similar percentage compared with that reported in the previous study (51.9%). *H. gymnurus* was the second species more frequently captured in the area (18.64%) increasing its proportion from 2.4% in the 1990's to 18.6% in our sampling (figure 6). In the past *O. caliginosus* used to be more common than *O. alfaroi* but this trend reversed in the present study.

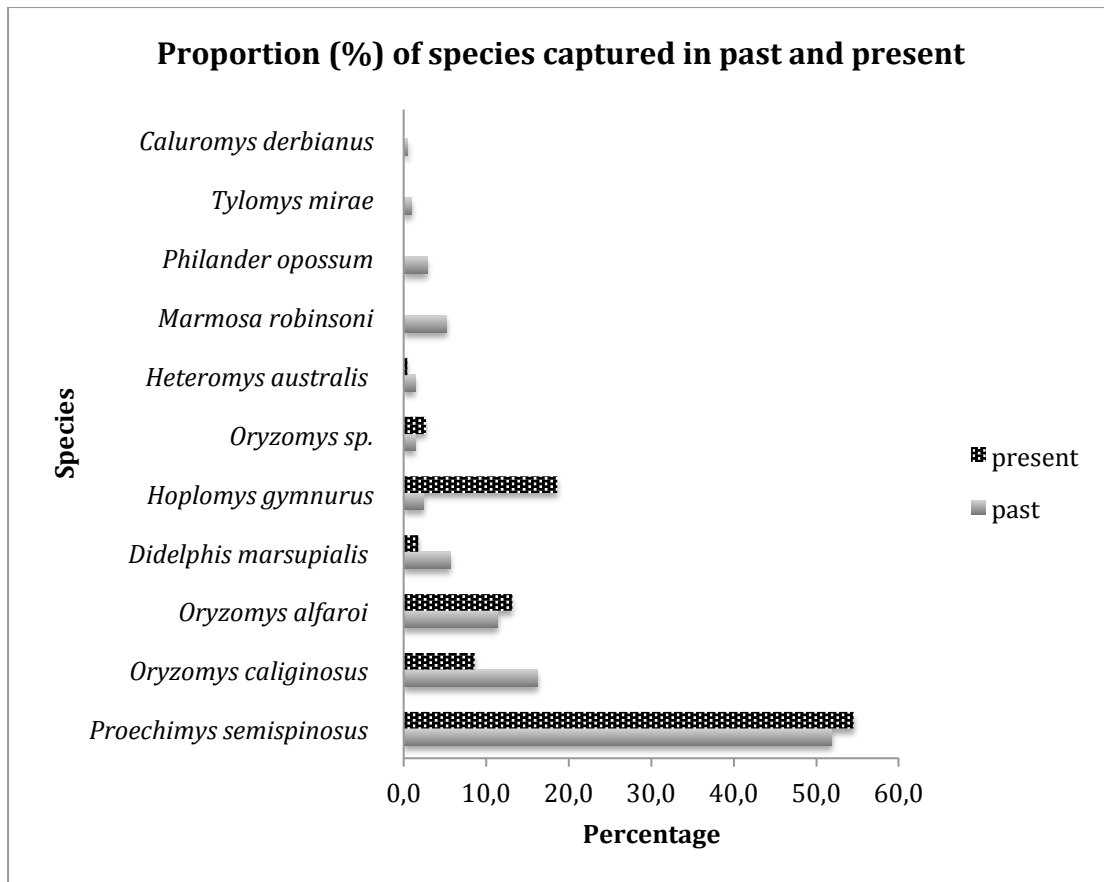


Figure 6: Comparison of the percentage of species captured with the traditional trapping system between 1990's (data from Suárez *et al.* 1995) and 2016 (this study) in two Afroecuadorian communities in North-Western Ecuador.

In the study by Suarez *et al.* (1995) trapping success per line ranged from 9.7 to 61 percent, with an overall mean success of 24.3 % for the trapping session. Currently, trapping success per line ranged from 0 to 86.61 %, with an overall mean success of 31.75 % for the trapping session.

The diet in both communities is similar in the general pattern, but also exhibits some important differences (Figures 7 and 8). In both cases the diet of these communities is mainly dominated by two staple food items (plantain and rice), which are accompanied by a protein source that frequently comes from external sources (*e.g.* chicken, eggs and sea fish). On average, external sources of protein were consumed between 1.2 and 1.6 times more frequently than freshwater fish, and between 3 and 5 times more frequently than wild meat.

