

Université Libre de Bruxelles

Institut de Gestion de l'Environnement et d'Aménagement du Territoire

Faculté des Sciences

Master en Sciences et Gestion de l'Environnement

**Primate conservation from Waorani's perspective in Ecuador's Yasuní
National Park. Study case in the community of Guiyero.**

Mémoire de Fin d'Etudes présenté par

DUVIVIER, Zoé

en vue de l'obtention du grade académique de

Master en Sciences et Gestion de l'Environnement

Finalité Gestion de l'Environnement M-ENVIG

Année Académique : 2019-2020

Directrice: Marie-Françoise Godart

Co-directeur: Santiago Espinosa

Acknowledgements

The writing of this dissertation would not have been possible without the support of the people who collaborated with me in Belgium and in Ecuador.

For this, I would like to express my gratitude to

Marie-Françoise Godart, my director, for supervising this dissertation;

Santiago Espinosa, my co-director, for his availability and valuable advice;

Edwin Zaccai, for always supporting my projects in Ecuador during this master's degree;

Régine Vercauteren Drubbel, who I met thanks to Martine Vercauteren, for her kind help;

David Lasso and Miguel Ángel Rodríguez, the directors of Yasuní Scientific Station, for their trust and logistical support;

Juan Carlos Armijos, for involving me in his everyday work with the Waorani, for his positive energy and dedication;

The members of the Wildlife Conservation Society, for their enriching collaboration on many occasions during my projects in Ecuador;

The personnel of Yasuní Scientific Station, “Los maperos”, the members of the MAE, the teacher of Guiyero, as well as all the people I met during my field work;

Of course, the Waorani of Guiyero, Ganketapare, Paraíso and Timpoka, for sharing this time with me;

Olivia Crasset and Louise Plumhoff, my talented proofreaders, for their time, skills and interest in my work;

My parents, without whom none of this would have been possible.

Finally, I would like to particularly thank ARES for bringing me a financial support in the context of this master's thesis.



Résumé

Depuis l'intrusion des missionnaires évangéliques dans les communautés Waorani, succédée par le développement de l'industrie pétrolière dans l'Amazonie équatorienne, le mode de vie des populations indigènes du Yasuní a été profondément transformé. Ces deux influences ont entraîné de nombreuses répercussions dans les communautés Waorani, entre autres; une croissance démographique, l'introduction massive d'armes à feu dans les parties de chasse, de nouvelles nécessités matérielles et économiques liées à la société occidentale et un accès par la route aux zones où la faune était encore abondante ainsi qu'aux endroits stratégiques pour la vente d'animaux sauvages. Alors que les primates ont toujours fait partie du régime alimentaire des Waorani en tant que chasseur-cueilleurs, ces facteurs ont contribué à la diminution des populations de primates, amenant les espèces les plus vulnérables au bord de l'extinction aux alentours des communautés Waorani. Cette situation représente une menace pour toute la biodiversité du Yasuní puisque les primates remplissent des fonctions essentielles dans les écosystèmes de la forêt amazonienne. Cette analyse fait ressortir le fait que les espèces de grande taille sont les plus vulnérables, les plus chassées pour leur protéine et valeur marchande et ont un rôle indispensable dans la dispersion de graines. Les mesures en termes de conservation proposées jusqu'à présent sont difficilement applicables à cause du manque de soutien institutionnel et des différents conflits d'intérêts liés à cette région. De plus, elles n'apportent aucune garantie sur le long terme puisque la chasse non-durable est le résultat des récentes transformations socioéconomiques et culturelles chez les populations locales. Ce travail émet l'hypothèse que le développement d'une activité économique durable par les Waorani pourrait être utilisé comme stratégie de conservation des primates. Une étude de cas dans la communauté de Guiyero démontre que les habitants aimeraient faire du tourisme afin de devenir autonomes financièrement, mais aussi pour promouvoir la culture Waorani et maintenir la biodiversité locale. Cependant, pour éviter les potentiels effets néfastes de cette activité, une série de conditions doivent être mises en place. Cela est fort limité par les dynamiques actuelles de Guiyero, à savoir l'absence d'organisation et de leadership au niveau communautaire et la dépendance matérielle envers la compagnie pétrolière Repsol. D'autres stratégies pourraient être envisagées, par exemple la certification de peau de pécarí, à condition de recevoir un soutien externe encourageant l'autonomie des Waorani sur le long terme, et que ceux-ci s'engagent délibérément dans le projet.

Abstract

Since the intrusion of the evangelic missionaries in the Waorani communities, followed by the development of the oil industry in the Ecuadorian Amazon, the lifestyle of Yasuní's indigenous populations underwent deep transformations. The repercussions of these two influences in the Waorani communities include a demographic growth, the massive introduction of firearms in hunting parties, new material and economic needs associated with the Occidental society, and an access by road to areas where fauna was still abundant as well as to strategic places for wildlife commercialization. Whereas primates had always been part of the Waorani's diet as hunter-gatherers, these factors contributed to the depletion of primate populations, leading the most vulnerable species on the verge of extinction around the Waorani communities. This situation represents a threat for the whole biodiversity since primates have essential functions in the Amazon rainforest ecosystems. This analysis points out the fact that large-sized species are the most vulnerable and the most hunted for their protein and market value, and are indispensable seed dispersers. So far, the conservation measures that have been suggested are difficult to implement due to the lack of institutional support and the conflicts of interests related to this area. Moreover, they provide no long-term guarantee since unsustainable hunting is the result of the recent socioeconomic and cultural transformations among local populations. The assumption of this dissertation is that the development of a sustainable economic activity by the Waorani could be used as a strategy for primate conservation. A study case in the community of Guiyero suggests that the inhabitants would like to develop tourism not only to become financially autonomous, but also to promote the Waorani culture and to maintain the local biodiversity. Nevertheless, to prevent the potential detrimental effects of this activity, several conditions have to be implemented. This is strongly limited by the current dynamics of Guiyero, characterized by the absence of organization and leadership at the community level, and the material dependence on Repsol oil company. Alternative strategies can be considered, such as peccary skin certification, provided that external support promoting Waorani's long-term autonomy gets involved and that, in turn, they deeply commit in the project.

List of contents

List of abbreviations.....
List of figures
List of tables.....
Introduction	1
Chapter 1: Background of a socio-cultural evolution in Yasuní	3
1. The Waorani.....	4
1.1. A long period of isolation: main cultural aspects.....	4
1.2. Native Amazonian hunters	5
1.3. In the present	6
2. External influences.....	7
2.1. The Evangelical Church: from isolation to first cultural changes.....	7
2.2. Oil development: landscape transformations in Yasuní.....	8
3. Repercussions of the external interventions in the Waorani territory	10
3.1. Indigenous resistance and territorial adaptations.....	10
3.2. Identity crisis and Integration into the market economy	11
4. Conclusion of Chapter 1	12
Chapter 2: Implications of oil development for biodiversity and primate conservation. 12	
1. Main impacts on primates and their environment	13
1.1. Oil contamination	13
1.2. Colonization and deforestation.....	13
1.3. Other disturbances related to oil infrastructure	14
1.4. Overhunting and related factors	15
2. Focus on primates: species' use by hunters, ecological roles and conservation status.....	18
2.1. Changes in Waorani hunters' resource use from the perspective of primates.....	18
2.2. Factors of vulnerability.....	20
2.3. Main ecological functions of primates in Amazon ecosystems	21
2.4. Overview of today's situation: primate conservation status, threats, and ecological roles.....	23
3. Primate conservation in Yasuní: needs, actions and limits.....	26
3.1. Reinforcing the control of wildlife traffic	27
3.2. Managing hunting practices	28
3.3. Limiting the presence of humans and infrastructures in protected areas	30
4. Conclusion of Chapter 2.....	32

Chapter 3: Primate conservation together with local communities. Study case in the Waorani community of Guiyero	33
1. Why integrating the Waorani in primate conservation issues?	33
2. Study area	35
3. Method	37
4. Results and discussion	39
4.1. Waorani's perception of primate depletion and conservation	39
4.2. The place of the ancestral culture in wildlife conservation	40
4.3. Tourism: a sustainable alternative to wildlife commercialization?	41
4.4. Alternative community-based conservation strategies	45
4.5. Limits to primate conservation with local populations in Guiyero	48
5. Conclusion of Chapter 3	51
General conclusion	52
Bibliography	55
Annexes	70

List of abbreviations

AMWAE	Asociación de Mujeres Waorani de la Amazonia Ecuatoriana (Association of Waorani Women of the Ecuadorian Amazon rainforest)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
Conaie	Confederación de Nacionalidades Indígenas del Ecuador (Confederation of Indigenous Nationalities of Ecuador)
ECY	Estación Científica Yasuní (Yasuní Scientific Station) / Yasuní Research Station
EIA	U.S. Energy Information Administration
FAL	Fundación Alejandro Labaka (Alejandro Labaka Foundation)
FAO	Food and Agriculture Organization of the United Nations
FIDAL	Fundación para la Integración y Desarrollo de América Latina (Foundation for the Integration and Development of Latin America)
GOFC-GOLD	Global Observation of Forest Cover and Land Dynamics
HDI	Human Development Index
IUCN	The International Union for Conservation of Nature
ITT	Ishpingo-Tambococha-Tiputini oil fields
MAE	Ministerio del Ambiente Ecuatoriano (Ecuadorian Ministry of the Environment)
ONHAE	Organización de la Nacionalidad Huaorani de la Amazonia Ecuatoriana (Organization of the Huaorani Nationality of the Ecuadorian Amazon)
PES	Payments for Environmental Services
SIL	Summer Institute of Linguistics
RDC	Rural District Councils
REW	Reserva Étnica Waorani (Waorani Ethnic Reserve)
UNESCO	United Nations Educational, Scientific and Cultural Organization
WCS	Wildlife Conservation Society
WWF	World Wildlife Fund
YNP	Yasuní National Park
YBR	Yasuní Biosphere Reserve

List of figures

Figure 1: Species richness of northern South America, including YNP, for A) amphibians, B) birds, C) mammals and D) vascular plants (Bass et al., 2010).	1
Figure 2: Painting illustrating a Waorani ancestral tradition; women used to paint their face with red pigment of achiote, a plant that grows in the Amazon rainforest (School of Guiyero, February 2020, photo by Z. Duvivier).....	5
Figure 3: Map of YNP and REW (Modified from Espinosa et al., 2014). It shows the market of Pompeya, i.e., main spot for wild meat traffic; the Maxus road; and the main Waorani communities located alongside the Maxus road.	6
Figure 4: Map of the oil blocks covering the Napo Moist Forests ecoregion and YNP, including oil access roads within and surrounding the park (Modified from Bass et al., 2010).	9
Figure 5: Landscape of Ecuador’s Yasuní, including indigenous groups and protected areas (WCS, 2007-2020).	11
Figure 6: Map of the area along the Maxus road, including Guiyero, Ganketapare, Timpoka, Yasuní Scientific Station (ECY) and Repsol oil company (modified from Merlyn Sacoto, 2018b). Repsol controls the access to Maxus road, provides free transportation and most facilities that are represented on this map, i.e., wood and cement houses, school, children’s playground, cement stadium in Guiyero.	35
Figure 7: Entrance to the community of Guiyero alongside the Maxus road. At the end of the road, there is the school, the stadium of Guiyero, and the bus of Repsol used by the Waorani (Guiyero, March 2020, photo by Z. Duvivier).....	36
Figure 8: <i>Lagothrix lagothricha poeppigii</i> and <i>Cebus yuracus</i> , juvenile kept as pets in Guiyero (Guiyero, March 2020, photo by Z. Duvivier).	39
Figure 9: handicraft made of chambira, a local palm tree, by the Waorani women (Guiyero, March 2020, photo by Z. Duvivier).....	40
Figure 10: The “cabaña” (lodge) built for tourism in Guiyero but left unsued (Guiyero, March 2020, photo by Z. Duvivier).....	42
Figure 11: The chacra of a Waorani family of Guiyero (Guiyero, March 2020, photo by Z. Duvivier).	46
Figure 12: Traditional dance lesson as part of the “Waorani culture” class given at the school of Guiyero (Guiyero, February 2020, photo by Z. Duvivier).....	50

List of tables

Table 1: Species most vulnerable to overhunting and their relative contribution to total harvests (% of total kg harvested) (Franzen, 2006). It shows the results for the Waorani communities of Tiimpuca (i.e., Timpoka), Guiyero, and Dicaro studied by Franzen (2006); Quehueiri-ono and Huentaro studied by Lu (1999); Quehueiri-ono studied by Mena et al. (2000); Tewaeno, Tzapino, Quiwado and Wamono studied by Yost & Kelley (1983)..... 19

Table 2: Summary of Yasuní's primate species, including common English and Spanish names, scientific names, Global Conservation Status (IUCN, 2020a), Local Conservation Status (Tirira, 2011), Main threats (Tirira et al., 2018a) and Ecological roles (de la Torre et al., 2019)..... 24

Introduction

Ecuador's Yasuní is a portion of the Amazon rainforest that presents three major particularities. First, recognized as a National Park (YNP), it holds one of the last tracts of pristine tropical forests in eastern Ecuador, including more than 3000 vascular plant species (H. Mogollon & J. Guevara, unpub. data, paraphrased by Bass *et al.*, 2010) and at least 200 mammal species (Voss & Emmons, 1996). This biodiversity richness, illustrated in Figure 1, contributes to Yasuní's conservation significance at the global level (Bass *et al.*, 2010).

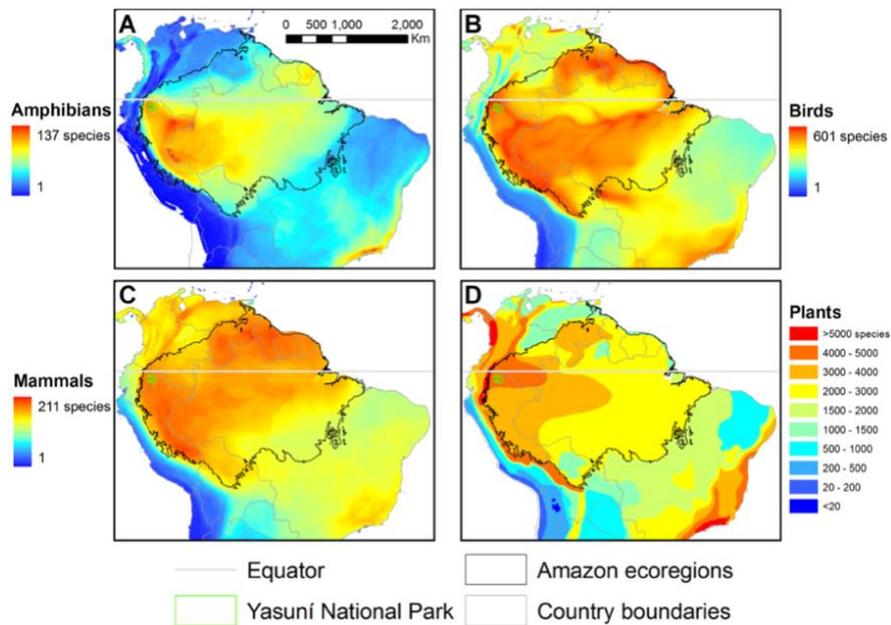


Figure 1: Species richness of northern South America, including YNP, for A) amphibians, B) birds, C) mammals and D) vascular plants (Bass *et al.*, 2010).

Second, Ecuador holds the third-largest oil reserve in South America, after Venezuela and Brazil (EIA, 2017), and its second largest untapped oil fields (ITT fields) lie beneath the northeastern section of YNP (Bass *et al.*, 2010) (Figure 4, Ch.1 section 1.3.). Today, Ecuador's economy relies to a large extent on oil activities; the country exports 70% of the crude oil it produces and is the third-largest supplier of crude oil imports to the U.S. West Coast behind Saudi Arabia and Canada (EIA, 2017). Since the beginning of oil exploitation in the 20th century, petroleum has provided over half of the value of Ecuador's export revenues and over half of government revenues every year since the 1970s (Bilsborrow *et al.*, 2004). According to WWF, oil exploration and exploitation in South America are increasing and Yasuní represents an immense potential (Charity *et al.*, 2016).

Third, the Ecuadorian Amazon houses several indigenous groups, partially or totally isolated in the forest. Yasuní is predominantly inhabited by the Waorani, a group that today includes between two and three thousand individuals, distributed in about 24 communities in the provinces of Orellana, Pastaza and Napo (Conaie, n.d.; Cano Molestina, 2018). Their territory, recognized as the Waorani Ethnic

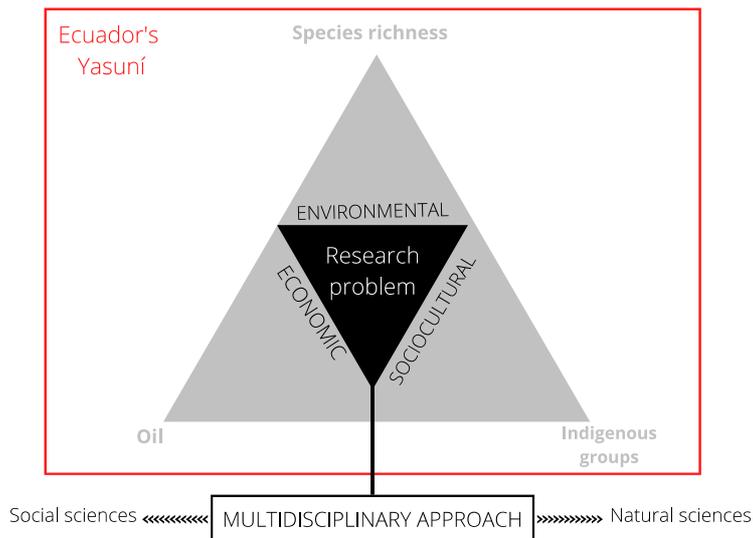
Reserve (REW) since the 1990, currently extends to about 800 000 hectares (WCS, 2007-2020) and is adjacent to YNP (Figure 5, Ch.1 section 3.1.).

Since the 1950s, the combination of these three particularities has created a deeply complex issue in Yasuní, involving multiple actors, interests, and cascading effects. Indeed, the massive development of oil exploitation has accelerated the acculturation process among the Waorani, who had lived in voluntary isolation until the 1950s. Acculturation is understood as a process by which individuals try to accept and adopt values and practices from another culture, through contact and communication with culturally dissimilar groups, although it involves retaining their own culture (Gibson, 2001). In this case, acculturation results from the contact between the Waorani and people from the Occidental society. The latter refers to Western countries and their values and culture, defined by free markets and consumerism, which is believed to dominate globalization (Arnett, 2002). Simultaneously, a series of environmental impacts appeared as a result of both oil exploitation and changes in Waorani's lifestyle. Threatened by intensive subsistence hunting, wildlife traffic and deforestation (Cervera *et al.*, 2017), neotropical primates are at the forefront of these new dynamics. The decline of their populations reported by several recent studies (de la Torre, 2010; 2012; Tirira *et al.*, 2018a) and the potential effects of their depletion on Amazonian ecosystems call for urgent actions to diminish the threats and to promote their conservation (Tirira *et al.*, 2018a).

Among the research on the effects of oil upon biodiversity (Espinosa *et al.*, 2014; 2018; Suárez *et al.*, 2009; 2012; WCS, 2006; 2010) or hunting upon game populations (Novaro *et al.*, 2000; Mena *et al.*, Portilla, 2016; Yost & Kelley, 1983; Zapata-Ríos *et al.*, 2011; Franzen, 2006), primate conservation has mostly been addressed from one perspective, that is, the causal relationship of human activities on the environment. However, the multifaceted nature of Yasuní's primate issue suggests that a larger perspective needs to be considered. Since primate depletion is interrelated with non-environmental questions, for example, changes in the Waorani culture, this dissertation will be guided by the following research question:

“What is the contribution of the Waorani to primate conservation in Yasuní National Park?”

In the context of primate conservation, “It is essential to identify and understand drivers of wildlife consumption” (Fa & Tagg, 2016, p.152). This can be achieved by adopting the perspective of the Waorani and by completing the work of natural sciences with social sciences, such as studies focused on the current socio-cultural dynamics among the Waorani (Merlyn Sacoto, 2018a; Lu, 1999, Cabodevilla, 2016; Rival, 1992; 1996, Rivas & Lara, 2001). Indeed, Yasuní's research problem involves a multidisciplinary approach that can be summarized as follows:



To replace the ecological question within its societal context – or, in a way, the social question within its ecological context –, the first two chapters will provide a state of the art following two tematics. First, Chapter 1 will introduce the traditional aspects of the Waorani culture and lifestyle, the main sources of influence and associated socio-cultural impacts on Waorani communities. Second, Chapter 2 will present the environmental impacts of oil on primates and their habitats, including subsequent overhunting and species use by the Waorani hunters. To understand the implications of this situation in Amazonian ecosystems, the ecological functions of primates will be described, as well as today’s state of primate conservation. The last section of this chapter will provide an overview of the actions suggested by academics in terms of primate conservation, and their limits.

Finally, Chapter 3 will be centered around the hypothesis that the development of an economic activity by the Waorani could foster primate conservation, which will be explored in a study case conducted in the Waorani community of Guiyero. The method used for this study will be described at the beginning of the chapter. A key element of that section is the concept of “participatory conservation”, that can be described as the restauration and rehabilitation of natural and cultural heritage through a collaborative and sustainable management of the whole territory with the local population (Perasso *et al.*, 2018). Finally, the results and limits will be discussed in light of literature specific to that subject.

Chapter 1: Background of a socio-cultural evolution in Yasuní

Today’s need for primate conservation in Yasuní is the product of decades of important cultural modifications in Waorani’s traditions, as will demonstrate the first and second chapters of this paper. Therefore, this portion of the Ecuadorian Amazon is now facing a complex situation that requires a deep understanding of all stakeholders and their respective interests. For this purpose, the first part of this

study will present general aspects about the Waorani culture, the main external sources of influence as well as their associated landscape modifications in Yasuní and sociocultural repercussions in the communities.

1. The Waorani

1.1. A long period of isolation: main cultural aspects

The portion of the Ecuadorian Amazon that is today recognized as REW is adjacent to YNP. However, these 800.000 hectares of legally recognized Waorani territory have not always been delimited in that way. Until the 1950s, this area of the Ecuadorian Amazon was considered too dangerous to visit by the Western world. The Waorani, almost unknown, were called *Aucas*¹, meaning “savage” in the Kichwa language. The Waorani were strategically used to living in areas difficult to reach, being voluntarily isolated and hostile to any contact with outsiders² (Cano Molestina, 2018).