Three of the food items that were evaluated showed significant differences between the two communities: noodles ($W = 1183.5$; $p = 0.041$), chicken ($W = 1224$; $p = 0.017$) and wild meat ($W = 1456$; $p = <0.001$). For these food items, Playa de Oro was the community with higher frequency of consumption. The standard deviation also shows that the diet inside these communities is heterogeneous.

In terms of local protein, both communities have a higher consumption of fish compared to wild meat. However, wild meat is consumed in both communities and is part of the diet approximately 1.4 days/week in Playa de Oro and 0.63 days/week in San Miguel.

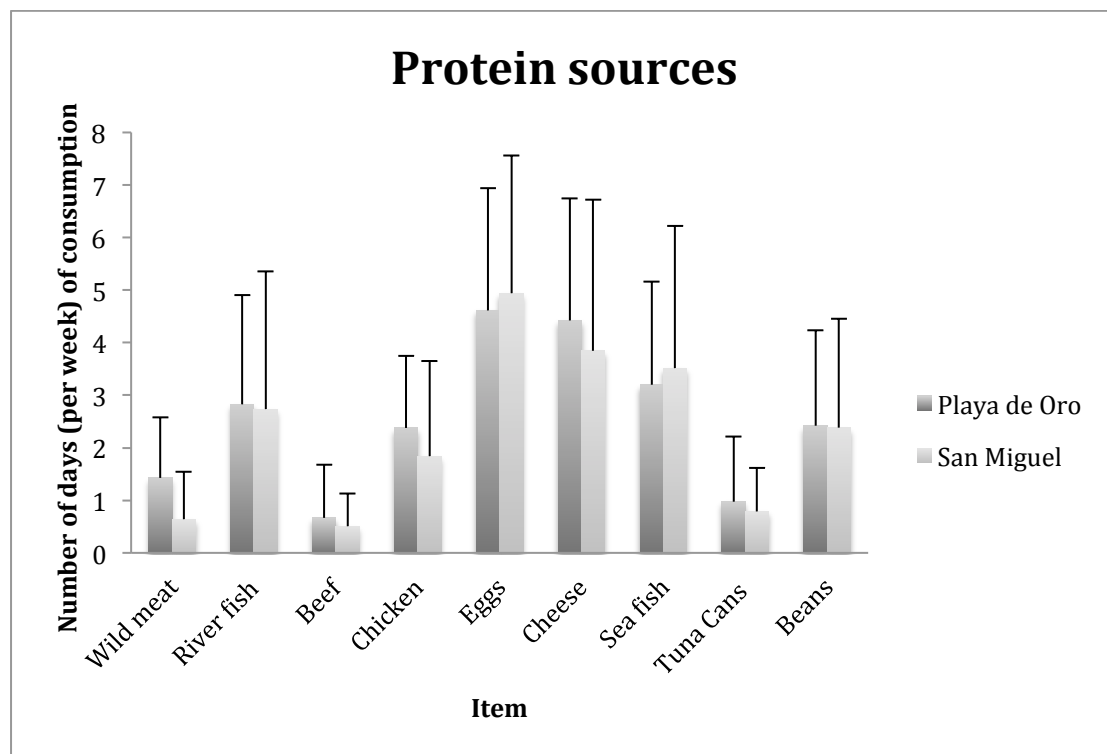


Figure 7: Number of days per week that different protein sources are consumed in the communities.

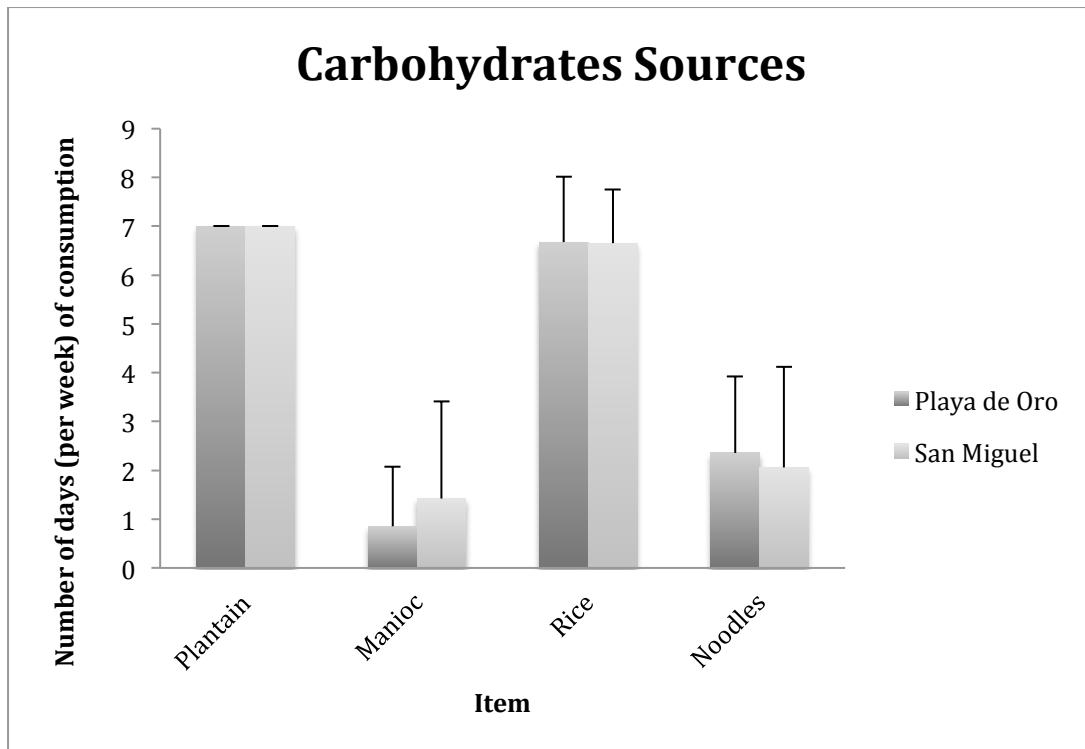


Figure 8: Number of days per week that different carbohydrates sources are consumed in the communities

The main economic activities in this area are agriculture, logging and mining (mostly artisanal). In Playa de Oro the most important activities are agriculture and gold extraction, while people in San Miguel mostly work on subsistence agriculture. As for other jobs, only 8.82 % of the families in San Miguel and 8.33% of the families in Playa de Oro have regular salaries in jobs usually related with education, or with control positions at the CCER.

The relative material wealth as estimated by the prices of the domestic appliances owned by the families was similar between San Miguel and Playa de Oro ($W = 1241.5$; $p = 0.081$). However, if the type and cost of the houses are taken into account, Playa de Oro families have a significantly higher level of wealth ($W = 1368$; $p < 0.001$) than families in San Miguel.

Differences between the prices of selected products in the communities and in the most important market on the area (Figure 9.) indicate that all the products, excepting carbohydrates, are more expensive in San Miguel, where the prices

were between 43,6% and 240% more expensive than in Playa de Oro, especially those used for transportation and cooking.

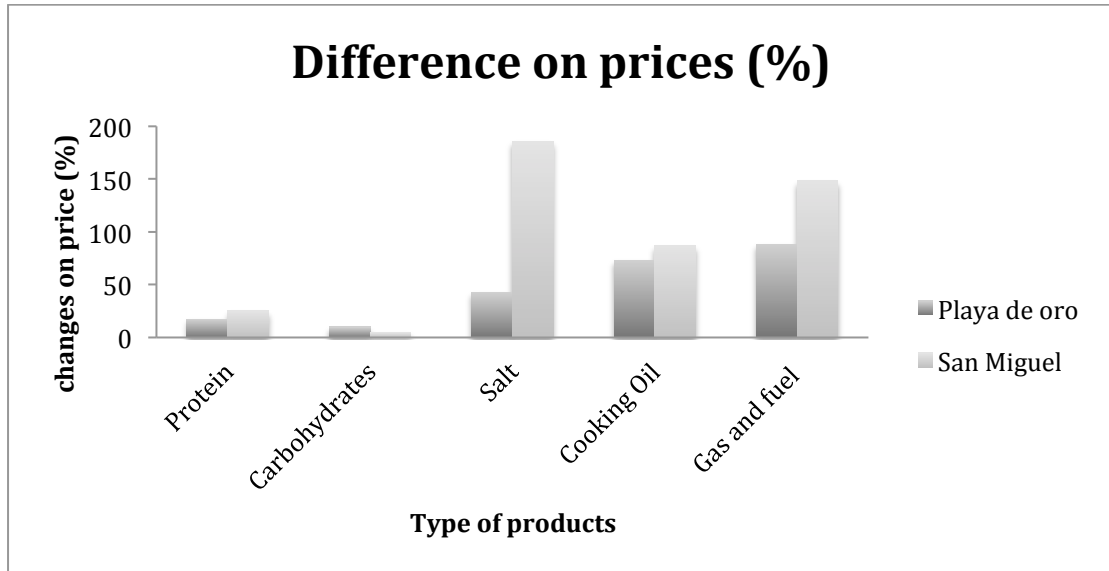


Figure 9: Difference in prices of specific food and cooking products between the two communities and most important commercial center of the area (Differences expressed as percentages).