According to the literature, the first period of contact with the Waorani in the Ecuadorian Amazon occurred between 1880 and 1920 with the rubber trade. These “oro verde” (“green gold”) exploitations brought foreign intrusion into the most remote areas, violent conflicts, and the enslavement of many indigenous people (Cabodevilla, 2016). This period gave rise to small groups hostile to one another, totaling about 500 people and being the ancestors of today’s Waorani (Yost, 1981; Cabodevilla, 2016). As a result of numerous interethnic conflicts and the progressive extinction of their indigenous neighbors, the Waorani became the owners of an immense territory (Cabodevilla, 2016; Burzio, 2007; Rival, 2002). The Waorani language, *wao tededo*, without any known congeners (Lu, 2001; Rival, 2002), as well as the genetic homogeneity of these groups (Larrick *et al.*, 1985; Cardoso *et al.*, 2008), confirm their isolation from adjacent peoples (Finer *et al.*, 2009; Stocks *et al.*, 2012).

Each group was completely autonomous, and there was neither an authority beyond individuals, nor economic obligations to limit individuals’ freedom of action. In this society, described as egalitarian, independent, and individualistic (Yost, 1991; Rival, 2015), nobody had duties to other members, and everyone was responsible for his own life, with little or no sharing or cooperation. Any dispute could lead to a homicidal confrontation as there were no conflict management mechanisms and no hierarchies (Robarchek & Robarchek, 1998). They used to be nomadic hunter-gatherers who cyclically moved to distinct locations every three or four months. Waorani’s traditional economic system was based on

¹ In Kichwa, the language of the Kichwa people, *Auca* means “savage” or “barbarian”. The Kichwa, whose territory is at the fringe of the Waorani territory and who were already in contact with the Western civilization, used this word to refer to non-Kichwa speaking native peoples from the Amazon (Yost, 1981, p.677).

² The Waorani identify themselves as *wao* (*waorani* being the plural form), namely “person” or “human” (Trujillo, 2001; Rival, 2015; Conaie, n.d.). In the past, they fiercely rejected all the other peoples with non-Waorani parents and who did not speak *wao tededo*, calling them *cowudi*, which means “non-human”, “foreigner” or “cannibal” (Rival, 2002, Wierucka, 2015; Conaie, n.d.).

subsistence economy, and their main activities were hunting, horticulture, gathering and fishing (Lu, 1999; Almeida & Proaño, 2008).



Figure 2: Painting illustrating a Waorani ancestral tradition; women used to paint their face with red pigment of achiote, a plant that grows in the Amazon rainforest (School of Guiyero, February 2020, photo by Z. Duvivier).

1.2. Native Amazonian hunters

The early literature about the Waorani describes them as native hunters that had a high impact on game populations for the intensity at which they hunted, unlike other Amazonian groups (Beckerman, 1994; Redford & Robinson, 1991; Yost & Kelly, 1983). Primates have always been a large part of their diet, as they are an important source of protein (Lu, 1999; Mena, 1995, Yost & Kelley, 1983). Amongst the game species hunted by the Waorani, the following primate species could be found: spider monkey (*Ateles belzebuth*); woolly monkey (*Lagothrix lagothricha*); red howler monkey (*Alouatta seniculus*); night monkey (*Aotus vociferans*); white-fronted capuchin (*Cebus albifrons*); saki (*Pithecia spp.*); pygmy marmoset (*Cebulla pygmaea*); squirrel monkey (*Saimiri sciureus*); red-mantled tamarin (*Saguinus lagotonus*) (Lu, 1999; Yost & Kelley, 1983).

Although hunting was predominantly an adult male activity, it was divided in different tasks involving both men and women. Their main weapons were spears, blowguns, darts and sticks. As it is still the case today, hunting was more intense during the months of October to May since the animals are attracted by the flourishing flowers and fruits; it is the “fat season of monkeys”, especially for woolly monkeys (Lu, 1999; Yost & Kelley, 1983).

In case of protein scarcity, most of the time due to an increase in population density, the Waorani moved to a different settlement (Coimbra, 1988) or adapted their way of hunting, for example by undertaking multi-week treks and multi-day hunts (Good, 1987). The meat obtained was equally distributed to adult males in the village, although portions tended to be smaller and some individuals could be left out if the population size was too high (Lu, 1999). As a mechanism of risk reduction in case of food scarcity, meat distribution was the only village-wide form of reciprocal food exchange as well as one of the most

important village-integrating mechanisms (Good, 1987). Increase in population density was therefore a source of interpersonal conflicts which could threaten the village cohesion (Lu, 1999).

These considerations raise an interesting concern about today's situation, that is, the possible social implications of primate scarceness around Waorani communities or of the implementation of a hunting management program, as suggested by researchers (Bodmer *et al.* 1994; 1997; Espinosa *et al.*, 2018).

1.3. In the present

Nowadays, about 24 Waorani communities totaling between two and three thousand individuals are distributed in the provinces of Orellana, Pastaza and Napo (Conaie, n.d.; Cano Molestina, 2018). Most of them live in permanent settlements along rivers or two roads, the Auca road and the Maxus road (Espinosa *et al.*, 2014). Their territory, the REW, overlays a part of YNP, in which they cohabit more or less closely with other indigenous nationalities, such as the Kichwas and the Shuar (Figure 3; Figure 5, section 3.1).

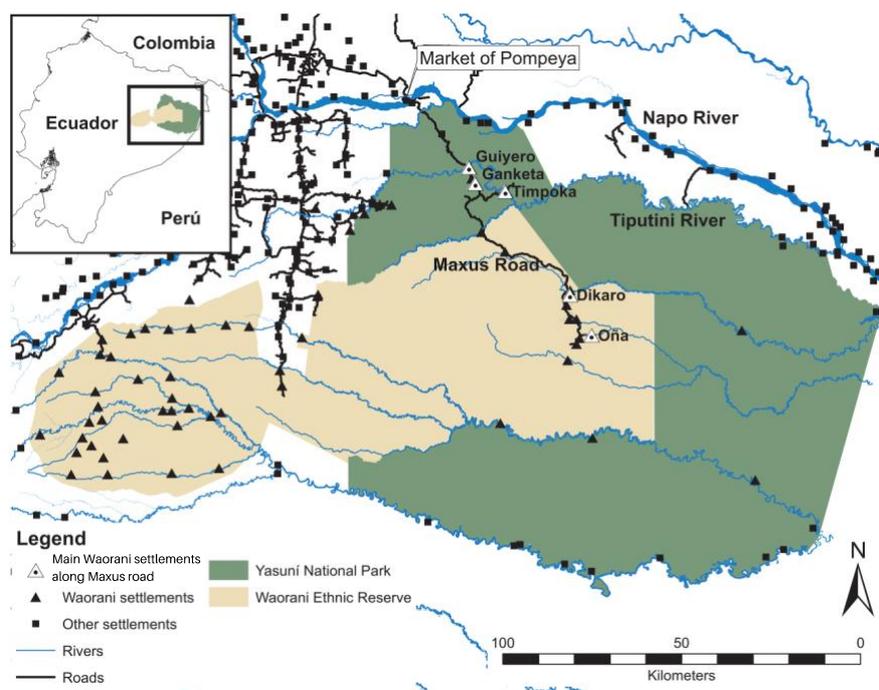


Figure 3: Map of YNP and REW (Modified from Espinosa *et al.*, 2014). It shows the market of Pompeya, i.e., main spot for wild meat traffic; the Maxus road; and the main Waorani communities located alongside the Maxus road.

In the most remote eastern area, some Waorani communities inhabit alongside the territory of the *Taromenane* and *Tagaeri*, the last indigenous groups of Ecuador living in voluntary isolation. They are hostile to any contact with foreigners and move through a territory called “la zona intangible” (“the intangible zone”) in the eastern part adjacent to YNP (Figure 5, section 3.1.) (Robarchek & Robarchek, 1998). In the western part of the territory, the Waorani have abandoned many of their ancestral traditions and are familiarized with the Occidental cultural aspects, although they still inhabit the forest. Indeed,

their culture and lifestyle have evolved with the influence of external actors that will be described in the following point.

2. External influences

The endogamous and autarkic society of the Waorani started to change from the 1950s due to two main influences: the missionaries and the oil industry. While the cohabitation with the colonists, a legacy of the “rubber era”, triggered incessant interethnic wars (Burzio, 2007), the more pacific and continuous contact with outsiders during the following period is the actual turning point of their culture.

2.1. The Evangelical Church: from isolation to first cultural changes

Between 1937 and 1950, the failed attempt to start oil operations in the northern Waorani territory by the Royal Dutch Company Shell, who finally withdrew after bloody confrontations with the Waorani (Rival, 2002; Wierucka, 2015; Kimerling, 2016), drew the attention of Evangelic missionaries from the SIL (Rivas & Lara, 2001). It is the overseas arm of the Wycliffe Bible Translators, the world’s largest Protestant missionary organization, whose aim is to translate the Bible into all of the world’s some 3000 languages and to introduce native peoples to Christianity through their local language. As a result, between 1955 and 1960, the missionaries launched the so-called “Auca Operation” and established the first close and pacific contact with about 100 Waorani, although it cost the life of several missionaries during the first attempts (Rivas & Lara, 2001; Rival, 2002; Burzio, 2007).

This period drew substantial changes in the Waorani culture. For example, they were encouraged to cease infanticides and warfare with other groups, they started living in more permanent settlements to remain close to schools and they were introduced to outside technologies and food (Lu, 1999; Cabodevilla, 2016). Importantly, the contact with missionaries brought for the first time the concept of schooling to the Waorani, which progressively became another main factor of acculturation. While children traditionally used to learn through experience and observation, taking part in most activities on the field with older members of the community (Rival, 1992), Rival (1992; 1996) found that modern schools’ curriculum emphasized the concept of “citizen of Ecuador” and taught how to be “healthy”, “clean” and “civilized”.

Whereas the transformations related to the missionaries’ intervention were limited to a restricted area, the following oil boom considerably increased the scale of contact with the Western world and caused subsequent environmental impacts.

2.2. Oil development: landscape transformations in Yasuní

2.2.1. *The Protectorate: free access for oil companies*

In 1967, Texaco-Gulf discovered enormous hydrocarbon fields at the north of the Waorani territory. At this point, oil had become a key element for the Ecuadorian government to develop the national economy and the presence of hostile indigenous populations disturbed both the government and oil companies' movements. Therefore, the oil industry, the Ecuadorian State – including the Military Forces –, and the missionaries – who had acquired an important control on Waorani's marriages and alliances – worked together to progressively gather all the Waorani groups in one location (Cabodevilla, 2004; Rivas & Lara, 2001; Kimerling, 2016). It led to the creation, in 1969, of a reserve of 16 000 hectares for the Waorani called "Protectorado" ("Protectorate") (Cano Molestina, 2018; Bledsoe, 1972; Lu, 1999; Yost, 1981). By the mid-1970s, more than 500 Waorani lived in a surface that represented less than 10% of their ancestral territory (Rivas & Lara, 2001; Finer *et al.*, 2009). Only two groups, known as *tagaeri* and *taromenane*, escaped this dynamic and still live in voluntary isolation today (Rivas & Lara, 2001; Cabodevilla, 2016).

In addition to paving the way for larger oil exploitation, the Protectorate enabled to reshape the inherent characteristics of this group through Christian rules promoted by the SIL (Wierucka, 2015), which could be part of the concept of ethnocide according to Rivas & Lara (2001). Besides interclan conflicts and illness, natural resources became overexploited because of the intensive subsistence hunting activity (Cabodevilla, 2016; Wierucka, 2015). At the beginning of the 1970s, these social and ecological damage led to the disintegration of the Protectorate into many communities through the Provinces of Napo, Pastaza and Francisco de Orellana (Rivas & Lara, 2001).

2.2.2. *Oil boom and its infrastructures*

In the 1980s and 1990s, Yasuní, including the territory where lived the Waorani, underwent important landscape transformations associated with oil activities. For example, the first road, the Auca road, was opened by Texaco Oil Company (Jorgenson & Rodríguez, 2001; Espinosa *et al.*, 2014). Also, a 150-km road network, the Maxus road, was constructed by Maxus Oil Company (Espinosa *et al.*, 2014) (Figure 4).

Nevertheless, the Constitution draw up by the President Rafael Correa in 2006 illustrated an ecologist spirit and the recognition of indigenous people's rights. He launched the Yasuní-ITT initiative, aiming to place a moratorium on oil extraction from the Ishpingo-Tambococha-Tiputini (ITT) fields (Block 43), holding most Ecuador's total oil, in exchange for a financial contribution from the international community. The exploitation of these fields threatened not only species, as confirmed Ecuador's state oil company (Petroecuador, 2007), but also the indigenous groups living there. However, the initiative

failed and the exploitation of Block 43 started, supporting a national economy based on oil and mine exploitation (Lavaud, 2010).

Although Wunder (2003) points out the fact oil development typically decreases overall deforestation by reducing pressure from agricultural and logging interest, Myers (1993) asserts that oil development impacts in Ecuador had turned the Napo region into one of the 14 major deforestation fronts in the world. It can be explained by oil's location deep in primary forest, which involves many indirect impacts associated with extensive transport and pipeline infrastructure, as demonstrated Petroecuador's study on ITT exploitation's environmental impacts (Petroecuador, 2007). Although it was still unknown if the preferred way of access for the project would be trains or roads, researchers already predicted that "there would be unprecedented human access to one of the most intact portions of the Ecuadorian Amazon" (Finer *et al.*, 2008, paraphrased by Bass *et al.*, 2010, p.15)

From the beginning of this petroleum boom, oil concessions did not stop, as illustrated on Figure 4. In 2017, 76% of Ecuador's total energy consumption, more than half of the country's export earnings, and about 25% of public sectors revenues depended on oil (EIA, 2017). Today, at least eight blocks are located in the area of Yasuní, from which six have extensions in Waorani territories and five in YNP, involving a subsequent red of roads (Cano Molestina, 2018).

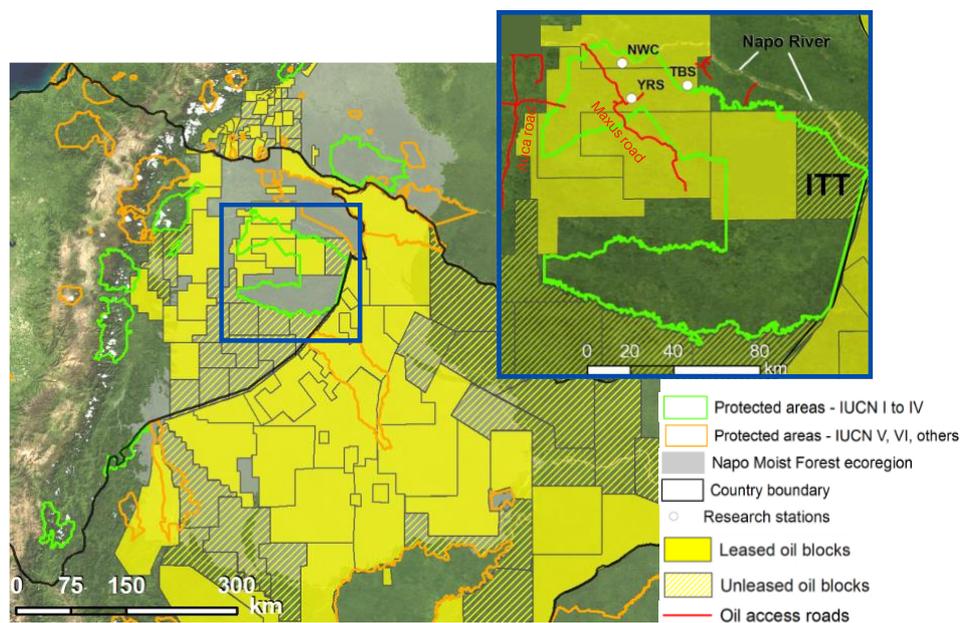


Figure 4: Map of the oil blocks covering the Napo Moist Forests ecoregion and YNP, including oil access roads within and surrounding the park (Modified from Bass *et al.*, 2010).

ITT = Ishpingo-Tambococha-Tiputini oil fields; NWC = Napo Wildlife Center; TBS = Tiputini Biodiversity Station; YRS = Yasuní Research Station (i.e., ECY).

3. Repercussions of the external interventions in the Waorani territory

3.1. Indigenous resistance and territorial adaptations

Ecological and social impacts of petroleum exploitation had been recognized and documented over the years (Kimerling, 1991; Martínez, 1997; Bass *et al.*, 2010). The turmoil and political infighting that ensued the advent of oil exploration in Waorani territory convinced the Waorani to form an organization of their own to represent their interests; the Waorani federation ONHAE (Lu, 1999). Through their struggle, they acquired more visibility and power at the national and international political levels.

Sawyer (1996) highlights their role in making oil companies more socially accountable and environmentally conscious, e.g., through a community relation program established by the company. Yet Lu (1999) argues that such programs mostly entail listing of gifts to the Waorani in return for their cooperation during oil activities. Such initiative was implemented by Maxus Oil Company in block 16 and continued by Repsol-YPF, as it will be discussed in Chapter 3.

Additionally, after intense struggles led by indigenous organization, environmentalists, and missionaries at the political and legal levels, the Waorani territory was partially recognized by the Ecuadorian State through property titles that were extended over the years (Cabodevilla, 2005). In 1990, the REW was created with an extension of 600 000 hectares (Cano Molestina, 2018). Although it was an important victory for the indigenous community, Cabodevilla (2005; 2016) asserts that it was decided at the convenience of religious groups and conservationists, and, especially, other actor's economics interests, instead of guaranteeing the actual recognition of Waorani's ancestral rights. Indeed, Waorani's legal concessions were granted at the cost of the acceptance of a 1000 000 hectares protected area, YNP, created in 1979, and the development of a large-scale oil industry on their ancestral territory (Rivas & Lara, 2001; Cabodevilla, 2005). In 2009, the REW was extended to 800 000 hectares, its northern limit being adjacent to YNP and the Kichwa communities, and its southern border being at the edge of colonist settlements and other Kichwa communities (WCS, 2007-2020) (Figure 5).

As YNP did not consider the ethnic aspects of that area at its creation, the Park was declared UNESCO Biosphere Reserve (YBR) in 1989, which includes the Waorani territories (UNESCO, 2019). Moreover, part of the territory was declared "intangible zone" in 1999, a decision dedicated to the recognition and protection of isolated indigenous peoples (Rivas & Lara, 2001) (Figure 5). In Ecuador, the national law prevails over the protection categories, as illustrated in YNP and REW where the subsoil remains property of the Ecuadorian government and is likely to be exploited. However, by the Executive Decree No 751, no extractive activity is permitted in the intangible zone, including in the subsoil (Presidencia de la República del Ecuador, 2019).

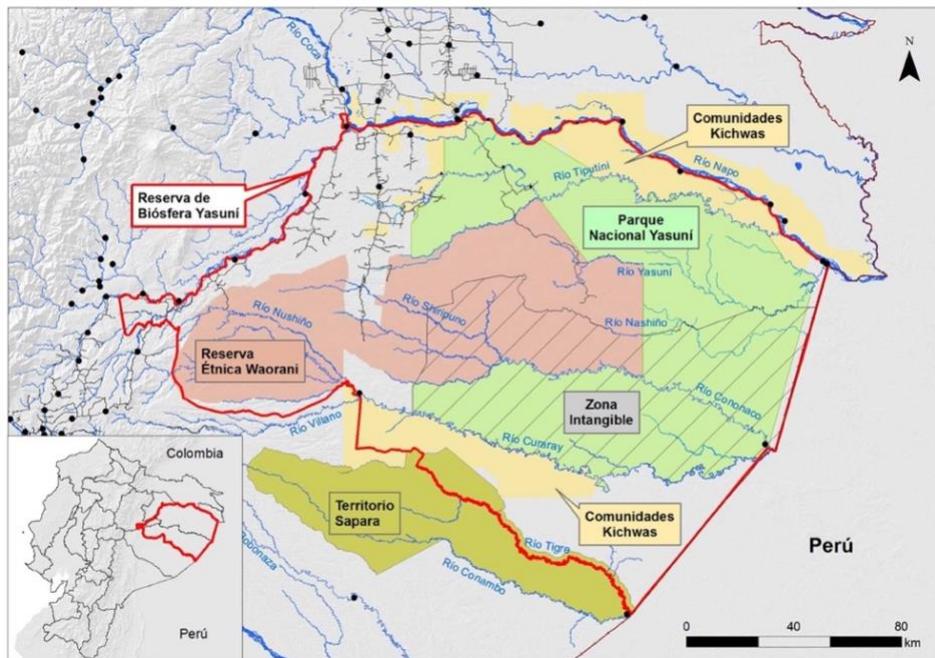


Figure 5: Landscape of Ecuador's Yasuni, including indigenous groups and protected areas (WCS, 2007-2020).

3.2. Identity crisis and Integration into the market economy

One important consequence of the period of contact with the external world is that the Waorani discovered the outside perception of them as “savage”. It urged them to identify themselves with Western civilization’s customs and values, by abandoning some ancestral traditions (e.g., physical marks [Figure 2, section 1.1.], traditional houses, nomadic lifestyle) and adopting “modern” habits (e.g., modern clothes, manufactured products, Occidental construction, sedentary lifestyle) (Lu, 2001; Wierucka, 2015). According to Rival (1996), in this context, the institution of school “creates the conditions for dominant identities to undermine the continuity of minority identities” (Rival, 1996, p.153).

Formal education also inculcates the idea of being productive and happy, which refers to engaging in wage labor and earning money (Lu, 1999; Rival 1992; 1996). As a result, many Waorani men left the communities to work for the oil industry, in tourism agencies, as teachers or for the ONHAE. According to authors of the 1980s and 1990s, beyond the preconceived idea that Native Amazonian do not want to work, there are few desirable opportunities in the labor market in the Ecuador’s Amazonian frontier, besides sporadic jobs provided by oil companies (Vickers, 1983; Lu, 1999; Rival, 1992).

Importantly, the entrance into the market economy led to the massive introduction of shotguns amongst Waorani hunters, that progressively replaced traditional weapons as from the 1970s. The main reason for this replacement is that shotguns have a greater velocity and range for killing game and are also more maneuverable. Furthermore, the Waorani started to sell their traditional weapons to tourists or shops, which made them even more dependent on firearms, not only for subsistence hunting but also to provide

continued access to ammunition (Yost & Kelley, 1983) through wildlife commercialization. Lu (1999) calls this evolution “a loss of technical economy” (p.78) and describes petroleum exploitation as:

one of the most important external forces of cultural change influencing the Huaorani (...). Oil has built the roads cutting into Huaorani territory and has brought market forces closer; it has paid for the construction and maintenance of a school in one of the village I studied; it is the most important source of consistent readily-available and relatively lucrative wage labor for Huaorani men; and it pays for the acquisition of new procurement technologies and other manufactured goods (Lu, 1999, p.1).

4. Conclusion of Chapter 1

This chapter showed that oil has connected within a few years two civilizations that had followed an evolution process significantly different and, despite this enormous gap, no long-term community management program was implemented in Yasuní. Oil is the most powerful force of change in the Waorani culture since it has led to and facilitated various actions and transformations that have effects on the populations. Goodland *et al.* (1989) summarize such socio-cultural transformations in five factors that led to the breakdown of traditional common property management systems: (1) increased participation in the market economy; (2) breakdown of tradition value system; (3) population growth; (4) technological change; (5) increased centralization of power and application of inappropriate pricing, subsidies, legislation, or other government incentives.

A concrete example of this clash of cultures is the Waorani’s relationship to alcohol. While alcohol was traditionally used in the form of fermented beverages for ceremonies, it has become a common product of consumption. This tendency has been facilitated by recent income-generating activities, e.g., wildlife commercialization and jobs provided by oil companies. Nowadays, alcoholism is a frequent problem in Waorani’s households (Merlyn Sacoto, 2018a).

Chapter 2: Implications of oil development for biodiversity and primate conservation

Because of its particular location at the intersection of the Andes, the Amazon and the Equator (Annex 1), YNP benefits from unique climatic and geological conditions. This combination favors the growing of a large number of plants that constitute essential habitats and alimentary resources for fauna’s development. It makes this site one of the world’s last high-biodiversity wilderness areas and it is therefore recognized for its global conservation significance (Bass *et al.*, 2010). Unsurprisingly, the future of this “green island” is uncertain in the current context of landscape modifications and local inhabitants’ acculturation process. Primates, whose ecological roles are essential in neotropical

ecosystems (de la Torre, 2010; 2012), are particularly vulnerable to recent anthropogenic activities in Yasuní.

In the first place, this chapter links human-related activities and environmental degradation, which have been affecting primates and their surrounding habitat since the development of oil exploitation in Yasuní. Secondly, it presents the current state of primate conservation in relation to changes in resource use by Waorani hunters as well as the importance of their conservation at the level of the rainforest ecosystems. Finally, it provides an overview of the needs, actions, and limits in terms of conservation.

1. Main impacts on primates and their environment

1.1. Oil contamination

Contamination has been largely recognized as one major direct consequence of oil development. Coming from any project-related spills, leaks or accident (Bass *et al.*, 2010), it can affect soil and water quality (WCS, 2010; Bryja, 2009). In addition to the risks for local human populations' health (San Sebastián, 2003; Becerra *et al.*, 2013; Merlyn Saco, 2018a), oil contamination is particularly worrying for aquatic ecosystems (Bass *et al.*, 2010; Jorgenson & Rodríguez, 2001). In the case of Cepe-*Texaco* operations in YNP, it led to local fish extinction and contamination of the water used for human consumption (Jorgenson & Rodríguez, 2001). Although contamination of rivers does not directly threaten primates, it raises several concerns. Considering that fishing and hunting constitute the main sources of protein of the Waorani, one may wonder what the alternative source of subsistence would be if they cannot fish as much as they used to because of river contamination. Additionally, it would be relevant to question the effects of contamination on tourism development, which is a potential income-generating alternative to prevent bushmeat commercialization by indigenous groups, as exemplified in Chapter 3.

1.2. Colonization and deforestation

According to FAO (2020), Ecuador has had the highest deforestation rate of South America's countries between 1990 and 2010. Although urbanization within the Amazon, especially in the 1990s, has facilitated population mobility and the deforestation process (Bilborrow *et al.*, 2004), the literature about landscape transformation in Yasuní points out the oil industry and its infrastructures as the major driver of deforestation.

Indeed, the construction of roads in Yasuní has triggered cascading effects by facilitating the colonization process, which happens when the use of roads within oil concessions is not controlled by oil companies. It leads to subsequent deforestation for agriculture and cattle by farmers, which represents a major source of habitat loss, fragmentation, and soil degradation (Bilborrow *et al.*, 2004;

Wunder, 2003; Zapata-Ríos *et al.*, 2006). Annex 2 shows that indirect impacts of road construction, namely, clearing forest to plant crops and graze cattle, are in fact much greater than direct impacts associated with the removal of natural vegetation and topsoil for the actual construction of the road (WCS, 2010; Zapata-Ríos *et al.*, 2006). Primates have multiple habitat uses depending on their locomotive behavior in relation to their body size (Pozo-Rivera, 2004b) and on species-specific ecological needs, namely, fruit distribution and availability, nonfood resource access, risk limitations and competition reduction (Wallace, 2008). For instance, a group of spider monkeys (*Ateles belzebuth*), studied by Pozo-Rivera (2004a) in YNP, appeared to use a total area of 469ha due to intra-group social dynamics, foraging behavior and food consumption. Forest fragmentation could therefore threaten primate populations' stability, as exemplified in section 2.4.

In addition to causing deforestation, the cattle industry and agriculture derived from colonization deteriorate natural habitat by adding contamination, especially by introducing agrochemicals (Jorgenson & Rodríguez, 2001). Colonists also put pressure on wildlife by increasing game hunting (Bryja, 2009), although they have a minor role in the Pompeya market, i.e. the main place for wildlife trade by Yasuní's indigenous communities (WCS, 2010).

In 2005, the Wildlife Conservation Society (WCS) initiated a study aiming to characterize the fauna communities in the area of influence of the Auca road, where road access had not been controlled, and the Maxus road, where road access had been strictly controlled, as well as in an area without significant human influence. The results evidenced that both fauna diversity and relative abundance had been drastically affected along the Auca road, due to hunting and deforestation. Woolly monkeys (*Lagothrix lagothricha*) and large-headed capuchins (*Sapajus macrocephalus*), relatively frequent in the area without significant human influence, had already disappeared or were extremely rare (WCS, 2006).

1.3. Other disturbances related to oil infrastructure

Beside the most frequently mentioned environmental impacts of oil exploitation, some additional effects come from the production process and infrastructure. Firstly, noise from oil wells (Bryja, 2009), bombs used in oil prospection and vehicles from the road generate another form of contamination. Whereas the noise from oil infrastructure could possibly limit the effects of intensive hunting, by driving animals away or by interfering with hunters' most important sense, i.e., hearing (Yost & Kelley, 1983; Z. Duvivier, pers. obs.), it also has negative effects on local fauna (Jorgenson & Rodríguez, 2001). Acoustic contamination is cited in the "plan de acción para la conservación de los primates del Ecuador" ("conservation action plan for Ecuadorian primates") (Tirira *et al.*, 2018b) as one impact that affects the behavior and physiology of primate individuals. However, further research is needed to evaluate the magnitude of the impacts (Jorgenson & Rodríguez, 2001). Jorgenson & Rodríguez (2001) also mention the smell of vehicles amongst the threats related to roads and their area of influence. Finally, roads

represent an important cause of vertebrate mortality due to vehicle collisions and, although it mainly affects terrestrial animals (Forman & Alexander, 1998), it is an additional threat for several primate species (Tirira *et al.*, 2018a).

1.4. Overhunting and related factors

As neotropical primates are part of a complex ecosystem, it is important to consider the multiple impacts likely to affect their habitat and resource use. However, the major direct threat to primates in Yasuní nowadays is hunting, which has become unsustainable due to the recent dynamics experienced by local populations. Therefore, primate conservation will be addressed from a socio-economic point of view, starting by identifying the factors influencing hunting activities.

1.4.1. *Increasing human population density*

Throughout the period of contact with Western culture, Waorani's new living conditions reduced the main traditional causes of death, namely, interethnic wars, infanticide and illness, which led to communities' sedentarization and concentration in areas close to schools (Merlyn Sacoto, 2018a). As a result, the population density highly increased and game and fish rapidly became overexploited (Yost, 1981).

While this tendency had already been identified a few decades after the beginning of the period of contact (Yost, 1981; Lu, 1999), more recent studies still show the necessity for hunters to travel further distances because of local game depletion near settlements (Espinosa *et al.*, 2014; Peres & Lake, 2003; Sirén *et al.*, 2004). However, the study of Espinosa *et al.* (2014), which highlights an increase in bushmeat extraction for commercial purpose along the Maxus road between 2002 and 2009, indicates that the increasing bushmeat trade is not linked to population growth in the communities of Guiyero, Timpoka and Dikaro (whose location is illustrated on Figure 3, Ch.1 section 1.3.). Indeed, their human population increased only by 7.7% during this period. Despite this precision, the authors point out that “if access to Yasuní and human populations continue to grow with new road development, not only may game populations decline but also the future ability of Waorani to procure their source of protein could be compromised” (Espinosa *et al.*, 2014, p.14).

Yasuní has a relatively low population density, with mostly indigenous groups as inhabitants (Finer *et al.*, 2009). However, this situation could rapidly change, considering Ecuador's high population

density³, the colonization process within Yasuní and the current demographic and social dynamics among the Waorani⁴.

1.4.2. *New material and economic necessities*

Fa & Tagg (2016) classify hunting in three categories: subsistence, commercial and recreational. Subsistence hunting is inherent to Waorani's traditional culture. They also used to keep a large variety of birds and mammals as pets in their household, including monkeys (Lu, 1999; Mena *et al.*, 2000; Yost & Kelley, 1983). Yet, after the contact with the Occidental culture, hunting acquired a new dimension to respond to recent economic and material necessities, such as the acquisition of manufactured products (Lu, 2001; 1999; Wierucka, 2015). As income generating activities among the communities are strongly limited, many Waorani's involvement in the market economy currently relies on forest extraction for timber and animal commercialization.

By facilitating the access to the Occidental society, oil exploitation has created new needs amongst communities and has made the populations dependent not only on oil companies, but also on hunting, to meet these requirements (Zapata-Ríos *et al.*, 2011). Following this logic, one can wonder what the alternative to integrate the market will be when oil companies retire or when natural resources start to run out.

1.4.3. *Modern hunting implements*

As mentioned in Chapter 1, the contact period induced a radical shift from traditional weapons to firearms, since it gives the possibility for hunters to use only one weapon to kill all types of prey, instead of using separately a spear for terrestrial prey and a blowgun for arboreal prey (Hames, 1979; Yost & Kelley, 1983; Mena *et al.*, 2000). Access to firearms and ammunitions has been facilitated by recent sources of money, e.g., jobs in oil exploitation, money granted from companies to compensate the damage on the Waorani territory, or the selling of artisanry such as tourist-style blowguns and spears (Lu, 1999; Mena *et al.*, 2000; Yost & Kelley, 1983).

Yost & Kelley (1983) already observed that the use of shotguns had effects on fauna, since it gave a higher kill rate, and predicted that this tendency would increase once the Waorani fully learn to use this technology. Indeed, Mena *et al.* (2000) report that the Waorani were taking more individuals and weight of game, and that five species of primates were already partially extirpated from the more hunted studied areas. The authors warned that large-bodied animals would be extirpated around the village if this pattern continued. These results are in line with Lu's study (1999), collected in the same community

³ Ecuador has a population density of approximately 55 inhabitants/km², that is, the highest in South America (FAO, 2020; Ecuador, INEC, 2015).

⁴ The current demographic and social dynamics among the Waorani refer not only to the new living conditions reducing the factors of death, but also to the interactions and marriages between the Waorani and their neighbors Kichwas (Merlyn Sacoto, 2018a).

during the 1990's. She found a negative relation between both human population increase and new procurement technologies, and the time humans can be maintained by prey resources before it becomes locally depleted and the system collapses.

1.4.4. *Easy access to markets and hunting areas*

Contrary to what happened around the Auca road, the process observed along the Maxus road showed that access control by oil companies can stop the colonization process and prevent its associated impacts on the environment. However, the presence of the road intensified the acculturation process in the Waorani communities. They built permanent settlements along the road and started to use the transport freely provided by the company to go hunting in remote areas that were not used before. Historically, as the Waorani were semi-nomadic, their hunting areas moved through time, but these were always limited to zones they could reach on foot; they only used small areas for short periods of time (Yost & Kelley, 1983; Espinosa *et al.*, 2014). In permanent settlements along the roads, they travel on a daily basis up to 40 km along the roads to start hunting, which strongly reduces the proportion of un hunted areas that serve as wildlife refugia (Espinosa *et al.*, 2014).

Not only does the transport by road extend the portion of the forest accessible to hunters, but it also facilitates access to market areas; both are factors of increased hunting and wildlife traffic in Yasuní (Bass *et al.*, 2010; WCS, 2010). The result is the development of a wild meat market in Pompeya, at the northern limit of Yasuní and the beginning of the Maxus road (Suárez *et al.*, 2009) (see the map on Figure 3, Ch.1 section 1.3). Between 2002 and 2009, bushmeat extraction along the Maxus Road by the communities of Guiyero, Timpoka and Dikaro for commercial purposes increased significantly rapidly. By 2009, it provided around 18,500 kg of bushmeat for trade in the same market in a single year. Yet primate bushmeat corresponded to 347 kg, that is, 1.9% of the total harvested biomass (Espinosa *et al.*, 2014). This positive relation between rates of bushmeat extraction, trade and the proximity to market is consistent with Espinosa *et al.*'s study (2018) and the results of WCS' research:

In this way, oil companies that operate in this block are indirectly subsidizing an increase of wildlife extraction capacity and are extending the forest area under human influence along the road. An evidence of these changes is the development of a wild animal meat market at the entrance of the Maxus road (Pompeya North), in which around 50% of the commercialized meat comes from communities settled along that road (Translated from Spanish from WCS, 2006, p.2)

Those studies also evidence the associated impacts on fauna, in the same way as Franzen (2005) and Robinson & Redford (1991), who demonstrated the unsustainability of large monkey extraction rates along the roads.

1.4.5. *Increasing demand for bushmeat*

The choice of game for commercial purposes by hunters is not only related to access, but also to the nature of the available market. According to the Ecuadorian Environmental Ministry (MAE, 2017),

bushmeat trade means wild fauna meat extraction and trade for consumption in markets and restaurants of medium- and large-sized cities; and at a minor scale, for self-consumption by rural people's relatives living in cities for academic and work-related reasons, or for religious celebrations. Indeed, market pressure and unsatisfied demand for wild meat have been recognized as factors that contribute to increasing hunting for the last decades (Bodmer *et al.*, 1994; 1997; Suárez *et al.*, 2009). In the context of Yasuní, the main place for bushmeat trade by indigenous communities is the market of Pompeya, where the meat is expected to go to markets and restaurant of other towns (Suárez *et al.*, 2009). Since the price per kilogram of meat is similar for almost all game species, large-bodied animals, such as woolly monkeys (*Lagothrix lagothricha*) among primate species, provide a greater financial return and are thereby more harvested (Espinosa *et al.*, 2014).

To conclude this section about the effects of human activity on wildlife, an interesting point that can be highlighted is the fact that all impacts are interconnected. For example, on one hand, road construction facilitates colonization, which rapidly converts forest into farms and pasture, as it has been observed in the Auca road. As a result, biodiversity faces deforestation and landscape fragmentation, in addition to the local effects directly associated with road construction. On the other hand, when immigration is controlled but transportation of natural resources is not, fauna is depleted by unsustainable hunting and wildlife trade, as it is the case along the Maxus road (WCS, 2010; 2006; Espinosa *et al.*, 2014; 2018). Primates are therefore threatened in numerous ways, which is essential to consider when implementing conservation strategies. Importantly, the different factors of environmental impacts previously identified are somehow triggered or intensified by the presence of the road, including the process of acculturation. Even in communities that have no access by road, most men have found a way to procure firearms and ammunitions since they can reach the Auca road on foot. Hunting has thus also become unsustainable for many large-bodied primates (Mena *et al.*, 2000).

2. Focus on primates: species' use by hunters, ecological roles and conservation status

De la Torre (2012) presents Ecuador as “a small country with one of the most diverse and threatened primate communities in the Neotropics” (p. 25). After having understood the threats and their associated sociocultural background, it is time to focus on their actual influence on primate populations in Yasuní. The following section presents an evolution of primate species' use by hunters, their factors of vulnerability, the role of primates in rainforest ecosystems and their current state of conservation.

2.1. Changes in Waorani hunters' resource use from the perspective of primates

By comparing Waorani's hunting activity over time, several patterns of resource use associated to primates can be observed. The first studies on Waorani's hunting activities registered eight species of primates harvested, from which monkeys were the most common game in the 5-10 kg fat range (Yost

& Kelley, 1983). The register of Yost & Kelley (1983) evidenced that the woolly monkey (*Lagothrix lagotrucha*) and howler monkey (*Alouatta Seniculus*) were amongst the most hunted species in terms of weight (kg) and frequency. Table 1 illustrates these data and shows that, at the time of Mena *et al.*'s study (2000), woolly monkeys still represented 23.3% of the total harvests (kg), having the second highest contribution to this total. According to Mena *et al.* (2000), the howler monkey was amongst the most preferred species for consumption, however, the woolly monkey was the most hunted in persistently hunted areas due to its size, abundance, and ease of capture. In addition to woolly monkeys, spider monkeys (*Ateles belzebuth*) and squirrel monkeys (*Saimiri sciureus*) were locally extinguished, and capuchins (*Cebus yuracus*), sakis (*Pithecia napensis*) as well as howler monkeys were substantially reduced in persistently hunted areas.

Interestingly, Lu (1999) found that the Waorani's hunting returns in terms of primates had decreased in comparison with Yost & Kelley's study of 1983 (Table 1), despite the use of firearms. She hypothesized that the local depletion of large game around the community could be part of the reason of this decline. Consequently, Waorani's diet shifted from primates towards rodents, which is consistent with what predicted Mena *et al.* (2000). As the Waorani hunt the largest and most easily acquired species first, after the primates have gone, they would switch to other species that produce more meat per unit hunting effort, for example large-bodied rodents (Mena *et al.*, 2000). However, with the extinction of woolly monkeys, other prey such as collared peccary (*Tayassu tajacu*) and agouti (*Dasyprocta* spp.) may not sustain the human population on their own (Lu, 1999). Between 2002 and 2015, a decline in woolly and spider monkeys' contribution to harvest was still observed by Franzen (2006) and Portilla (2016).

Species	Tiimpuca	Guiyero	Dicaro	Lu (1999)	Mena V. et al. (2000)	Yost & Kelley (1983)
Primates	30.8	4.2	17.4	20.4	31.2	16.6
<i>Ateles belzebuth</i>	18.0	0.0	4.0	0.0	0.7	0.6
<i>Alouatta seniculus</i>	1.8	0.2	3.7	5.2	6.1	11.8
<i>Lagothrix lagotrucha</i>	10.3	4.0	8.5	13.8	23.3	20.7
<i>Cebus albifrons</i>	0.7	0.0	1.2	1.4	1.1	2.1
Ungulates	57.3	90.0	65.8	64.5	38.3	49.5
<i>Tapirus terrestris</i>	0.0	12.2	7.3	0.0	6.4	7.0
<i>Tayassu pecari</i>	49.0	48.4	42.6	0.0	0.0	26.4
<i>Tayassu tajacu</i>	4.8	29.4	7.0	54.8	22.0	14.7
<i>Mazama americana</i>	3.5	0.0	8.9	9.7	9.9	1.4
Birds	6.1	2.2	5.1	2.2	4.1	5.7
<i>Mitu (Crax) salviini</i>	4.3	1.8	2.1	0.5	2.1	3.3
<i>Psophia crepitans</i>	0.3	0.0	0.5	0.4	0.6	0.4
<i>Aburria (Pipile) pipile</i>	1.5	0.4	2.2	0.2	0.4	1.4
<i>Tinamus major</i>	0.0	0.0	0.3	1.1	1.0	0.6
Total	94.2	96.4	88.3	87.1	73.6	71.8

Table 1: Species most vulnerable to overhunting and their relative contribution to total harvests (% of total kg harvested) (Franzen, 2006). It shows the results for the Waorani communities of Tiimpuca (i.e., Timpoka), Guiyero, and Dicaro studied by Franzen (2006); Quehueiri-ono and Huentaro studied by Lu (1999); Quehueiri-ono studied by Mena *et al.* (2000); Tewaeno, Tzapino, Quiwado and Wamono studied by Yost & Kelley (1983).

This tendency is not surprising since the most vulnerable species, represented on Table 1, also made up the greatest percentage of weight harvested (% of total kg harvested). Being firstly hunted and

vulnerable, such species rapidly become depleted, which is the case for spider monkeys (Yost & Kelley, 1983) and woolly monkeys (Peres, 1990). In the same way, Franzen (2006) explains the high contribution of spider monkeys to total harvests in Timpoka, i.e., 18% (Table 1), by the fact that this community is the most recently established, that is, in 2001, which helps indicate which species are targeted in an area relatively free of hunting pressure. Data collected in Guiyero (0%) and Dicaro (4%) therefore suggest a local depletion of this species in these communities, established in the 1992-1993 (Franzen, 2006).

In spite of game depletion, Lu (1999) found a pattern of continuity in prey types, which included howler and woolly monkeys. This can possibly be explained by Descola's theory of "game reserves" observed in another indigenous group, the Achuar. He found that beyond the forty or fifty square kilometers to which a hunter normally confines his activities, there is a sort of no-man's land where game is abundant and so unaccustomed to human presence that it has lost its fear of people (Descola, 1996). Although Lu (1999) mentioned the existence of such a game reserve around the Waorani communities she studied, its use by hunters and potential contribution to fauna conservation should be further studied.

It is important to note that data on resource use from different research may differ due to community-specific features; the number of hunters and families as well as the level of accessibility can vary and therefore influence the results. For instance, it appears that large monkeys continue to be extracted above sustainable levels around the Maxus road because it is located within a vast area of intact forest. This zone functions as refugium for wildlife of hunted areas and its access is facilitated by the road (Espinosa *et al.*, 2014).

Finally, despite the decreasing hunting returns for large-sized primates reported by several authors (Lu, 1999; Franzen, 2006; Portilla, 2016), Espinosa *et al.* (2014) and Portilla (2016) point out the fact that the proportion of the total harvested biomass that is commercialized has increased over the past few years. Woolly, spider and howler monkeys were included in the most important species harvested and traded by the Waorani along the Maxus road, that is, the species that have a total harvest above 100kg for the 12-14 months studied period (Espinosa *et al.*, 2014).