DISCUSSION

Hunting strategy in both communities is opportunistic since this practice occurs nearby or in the farms and, for the most part, people is not going out to the forest specifically to hunt. Using this strategy, the inhabitants of these communities can get protein while carrying out other activities. In this way, by removing herbivore vertebrates through hunting they protect their farm's production and at the same time obtain some protein. This type of "garden hunting" allows the procurement of local carbohydrates and protein in the same area, optimizing subsistence activities (Smith 2005). Equally important is the fact that hunting remains close to the farms where sustainable hunting is likely to happen (Robinson and Bennett 2004), by concentrating the pressure on medium-sized mammals such as agouti (*Dasyprocta* spp.) and armadillos (*Dasypus novemcinctus*.) that have high reproductive rates and usually thrive in matrices of secondary forests and farms. This hunting pattern has the additional advantage of reducing pressure on source areas where the species can grow (Novaro et al. 2000), such as the Socio-Bosque and the CCER, which can be considered as reservoirs of diversity where species are not exposed to high pressures of hunting.

In terms of the number of species used in the two communities, Playa de Oro exhibited a greater amount of hunted species. One possible explanation for this pattern is that Playa de Oro is the last community of the Santiago River and its territory is directly adjacent to the CCER and has a larger amount of communal forest. In contrast, although San Miguel is a smaller community, it is located in a much more densely populated area of the Cayapas River, where the impacts of hunting and land-use change are more concentrated. In fact, based on the last population census of Ecuador (INEC 2010), the area surrounding San Miguel has a population density (4.46 inhabitants/km²) that is 9.5 times higher than that of Playa de Oro (0.47 inhabitants/km²). From this perspective, we could assume that the CCER still serves as a source area that supplies Playa de Oro with a larger amount of animals, while San Miguel is isolated from that source by a matrix of altered and densely populated land. In this context, the larger amount

of hunted animals in Playa de Oro could be explained within the framework of source-sink areas (Novaro et al. 2000) where the migration of species occurs from well-conserved areas towards the farms where most of the hunting occurs in this landscape.

The most common game species that we recorded were *D. punctata*, *C. paca*, and *D. novemcinctus*. These animals are commonly reported in several Neotropical studies as the most hunted species and, in many cases, their harvest is considered sustainable given their high reproductive rate and relative high densities (Peres 2001; Robinson and Redford 1994; Robinson and Bennett 2000; Zapata-Ríos 2001, Zapata-Ríos et al. 2009). However, we recorded other species such as sloths (*B. variegatus* and *C. hoffmanni*), tamanduas (*T. tetradactyla*), and white-lipped peccaries (*T. pecari*) that have lower reproductive rates and might be being hunted in unsustainable levels (Peres 2000). Although we have no data to evaluate this possibility, it needs further attention as these communities struggle to find alternative sources of income through ecotourism and sustainable agriculture.

Among the small-mammals, *P. semispinosus* and *O. alfaroi* are still some of the most common species captured with the local trapping systems, accounting for 55% and 13% of the captures, respectively. These percentages are almost identical to those reported by Suárez *et al.* (1995) for the same area. Moreover, the trapping success that we reported for these species falls well within the range of trapping success reported in the 1990's. However, other species like *O. caliginosus*, *Marmosa robinsoni*, *Philander opossum* and *Tylomis mirae*, either decreased in their representation among the hunted animals or were absent in our sampling. If these changes are due to the shorter sampling of our study compared to that of Suárez et al (1995), or if they represent a real change in the communities, it is difficult to evaluate. However, the inhabitants of both communities expressed that approximately seven years ago the populations of small mammals almost disappeared from the area, leading most of the hunters to abandon their trapping lines because the hunting effort was too big compared to the amount of animals that they were capturing. From this perspective, further

studies are needed to evaluate the sustainability of the current hunting practices in the changing environmental and socioeconomic context of this region. This is especially important considering that hunters in both communities stated that small rodent populations have been rising during the last few months, suggesting that this hunting practice might be subject to strong population cycles with important implications for the impacts and the social purpose of this trapping system.

In terms of the role of wild animals in the feeding of these communities, our data suggest two main patterns. First, terrestrial species, including small-mammals, are becoming a small fraction of the diet of local communities in this region, and have been mostly replaced by external sources of protein (*e.g.* chicken, sea fish). Second, fresh-water fish species remains an important contributor to the food security in these communities.

Regarding the first point, this conclusion is supported both by the small number of hunted animals that we recorded during the study, and by the relatively small frequency with which these species appeared in the daily diet of the families (Figure 7). In the 1990's, for example, mammals were frequently hunted by the large majority families in San Miguel and Playa de Oro, and their hunting system was wide-spread, elaborated, and included at least five different types of traps for small-mammals. In contrast, during our sampling, many families reported that they have not used traps for several years, the frequency of traps use decreased (Table 4), and only two types of traps were recorded (Figure 5). Furthermore, although some families still maintain trap lines in forest areas, their representation has decreased from 32 % in the 1990's to 17.4 % in the present study. As note before, this pattern might respond to the advantage of obtaining a local source of protein from small-mammals, while at the same time protecting the crops (Suarez *et al.* 1995).

As for the second point, our data shows that, while protein supplied by terrestrial species has been mostly replaced by external sources (mostly sea fish and chicken), freshwater fish is still a key source of protein for these

communities, even after 25 years of continuous use. This is striking, especially considering that our fishing data could be underestimating the importance of fish in the diet. As most people engage in fishing while performing other activities or through passive trapping methods, these events were not always recorded in our surveys. Moreover, local people in this region frequently regards fishing as a completely different pursuit from hunting, even if both activities involve the capture of wild animals as a source of protein. The fact that freshwater fish is present in at least three meals per week (Figure 7), makes these animals the most important source of local protein for these communities. From this perspective, management initiatives should pay special attention to fishing, not only in terms of its importance, but also in terms of its impact on fish populations and their ecosystem (Rowcliffe et al 2005).

Due to the diversity of the diet of these communities it is possible to assume that, under current conditions, they are not so susceptible to food security problems. Different food sources contribute to different micronutrients, and a diversified diet might decrease health problems. Moreover, the use of wild meat in low quantities might have a positive effect in the inhabitants because it tends to be high in micronutrients, and fiber, and low in sodium and fat. For this reason, even the small amount of wildmeat that we recorded in this study might be important in terms of mitigating the consequences of the nutrition transition (Arnold *et al.* 2011) that these communities are undergoing.

In terms of the changes in the diet of the families of Playa de Oro and San Miguel, our data suggest that external sources of protein have become more important and are progressively replacing wild meat, with the exception of freshwater fish, which is still well represented in the local diet. Based on our assessment of the current conditions of these communities, this nutritional transition in the diet could be due to i) increased accessibility to the communities, and/or ii) incorporation into regional markets and altered economic activities.

Regarding accessibility and transportation, it is safe to assume that accessibility has improved for both communities, first as a result of the construction of a new road to the community of Selva Alegre in the Santiago River, which reduced the boat ride to this community by at least 1.5 hours; second, through the widespread improvement of the road system in Ecuador that was facilitated by the huge increase that the national budget experienced during the last 8 years of high oil-prices. However, Playa de Oro is more easily accessible than San Miguel because the boat ride needed to get to the former community is much shorter. The difference in the costs of transportation is clearly reflected in the prices of external products (salt, oil, natural gas), which were higher in San Miguel than in Playa de Oro (Figure 9). These differences in prices, are consistent with our data on the diet, which showed that families at Playa de Oro consumed some food items of external origin (chicken and noodles) with significantly higher frequency than families at San Miguel (Figures 7 and 8). However, no significant differences were found in the frequency of consumption of sea fish, which accessibility also depends on transportation and is one of the most prevalent protein sources in this region. This apparent inconsistency suggests that, even if prices of external food items in San Miguel are higher, families in this community are still more likely to buy external protein (*i.e.* sea fish) because i) the time and effort needed for hunting is too large compared to the protein yield that they obtain, or ii) they are engaged in other subsistence activities (*e.g.* agriculture) that leave little time for other endeavors such as hunting. Thus, higher prices and higher time in mobilization in San Miguel do not seem to constrain the acquisition of external food items that replace protein from wild animals, suggesting that the changes in the local families' diet are only partly related to the increased accessibility of these communities.