2.2. Factors of vulnerability

There is a lack of studies on the exact effects of hunting on Ecuadorian primate populations (de la Torre, 2010). However, research carried out in YNP and in the north of the Napo River shows how the impacts of hunting could be considerable on the populations of larger species, especially when it is related to illegal trade (Zapata-Ríos, 2001; WCS, 2006; de la Torre, 2010). The price of bushmeat is determined by its weigh, large size primates are thus more profitable prey. However, it seems that the primates harvested along the Maxus are primarily used for self-consumption rather than trading. Indeed, Espinosa *et al.*'s study (2014) shows that about 10 to 13% of harvested biomass of large monkeys is

commercialized, compared to 33% and 39% of biomass of red brocket deer (*Mazama americana*) and white-lipped peccary (*Tayassu pecari*), respectively. Moreover, primates contribute to only 1.9 % of the total traded biomass, while the white-lipped peccary (*Tayassu pecari*) alone contributes to 56.7% of this total.

Besides the market-related criterion, the large size of some species also makes them more vulnerable to subsistence hunting. Studies prior to the expansion of the meat trade show that the Waorani have always looked for species that produce more meat per unit effort (Mena *et al.*, 2000):

Large-bodied, noisy primates are diurnal, gregarious, and easier to spot and kill than the more nocturnal or crepuscular large rodents, deer, and peccaries. Many of the large-bodied primates were already gone from the persistently hunted area, and our interpretation is that the Huaorani were simply responding to what was locally available (...). They did not follow a conservation-based strategy using the reproductive biology to guide their hunt; rather, they hunted the largest and most easily acquired species first. (p.76).

This observation is confirmed in different studies of the 1980s and 1990s, in which woolly monkey is classified as the most frequently hunted and the second most heavy hunted mammal (Mena *et al.*, 1995; Yost & Kelley, 1983; Lu, 1999), as it can be seen in Table 1 (section 2.1.)

Three additional characteristics seem to influence the animal vulnerability to population overexploitation, namely, the rate of population increase, longevity, and generation time. It appears that primates have low rates of population increase (Bodmer *et al.*, 1997; Alvard, 1993). More specifically, large-bodied primates have low birth rates, long periods of infant development, long interbirth intervals, and late ages of first reproduction (Robinson & Redford, 1986b). For example, spider monkey females first start to reproduce at the age of 6.5 years and the species has a generation time of approximately 15 years (Álvarez-Solas *et al.*, 2018b). For the woolly monkey, it can reach up to 20 years (Robinson & Redford, 1986b). Another pattern found by Robinson & Redford (1986a) is the fact that large-bodied species occur at lower densities, which makes them more vulnerable to localized extinction.

Finally, according to Lu (1999), monkeys are easy targets as they do not automatically flee but stop and look at the hunter instead. Some species are even easier to hunt since females stay around when a head male is killed to “mourn” him.

2.3. Main ecological functions of primates in Amazon ecosystems

One may wonder why it is so important to conserve primate populations and what difference it would make if a few species went extinct. It would actually make a significant difference in ecosystems compositions.

These potential changes can be explained by the fact that monkeys are important seed dispersers (Bufalo *et al.*, 2016; Chapman & Dunham, 2018; Chanthorn *et al.*, 2017; Terborgh *et al.*, 2008). Indeed, the diet of monkeys includes a large number of fruits and, as they forage for food, they travel long distances and

defecate far away from the parental tree. This process makes seed dispersal more efficient, controls plant densities, and increases the reproductive success of many tropical plant species (Stevenson, 2000). Stevenson (2000) reported that woolly monkeys can potentially drop seeds up to 1.5 km away from the parent tree and Link & Di Fiore (2006) found that one group of spider monkeys of YNP dispersed a total of 13 512 seeds per hectare and per year. Importantly, woolly and spider monkeys play the role of seed dispersers for more than 200 species of tropical trees in Yasuní and, for some large-seed species, they are the only dispersers (Álvarez-Solas, 2018a; 2018b; Bass *et al.*, 2010; Link & Di Fiore, 2006; Stevenson, 2000). Yet these same primates are the first species to go locally extinct in affected areas. The actions that threaten the animals playing this ecological role are thought to drive long-term changes in the composition and structure of plant communities, even if there is no deforestation (Peres, 1990; Peres & Palacios, 2007; Link & Di Fiore, 2006; Bufalo *et al.*, 2016).

Modifications in flora composition can also alter other functions of the forest that are crucial for all living beings; CO₂ absorption, water availability and quality, temperature regulation, and soil quality maintenance. Moreover, the western Amazon, identified as the “Core Amazon”, can help mitigate the impacts of climate change, by maintaining wet rainforest conditions while drought intensifies in the eastern Amazon. Provided that corridors are established within protected areas systems, Yasuní could serve as potential refugia for humid forest species adapting to these changes (Bass *et al.*, 2010; Killeen & Solórzano, 2008).

Another interesting point is the fact that one primate species can be found in association with other species to travel and forage together, as it has been largely observed in YNP (Marsh, 2004). For example, white-fronted capuchins can form mixed groups of up to 30 individuals with spider, howler and squirrel monkeys during up to 80% of their time. It is a common defensive mechanism against predators and an efficient way to allocate available resources amongst the different species (Álvarez-Solas *et al.*, 2018c). Woolly monkeys have even been observed in association with a bird species, the double-toothed kites (*Harpagus bidentatus*); the latter forages for insects that are disturbed by the passing monkeys (Marsh, 2004).

Despite the need for more studies on the ecological roles of primates in ecosystems (de la Torre, 2012), these animals can be considered as “umbrella species” (Lambert, 2010), which means that the conservation of such species confers protection to numerous natural co-occurring species (Roberge & Angelstam, 2004). This concept appeared in the face of limited funding, knowledge, and time for conservation action and it is a strategy that can be used to make shortcuts for the maintenance of biodiversity (Roberge & Angelstam, 2004). This choice is justified by the fact that primates are both endangered and important seed dispersers, thus, the cascading effects on forest ecology that may be triggered by a species removal makes them a priority in conservation planning (Lambert, 2010; Aureli & Schaffner, 2010). Moreover, primates are sometimes considered as “flagship” species, which means charismatic species that can be used as a symbol to draw public attention and stimulate conservation

awareness and action (Caro *et al.*, 2004). For example, the spider monkey is an umbrella and flagship species for the Proyecto Washu (Washu, n.d.a) and the pygmy marmoset (*Cebuella pygmae*) is cited in the conservation action plan for Ecuadorian primates as a charismatic species that can be used for environmental education (Tirira *et al.*, 2018b).

2.4. Overview of today's situation: primate conservation status, threats, and ecological roles

Table 2 presents a summary of Yasuni's primate species, their conservation status, main threats and ecological roles. In line with the data of sections 1.4 and 2.1. of this chapter, it shows that hunting and illegal use and trade are main threats to all species, in addition to other oil-related threats such as habitat loss or agriculture and farming. Species-specific information is provided in sections 2.4.1. to 2.4.3..

Common name English/ Spanish	Scientific name(s)	Conservation status Global/Local	Main threats	Ecological roles
Equatorial saki/ Parahuaco ecuatorial	<i>Pithecia aequatorialis</i>	LC/NT	H HL IUT	CI SD
Golden-mantled tamarin/ Chichico de manto dorado	<i>Leontocebus tripartitus</i> ; <i>Saguinus tripartitus</i>	NT/VU	H HL IUT	SD P CI
Large-headed capuchin/ Machín negro	<i>Sapajus macrocephalus</i> <i>Cebus apella</i>	LC/NT	H HL IUT	CI CV P SD
Napo saki/ Parahuaco negro	<i>Pithecia napensi</i> <i>Pithecia monachus</i>	LC/NT	H HL IUT	CI SD
Pygmy marmoset/ Leoncillo, Titi	<i>Cebuella pygmae</i> ; <i>Callithrix pygmaea</i>	VU/VU	AF D H HL HP IUT NBM	CI P
Red howler monkey/ Mono aullador rojo	<i>Alouatta seniculus</i>	LC/NT	AF H HL IUT	SD
Red titi monkey/ Titi rojizo, Cotoncillo rojo	<i>Plecturocebus discolor</i> <i>Callicebus discolor</i>	LC/NT	AF H HL IUT	CI SD
Red-mantled saddle-back tamarin/ Chichico rojo	<i>Leontocebus lagonotus</i> ; <i>Saguinus fuscicollis</i>	LC/NT	AF H HL IUT	C SD P
Spix's night monkey/ Mono nocturno (de Spix)	<i>Aotus vociferans</i>	LC/NT	AF H HL IUT	CI SD
Squirrel monkey/ Mono ardilla Barizo	<i>Saimiri sciureus</i> <i>cassiquiarensis macrodon</i>	LC/NT	AF H HL IUT	CI P SD
White-bellied spider monkey/ Mono araña de vientre amarillo	<i>Ateles belzebuth</i>	EN/EN	AF H HL IUT	SD

White-fronted capuchin/ Capuchino de frente blanca	<i>Cebus albifrons yuracus</i>	LC/NT	AF CC D H HL IUT M	CI CV P SD
Woolly monkey/ Mono lanudo, Chorongó rojizo	<i>Lagothrix lagothricha</i> <i>poeppigii</i>	VU/EN	AF H HL IUT	SD

Table 2: Summary of Yasuni's primate species, including common English and Spanish names, scientific names, Global Conservation Status (IUCN, 2020a), Local Conservation Status (Tirira, 2011), Main threats (Tirira et al., 2018a) and Ecological roles (de la Torre et al., 2019).

Key to Conservation Status in IUCN Red List: LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered; NE = Not Evaluated (see Annex 3 for more details about IUCN Conservation Status). Key to main threats, alphabetically: AF = Agriculture and Farming; CC = Climate Change; D = Disease; H = Hunting; HL = Habitat Loss; HP = Human Presence; IUT = Illegal Use and Trade; IS = introduced species; M = mining; NBM = Noise of Boats and Motors; RC = Road Collisions; Key to ecological roles, alphabetically: CI = Control of Insect Population; CV = Control of Vertebrate Population; P = Pollinator; SD = Seed Disperser.

2.4.1. The heavier, the more threatened

The spider monkey (*Ateles belzebuth*) is the largest primate of YNP, weighing approximately 8.5 kg (Franzen, 2005). It is the most striking example that illustrates hunters' resource use patterns, species vulnerability and its associated population reduction. It was uplisted from "Vulnerable" to "Endangered" in 2008 because the population appeared to have declined by at least 50% over the past 45 years, i.e. three generations, mainly due to hunting and habitat loss (Link et al., 2019). Today, this animal is considered as the most threatened primate species in the Ecuadorian Amazon (Álvarez-Solas et al., 2018b). The woolly monkey (*Lagothrix lagothricha*), also one of the largest primates of YNP, is particularly sensitive to areas of altered vegetation, has low reproduction rates and population density, and is therefore one of the first species to be locally extinct. Moreover, it has become the most hunted primate species for food purposes in his living area and it is also highly captured as pets. In view of the current context, the intensive forest diminution and the overhunting that have been registered over the past two decades are also projected for the next three generations, i.e. 45 years (Álvarez-Solas et al., 2018a; Tirira, 2011). In spite of this alarming situation, the current state of spider and woolly monkey populations is little known and further studies are needed in order to establish an accurate management of these species (Álvarez-Solas et al., 2018a; 2018b). Howler monkeys (*Alouatta seniculus*) seem to be more resistant to human pressure because of their relatively small living area and folivore food habits (Martin-Solano et al., 2018), although the populations are affected in areas of human influence (Franzen, 2006; Martin-Solano et al., 2018).

2.4.2. Smaller species, illegal trade, and other threats

Smaller species like titi monkeys (*Callicebus discolor*), tamarins (*Leontocebus* spp.), capuchins (*Cebus* spp.) and squirrel monkeys (*Saimiri sciureus*) have become victims of the increasing illegal trade as

⁵ "Folivore food habits" refers to the fact that howler monkeys' diet is predominantly made of young leaves, which requires little foraging activity (Martin-Solano et al., 2018).

living pets (Tirira *et al.*, 2018a). Since live primate capture and trade are furtive activities, it is difficult to quantify their impacts (de la Torre, 2012). However, an analysis of data from confiscations by the environmental police and other environmental control agencies from 2003 to 2008, showed that primates were the taxonomic order most affected by this activity. Except two species, representatives of all Ecuadorian primate species were captured, amongst which squirrel monkeys (*Saimiri sciureus*) and white-fronted capuchins (*Cebus albifrons*) were particularly highly represented (Ministerio del Ambiente, 2008). This tendency was confirmed by a more recent study carried out between 2008 and 2010, highlighting the significant number of squirrel monkeys amongst the captured individuals, although the exact effects of illegal trade on this species still need to be further studied (de la Torre, 2012).

Even though there is little information about the final destination and survival rates of the confiscated animals (de la Torre, 2012), life conditions in captivity and post-release monitoring are important aspects to consider. On one hand, to prevent captive animals from becoming a form of tourist attraction instead of actual species conservation, the question of wildlife rescue centers' politics and goals need to be addressed. On the other hand, the reintroduction of some species in their natural habitat after being in contact with humans is a complex process (Tirira *et al.*, 2018a). Thus, illegal trade – and the subsequent animal confiscation – could become a factor that facilitates long-term captivity or that compromises the survival probabilities in the wild. Actually, the risks related to uncontrolled releases have already been evidenced with the reintroduction in the wild of white-fronted capuchins. It generated intergroups conflicts due to their territorial nature and introduced pathogens that could contaminate other species. Moreover, parasitic infections could be intensified by climate change, which would increase the threat to populations vulnerable to these diseases such as primates (Álvarez-Solas *et al.*, 2018c). White-fronted capuchins (*Cebus albifrons*)' conservation state needs to be accurately evaluated in view of the numerous threats associated with these animals. Not only are they sufficiently large to replace large-sized species that have been depleted in the diet of indigenous communities, but they are also greatly commercialized as pets because they better adapt to habitat changes and to captivity living conditions. Since they come close to affected areas and cross the road relatively easily, collision is another risk faced by this species (Álvarez-Solas *et al.*, 2018c).

In 2008, the golden-mantled tamarin (*Leontocebus tripartitus*) was classified as “Near Threatened” and the projections showed a population decline of around 25% over the course of the three generations, i.e., 18 years, due to anticipated high rates of oil-related deforestation (de la Torre & Cornejo, 2008). Since 2011, it has been locally uplisted to “Vulnerable” because its habitat, already limited to less than 20 000 km², was being deteriorated by oil activities (de la Torre & Tirira, 2018). It is particularly worrying since this species is an endemic mammal of the Napo Moist Forests ecoregion; YNP is the only protected area for the golden-mantled tamarin (Bass *et al.*, 2010).

The pygmy marmoset (*Cebuella pygmea*) is probably the most studied in terms of Ecuadorian primate species populations. The species densities appear to be minor in areas affected by human activities. Available data suggest that the establishment of new groups is a long process, which makes the species recovery in impacted areas particularly difficult (de la Torre, 2010).

2.4.3. A gap in scientific research about primates

Little data are available regarding the red-mantled tamarin (*Leontocebus lagotonus*), the brown capuchin (*Sapajus macrocephalus*), the night monkey (*Aotus vociferans*), the Napo saki (*Pithecia napensis*) and the red-crowned titi monkey (*Callicebus discolor*), although they also suffer from the anthropologic threats faced by the other primate species. Yet it seems that red-mantled tamarins, brown capuchins and titi monkeys are more likely to adapt to habitat alteration, always to some extent (Tirira *et al.*, 2018a; Carrillo-Bilbao *et al.*, 2005). The equatorial saki (*Pithecia aequatorialis*) is another endemic mammal of the Napo Moist Forests ecoregion (Bass *et al.*, 2010). Today, although few sources confirm its presence in YBR (Tirira & de la Torre, 2018), its distribution, ecology and population dynamics in Ecuador still need to be further studied. This lack of information illustrates the absence of support for scientific research and wildlife conservation in Ecuador. As de la Torre (2012) points out, “field research has been carried out in very few areas on both sides of the Andes, leaving other primate populations almost completely unknown” (p.30).

To conclude this section about the current state of primate conservation, it is relevant to remind that human pressures studied among the Waorani populations only show the tip of the iceberg. The Waorani communities are surrounded by many other ethnic groups, in addition to colonists, such as the Shuar and the Kichwas, which include sometimes many more families than the Waorani and use similar hunting methods (Mena *et al.*, 2000). The amount of game harvested for subsistence or commercialization is therefore substantial. For example, a twelve-month study in four Shuar communities (approx. 1000 people) registered 531 woolly monkeys harvested (Zapata-Ríos *et al.*, 2009). For the Waorani communities located along the Maxus road (approx. 320 people), Espinosa *et al.* (2014) registered 280 woolly monkeys harvested during a period of 12-14 months. Although the hunting of this species seems less intensive by the Shuar than by the Waorani in view of their respective population size, the total number of individuals harvested by the Shuar is outweighed by their high human population.

3. Primate conservation in Yasuní: needs, actions and limits

In 2018, a first primate-specific strategy of conservation was established by the MAE in collaboration with several groups of scientific experts: the conservation action plan for Ecuadorian primates. Its objective is to “maintain and restore ecologically functional primate populations in coexistence with humans, as an integral part of the ecosystems and landscapes of Ecuador” (Translated from Spanish

from Tirira *et al.*, 2018b, p.27). Its vision aims to decrease the extinction risks by one category (according to the evaluation of the Libro Rojo de los Mamíferos del Ecuador [Tirira, 2011]) for threatened and near threatened species as well as to provide data to evaluate the other species. It is planned over 10 years (until 2028) and includes short-, medium- and long-term actions. Action lines, including all the species present in YNP, focus on normative measures, *in situ* and *ex situ* management, illegal trade and hunting control, research, environmental education and the improvement of the work of expert groups.

On paper, it would appear that there is a response to the need for action in terms of primate conservation in Ecuador. The multidisciplinary approach of this plan reflects the need for collaboration between all actors, strongly emphasized in literature, in order to achieve long term conservation. Although it is too early to fully assess the practical applications of this Plan, this section will present an overview of the main measures, recommendations, and limits that have been identified so far regarding primate conservation in relation to the Waorani.

3.1. Reinforcing the control of wildlife traffic

The control of illegal trade is crucial because this activity does not only affect primate populations, but also ecological dynamics of forests and ecosystems, as well as the food security of communities whose diet is based on wild animals' proteins (MAE, 2017).

Ecuador signed the CITES agreement in 1975, and the Ecuadorian law of wildlife management and conservation stipulates that wild animal trade is forbidden. Wildlife traffic includes the use, transport, illegal trade, smuggling, poaching, capture and collection of fauna species and byproducts. The sanctions for perpetrators include fines or imprisonment and the confiscation of the animals (de la Torre, 2012; MAE, 2017; Tirira *et al.*, 2018a). Earlier literature reports the magnitude of wildlife traffic and deplores the lack of practical application of the law, due to limited financial and material resources and to the poor public awareness of the effects of wildlife trade (de la Torre, 2012; Suárez *et al.*, 2009; Bryja, 2009; WCS, 2010).

However, during the last decade, the MAE, in collaboration with other institutions, started to control wildlife traffic at the market of Pompeya. According to the “State of Conservation of the Ecuadorian Primates” (Tirira *et al.*, 2018a), all primate species present in Yasuní are protected by the Ecuadorian law and are included in the CITES. Bushmeat trade is no longer visible in local markets but clandestine trade by the Waorani still occurs and will probably continue as long as a market for bushmeat exists (Espinosa *et al.*, 2014) and alternatives to generate income are limited.

Whereas wildlife trade is prohibited, the article 247 of the Organic Integral Penal Code of 2014 allows subsistence hunting of primate species and their use in traditional medicinal practices by indigenous communities within their territories, for other purposes than commerce and profit (Registro Oficial

2014). One obstacle to the control of wildlife trade is the fact that the Waorani can easily get around the law by claiming that the controls affect their source of subsistence. Moreover, the application of sanctions related to wildlife trade to the Waorani is very flexible because of the fear of retaliation. For instance, in the community Guiyero, where the study case of Chapter 3 was carried out, the oil company and ECY are located within an area considered as Waorani territory by the communities. A conflict with them would thus threaten the security of the people working there (Z. Duvivier, pers. obs.).

3.2. Managing hunting practices

The possibility of wildlife depletion already existed when the Waorani were experiencing slow population growth, but they avoided it by moving their settlements (Lu, 1999). With the current population density, permanent settlements and the use of modern weapons, another solution needs to be found to avoid overexploitation of local fauna. According to Alvard (1993), who analyzed both interspecific and intraspecific prey choice among indigenous groups to test conservationist behavior, conservation implies “hunting decisions that are costly in terms of short-term harvest rate maximization, yet increase the long-term sustainability of the harvest” (p.358). This suggests that conservation can be managed through hunting practices.

For this purpose, Alvard (1993) first estimated the optimal diet. A prey item is included in it if the expected return rate for pursuing that item upon encounter is higher than the expected average return rate for continued search for higher-ranked items. According to his method, hunters who behave as conservationists follow the “zero-one rule”, which means that they sometimes pursue a prey while, at other times, they ignore it, even if this prey is part of the optimal diet (Alvard, 1993). Lu (1999) reproduced this model for the Waorani and found that their optimal diet would include woolly and howler monkeys. If the Waorani’s hunting practices aimed to conserve their faunal resources, they would sometimes forego these two species. However, her hunting data showed that they pursued woolly and howler monkeys 83% and 60% of the time, respectively. Better management options would include restricting the hunting of woolly monkeys until the populations have recovered, limiting the take of other primates such as howler and capuchin monkeys, and diverting hunting pressure to species with a higher productive rate, i.e., rodents, peccaries, and deer (Lu, 1999). Bodmer *et al.* (1997) also highlight the potential of managing game populations in tropical forests as a conservation strategy. For instance, favoring the hunting of shorter-lived individuals and shorter-generation-time species would have a positive impact on population recruitment of longer-lived individuals and longer-generation-time species (Bodmer *et al.*, 1997).