As for the second option (incorporation of the communities into regional markets and altered economic activities), our data shows that at least two activities (artisanal gold mining and cacao production) have become increasingly important in this region, probably reducing the incentive and time that local people had in the past for engaging in hunting activities. Although gold mining has been present in this area for decades, our interviews revealed that currently

a much larger proportion of the population participates in this activity, especially in Playa de Oro. This observation is further supported by the observation of new and more sophisticated mining techniques (*e.g.* scuba diving suits, dredges, and pumps) that were absent from this region in the 1990's. Moreover, gold prices have been climbing consistently since the 1990's, creating additional incentive for families that are using this activity as a source of income (Alvarez-Berríos and Aide 2015). At the same time, cacao production and timber extraction have also intensified in the region as a result of increased accessibility and incorporation into markets. This agricultural activity, which used to be a minor endeavor in these communities, has gained importance and many families invest considerable time and resources cultivating cacao to be sold in the local markets. As a result, less time is devoted to hunting, and the subsistence of the families is mostly dependent on cash sources used to purchase food items from external sources.

Our comparison of hunting and feeding patterns between the 1990's and the present, portrays a conflicting picture that is probably common across the Tropics. On one hand, the food transition that occurs as local people consume less wild animals and become more dependent on external food items could reduce pressure on wild populations, increasing their probabilities for long-term survival. On the other hand, these transitions often occur as a result of intensification of other activities such as mining or agricultural expansion, which can also affect native ecosystems (Alvarez-Berríos and Aide 2015), thus impacting on local wildlife. In this way, if these activities are developed without planning or assessment of their impacts, they could affect wildlife in stronger and more pervasive ways than hunting.

Long-term comparisons of wildlife use by local communities offers useful insights into the complex mechanisms that control the relationships between human populations and game species. From this perspective, our study shows that incorporation of economic alternatives that reduce hunting pressure will only be effective in strengthening conservation if they do not affect remaining habitats. At the same time, as hunting has become a minor element in the local

diet, management efforts should favor the strengthening of other economic alternatives that place an increased value on biodiversity and other non-timber forest products, such as ecotourism and sustainable agriculture.

CONCLUSIONS

Although hunting occurs in both communities, the biomass of wild meat used in the area doesn't represent an important amount in terms of food. However, the use of wildlife (specially fresh water fish) might play an important role as a supplementary source of food and important microelements for the diet of the members of these communities.

The decrease in the use of wildlife as food in these communities is indicative of the economic transitions that the region has experienced, including improved access to markets and intensification of economic activities (agriculture and mining) that provide cash that can be used to acquire external sources of food.

The use of traditional traps and the consumption of small mammals are less important than in the 1990's, but they are still present on the area and might be maintained as part of the local farming systems. In this way, this practice might still play an important role in the diversification of diet and optimization in the use of local resources.

REFERENCES

- Alvarez-Berríos, N. L., and Aide, T. M. (2015). Global demand for gold is another threat for tropical forests. *Environmental Research Letters*, 10(1), 014006.
- Arnold, M., Powell, B., Shanley, P., and Sunderland, T. C. H. (2011). Editorial: Forests, biodiversity and food security. *International Forestry Review*, 13(3), 259-264.
- Blackwell, A. D., Pryor, G., Pozo, J., Tiwia, W., and Sugiyama, L. S. (2009). Growth and market integration in Amazonia: a comparison of growth indicators between Shuar, Shiwiar, and nonindigenous school children. *American Journal of Human Biology*, 21(2), 161-171.
- Bennett, E. L., Milner-Gulland, E. J., Bakarr, M., Eves, H., Robinson, J. G., and Wilkie, D. S. (2002). Hunting the world's wildlife to extinction. *Oryx* 36:328-329.
- Collaborative Partnership on Sustainable Wildlife Management CPW. (2014) Factsheet 2: Sustainable wildlife management and wild meat, viewed 10 July 2016, < <http://www.fao.org/3/a-i5185e.pdf>>
- Dirzo, R., and Miranda, A. (1990). Contemporary neotropical defaunation and forest structure, function, and diversity—a sequel to John Terborgh. *Conservation Biology*, 4(4), 444-447.
- Franzen, M., and Eaves, J. (2007). Effect of market access on sharing practices within two Huaorani communities. *Ecological Economics*, 63(4), 776-785.
- Ghanem, S. J., and Voigt, C. C. (2013). Defaunation of tropical forests reduces habitat quality for seed-dispersing bats in Western Amazonia: an unexpected connection via mineral licks. *Animal Conservation*, 17(1), 44-51.
- Godoy, R., Undurraga, E. A., Wilkie, D., Reyes-García, V., Huanca, T., Leonard, W. R., McDate, T., Tanner, S., and Vadez, V. (2010). The effect of wealth and real income on wildlife consumption among native Amazonians in Bolivia: estimates of annual trends with longitudinal household data (2002–2006). *Animal Conservation*, 13(3), 265-274.
- Golden, C. D., Fernald, L. C., Brashares, J. S., Rasolofoniaina, B. R., and Kremen, C. (2011). Benefits of wildlife consumption to child nutrition in a biodiversity hotspot. *Proceedings of the National Academy of Sciences*, 108(49), 19653-19656.
- Instituto nacional de estadística y censos INEC. (2010), viewed 5 March 2016, < <http://www.ecuadorencifras.gob.ec/censo-de-poblacion-y-vivienda/>>
- Lobo, J. (2015). A 'política do lugar': a Comuna afrodescendente Playa de Oro, Esmeraldas - Equador. *Universitas Humanística*, 80, 237-262.
<http://dx.doi.org/10.11144/Javeriana.UH80.aplc>