Another approach to orientate hunting practices to sustainable resource management would be to limit the impact on prey population growth, e.g., by selectively kill older adults to keep reproductive-age animals alive or by avoiding female-based harvests, since the overall reproductive rate and offspring

mortality rely more on the number of females than on the number of males (Alvard, 1995). The strategy of male-directed hunting has also been suggested by Bodmer *et al.* (1994) as the lifetime reproductive success of males is determined by access to females, while female reproductive success is mainly limited by resources. Nevertheless, studies focused on Waorani's hunting patterns suggest that they simply respond to what is locally available, instead of following a conservation-based strategy using the reproductive biology to guide their hunts (Mena *et al.*, 2000; Lu, 1999). It is even not uncommon that they hunt nursing females with their offspring, the latter being kept as a pet or sold (Lu, 1999; Z. Duvivier, pers. obs.). In the same way, recent research supports the need to report and assess current wildlife management, to develop alternatives for game management in YBR (Espinosa *et al.*, 2018), to manage harvests by establishing and enforcing hunting quotas, and to conduct spatial controls of hunting⁶ (Espinosa *et al.*, 2014).

While methods to evaluate hunting sustainability exist and have been applied, such as Robinson & Redford's model based on maximum production (1991), there is little evidence of the application of adaptive hunting practices among the Waorani communities. The way to implement and finance hunting management programs in those places still needs to be found. It is likely that the Waorani do not accept such a regulation on their hunting practices since this activity is part of their ancestral traditions and game represents their main source of protein. Moreover, subsistence hunting is protected by the law (Registro Oficial 2014). Those arguments would be coherent with the recent shift from conservation based on human presence prohibition in protected areas to participatory conservation, after estimating that some conservation measures appeared to have effects in terms of social justice (Perasso *et al.*, 2018). Thus, since wildlife management through adaptive hunting practices strongly depends on the will of local people to conserve biodiversity, a clue would be to attach importance to the participatory nature of such projects. In other places, many conservation initiatives have shown the importance and efficiency of including local hunters in wildlife monitoring (Puertas *et al.*, 2000; GOF-C-GOLD, 2017; Bowler *et al.*, 2013). In Ecuador, some Kichwa communities have established their own hunting quotas but no quantitative evidence was found about the effects of these practices on wildlife.

Finally, it is relevant to consider the possibility of managing hunting implements, especially because shotguns kill a high number of individuals, from which only a few are collected as they fail to fall out of the tree, which is avoided with traditional weapons⁷ (Mena *et al.*, 2000; Yost & Kelley, 1983; Z. Duvivier, pers. obs.). However, this option would be particularly difficult to put into practice because of the multiple sources of supply of guns and ammunitions, as well as because controlling the possession

⁶ "Spatial controls of hunting" refers to leaving some areas for extraction, which functions as "sinks", and some areas inaccessible to hunters as "sources". This strategy aims to have a flux of animals from sources to sinks, which can be used by local people (Santiago *et al.*, 2014).

⁷ Yost & Kelley (1983) indicate that the poison of the blowgun is a muscle relaxant; as a monkey dies, it relaxes its grip and it falls.

of guns within the communities is likely to trigger important conflicts in the same way as wildlife traffic control.

3.3. Limiting the presence of humans and infrastructures in protected areas

The Amazonia is the most important remaining “wilderness area” thanks to its intactness, the low human population, and a high level of protected areas (Mittermeier *et al.*, 2003). As a National Park and Biosphere Reserve, Yasuní contributes to the protection of Amazon’s biodiversity value. However, if human activities continue to extend, reinforcing the control on wildlife trade and adapting hunting practices will not be enough to ensure its efficiency as a protected area. Actions need to be taken at larger scales to minimize the impacts of human presence in Yasuní.

Bass *et al.* (2010) reach the conclusion that Yasuní’s global conservation significance can be maintained if 1) no new roads or transportation access routes are permitted in YNP and its buffer zones; 2) no new oil exploration and development are allowed, in particular in Block 21 and ITT Block; 3) protected biological corridors are created from Yasuní to near higher-elevation Andean parks for species that move due to climate change; 4) a system of protected areas and no-go zones is created in the northern Peruvian Amazon; 5) a protected corridor between Yasuní, Cuyabeno Wildlife Reserve and the Peruvian reserves is created to form a mega reserve.

3.3.1. Roads’ impact evaluation and control

Since indigenous hunters concentrate their activities near settlements, their behavior would facilitate wildlife persistence across landscape if the settlement density remained low and if roads were not built within inhabited protected areas (Novaro *et al.*, 2000; Espinosa *et al.*, 2014). Yet the construction of roads in Yasuní has been identified as one major driver of acculturation and fauna depletion, which reduces the capacity to sustain wildlife populations and threatens livelihoods of indigenous groups (Espinosa *et al.*, 2014).

Although some cases illustrate the effectiveness of controlling road access to avoid ecosystem destruction due to hunting and colonization (Laurance *et al.*, 2006), it does not appear to be a long-term solution in Yasuní. Access control depends on oil companies’ will and efforts to protect the environment, which is illustrated by the significantly different road management between the Auca road and the Maxus road. However, concessions frequently change ownership, or the companies just leave the road when resource extraction activities are terminated, and there is no resources available to enforce control (Espinosa *et al.*, 2014). It is particularly the case in tropical protected areas, in low-income countries with high pressure on land and natural resources, and in places where environmental institutions are weak and resources to conserve biodiversity are limited (Barrett *et al.*, 2001). Moreover, road access control is not effective for long-term biodiversity protection when oil companies’ practices

alter the social dynamics of local indigenous communities (Suárez *et al.*, 2012), which is happening along the Maxus road (WCS, 2010).

It is therefore essential to evaluate the risks before constructing new roads within such a protected area. Moreover, the construction of the road needs to be coupled with strict access control to avoid colonization and deforestation, as well as with strategies to manage long-term harvest of game by local populations, such as community-based programs (Espinosa *et al.*, 2014).

3.3.2. *Landscape management in a “land of no one” (“tierra de nadie”)*

Primates’ use of habitat is multiple due to their species specific locomotive behavior, inter- and intra-group social dynamics, as well as food and nonfood resource needs (Wallace, 2008; Pozo-Rivera, 2004a; 2004b). The conservation of all species necessarily relies on the maintenance of wide protected areas. In the neighboring Peruvian Amazon, it has been estimated that 61% to 72% of the area must be maintained as a protected area with no hunting to prevent the decline of primates (Novaro *et al.*, 2000). Yet the study of Espinosa *et al.* (2014) demonstrates that a single road segment of 117 km made an area accessible to hunters that corresponds to 9% of YNP and REW.

Thus, to ensure the protection of biodiversity, areas affected by hunting should be compensated by the establishment of areas that serve as refugia and that would remain inaccessible to hunters (Espinosa *et al.*, 2014; 2018; Bass *et al.*, 2010). It is consistent with the necessity, highlighted by several authors, to establish protected corridors to form mega-reserves. These “mega-reserves”, of at least 10 000 km² and connected to relatively intact surrounding landscapes, are key to maintaining Amazonian biodiversity in the long term (Peres, 2005; Bass *et al.*, 2010; Espinosa *et al.*, 2018; Laurance, 2005).

Such a network for primates was already created in the north-west part of Ecuador to respond to the urgent need for refuges for the critically endangered brown-headed spider monkey (*Ateles fusciceps*), i.e., the PRIMENET project (Darwin Initiative, 2015). However, it received very low support from local and national governments, which limits its potential for conservation (de la Torre, 2012). Actually, landscape management in relation to biodiversity protection is part of the role of a National Park (IUCN Category II):

- Protecting larger-scale ecological processes that will be missed by smaller protected areas or in cultural landscapes;
- Protecting particular species and communities that require relatively large areas of undisturbed habitat;
- Providing a “pool” of such species to help populate sustain-ably-managed areas surrounding the protected area;
- To be integrated with surrounding land or water uses to contribute to large-scale conservation plans (IUCN, 2020b)

Despite the fact that YNP has a surface area of approximately 10 000 km², its ecological functions are largely compromised by the high level of human intervention, as illustrated in Figure 4 (Ch. 1 section

2.2.2). The IUCN category II does not allow resource use except for subsistence or minor recreational purposes (IUCN, 2020b), however, oil companies generally know that the status of protected area is not an obstacle to their operations (Charity *et al.*, 2016). The efficiency of YNP should therefore be evaluated (de la Torre, 2010; 2012). As pointed out by Bass *et al.* (2010), “The protection actually afforded Yasuní under the title of ‘national park’ is in some respects only on paper, as exemplified by the extensive, ongoing oil extraction activities and permitted oil access roads” (p.13).

These inconsistencies are partially related to the fact that Yasuní is in some way considered as “tierra de nadie” (“a land of no one”). The Waorani have legal title to their territory, but under the Ecuadorian law, all subsurface minerals are claimed as the property of the national government. As a result, no land titles are truly secure since the law reserves the right to grant concessions of prospecting areas to private companies, except in the intangible zone. To summarize, Yasuní is inhabited by indigenous communities, concessions are granted by the Ecuadorian government, and national or foreign companies decide how to manage the territory where they operate. Ironically, the Ecuadorian Constitution of 2008 recognizes nature as a subject of right (Registro Oficial 2008), but a large part of the country’s second most important protected area, after the Galapagos Islands, is leased by oil companies.

The situation faced by Yasuní can be compared to Hardin’s tragedy of the commons, in which each individual or group acts in his own interest on a common pool resource. The result is that the resource is finally overexploited, and no one benefits from it (Hardin, 1968). There is a general consensus amongst academics on the fact that it happens when the resource is valuable and under an “open access regime” (Bromley & Cernea, 1989; McKean, 1996; Berkes & Farvar, 1989; McCay & Acheson, 1987), characterized by a lack of property rights as a result of the non-establishment or breakdown of a management authority system (Bromley & Cernea, 1989). Common property regimes, described as a private property for the group (Bromley & Cernea, 1989), have nevertheless been recognized to be beneficial for the conservation of natural resources (e.g., by avoiding habitats fragmentation and limiting resource access when they privatize rights to goods in a way that does not create boundary demarcation) and for the local community security and integrity (e.g., by enabling community to plan, restrict and monitor the resource use in an equitable and sustainable manner) (McCay & Acheson, 1987; McKean, 1996; Berkes & Farvar, 1989).

4. Conclusion of Chapter 2

Even if the main direct source of primate depletion in Yasuní is hunting, primate conservation cannot be dissociated from oil exploitation and Waorani’s cultural context. Not only does oil exploitation have deep implications on Waorani’s hunting activities, but its other environmental impacts, namely, contamination, deforestation, colonization and oil related disturbances, also intensify the deterioration of primates populations due to hunting.

The current state of primate conservation reflects the complexity of this context and the multiple anthropogenic threats. Historically, spider and woolly monkeys have been the most affected species by hunting because of their weight and ease of capture as well as their vulnerability due to their high generation time, longevity and low rate of population increase. Nevertheless, most other species are locally classified as “near threatened” or “vulnerable” because a further deterioration is expected if the current human pressures persist. Primates’ ecological functions in ecosystems are crucial and the potential cascading effects triggered by their extraction reinforce the need for conservation efforts. However, measures have to be coherent with reality, which requires an accurate understanding of primate population dynamics and needs, and of the exact effects of human activities on them. Yet it is not the case according to researchers, partially due to the absence of political and financial support from the Ecuadorian institutions.

The implementation of conservation measures does not depend on the separate efforts from the Ecuadorian government, oil companies, environmental organizations, researchers, Waorani communities, or MAE; it depends on the possibility to cooperate towards one common purpose that would replace Yasuní’s integrity as a priority. In line with the conservation action plan for Ecuadorian primates of 2018, the existing literature highlights some conservation measures and strategies that are already implemented or recommended, such as reinforcing controls on illegal trade or managing hunting practices together with local populations. Additionally, conservation associated with landscape management is crucial to guarantee the protection of Yasuní’s ecosystems. The expected ecological functions of YNP as a protected area are not effective because of the confusing legal framework of this territory and the current incompatible economic, cultural and environmental interests.

Chapter 3: Primate conservation together with local communities.

Study case in the Waorani community of Guiyero

1. Why integrating the Waorani in primate conservation issues?

At the global level, one aspect that makes biodiversity conservation together with local communities relevant is the fact Human Development Index (HDI) is the lowest in the places where biodiversity richness is the highest, as illustrated in Annex 4 and 5.

In the context of Yasuní, several studies have been focused on the effects of road development on biodiversity (Espinosa *et al.*, 2014; 2018; Suárez *et al.*, 2009; 2012; WCS, 2006; 2010), on the impacts of hunting on fauna (Novaro *et al.*, 2000; Mena *et al.*, 2000; Portilla, 2016; Yost & Kelley, 1983; Zapata-Ríos *et al.*, 2011; Franzen, 2006) or on the evaluation of primate state of conservation (de la Torre, 2012; Tirira, 2011; Tirira *et al.*, 2018a). However, few studies have addressed Yasuní’s environmental issues

from a socio-cultural point of view. This dissertation has demonstrated that primate main direct threat, namely, overhunting, is the product of a large acculturation process triggered by oil development that also has effects on Waorani communities. Taking measures to control wildlife traffic, to manage hunting practices or to reinforce protected areas is crucial to help natural ecosystems to recover. However, primate conservation in Yasuní is above all a socio-economic matter:

In this region, it is imperative that conservation interventions are sensitive to the needs of both wildlife and humans, as the park and its buffer zone encompass one of the world's richest areas for biodiversity and are the traditional home of indigenous communities whose long-term survival is threatened by unplanned development, unregulated oil industry, acculturation, and the unsustainable use of wildlife (WCS, 2010 p.7).

Natural resources are likely to be extracted as long as the basic needs of local communities are not met, thus biodiversity conservation must be addressed from a multidisciplinary perspective. This approach is consistent with the research question that has guided this analysis so far: What is the contribution of the Waorani to primate conservation in Yasuní? Although the question is not answered, addressing primate conservation from this angle is a way to tackle the problem from one of its main sources. Importantly, this analysis reveals an additional, and perhaps more important, question: what can be the contribution of primate conservation to the Waorani in Yasuní? As reminded by Jacobson (2010), “healthy human communities depend on healthy natural systems” (p.415).

Dalton (1969) calls “development” a change characterized by continuous income growth for the local community through economic, political, and cultural integration into a larger socio-economic entity, of which it is a part, without losing its ethnic identity or feeling unease. Nevertheless, in light of Lu's study (1999) as well as the present analysis, it seems that the Waorani are rather experiencing what Dalton (1969) calls “a cash income growth without development” (p.77), that is, a type of change without development in terms of high standards of living and quality of life that involves resource depletion in a way that prevents future generations from experiencing the same lifestyle (Dalton, 1969).

A study carried out in the Kichwa community of Sarayaku, where the populations of several game species are affected by hunting, aimed to evidence if increasing people's monetary income would help to halt game depletion, as claimed by many members of the community. The results suggest that increasing income *in connection with steady employment* may potentially alleviate pressure on wildlife. (Sirén *et al.*, 2006). Although several additional factors have to be considered in the context of the Waorani (e.g., the fact that hunting is still an important tradition for older generations), the potential of developing an income-generating activity as a conservation strategy deserves more attention. Therefore, on the basis of a qualitative study carried out in the Waorani community of Guiyero, this chapter will explore the potential and limits of fostering primate conservation through community development initiatives.

2. Study area

The study was carried out in the Waorani community of Guiyero, located in the province of Orellana within the Amazon rainforest and YNP. Yasuní's climate is characterized by warm temperatures (24-27°C for all months), high annual rainfall with no severe dry season (3,200 mm annually) and high relative humidity (80-94% throughout the year) (Bass *et al.*, 2010).

Guiyero was created with the establishment of the Maxus road, between 1992 and 1993. In 2001, two families of Guiyero created Timpoka and, later, Ganketapare, two additional communities along the Maxus road (Espinosa *et al.*, 2014) (Figure 6). The community of Guiyero includes about 80 people distributed among 18 households, and all its members have the Waorani nationality, except one Kichwa family. Guiyero is the biggest and oldest community of the area and, since it includes the school and is relatively close to Timpoka and Ganketapare, it is used for most meetings of those three communities. In fact, they are sometimes considered as only one extended community given their closeness and the numerous inter-community family bonds, totaling about 180 people.



Figure 6: Map of the area along the Maxus road, including Guiyero, Ganketapare, Timpoka, Yasuní Scientific Station (ECY) and Repsol oil company (modified from Merlyn Sacoto, 2018b). Repsol controls the access to Maxus road, provides free transportation and most facilities that are represented on this map, i.e., wood and cement houses, school, children's playground, cement stadium in Guiyero.

This area is a strategic place in the context of this dissertation since the lifestyle and traditions of the Waorani of Guiyero, Ganketapare and Timpoka are being altered at a particularly high level in comparison with more remote communities. It is due to the fact that they are established along the Maxus road and within Block 16, an area currently strictly controlled and managed by Repsol oil company (Figure 6). Free transportation is provided by the company on a daily basis and is used by the Waorani to reach hunting areas, go to school (Figure 7), move between communities and travel every weekend to the market of Pompeya (which is 32 kilometers and 1,5-2 hours away from Guiyero).

Moreover, Guiyero is the first Waorani community along the Maxus road, and is thus a crossing point between Pompeya, the Kichwa communities, other Waorani communities, researchers and workers from

Repsol (Figure 3, Ch.1 section 1.3.; Figure 6). As partially illustrated in Figure 6, the company also provides food, occasional jobs, basic services and modern infrastructures through its human resources Department. According to Sánchez & Gúzman (2007), the company's intervention and its effects on local people's life and traditions include an “assistencialist” form. As a result, the sociocultural aspects of these communities have been progressively replaced by Occidental habits, but no commercial activity has been developed and it has been determined that the habitants of Guiyero are ignorant of commercialization and product promotion processes (Sánchez & Gúzman, 2007).



Figure 7: Entrance to the community of Guiyero alongside the Maxus road. At the end of the road, there is the school, the stadium of Guiyero, and the bus of Repsol used by the Waorani (Guiyero, March 2020, photo by Z. Duvivier).

Furthermore, this area is characterized by a high natural potential such as lakes, the Tiputini river and primary forests that house numerous species of plants and animals (Sánchez & Gúzman, 2007), including most primate species of Yasuní. At the time of the study, i.e., in February 2020, members of the WCS were finalizing a six-month research on the state of primate populations in the area. Even though the results were not yet published, they asserted during an interview that large monkeys, i.e., woolly, spider and howler monkeys, were found increasingly further from the community. It is consistent with previous studies that reported the significant hunting rate of large primate species along the Maxus road by the Waorani (Franzen, 2006; Suárez *et al.*, 2009; Espinosa *et al.*, 2014). Bushmeat commercialization may have decreased due to the controls on wildlife trade, yet the informants of the WCS thought that it could also be due to the fact that primate populations have become so small that the profitability of hunting these animals does not compensate the efforts to find them. Importantly, these informants observed that the portion of the forest where most primates can be observed is located in an area also known to be used by the *Taromenane*, still living in voluntary isolation, which explains why most Waorani hunters do not go there. The presence of the *Taromenane*, highly feared by the other ethnic groups because of violent confrontations that occurred in the past, is somehow contributing to forest conservation in Yasuní. However, the fact that such territories serve as refuge for species hunted in other areas is likely to generate interethnic conflicts in the future.

Finally, Yasuní Scientific Station (ECY) is also located along the Maxus road, about 17 kilometers after Guiyero and 3 kilometers before Timpoka (Figure 6). It receives many researchers and students in the

areas of biology and botany, and, less frequently, sociology and anthropology. Many of them work with Waorani from the three communities as field assistants, which provides them with a temporary source of income.

3. Method

The field work took place from February 9 to March 1, 2020. The first week was a period of integration through voluntary work at the school of Guiyero, teaching English and informatics to both children and adult students. The two following weeks were dedicated to data collection from different actors present in the study area; the Waorani of Guiyero, Timpoka and Ganketapare; biologists of the WCS; rangers of the MAE; teachers of the Waorani; and a member of the foundation Alejandro Labaka (FAL). In accordance with the directors of the ECY, every interviewed person had to approve an informed consent protocol prior to the interview. All interviews were oral, individual or in groups of maximum three people.

To evaluate the possibilities to develop an economic activity that would foster primate conservation by the Waorani, the interviews were made of open questions around three general topics. First of all, to briefly compare today's situation with past literature, a few questions were asked on the current hunting activities of the Waorani, for example: "Do you think that as many people as before hunt monkeys?"; "How often do you eat monkey?"; "What proportion is used for self-consumption and for selling?"; "What species are most hunted/eaten?"

Another important aspect was to understand Waorani's perception of the state of primate populations around the communities, as well as to which extend primate conservation is relevant for them. Indeed, research has shown that native Amazonians do not particularly perceive limits to natural resources (Lu, 1999; Mena *et al.*, 2000; Rival, 1992; Zapata-Ríos *et al.*, 2009), which can influence their interests in and motivation for taking part in conservation initiatives. Jacobson (2010) highlights the fact that:

natural resource managers often make the mistake of designing messages that contain only important factual information concerning the behavior they desire people to change, failing to consult the intended recipients of the message to identify which of their beliefs really influence how they behave in a particular situation (p.417).

For this purpose, questions such as the following were asked: "Do you see as many monkeys as before in this area?"; "Do you believe that monkeys are closer or further than before?"; "Why would you want to conserve monkeys?"

Finally, it was necessary to identify (1) their actual expectations in terms of human development, e.g., the balance between the maintenance of ancestral traditions and the Occidental habits and values; and (2) their awareness and preferences regarding the existing options to generate income in a sustainable way. For example, some key questions were the following: "Do you know another way to earn money

in the community?"; "What would be necessary to implement such a project in your community?"; "Do you think that it is important to conserve the Waorani culture? Why and how?"

Besides interviewing specific people, additional information was collected through observation and participation in Waorani's daily activities, such as the creation and exchange of handicraft with the women, workshops given by the FAL and the WCS to the population, data collection in the forest in the context of scientific research, reunions and discussions at families' home. Interviews to non-Waorani people included the current state of primate conservation in the area, the needs, priorities and existing measures in terms of primate conservation, the possible options to develop an economic alternative in Guiyero and the limits to implement it.

The collection of data was limited by several factors. First, despite several meetings with the directors of ECY, the accurate planification of the field work was restricted because neither the Waorani nor the study area were known beforehand. Also, the budget, material and time were very limited due to the nature of the research, that is, an individual study in the context of a master's dissertation. Second, the study period coincided with Carnival, during which the school is close for several days and many Waorani go on trip to the closest cities or stay at home to celebrate together. Moreover, the bus provided by the company comes less regularly, which strongly limits the movement to and from the communities. Additionally, a five-day camp was organized by the evangelic missionaries for all children in the Waorani community of Dikaro (located 2 hours away along the Maxus road), thus most young people and some adults left the study area. On account of these circumstances, the questions and activities had to be adapted on site. For instance, a workshop on biodiversity and waste management, that would have been useful to collect data, could not take place. Finally, interviews with the Waorani were limited by numerous cultural differences such as language, manners and cosmovision. In addition to the fact that adults and elderly people have no or limited knowledge of Spanish, many Waorani show reserve with regard to foreigners or no interest in interacting with them. Furthermore, they are used to receiving a financial or material contribution in exchange for their participation in scientific activities and they are very reluctant to collaborate without such incentives. As a result, interviews with the Waorani took the form of guided conversations, as more systematic approaches were negatively received or misunderstood by the participants. The present study should therefore be completed with additional data collected in the context of more extensive research and field work.

A total of 15 Waorani participated in the study, including 7 men and 8 women, aged from 16 to approximatively 40 years old. Most of them were students of the English class given at the beginning of the field work. Many of them did not have any specific profession, although several did have an occasional income-generating activity, as a teacher of "Waorani culture" at the school of Guiyero, path cleaners for Repsol, field assistants for scientific research or creators and sellers of handicraft.

4. Results and discussion

4.1. Waorani's perception of primate depletion and conservation

According to three participants, monkeys were mostly hunted by the elder men of the community as a traditional custom, as well as by some younger men. Two participants reported that a small proportion of the bushmeat was sold outside the forest, while another respondent asserted that it was exclusively used for self-consumption. It was also reported that currently most people have stopped selling meat at the market since it is prohibited and controlled by the MAE and because they have participated in workshops on the effects of wildlife traffic. Interviewees reported that they eat monkeys between less than once a week and two times a month, which is less than what they used to eat when they were younger. The species most hunted and eaten are woolly monkeys and, less frequently, spider monkeys, which confirms the tendencies identified in Chapter 2. However, one respondent said that nowadays, they eat more food that comes from the outside.

The perception of primate depletion among the participants was not homogeneous. One woman recognized that there were more monkeys before. She observed that now they “go away” because they are afraid of the noise of vehicles and guns, whereas their grandparents killed less game and used silent blowguns and spears. It was also reported that “ahora los están matando y se van para algún lado, antes estaban por aquí, por las vías” (“Today they [the monkeys] are being killed and they go somewhere, before they were here by the roads”). On the other hand, others believe that monkeys could eventually disappear after many years, but that currently there are still a lot of them.

All participants questioned about their perception of wildlife conservation believed that it was necessary to conserve monkeys since it is a source of food and because they are used to having monkeys as pets (Figure 8).



Figure 8: *Lagothrix lagothricha poeppigii* and *Cebus yuracus*, juvenile kept as pets in Guiyero (Guiyero, March 2020, photo by Z. Duvivier).

A study focused on the relationship between the Waorani and primates (Papworth *et al.*, 2013) suggested that these animals are not more important than other mammals but rather that a small number of key species are important in their diet and culture, such as woolly monkeys. Thus, Western references in terms of taxonomic groups and conservation goals should be adapted when addressing conservation with these communities (Papworth *et al.*, 2013).

4.2. The place of the ancestral culture in wildlife conservation

The interviewees voiced their concern about the loss of the Waorani culture; “antes habían nuestros abuelos para cantos, bailes, matrimonios, fiesta... allí algo tenía. Pero ahora poco a poco, los niños ya no puede, perdimos poco a poco, pero mayorcito todavía costumbre tiene, mi mama...” (“before there were our grandfathers for songs, dances, weddings, celebration... There was something. But now little by little, children can’t anymore, we are losing little by little, but older people still have the customs, my mom...”). As part of an activity on the use of computers in Guiyero, all students chose to make a presentation on topics related to the Waorani culture, for example, handicraft by Waorani women (Figure 9), traditional Waorani tales, animals of the forest, and medicinal plants. Although one informant said that they are afraid to show some traditions to foreigners (e.g., physical marks), it seems that these elements are still an important part of their cosmovision, and the interviews showed that they are worried at the idea of forgetting it. Nevertheless, the place of ancestral traditions is uncertain in the current context of socio-cultural changes among the communities.



Figure 9: handicraft made of chambira, a local palm tree, by the Waorani women (Guiyero, March 2020, photo by Z. Duvivier).

Yet the literature provides interesting insights about the role of traditional culture in today’s conservation concerns. Between the 1980s and the early 1990s, indigenous peoples were considered as a key element to resolve the environmental crisis because of their culture and ideology related to the

⁸ Papworth *et al.* (2013) found that the distinction between primates and non-primate species is not even clearly defined by the Waorani. They also include the non-primate olingo (*Bassaricyon alleni*) and kinkajou (*Potos flavus*) in the group “monkeys” according to their own criteria.

*Pachamama*⁹, by contrast with industrialized countries that were alienated from nature (Barreiro, 1991; Clad, 1988). However, the studies focused on actual behaviors and quantitative evidence regarding native Amazonians' practices (Mena *et al.*, 2000; Hames, 1991; Alvard, 1995) and their conception of “biodiversity” or “conservation” (Hill, 1996; Stearman, 1996) showed that they actually act more according to efficiency than conservation principles, such as selective prey choices.

However, Native Amazonians' cosmovision understands humans as an inherent part of biodiversity, in contrast to the Western society, governed by an economic system that views environmental damage as an externality (Daly, 1968). It confers to these people a deep understanding of natural ecosystems, e.g., when learning to become effective hunters, young boys have to acquire an extensive knowledge of the calls, nesting habits, breeding behavior, feeding cycles, and habitats of a large number of species (Yost & Kelley, 1983). Jose Barreiro, an native American wrote: “In some cases, such as the meso-American and Amazonian rainforests, they are the only cultures that understand the relationship of the human society to those fragile ecosystems (...). In many respects, to support the survival struggles of the Amazonian Indians is to support the protection of the rain forests (...)” (Barreiro, 1991, p.199-200).

Does it mean that primate conservation has to go together with the conservation of native Amazonians' ancestral tradition? De la Torre *et al.* (2020) highlight the fact that, for the Secoya, other native Amazonians of Ecuador who have many common points with the Waorani (e.g., deep knowledge of the forest, using monkeys as a valuable source of protein, keeping monkeys as pets and, more recently, intensive hunting with modern weapons and loss of traditional culture), preserving their ancestral knowledge would be an asset to conserve wild primates and Amazonian rainforests.

4.3. Tourism: a sustainable alternative to wildlife commercialization?

4.3.1. Waorani's point of view

Three participants mentioned the fact that they have to find an alternative to respond to their needs in case Repsol stops its activities in the area, especially since the company currently represents the main source of employment for many members of the community. A Waorani teacher at the school of Guiyero stated “quisiera cambiar cosas más en la educación, lo que es emprendimiento, hacer cada uno mismo, ser emprendedores” (“I would like to change things in education, what is undertaking, to make things on our own, to be entrepreneur”).

They expressed their interest in tourism as a way to generate income but also to foster the traditional culture and biodiversity conservation; “si nosotros hacemos este tipo de proyecto de turismo entonces cuidemos el ambiente, animales y aves, mantengamos eso para poder trabajar con los turistas” (“if we

⁹ *Pachamama* is a word related to Andean countries' cosmovision and refers to the nature “where life happens and reproduce”, i.e., Madre Tierra (Mother Earth) (Haidar & Berros, 2015).

do this kind of project, we have to take care of the environment, animals, birds, to maintain this to work with tourists”). One man of the neighborhood of *Paraíso* (a group of households within Guiyero, also called *Nenkiguiro*) reported that they have the project of building a “cabaña” (“lodge”) so that the tourists can come visit and people can sell handicraft. This project has been presented to the Fundación FIDAL, whose “Escuela de Liderazgo” has already given workshop on project development in Waorani communities and will select 50 projects that will be granted by their 2020 program (FIDAL, 2019). Actually, it appears that another lodge had already been built at the entrance of Guiyero (Figure 10) but was finally left unused. The informants of the MAE and WCS also mentioned tourism as a potential economic activity, especially because the impacts on biodiversity sustainability could be very high if Repsol left the area, given the current material and food dependence on the company.



Figure 10: The “cabaña” (lodge) built for tourism in Guiyero but left unused (Guiyero, March 2020, photo by Z. Duvivier).

4.3.2. Critical approach to tourism

Although tourism is an economic activity preconized by the habitants of Guiyero, the development of touristic projects¹⁰ in other places has showed that its effects on local populations and biodiversity conservation can be disappointing. On one hand, in developing countries, the expectations in terms of socioeconomic development are high: employment opportunities, social services and infrastructures, communities empowerment, promotion and improvement of the local culture (Cobbinah *et al.*, 2015; 2017; Froger, 2012). Nevertheless, in reality, the venue of tourists can lead to the deterioration of the local culture, e.g., acculturation, adulteration, or “Westernisation” of the local population (Wunder, 2000; Cobbinah *et al.*, 2017; Ormsby & Mannie, 2006). Moreover, it is likely that income from tourism to the communities is limited and insufficient to improve their living conditions or to invest in better touristic services (Lasso, 2013). It is particularly the case when the benefits are not equally distributed

¹⁰ Even though tourism associated with biodiversity conservation and local development can take many different forms (e.g., ecotourism, sustainable tourism, community tourism, or solidarity tourism), the distinction between those concepts is sometimes confusing (Froger, 2012). This is why this analysis does not enter this semantic debate and includes all categories under the denomination “tourism”.

between external agents and communities, which can create a relation of dependence towards external support (Froger, 2012). In addition, touristic projects focused on conservation goals may generate conflicts at the local level if conservation measures limit the financial benefits in or are detrimental to local populations (Cobbinah *et al.*, 2017; Froger, 2012).

On the other hand, in regions where ecosystems are endangered and threatened by anthropogenic activities, it is often expected that tourism will foster wildlife conservation, for example through financial support for protected area management, public awareness, changes in natural resource use by local populations, and habitat preservation (Cobbinah *et al.*, 2017; Froger, 2012). However, economic benefits are sometimes insufficient to protect the environment (Tardif, 2003) and the potential impacts resulting from tourism-related factors (e.g., visitors, vehicles, infrastructures) are numerous, for example: animals' behavioral changes resulting from feeding and monkey-human interactions, capture of animals (de la Torre *et al.*, 2000), biologic contamination, oil and gas pollution, soil erosion, litter, illegal hunting and fishing, or plant collection (Farrel & Marion, 2001).

Thus, the positive outcomes of a touristic initiative in a protected area are not guaranteed and unappropriated management can result in more negative than positive effects. On the basis of other places' experience (Wunder, 2000; Cobbinah *et al.*, 2017; 2015; Ormsby & Mannie, 2006), some key factors have been identified to optimize the benefits to local populations and wildlife:

(1) The participation of local communities:

“Local” can be defined as the residents of the protected area and “tourism participation” as the ability that have the residents to influence the operation and its outcomes (Wunder, 2000). First, their participation is essential to develop a product that motivates and interests them. At the financial level, the way local populations profit from tourism strongly relies on their level of participation. It also helps promote the local culture and generates a sense of pride among local populations (Froger, 2012). A tool has been developed to evaluate the level of participation of individuals: the scale of participation (Annex 6). Most initiatives stay at the level of “tokenism”, which includes advice, consultation and information, while participatory conservation aims to reach the level of “citizen power” (Perasso *et al.*, 2018). Finally, involving local populations in the whole process is an efficient way to increase their autonomy and to raise awareness regarding conservation issues and sustainability (Wunder, 2000).

(2) The nature of external agents' intervention:

In communities with few or no experience in tourism, commercialization processes and in product promotion, external support is often necessary to develop a product that is adapted to tourists. For this purpose, the training of individuals in tourism-related fields is crucial. The cooperation with agencies may also be necessary to help promote the project. Moreover, to evaluate the effects of tourism in terms of primate conservation, local populations need to be trained to be able to monitor monkey populations before and during the implementation of the activities. Also, the collaboration with experienced actors

can help manage community expectations through education (Cobbinah *et al.*, 2017). Importantly, the intervention of external agents should not preclude the realization of factor (1).

(3) Mechanisms of income management and distribution:

The socioeconomic impacts of tourism do not only rely on the size of the income, but also on the induced process of change in the local system (e.g., the shift towards cash economy or local investment possibilities). Income may come from different tourism-related jobs (e.g., guiding, accommodation, sale of handicraft, transport) or a more centralized mechanism can be established to avoid income concentration in the hands of few individuals (Wunder, 2000). In the same way, the impacts of tourism on wildlife partially relies on the ability to invest in resource sustainability, such as less contaminant techniques (Wunder, 2000; Froger, 2012).

(4) Community-wide mechanisms of wildlife management:

A policy on the use of natural resources needs to be established and respected by all members of the community, such as restrictions on forest extraction (Wunder, 2000). In the Kichwa community of Añangu, the members have agreed to stop hunting, fishing, and extracting timber to maintain biodiversity as a tourist attraction. Mechanisms of control have also been established by themselves (Comunidad Kichwa Añangu, 2018). Moreover, in places where several indigenous communities cohabit, agreements between those communities may be necessary to prevent the biodiversity conservation in one area from becoming a resource sink for the neighbors. A balance needs to be found between conservation and socioeconomic goals, this why the implication of local populations in the decision-making process is crucial.

Besides these general patterns, the way tourism will benefit local populations and biodiversity depends on other elements such as the geographical location of communities, tourist flow patterns, ownership of the territory and facilities (Cobbinah *et al.*, 2017), the intensity of tourist-site use and development, the resiliency of the ecosystem, the time-perspective of the tourist developer, and the transformational character of tourist development (Cohen, 1978).

4.3.3. Comparison of the factors of success with the situation of Guiyero

After this analysis, the important question is whether or not such conditions can be implemented in Guiyero. Currently, there is very few evidence of leadership and community-wide organization, which is probably not proper to Guiyero but rather to the traditional socio-political system of the Waorani. Lu (1999) reported that, in another community, a teacher tried to elaborate a decision-making process to instill a sense of community and to elect a community president and vice president, which was poorly received by the members. It can be explained by the fact that Waorani's traditional forms of organization are based on individualism, independence, or situational leadership (Lu 2001; Rival, 1992; Rivas & Lara, 2001). A woman of Guiyero mentioned tourism as a way to maintain the Waorani culture and the president's role in the organization, but added that "falta alguien para hacer" ("Someone to do it is

needed”). She highlighted the bad leadership in the community by saying that “solo personal esta trabajando” (“only personnel [of the oil company] is working”).

The lack of organization in Guiyero is intensified by the intervention of the oil company, which does not foster a long-term autonomy among the residents. The interviews have shown that the Waorani positively see the services provided by Repsol but recognize that it is not enough. When asked what kind of help they would need for the touristic project of Paraíso, the answer was “necesitamos una persona que conozca como trabajar, una vez el proyecto ya se encuentre, una persona capacitada, que tenga conocimiento y experiencia para poder trabajar con él” (“we need a person who knows how to work, once the project has been established, a trained person, with knowledge and experience so that we can work together”). In her analysis about changes in time allocation and dietary intake after the beginning of Oryx’s oil exploitation, Lu (1999) found that most men had left the community to work for Oryx and that food was dropped every day to the community by helicopters. As a reminder, food sharing is a mechanism of risk reduction and it reinforces social cohesion amongst the Waorani. The result of Oryx’s actions was that hunting activities and the level of food sharing had decreased and the relation between households was altered.

Thus, these elements suggest that the current organizational system of Guiyero is not particularly suitable for the development of tourism according to the conditions previously identified, that is, a high level of members’ participation, a constructive collaboration with external actors, an internal organization involving the understanding about membership, solid-decision making and conflict resolution mechanisms. For example, mechanisms of community-wide organization would be necessary to convince all members to stop hunting, including the elderly for whom it is a traditional habit. Although this area has a high potential in terms of touristic attraction (i.e., the high biodiversity richness, the culture and knowledge of the Waorani) and could be reachable by road – with the company’s permit and a way to cross the Napo river –, the current system needs to be redesigned to prevent detrimental effects on populations and ecosystems.

4.4. Alternative community-based conservation strategies

It is likely that the Waorani of Guiyero mentioned tourism because it is the best-known activity associated with community development and wildlife conservation in the area. However, alternative initiatives exist and have shown positive results in other places.

4.4.1. Agroforestry

In the Ecuadorian province of Esmeraldas, soil management has been tested by the NGO “Proyecto Washu” to protect the Critically Endangered brown-headed spider monkey (*Ateles fusciceps*). A strategy of participatory conservation was used to develop a sustainable cacao production for export together with local communities on the territories where spider monkeys live. Although quantitative effects on

monkey populations have not been evaluated, it has reduced the deforestation due to timber extraction by local populations, and some families have already become financially autonomous (Washu, n.d.b; 2017). Actually, a small cacao production has been initiated by the Association of Waorani Women of the Ecuadorian Amazon rainforest (AMWAE, n.d.).

Similarly, a member of the FAL suggested implementing a sustainable management system of the *chacras*¹¹ (Figure 11) in Guiyero, so that the families could be more autonomous in terms of consumption and production. He mentioned the possibility of organizing *mingas*¹² for this purpose. Such system is already used by the Kichwa, who have a very efficient use of their *chacras* and who are used to doing *minga*, which enables them to cultivate plants such as coffee and cacao for commercialization.



Figure 11: The *chacra* of a Waorani family of Guiyero (Guiyero, March 2020, photo by Z. Duvivier).

However, different non-Waorani informants questioned about the potential of developing a cacao production in Guiyero opined that it would be very difficult because the Waorani do not have the culture of land cultivation. During an interview, two teachers explained that they already tried to plant new varieties of seeds with them to improve their soil management. It did not work because, after eating or selling what had grown once, they did not maintain the plantations. Indeed, they usually cultivate small quantities of varieties that grow easily in the *chacra*, whereas a cacao plantation requires more technical soil management and *minga* implies a form of community organization. Rival (1992) observed that as gatherers, the Waorani prefer to rely on any kind of food that can be obtained without having to produce it through work. Finally, if the human population continued to grow, each family's *chacra* would potentially cause a reduction of the territory available for primate conservation, as mentioned by an informant of the WCS.

¹¹ *Chacra* is a word coming from the Kichwa language and locally used to refer to the patch used by each family to cultivate several plants and vegetables varieties, i.e., vegetable garden.

¹² *Minga* is a concept used in other ethnic groups, such as the Kichwa, by which different families gather to work for a common good. According to Lu (1999) and Rival (1992), it did exist in the Waorani communities they studied but it turned out to be a foreign and imposed activity related to the presence of school and the establishment of a hierarchy alien to the Waorani culture.

4.4.2. Peccary skin certification

Before the 1970s, many countries of Latin America (including Ecuador) used to export peccary skin for the leather trade. After that, they progressively prohibited commercial hunting and wildlife trade, although illegal peccary skin trade still contributed to an important part of the market in the following years (Bodmer *et al.*, 1993; Fang *et al.*, 2008). Today, Peru is the only exporter and the management of this activity could become a model for other countries of the continent because of its potential in terms of wildlife conservation (Fang *et al.*, 2008). Indeed, there is an increasing demand from the international market, especially in Europe and the United States, for sustainable products (i.e., derived from well-managed forests). It has motivated many initiatives of certification of products derived from natural resources. The aim of product certification is to verify and recognize that it has been produced in a way that generates higher benefits at the social and environmental levels than products from forests of conventional management (Gullison, 2003). For this reason, a pilot program for skin certification has been implemented in Peru by FundAmazonia, Darwin Initiative and other collaborators as a mechanism to administrate sustainable wild bushmeat hunting. Peccary skin trading is legal only if it comes from subsistence hunting and the certification produces an added value to (and income from) the skin for hunters. It has a catalyst effect to implement more sustainable practices in communities (Fundamazonia, n.d.; Fang *et al.*, 2008). This program is based on a series of directives of wildlife management to obtain the certification, which can be applied differently depending on the socioeconomic and cultural realities of the communities. One of the directives is “To reduce or stop hunting of animals vulnerable to excessive hunting, such as primates (...)” and the long-term objective of the project is to conserve Amazonian forests with their biodiversity (Fundamazonia, n.d.).

According to Espinosa *et al.* (2014), white-lipped (*Tayassu pecari*) and collared peccaries (*Pecari tajacu*) accounted for 65% of total biomass extracted and 75% of total biomass traded by 33 Waorani households along the Maxus road between 2008 and 2009. As a result, those animals were the most intensively hunted species in this area (Espinosa *et al.*, 2014). Although it would probably not change the fact that primates are a game of choice in terms of preference and protein intake for the Waorani, creating an additional income from peccary skins may have an effect on the rate of primate hunting for commercialization purposes. Provided international organizations help cover the costs associated with the certification process, the support of external collaborators such as ONG's, universities and institutions (Fang *et al.*, 2008) could help improve the communities' practices for a more sustainable use of resources (e.g., through trainings, technical assistance and monitoring).

4.4.3. Appropriate Authority and payments for environmental services

In Zimbabwe, after a large period of conflicts between authorities, rural farmers and wildlife, an initiative for natural resource management based on proprietorship over wildlife, that is, CAMPFIRE, was created. In this sense, Rural District Councils (RDC) are the Appropriate Authorities for wildlife, i.e., they have the custody over and responsibility for wildlife resource management and the right to

directly benefit from their use. Producer communities receive a fixed percentage of the revenue earned. According to Frost & Bond (2008), CAMPFIRE can be called “payments for environmental services” (PES) since an environmental service is provided by the farming communities – as the fate of wildlife is determined by their land- and resource-use decisions – and bought by safari operators. This service is sold to eco-tourists and safari hunters as end users. The RDCs serve as intermediaries; they are the sellers on behalf of their constituent communities. In practice, safari operators buy the rights to bring ecotourists and sport hunters to track, observe and photograph wildlife or hunt a set quota of animals. The costs related to the programme implementation were covered by several donors, such as the United States Agency for International Development (Frost & Bond, 2008).