Ministerio de Ambiente del Ecuador MAE (2007). Plan de Manejo de la Reserva Ecológica Cotacachi – Cayapas. Quito.

Morsello, C., Yagüe, B., Beltreschi, L., Van Vliet, N., Adams, C., Schor, T., Quiceno-Mesa, M.P., and Cruz, D. (2015). Cultural attitudes are stronger predictors of bushmeat consumption and preference than economic factors among urban Amazonians from Brazil and Colombia. *Ecology and Society*, 20(4).

Nasi, R., Brown, D., Wilkie, D., Bennett, E., Tutin, C., Van Tol, G., and Christophersen, T. (2008). Conservation and use of wildlife-based resources: the bushmeat crisis. Secretariat of the Convention on Biological Diversity, Montreal. *and Center for International Forestry Research (CIFOR), Bogor. Technical Series, 50.*

Novaro, A. J., Redford, K. H., and Bodmer, R. E. (2000). Effect of hunting in source-sink systems in the neotropics. *Conservation Biology*, 14(3), 713-721.

Peres, C. A. (2000). Effects of subsistence hunting on vertebrate community structure in Amazonian forests. *Conservation Biology*, 14(1), 240-253.

Peres, C. A. (2001). Synergistic effects of subsistence hunting and habitat fragmentation on Amazonian forest vertebrates. *Conservation Biology*, 15(6), 1490-1505.

Popkin, B. M. (1994). The nutrition transition in low-income countries: an emerging crisis. *Nutrition reviews*, 52(9), 285-298.

Robinson, J. G., and Redford, K. H. (1991). *Neotropical wildlife use and conservation*. University of Chicago Press.

Robinson, J. G., and Redford, K. H. (1994). Measuring the sustainability of hunting in tropical forests. *Oryx*, 28(04), 249-256.

Robinson, J. G., and Bennett, E. L. (2000). Carrying capacity limits to sustainable hunting in tropical forests. In *Hunting for sustainability in tropical forests*, 13-30. Robinson, J. G. & Bennett, E. L. (Eds). New York: Columbia University Press.

Robinson, J. G., and Bennett, E. L. (2004). Having your wildlife and eating it too: an analysis of hunting sustainability across tropical ecosystems. *Animal Conservation*, 7(4), 397-408.

Rowcliffe, J. M., Milner-Gulland, E. J., and Cowlshaw, G. (2005). Do bushmeat consumers have other fish to fry?. *Trends in ecology & evolution*, 20(6), 274-276.

Sarti, F. M., Adams, C., Morsello, C., Van Vliet, N., Schor, T., Yagüe, B., Telles, L., Quiceno-Mesa, M.P., and Cruz, D. (2015). Beyond protein intake: bushmeat as source of micronutrients in the Amazon. *Ecology and Society*, 20(4).