This strategy is based on the assumption that the revenue from using wildlife can create an incentive for communities and households to modify or limit their use of land in appropriate ways. Yet, for local farmers, it represents a number of site- and agreement-specific costs associated with wildlife production. For example, it includes losing their crops and livestock to wildlife and the threat to their lives, stopping wildlife harassment and hunting, limiting the expansion of crops and livestock, or confining human settlements to agreed zones or move away from prime wildlife areas (Frost & Bond, 2008). The aggregate revenue from wildlife is significant, however, it represents a small value at the household scale that does not always compensate for the costs of wildlife production or that is not a sufficient incentive to forego land use practices (Frost & Bond, 2008; Tchakatumba *et al.*, 2019). Nevertheless, a recent study (Tchakatumba *et al.*, 2019) has shown that households perceive direct and indirect economic benefits, such as employment opportunities, bushmeat provision or facilities. However, the positive effects at the socioeconomic and environmental levels were worsened by a donor withdrawal. Even though the results suggest that the program has to be redesigned to empower the actors at the local levels (i.e., institutions, communities, and households), the vast majority of the households opted for its continuation and its contribution to conservation was also recognized (Tchakatumba *et al.*, 2019).

Whether or not this system would be possible with the Waorani communities depends on many factors, such as the interest of the populations in such project, buyers of environmental services, international donations, the capacity of local institutions to collaborate, the possibility of receiving proprietorship titles, mechanisms of training and monitoring of resource use by local populations, or the potential aggregate revenue. Regardless, receiving ecotourists raises the same questions that have already been discussed as for the development of tourism.

4.5. Limits to primate conservation with local populations in Guiyero

4.5.1. *The lack of cohesion in the actions undertaken in Yasuní*

One interviewed biologist highlighted the lack of unity in what is being done in Yasuní in terms of biodiversity management or sustainable development. Indeed, different organizations, researchers and

institutions have involved the Waorani in their projects, e.g., through workshops, field assistant jobs or trainings. Although many of these initiatives have shown positive results, Yasuní has become a sort of laboratory of projects with no common goal or long-term perspective, for example towards one common program of education or capacitation of local communities.

Also, legal concerns have to be addressed, for example, the question about how to plan a long-term project of biodiversity conservation in an area where local populations' right underneath the soil cannot be guaranteed. As reminded by Lu "this adds a great deal of uncertainty over any efforts to invest in a resource base if such investments could be undermined by petroleum development that the Huaorani themselves cannot control" (Lu 1999, p.276). In the same vein, several informants reported that the construction of a new road is planned, which will connect the community of Taracoa (located along the Auca road) to south Pompeya (on the other side of Napo River). Although the project is outside the limits of YNP and has the permit of the MAE, the interviewees of the WCS asserted that this new road is likely to facilitate the access to Yasuní and therefore increase forest and wildlife extraction.

4.5.2. *The lack of environmental education*

It is important to reinforce environmental education among the communities since it raises awareness individually and motivates personal decisions regardless any other type of incentive or punishment (Jacobson, 2010). In some cases, it is thought that increasing the income may reduce fauna depletion only because the time available to hunting has decreased due to labor work, rather than the individual's will to conserve wildlife (Wunder, 2000; Sirén *et al.*, 2006). Especially in the context of the Waorani, decision-making mostly occurs at the individual level, with little or no coordination at larger scales. Moreover, like other native Amazonians, they tend to believe in natural abundance and therefore do not perceive their resources as scarce, which can influence their interest in conservation initiatives (Lu, 1999; Mena *et al.*, 2000; Rival, 1992; Zapata-Ríos *et al.*, 2009). To foster local communities' participation, it is essential to connect education to their environment, e.g., through practical activities that make the connection between what they learn and their everyday life. It also helps generate a sense of pride about the forest and the motivation to protect it (Washu, n.d.b).

For example, the WCS initiated a management program for freshwater turtles (*Podocnemis unifili*), locally called "charapas", with several communities including Guiyero (WCS, 2010). In the same way, researchers have developed a program of environmental education for young people in indigenous and colonist communities to address pygmy marmoset (*Callithrix pygmae*) conservation issues. The project was completed by a conservation program together with local habitants, the Secoya, which provided important data for diversity management and the development of sustainable activities such as agroforestry, food production and tourism (de la Torre, 2010).

Some goals of primate conservation education include the protection of endangered species, sustainable management of the forest habitat, increasing recycling efforts or decreasing illegal pet trade (Jacobson,

2010). Nevertheless, the possibilities in terms of conservation education rely to a large extent on alliances between conservation organizations, governments, industries and research institutions (Jacobson, 2010), which are very limited in Yasuní.

4.5.3. A deficient educative system

The level of education in Guiyero is extremely low and the personnel working at the school deplors the lack of support for more human and material resources in education. The school of Guiyero is in fact a small extension of the school of Dikaro, which is one of several extensions of the educative unit *Yachana Inti* of the province of Orellana. As a result of the lack of budget and the constant population growth, there is only one teacher for the secondary school of Guiyero, who is working per period of two weeks with no substitute during the weeks off. This teacher is paid by Repsol, while the teachers of *Yachana Inti* are paid by the Ecuadorian government in most indigenous communities. According to the interviewed teacher of Guiyero, the Waorani have a role to play in asking for more support, which they have not done sufficiently so far.

Another important aspect is the inclusion of the Waorani culture in education. Although education is supposed to be bilingual, as indicated by the name of the school, i.e., Centro Educativo Comunitario Intercultural Bilingüe (Bilingual Educative Community Intercultural Center), the actual language of teaching is Spanish. This gap contributes to the loss of the Waorani culture, as confirmed by one man of *Paraíso*: “nuestros hijos, jóvenes, van a la escuela, profesores, hablan español, y se domina, entonces los niños ya se olvidan el idioma” (“our children, young people, go to school, the teachers, speak Spanish, which is mastered, so children already forget the language”). As illustrated in Figure 12, two members of the community were trained and hired to teach elements of the Waorani culture at school, such as the *wao tededo* language, dances and songs. However, it was part of a short-term project that ended as soon as the associated budget was spent.



Figure 12: Traditional dance lesson as part of the “Waorani culture” class given at the school of Guiyero (Guiyero, February 2020, photo by Z. Duvivier).

Additionally, the current spatial organization of the community does not stimulate cultural exchange since the families are distributed along the road and depend on the bus to go to school or to gather in the common spaces, especially the families located in remote settlements. In the same way, external people working with the Waorani (i.e., researchers, teachers, and volunteers) have few opportunities to exchange with them. The professor of Guiyero, who used to teach in the neighbor community of Dikaro, reported that he had learned many aspects of the Waorani culture while he was working in Dikaro, but that it was no longer possible in Guiyero.

4.5.4. The loss of cultural elements

Most non-Waorani informants highlighted the difficulties to implement a long-term project with the Waorani because of their lack of commitment and organization. It can partially be explained by their culture which is very remote from the Occidental system. For instance, it was reported that they are not used to receiving orders, making long-term financial planification, administrating, or maintaining biodiversity if it has no utility in terms of subsistence. For example, a project of pisciculture was created by Repsol in order to reduce the pressure of hunting and fishing in Guiyero. The Waorani were trained to run the project but, once it was in their hands, fish rapidly disappeared and an external person had to be hired for the management of the project. On the other hand, if these aspects are inherent to their culture and cosmovision, the possibility to develop an economic activity relies on a change in their traditions. Moreover, conservation goals may involve restrictions on hunting activities, which would lead to the loss of this element in their traditional lifestyle and to an increase in imported food. Yet, one can wonder if there is a boundary between the maintenance of the traditions and the community's socioeconomic development. It seems that a balance has to be found between the loss of traditional cultural aspects and their conservation.

4.5.5. The "population increase" factor

According to one respondent of the WCS, the fact that primate populations are increasingly depleted, in spite of the reduction in meat commercialization and consumption, can be explained by the constant population growth among the indigenous groups. Thus, taking measures to manage human population growth rate would be another priority. Nevertheless, such idea is likely to be poorly received by both the institutions and the populations, especially considering the importance of Catholic and Christian institutions in Ecuador, including among the indigenous communities of Yasuní.

5. Conclusion of Chapter 3

First, the interviews suggest that the perception of primate depletion is not homogenous among the Waorani and that their motivations for conservation differ from the ones of biologists or environmental organizations. These elements support the need for more environmental education and for the inclusion of their vision and references in conservation initiatives. Second, there is a general concern regarding

the loss of the Waorani culture due to the current acculturation process. However, the literature has shown that traditional knowledge is an asset for the understanding of natural ecosystems and should therefore not be dissociated from environmental conservation.

The Waorani informants expressed their will to develop an income-generating activity in order to be independent from the oil company. For this purpose, tourism was the most popular option and they believe that it would help conserve wildlife and promote the Waorani culture. In light of the literature and insights from other touristic projects, the potential detrimental effects of tourism on local populations and on the environment have to be seriously considered. The analysis showed that the benefits of tourism depend on numerous factors, including the participation of local populations, the nature of the intervention of foreign agents, mechanisms of income management and distribution and community-wide mechanism of wildlife management. Yet it seems that the current dynamics of Guiyero, especially the lack of community-wide organization and leadership and the constant assistance of Repsol, do not foster such conditions to develop tourism.

Nevertheless, alternative conservation strategies exist and have been implemented in other places, such as cacao productions in the Chocó, the certification of peccary skin in Peru or the system of PES in the CAMPFIRE programme of Zimbabwe. The significant number of peccaries among Waorani's game encourages a further exploration of the peccary skin certification as a wildlife conservation strategy in Yasuní. The feasibility of a PES-based program is difficult to evaluate because of the numerous cultural, institutional and organizational differences of Zimbabwe with Ecuador. Also, the past attempts of soil management with the Waorani do not encourage the agroforestry option. Importantly, the participation of local population is a key factor to proper long-term management in any community-based conservation project. The support of and collaboration with external actors is also essential, provided that their intervention promote the communities' long-term autonomy in terms of natural resource management.

Finally, the lack of cohesion in the actions undertaken in Yasuní, the need to reinforce environmental education, the poor basic education system, the potential loss of cultural elements and the constant population growth are significant barriers to the implementation of community-based conservation project in the community of Guiyero.

General conclusion

Centered around the question “What is the contribution of the Waorani to primate conservation?”, this dissertation has especially demonstrated *why* it is essential to address Yasuní's primate conservation issues from the Waorani's perspective. Firstly, it has shown that primate depletion, generally attributed to Waorani's unsustainable hunting practices, is the subsequent result of external human interventions

in Yasuní, that is, initially, the Evangelic Church and, to a larger extent, the Western culture through oil development. Indeed, these interventions are the sources of today's main factors of overhunting, which are the increasing population density, new material and economic necessities, the replacement of traditional weapons by firearms, the access to market and hunting areas, and the demand for bushmeat. As a result, long-term conservation measures need to consider both the direct and indirect threats to primates, namely, overhunting and the sources of changes in Waorani's resource use.

Secondly, the analysis of Chapter 2 highlighted the fact that large-sized primates are the first to become locally extinct since they are ecologically more vulnerable and because they are the most hunted species for their protein intake and market value. In addition, these animals play an indispensable role in seed dispersion. Therefore, they represent both a challenge and an asset in terms of biodiversity conservation. In spite of the fact that more research is needed on other species' ecology, conservation state and threats, monitoring large-sized primate populations around the Waorani communities could be a clue to evaluate the effectiveness of conservation strategies.

Although overhunting for subsistence and commercialization purposes is the main direct threat to primates in Yasuní, the literature reports other oil-related factors such as deforestation, habitat fragmentation or road collision. This situation is reflected in the actions and recommendations for primate conservation. Indeed, controls on wildlife traffic have already been implemented, however, the effectiveness of such measures is not guaranteed due to persistent clandestine trade and to the flexibility in the application of these measures to the Waorani. Besides, alternatives have been suggested to adopt more sustainable hunting practices, such as restrictions on vulnerable species or selective hunting to have a positive impact on prey population growth. While no evidence of their application to the Waorani was found, it seems that the participatory nature of such measures is a crucial feature when wildlife management depends on the motivation of local people. Finally, better management of Yasuní as a protected area is necessary in the context of large-scale primate conservation. It includes a systematic evaluation of the risks associated with road construction, road access control, landscape management through the creation of mega-reserves with ecologic corridors and refugium areas, and the establishment of legal bases that guarantee the protection of wildlife and local indigenous groups.

Importantly, by adopting the perspective of the Waorani, this analysis has shown that the fate of primates in Yasuní depends to a large extent on the socio-economic context of the Waorani communities. Therefore, primate conservation has to be considered from a wider perspective than the ecological sphere. This is why the development of an economic activity by the Waorani has been proposed as a conservation strategy. The study case in the community of Guiyero provided several elements in this regard. First, the Waorani do not always perceive resources as scarce and their motivations for conservation can differ from the ones of conservationists; it is essential to include their references and point of view in conservation strategies. Second, there is a real preoccupation regarding the loss of the Waorani culture due to Occidental influences. Although they traditionally behave in terms of efficiency

regardless the sustainability of resources, they possess an extensive knowledge of natural ecosystems. Hence, the conservation of their culture may benefit biodiversity conservation. Third, the habitants of Guiyero-Ganketapare-Timpoka are interested in tourism as a way to become autonomous, to promote their culture and to maintain local biodiversity. The realisation of such assumptions relies not only on their motivation and commitment in the touristic project, but also on the conditions implemented to optimize the positive effects of a touristic activity. Currently, the constant intervention of Repsol and the lack of leadership and community-wide organization in Guiyero does not foster their long-term autonomy and put in doubt the successful outcome of such initiative.

Since the Waorani occupy the same territory as primate populations, another way to promote conservation would be to adopt a sustainable and productive soil management system. However, Waorani's lack of organization and rigor as well as the failed past attempts do not encourage this possibility. Two more alternatives have been suggested: the peccary skin certification, which would represent a strong potential for the Waorani hunters, and a PES-based program, which seems less realistic in view of the legal, institutional and financial framework of Yasuní. Although a series of changes need to be implemented to develop an economic activity by the Waorani, e.g., guaranteeing efficient external support, improving the educational system and fostering environmental education, the economic stability and the empowerment of the communities may foster long-term primate conservation.

Also, the contact with the Western society has triggered a process of change in the Waorani culture; they have adopted some elements of the Occidental system, even though their lifestyle is ruled by traditional values and cosmovision. The subsequent need for natural resources conservation can only be responded if this process results in a balance between economic, ecological and cultural interests. Vickers (1994), who studied the process of change in resource management among another Amazonian indigenous, the Siona-Secoya, concluded that “ ‘conservation’ is not a state of being. It is a response to a people's perceptions about the state of their environment and its resources, and a willingness to modify their behaviors to adjust to new realities” (Vickers, 1994, p. 331).

Finally, analyzing the Waorani's relationship with primates shows the reflect of humans' relationship with natural resources, which represents the source of environmental issues at the global level. While wealth generation relies on natural capital, our system has failed to consider that natural resources are limited. Facing this situation involves questioning the sustainability of the current system and taking responsible decisions in collaboration with the different poles of the society, rather than finding short-term solutions. Similarly, addressing long-term primate conservation in Yasuní requires an effective and consistent collaboration between Ecuadorian institutions, oil companies, researchers, environmental organizations as well as indigenous populations. In the course of the year 2020, Ecuador will host the XVIII International Primatological Society Congress (Tirira *et al.*, 2018b). Will this event be the opportunity to stimulate such reactions – and actions?

Bibliography

- Almeida, A. & Proaño, J. (2008). *Tigre, Águila y Waorani. Una sola selva, una sola lucha*. Acción Ecológica, Instituto de Estudios Ecologistas del Tercer Mundo y la Alianza de Pueblos del Sur Acreedores de Deuda Ecológica, Quito, Ecuador. Retrieved February 1, 2020, from <http://www.biodiversidadla.org/Documentos/Tigre-Aguila-y-Waorani-una-sola-selva-una-sola-lucha>
- Alvard, M.S. (1993). Testing the “ecologically noble savage” hypothesis: Interspecific prey choice by Piro hunters of Amazonian Peru. *Human Ecology* 21(4), 355-387. Retrieved April 7, 2020, from <https://www.jstor.org/stable/4603101>
- Alvard, M.S. (1995). Intraspecific prey choice by Amazonian hunters. *Current Anthropology* 36(5), 789-818. Retrieved April 7, 2020, from <https://www.jstor.org/stable/2744021>
- Álvarez-Solas, S., Di Fiore, A., de la Torre, S. & Tirira, D.G. (2018a). Mono Lanudo de Pöppig. In D.G. Tirira, S. de la Torre & G. Zapata-Ríos (eds.), *Estado de conservación de los primates del Ecuador*, 193-201. Grupo de Estudio de Primates del Ecuador / Asociación Ecuatoriana de Mastozoología. Publicación especial sobre los mamíferos del Ecuador 12. Quito.
- Álvarez-Solas, S., Link, A., Di Fiore, A., de la Torre, S., Pozo-Rivera, W.E. & Tirira, D.G. (2018b). Mono araña de vientre amarillo. In D.G. Tirira, S. de la Torre & G. Zapata-Ríos (eds.), *Estado de conservación de los primates del Ecuador*, 163-171. Grupo de Estudio de Primates del Ecuador / Asociación Ecuatoriana de Mastozoología. Publicación especial sobre los mamíferos del Ecuador 12. Quito.
- Álvarez-Solas, S., Silva, M.A., de la Torre, S., Jiménez P., .P.J & Tirira, D.G. (2018c). Capuchino del marañón. In D.G. Tirira, S. de la Torre & G. Zapata-Ríos (eds.), *Estado de conservación de los primates del Ecuador*, 73-81. Grupo de Estudio de Primates del Ecuador / Asociación Ecuatoriana de Mastozoología. Publicación especial sobre los mamíferos del Ecuador 12. Quito.
- AMWAE (n.d.). Chocolate WAO. In *Productos*. Retrieved April 18, 2020, from <https://www.amwae.org/chocolate-wao/>
- Arnett, J.J. (2002). The psychology of globalization. *American Psychologist* 57(10), 774-783. <https://doi.org/10.1037/0003-066X.57.10.774>
- Aureli, F. & Schaffner, C.M. (2010). Spider monkeys. *Current Biology* 20(15), PR624-R626. <https://doi.org/10.1016/j.cub.2010.06.040>
- Barreiro, J. (1991). Indigenous peoples are the “miner’s canary” of the human family. In B. Willers (ed.), *Learning to Listen to the Land*, 199-201. Washington, DC, Island Press.
- Barrett, C.B., Brandon, K., Gibson, C. & Gjertsen, H. (2001). Conserving tropical biodiversity amid weak institutions. *BioScience* 51(6), 497-502. [https://doi.org/10.1641/0006-3568\(2001\)051\[0497:CTBAWI\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2001)051[0497:CTBAWI]2.0.CO;2)

- Bass, M.S., Finer, M., Jenkins, C.N., Kreft, H., Cisneros-Heredia, D.F., McCracken, S.F., ...Kunz, T.H. (2010). Global Conservation Significance of Ecuador's Yasuni National Park. *PLoS ONE*, 5(1), e8767. <https://doi.org/10.1371/journal.pone.0008767>
- Becerra, S., Paichard, E., Sturma, A. & Maurice, L. (2013). Vivir con la contaminación petrolera en el Ecuador: percepciones sociales del riesgo sanitario y capacidad de respuesta. *Revista Lider* 23, 102-120. Retrieved March 28, 2020, from <https://dialnet.unirioja.es/servlet/articulo?codigo=4959912>
- Beckerman, S. (1994). Hunting and fishing in Amazonia: Hold the answers, what are the questions? In A. Roosevelt (ed.), *Amazonian Indians from Prehistory to the Present*, 177-200. Tucson, AZ, University of Arizona Press.
- Berkes, F. & Farvar, M.T. (1989). Introduction and overview. In F. Berkes (ed.), *Common Property Resources: Ecology and Community-based Sustainable Development*, 1-17. London, Belhaven Press.
- Bilsborrow, R.E., Barbieri, A.F. & Pan, W.K. (2004). Changes in population and land use over time in the Ecuadorian Amazon. *Acta Amazonica* 34(4), 635-647. <http://dx.doi.org/10.1590/S0044-59672004000400015>
- Bledsoe, J. (1972). Saint. *Esquire* (1972, July 1), 127-154. Retrieved 25 January, 2020, from <https://classic.esquire.com/article/1972/7/1/saint>
- Bodmer, R.E, Eisenberg, J.F. & Redford, K.H. (1997). Hunting and likelihood of Extinction of Amazonian Mammals. *Conservation Biology* 11(2), 460-446. <https://doi.org/10.1046/j.1523-1739.1997.96022.x>
- Bodmer, R.E., Fang, T.G., Moya I, L. & Gill, R. (1994). Managing wildlife to conserve Amazonian forests: population biology and economic considerations of game hunting. *Biological Conservation* 67(1), 29-35. [https://doi.org/10.1016/0006-3207\(94\)90005-1](https://doi.org/10.1016/0006-3207(94)90005-1)
- Bodmer, R.E., Sowls, L. & Taber, A. (1993). Economic importance and human utilization of peccaries. In W.L.R Oliver. (ed.), *Pigs, pecaríes and hippos: status survey and conservation action plan*, 29-36. IUCN/SSC Pigs and Peccaries Specialist Group, IUCN, Quito. Retrieved May 23, 2020, from <https://portals.iucn.org/library/node/6805>
- Bowler, M., Valsecchi, J., Queiroz, H.L., Bodmer, R. & Puertas, P. (2013). Communities and uacaris: conservation initiatives in Brazil and Peru. In L.M. Veiga, A.A. Barnett, F. Ferrari & M.A. Norconk (eds.), *Evolutionary Biology and Conservation of Titis, Salis and Uacaris*, 359-376. Cambridge University Press 2013,. Retrieved May 23, 2020, from <https://www.researchgate.net/publication/282854835>
- Bromley, D.W. & Cernea, M.M. (1989). The management of common property natural resources: Some conceptual and operational fallacies. *World Bank Discussion Papers* 57. Washington, DC, The World Bank. Retrieved January 24, 2020, from <http://documents.worldbank.org/curated/en/548811468740174575/The-management-of-common-property-natural-resources-some-conceptual-and-operational-fallacies>

- Bryja, G. (2009). *Análisis de las presiones antropogénicas sobre biodiversidad en la Reserva de Biósfera Yasuní*. Informe Técnico #10. WCS-Ecuador. Retrieved November 26, 2019, from <https://www.portalces.org/biblioteca/areas-protegidas/analisis-de-las-presiones-antropogenicas-sobre-biodiversidad-reserva-de>
- Bufalo, F.S., Galetti, M. & Culot, L. (2016). Seed Dispersal by primates and implications for the conservation of a biodiversity hotspot, the Atlantic Forest of South America. *International Journal of Primatology* 37(3), 333-349. <https://doi.org/10.1007/s10764-016-9903-3>
- Burzio, M. (2007). *Huaorani: Los últimos guerreros*. Quito, Ecuador, Trama.
- Cabodevilla, M.A. (2004). *El exterminio de los pueblos ocultos*. CICAME, Pompeya.
- Cabodevilla, M.A. (2005). Introducción general. In M.A. Cabodevilla & M. Berraondo (eds.), *Pueblos no contactados ante el reto de los derechos humanos : Un camino de esperanza para los Tagaeri y Taromenani*, 13-25. Quito, Ecuador, CICAME, CDES.
- Cabodevilla, M.A. (2016). *Los Huaorani en la Historia de los pueblos del Oriente*. Centro de Publicaciones PUCE, Quito, Ecuador.
- Cano Molestina, V. (2018). Waorani: Tras las huellas de los humanos verdaderos. In M-F. Merlyn Sacoto (ed.), *Arrinconados en la Selva*, 10-46. Centro de Publicaciones PUCE, Quito, Ecuador.
- Cardoso, S., Alfonso-Sánchez, M.A., González-Andrade, F., Valverde, L., Odriozola, A., Pérez-Miranda, A.M., ...Pancorbo, M.M. (2008). Mitochondrial DNA in Huaorani (Ecuadorian Amerindians): A new variant in haplogroup A2. *Forensic Science International Genetics Supplement Series* 1(1), 269-270. <https://doi.org/10.1016/j.fsigss.2007.11.003>
- Caro, T., Engilis, A. Jr., Fitzhebert E. & Gardner, T. (2004). Preliminary assessment of the flagship species concept at a small scale. *Animal Conservation* 7(1), 63-70. <https://doi.org/10.1017/S136794300300115X>
- Carrillo-Bilbao, G., Di Fiore, A. & Fernández-Duque, E. (2005). Dieta, Forrajeo y Presupuesto de Tiempo en Cotoncillos (*Callicebus Discolor*) del Parque Nacional Yasuní en la Amazonia Ecuatoriana. *Neotropical Primates* (13)2, 7-11. <https://doi.org/10.1896/1413-4705.13.2.7>
- Cervera, L., de la Torre, S., Jerusalinsky, L., Fuentes, N., Alfonso-Cortés, F., Morcelos-Juárez, C., ...Tirira, D. (2017). Conservation Action Plan for Ecuadorian Primates: Process and Priorities. *Primate Conservation* 31(1), 9-15. Retrieved November 21, 2019, from <https://www.researchgate.net/publication/322021679>
- Chanthorn, W., Wiegand, T., Getzin, S., Brockelman, W.Y. & Nathalang, A. (2017). Spatial patterns of local species richness reveal importance of frugivores for tropical forest diversity. *Journal of Ecology* 106(3), 925-935. <https://doi.org/10.1111/1365-2745.12886>
- Chapman, C.A. & Dunham, A.E. (2018). Primate seed dispersal and forest restoration: an African perspective for a brighter future. *International Journal of Primatology* 39, 427-442. <https://doi.org/10.1007/s10764-018-0049-3>

- Charity, S., Dudley, N., Oliveira, D. & Solton, S. (eds.) (2016). *Amazonía Viva – Informe 2016: Un enfoque regional para la conservación en la Amazonía*. Iniciativa Amazonía Viva de WWF, Brasilia y Quito. Retrieved January 28, 2020, from <https://www.wwf.org.pe/?297070/informe%252Damazonia%252Dviva%252D2016>
- Clad, J.C. (1988). Conservation and indigenous people: A study of convergent interests. In J.H. Bodley (ed.), *Tribal Peoples and Development Issues: A Global Overview*, 320-333. Mountain View, CA, Mayfield Publishing Company.
- Cobbinah, P.B., Amenuvor, D., Black, R. & Peprah, C. (2017). Ecotourism in the Kakun Conservation Area, Ghana: Local politics, practice and outcome. *Journal of Outdoor Recreation and Tourism* 20, 34-144. <http://dx.doi.org/10.1016/j.jort.2017.09.003>
- Cobbinah, P.B., Black, R. & Thwaites, R. (2015). Biodiversity conservation and livelihoods in rural Ghana: Impacts and coping strategies. *Environmental Development* 15, 79-93. <http://dx.doi.org/10.1016/j.envdev.2015.04.006>
- Cohen, E. (1978). The impacts of tourism on the physical environment. *Annals of tourism research* 5(2), 215-237. [https://doi.org/10.1016/0160-7383\(78\)90221-9](https://doi.org/10.1016/0160-7383(78)90221-9)
- Coimbra Jr., C.E.A. (1988). Human settlements, demographic pattern, and epidemiology in lowland Amazonia: The case of Chagas's disease. *American Anthropologist* 90(1), 82-97. <https://doi.org/10.1525/aa.1988.90.1.02a00060>
- Comunidad Kichwa Añangu (2018). *Comunidad Kichwa Añangu*. Retrieved April 22, 2020, from <https://www.comunidadanangu.org/>.
- Conaie (n.d.). Huaorani. In *Nacionalidades-Amazonía*. Retrieved March 20, 2020, from <https://conaie.org/2014/07/19/waorani/>
- Dalton, G. (1969). Theoretical issues in economic anthropology. *Current Anthropology* 10(1), 63-102. <https://doi.org/10.1086/201011>
- Daly, H.E. (1968). On Economics as a Life Science. *Journal of Political Economy* 76(3), 392-306. <https://doi.org/10.1086/259412>
- Darwin Initiative (2015). Developing a sustainable network for primate conservation in Ecuador - PRIMENET. In *Projects. Forest Biodiversity*. Retrieved April 11, 2020, from <https://www.darwininitiative.org.uk/project/14040/>
- de la Torre, S. (2010). Los primates ecuatorianos, estudios y perspectivas. *ACI Avances en Ciencias e Ingenierías* 2(2), B27–B35. <https://doi.org/10.18272/aci.v2i2.30>
- de la Torre, S. (2012). Conservation of Neotropical primates: Ecuador – a case study. *International Zoo Yearbook*, 46(1), 25-35. <https://doi.org/10.1111/j.1748-1090.2011.00158.x>

- de la Torre, S. & Cornejo, F. (2008). *Saguinus tripartitus*. *The IUCN Red List of Threatened Species* 2008: e.T19824A9020295. <https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T19824A9020295.en>
- de la Torre, S., Snowdon, C.T. & Bejarano, M. (2000). Effects of human activities on wild pygmy marmosets in Ecuadorian Amazonia. *Biological Conservation* 94(2), 153-163. [https://doi.org/10.1016/S0006-3207\(99\)00183-4](https://doi.org/10.1016/S0006-3207(99)00183-4)
- de la Torre, S. & Tirira, D.G. (2018). Tamarín ensillado de dorso dorado. In D.G. Tirira, S. de la Torre & G. Zapata-Ríos (eds.), *Estado de conservación de los primates del Ecuador*, 49-53. Grupo de Estudio de Primates del Ecuador / Asociación Ecuatoriana de Mastozoología. Publicación especial sobre los mamíferos del Ecuador 12. Quito.
- de la Torre, S., Tirira, D., Alfonso-Cortes, F., Álvarez-Solas, S., Carrillo-Bilbao, G., Cervera, L., ... Rylands, A.B. (2019). *Primates de Ecuador Guía de Identificación de Bolsillo*. Global Wildlife Conservation. Retrieved April 3, 2020, from <https://ipsquito.com/wp-content/uploads/2019/12/PrimatesEcuador.pdf>
- de la Torre, S., Yépez, P. & Payaguaje, A. (2020). Past, Present and Future of Secoya Ethnoprimateology in the Ecuadorian Amazonia. In B. Urbani & M. Lizarralde (eds.), *Neotropical Ethnoprimateology*, 283-293. Springer, Cham. https://doi.org/10.1007/978-3-030-27504-4_13
- Descola, P. (1996). *In the Society of Nature: A Native Ecology in Amazonia*. Cambridge, Cambridge University Press.
- Ecuador, INEC (2015). *Población y Demografía*. Instituto Nacional de Estadística y Censos (INEC), Quito, Ecuador.
- EIA (2017). Ecuador. In *Countries. Analysis*. Washington, DC, U.S. Energy Information Administration. Retrieved November 17, 2019, from <https://www.eia.gov/international/analysis/country/EQU>
- Espinosa, S., Branch, L.C. & Cueva, R. (2014). Road development and the geography of hunting by an Amazonian indigenous group: consequences for wildlife conservation. *PLoS One* 9(12), e114916. <https://doi.org/10.1371/journal.pone.0114916>
- Espinosa, S., Celis, G. & Branch, L.C. (2018). When roads appear jaguars decline: Increased access to an Amazonian wilderness area reduces potential for jaguar conservation. *PLoS ONE* 13(1), e0189740. <https://doi.org/10.1371/journal.pone.0189740>
- Fa, J.E. & Tagg, N. (2016). Hunting and primate conservation. In S.G. Wich & A.J. Marshall (eds.), *An Introduction to Primate Conservation*, 143-156. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780198703389.003.0009>
- FAO (2020). *Food and Agriculture Organization of the United Nations*. Retrieved April 2, 2020, from www.fao.org

- Fang, T.G., Bodmer, R.E., Puertas, P.E., Aparicio, P.M., Peña, P.P., Villanes, R.A. & Hayman, D.T.S. (2008). *Certificación de pieles de pecaríes en la Amazonía Peruana*. First edition. Lima, Wust Ediciones. Retrieved, May 23, 2020, from <https://fundamazonia.org/peccary-pelt-certification.html>
- Farrel, T.A. & Marion, J.L. (2001). Identifying and assessing ecotourism visitor impacts at eight protected areas in Costa Rica and Belize. *Environmental Conservation* 28(3), 215-225. <https://doi.org/10.1017/S0376892901000224>
- FIDAL (2019). Información General. In *Centro de Formación para el Futuro. Escuela de Liderazgo. Descripción General*. Retrieved April 22, 2020, from <https://www.cff.fidal-amlat.org/descripciongeneral>
- Finer, M., Jenkins, C.N., Pimm, S.L., Keane, B. & Ross, C. (2008). Oil and gas projects in the western Amazon: Threats to wilderness, biodiversity, and indigenous peoples. *PLoS ONE* 3(8), e2932. <https://doi.org/10.1371/journal.pone.0002932>
- Finer, M., Vijay, V., Ponce, F., Jenkins, C.N. & Kahn, T.R. (2009). Ecuador's Yasuní Biosphere Reserve: A brief modern history and conservation challenges. *Environmental Research Letters* 4(3), 034005. <http://dx.doi.org/10.1088/1748-9326/4/3/034005>
- Forman, R.T.T. & Alexander, L.E. (1998). Roads and Their Major Ecological Effects. *Annual Review of Ecology and Systematics* 29, 207-231. <https://doi.org/10.1146/annurev.ecolsys.29.1.207>
- Franzen, M. (2005). *Huaorani resource use in the Ecuadorian Amazon: hunting, food sharing, and market participation*. PhD Dissertation. University of California, CA, Davis. Retrieved April 1, 2020, from <https://search.proquest.com/openview/1bbcb533d65c4a78e3df9621c2b43e24/1?pq-origsite=gscholar&cbl=18750&diss=y>
- Franzen, M. (2006). Evaluating the sustainability of hunting: a comparison of harvest profiles across three Huaorani communities. *Environmental Conservation* 33(1), 36-45. <https://doi.org/10.1017/S0376892906002712>
- Froger, G. (2012). Le tourisme durable dans les Suds : solutions ou mirage ? *Mondes and développement* 157, 29-46. <https://doi.org/10.3917/med.157.0029>
- Frost, P.G.H. & Bond, I. (2008). The CAMPFIRE programme in Zimbabwe: Payments for wildlife services. *Ecological Economics* 65(4), 776-787. <https://doi.org/10.1016/j.ecolecon.2007.09.018>
- Fundamazonia (n.d.). Certificación de pieles de pecaríes. In *Proyectos*. Retrieved May 23, 2020, from <http://www.fundamazonia.org/es/certificacion-de-pieles-pecaríes.html>.
- Gibson, M.A. (2001). Immigrant adaption and patterns of acculturation. *Human Development* 44(1), 19-23. <https://doi.org/10.1159/000057037>
- GOFC-GOLD (2017). A Sourcebook of Methods and Procedures for Monitoring Essential Biodiversity Variables in Tropical Forests with Remote Sensing. GOFC-GOLD & GEO BON (eds.). Report version UNCBD COP-13, GOFC-GOLD Land Cover Project Office, Wageningen University,

The Netherlands. ISSN: 2542-6729. Retrieved May 15, 2020, from <https://www.researchgate.net/publication/314417553>

- Good, K.R. (1987). Limiting factors in Amazonian Ecology. In M. Harris & E.B. Ross (eds.), *Food and Evolution: Toward a Theory of Human Food Habits*, 407-421. Philadelphia, PA, Temple University Press.
- Goodland, R., Ledec, G. & Webb, M. (1989). Meeting environmental concerns caused by common-property mismanagement in economic development projects. In F. Berkes (ed.), *Common Property Resources: Ecology and Community-based Sustainable Development*, 148-163. London, Belhaven Press.
- Gullison, R. (2003). Does Forest Certification Conserve Biodiversity? *Oryx* 37(2), 153-165. <https://doi.org/10.1017/S0030605303000346>
- Haidar, V. & Berros, M.V. (2015). Hacia un abordaje multidimensional y multiescalar de la cuestión ecológica: la perspectiva del buen vivir. *Revista Crítica de Ciências Sociais* 108, 111-134. <https://doi.org/10.4000/rccs.6133>
- Hames, R. (1979). A comparison of the efficiencies of the shotgun and bow in Neotropical forest hunting. *Human Ecology* 7(3), 219-252. <https://doi.org/10.1007/BF00889493>
- Hames, R. (1991). Wildlife conservation in tribal societies. In M.L. Oldfield & J.B. Alcorn. (eds.), *Biodiversity: Culture, Conservation, and Ecodevelopment*, 172-199. Boulder, CO, Westview Press.
- Hardin, G. (1968). The tragedy of the commons. *Science* 162(3859), 1243-1248. <https://dx.doi.org/10.1126/science.162.3859.1243>
- Hill, K. (1996). The Mbaracayú Reserve and the Aché of Paraguay. In K.H. Redford & J.A. Mansour (eds.), *Traditional Peoples and Biodiversity Conservation in Large Tropical Landscapes*, 158-195. The Nature Conservancy, Arlington, VA.
- IUCN (2012). *IUCN Red List Categories and Criteria: Version 3.1*. Second edition. Gland, Switzerland and Cambridge, UK, IUCN. Retrieved April 3, 2020, from <https://portals.iucn.org/library/node/10315>
- IUCN (2020a). *IUCN RED LIST OF THREATENED SPECIES*. Retrieved March 14, 2020, from <https://www.iucnredlist.org/>
- IUCN (2020b). Category II: National Park. In *Protected Areas*. Retrieved March 21, 2020, from <https://www.iucn.org/theme/protected-areas/about/protected-areas-categories/category-ii-national-park>
- Jacobson, S.K. (2010). Effective Primate Conservation Education: Gaps and Opportunities. *American Journal of Primatology* 72(5), 414-419. <https://doi.org/10.1002/ajp.20792>

- Jorgenson, J.P. & Rodríguez, M.C. (eds.) (2001). *Conservación y desarrollo sostenible del Parque Nacional Yasuní y su área de influencia*. Memorias del Seminario-Taller 2001. Ministerio del Ambiente/UNESCO/Wildlife Conservation Society. Editorial Simbioe. Quito, Ecuador.
- Jenkins, C.N., Pimm, S.L. & Joppa, L.N. (2013). Global patterns of terrestrial vertebrate diversity and conservation. *PNAS* 110(28), E2602-E2610. <https://doi.org/10.1073/pnas.1302251110>
- Killeen, T.J. & Solórzano, L.A. (2008). Conservation strategies to mitigate impacts from climate change in Amazonia. *Philosophical Transactions of the Royal Society B* 363(1498), 1881–1888. <https://doi.org/10.1098/rstb.2007.0018>
- Kimerling, J. (1991). Disregarding environmental law: Petroleum development in protected natural areas and indigenous homelands in the Ecuadorian Amazon. *Hastings International and Comparative Law Review* 14(4), 840-903. Retrieved January 25, 2020, from https://repository.uchastings.edu/hastings_international_comparative_law_review/vol14/iss4/6
- Kimerling, J. (2016). Habitat as Human Rights: Indigenous Huaorani in the Amazon Rainforest, Oil, and Ome Yasuni. *Vermont Law Review* 40 (445), 455-524. Retrieved January 25, 2020, from <https://ssrn.com/abstract=2856620>
- Lambert, J.E. (2010). Primate seed dispersers as umbrella species: a case study from Kibale National Park, Uganda, with implications for Afrotropical forest conservation. *American Journal of Primatology* 73, 9-24. <https://doi.org/10.1002/ajp.20879>
- Larrick, J.W., Yost, J., Gourley, C., Buckley III, C.E., Plato, C.C., Pandey, J.P., ...Kaplan, J. (1985). Markers of genetic variation among the Waorani Indians of the Ecuadorian Amazon headwaters. *American Journal of Anthropology* 66 (4), 445-453. <https://doi.org/10.1002/ajpa.1330660412>
- Lasso, L. (2013). Ecoturismo en la Reserva Ecológica Cayambe Coca (RECA Y): ¿mito u oportunidad? El caso de la comuna Kichwa de Oyacachi. *Letras Verdes. Revista Latinoamericana De Estudios Socioambientales* 2, 17-18. <https://doi.org/10.17141/letrasverdes.2.2008.814>
- Laurance, W.F. (2005). When bigger is better: the need for Amazonian mega-reserves. *Trends in Ecology & Evolution* 20(12), 645-648. <https://doi.org/10.1016/j.tree.2005.10.009>
- Laurance, W.F., Croes, B.M., Tchignoumba, L., Lahm, S.A., Alonso, A., Lee, M.E., ...Ondzeano, C. (2006). Impacts of roads and hunting on central African rainforest mammals. *Conservation Biology* 20(4), 1251-1261. <https://doi.org/10.1111/j.1523-1739.2006.00420.x>
- Lavaud, J-P. (2010). Indianisme et écologie dans les pays andins : dispositif légal, discours officiels et mobilisations. *Problème d'Amérique latine* 76, 95-117. <https://doi.org/10.3917/pal.076.0095>
- Link, A. & Di Fiore, A. (2006). Seed dispersal by spider monkeys and its importance in the maintenance of neotropical rain-forest diversity. *Journal of Tropical Ecology* 22(3), 235–246. <https://doi.org/10.1017/S0266467405003081>

- Link, A., Muniz, C., Rylands, A.B., Mourthé, Í., Cornejo, F.M., Urbani, B., ...Moscoso, P. (2019). *Ateles belzebuth*. In *The IUCN Red List of Threatened Species 2019*, e.T2276A17928557. <http://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T2276A17928557.en>
- Lu, F. (1999). *Changes in Subsistence Patterns and Resource Use of the Huorani Indians in the Ecuadorian Amazon*. PhD Dissertation. University of North Carolina at Chapel Hill.
- Lu, F. (2001). The common property regime of the Huaorani Indians of Ecuador: implications and challenges to conservation. *Human Ecology* 29(4), 425-447. <https://doi.org/10.1023/A:1013193821187>
- Marsh, L.K. (2004). Primate species at the Tiputini Biodiversity Station, Ecuador. *Neotropical Primates* 12 (2), 75-78. Retrived April 6, 2020, from <https://www.researchgate.net/publication/228743090>
- Martin-Solano, S., Gabriel, A., Carrillo-Bilbao, G.A., de la Torre, S. & Tirira, D.G. (2018). Mono aullador rojo de Linneo. In D.G. Tirira, S. de la Torre & G. Zapata-Ríos (eds.), *Estado de conservación de los primates del Ecuador*, 155-161. Grupo de Estudio de Primates del Ecuador / Asociación Ecuatoriana de Mastozoología. Publicación especial sobre los mamíferos del Ecuador 12. Quito.
- Martínez, E. (1997). Impactos sociales y culturales de la industria petrolera. In E. Bravo, E. Martínez & I. Yáñez (eds.), *Voces de Resistencia : Explotación petrolera en los Trópicos*, 92-101. OILWATCH, Quito, Ecuador.
- McCay, B.J. & Acheson, J.M. (1987). Human Ecology of the commons. In B.M. McCay & J.M. Acheson (eds.), *The Question of the Commons: The Culture and Ecology of Communal Resources*, 1-34. Tucson, University of Arizona Press.
- McKean, M.A. (1996). *Common Property: What Is It, What Is It Good For, and What Makes It Work?* Forests, Trees and People Programme. Phase II Working Papers. Washington, DC, Food and Agriculture Organization.
- Mena V., P., Bolaños, J.R. & Cueva, R. (1995). *La Cacería de los Huaorani : Visión Cognitiva y Sostenibilidad para el Futuro ; Comunidad Quehuero-ono, Río Shiripuno, Provincia del Napo, Ecuador (Informe de la Primera Fase)*. Quito, Ecuador, Fundación Ecuatoriana de Estudios Ecológicos.
- Mena V., P., Stallings, J.R., Regalado, B.J. & Cueva, R. (2000). The Sustainability of Current Hunting Practices by the Huaorani. In J.G. Robinson & E.L. Bennett (eds.), *Hunting for Sustainability in Tropical Forests*, 57-78. New York, Columbia University Press.
- Merlyn Sacoto, M-F. (2018a). *Arrinconados en la Selva. Salud mental y educación en las comunidades de Guiyero, Timpoka y Ganketapare*. Centro de Publicaciones PUCE, Quito.
- Merlyn Sacoto, M-F. (2018b). Voces waorani: Guiyero, Timpoka y Ganketapare. In M-F. Merlyn Sacoto (ed.), *Arrinconados en la Selva*, 47-70. Centro de Publicaciones PUCE, Quito, Ecuador.

- Ministerio del Ambiente (2008). *Situación actual del tráfico ilegal de la vida silvestre*. Quito, Dirección Nacional de Biodiversidad, Unidad de Vida Silvestre.
- MAE (2017). *Guía para la identificación de especies de fauna silvestre sujetas al tráfico y comercio ilegal de carne de monte – Recomendaciones para su manejo emergente*. MAE, WCS, GEF, PNUD.
- Mittermeier, R. A., Mittermeier, C.G., Brooks, T.M., Pilgrim, J.D., Konstant, W.R., da Fonseca, G.A.B. & Kormos, C. (2003). Wilderness and biodiversity conservation. *PNAS* 100(18), 10309–10313. <https://doi.org/10.1073/pnas.1732458100>
- Myers