- Smith, D. A. (2005). Garden game: shifting cultivation, indigenous hunting and wildlife ecology in Western Panama. *Human Ecology*, 33(4), 505-53
- Stearman, A. M. (2000). A pound of flesh: social change and modernization as factors in hunting sustainability among neotropical indigenous societies. *Hunting for sustainability in tropical forests*, 233-250.
- Suárez, E., Stallings, J., and Suarez, L. (1995). Small-mammal hunting by two ethnic groups in north-western Ecuador. *Oryx*, 29(01), 35-42.
- Suárez, E. and Suárez, L. (1997). La Cacería De Pequeños Mamíferos Y Su Importancia En La Alimentación De Afroesmeraldeños E Indígenas Chachi En El Noroccidente Del Ecuador. In: Mena, P.A., A. Soldi, R. Alarcon, C. Chiriboga & L. Suárez (Eds.) *Estudios Biológicos para la Conservación. Diversidad, Ecología y Etnobiología*. EcoCiencia. Quito, 427-439.
- Suarez, E., Morales, M., Cueva, R., Utreras Bucheli, V., Zapata-Rios, G., Toral, E., Torres J., Prado, W., and Vargas Olalla, J. (2009). Oil industry, wild meat trade and roads: indirect effects of oil extraction activities in a protected area in north-eastern Ecuador. *Animal Conservation*, 12(4), 364-373.
- Suárez, E., Zapata-Rios, G., Utreras, V., Strindberg, S., and Vargas, J. (2012). Controlling access to oil roads protects forest cover, but not wildlife communities: a case study from the rainforest of Yasuní Biosphere Reserve (Ecuador). *Animal Conservation*, 16(3), 265-274.
- Van Vliet, N., Quiceno-Mesa, M. P., Cruz-Antia, D., Tellez, L., Martins, C., Haiden, E., Ribeiro Oliveira, M., Adams, C., Morsello, C., Valencia, L., Bonnilla, T., Yagüe, B., and Nasi, R. (2015). From fish and bushmeat to chicken nuggets: the nutrition transition in a continuum from rural to urban settings in the Colombian Amazon region. *Etnobiology and Conservation*, 4(6).
- Wildlife Conservation Society WCS. (2015). Diagnóstico socioeconómico de las comunidades de influencia del Proyecto GEF-Paisajes Vida Silvestre. opinión pública Ecuador.
- Wilkie, D. S., and Godoy, R. A. (2001). Income and price elasticities of bushmeat demand in lowland Amerindian societies. *Conservation Biology*, 15(3), 761-769.
- Wilkie, D. S., Starkey, M., Abernethy, K., Effa, E. N., Telfer, P., and Godoy, R. (2005). Role of prices and wealth in consumer demand for bushmeat in Gabon, Central Africa. *Conservation Biology*, 19(1), 268-274.
- Wilkie, D. and the Living Landscapes Program (2006). Household surveys—a tool for conservation design, action and monitoring. Technical Manual 4, Wildlife Conservation Society, Living Landscapes Program, Bronx, NY

Zapata-Ríos, G. (2001). Sustentabilidad de la cacería de subsistencia: el caso de cuatro comunidades quichuas en la Amazonía nororiental ecuatoriana. *J. Neotrop. Mammal*, 8(1), 59-66.

Zapata-Ríos, G., Urgiles, C., and Suárez, E. (2009). Mammal hunting by the Shuar of the Ecuadorian Amazon: is it sustainable?. *Oryx*, 43(03), 375-385.

APPENDIX I.

QUESTIONNAIRE

Community:
Name:

Date:
Age:

- What activities do you perform? Hunting / Fishing / Agriculture ... Other economic activity?
- If permorm Agriculture activities :What products do you grow, what do you sell and what is for your own consumption? Size of land cultivated? * Selling price of products.
- When was the last time you hunted, fished.What technique did you used.
- How often do you feed on: wild meat / fish river? (Days / week)
- When was the last time you eat wild meat / fish river?
- What did you eat today?
- How often do you feed on: beef / chicken / egg / cheese / sea fish / pork? (per week)
- How often do you feed on green banas, cassava, chicha (per week)
- How often do you feed on: rice (local or cultivated), grains, pasta, canned (per week)
- What do you use to cook (gas, wood) * Gas Tank Price / Cost mobilization
- Do you have a job with salary?

Construction of Wealth Index

Variable	Description	Options
Housing Material	Material used in the construction of the house	•Wood and Palm • Wood •Cement, Wood and Corrugated metal •Cement and Corrugated metal
Tenancy	Ownership of the house	•Owner occupied •Rental •Borrowed
Asset Ownership	Ownership of the following assets	•Television •Refrigerator or freezer •Motor boat •Electric generator •Conventional phone

Do you get one of these state benefits?: solidarity bonus / retirement / Manuel Espejo (disabled).

APPENDIX II.

Traditional traps for Fishing:

Catanga:



Corral and Proceso (top and right respectively):



Hunting traps:

small mammal log-fall trap:



Gun trap:

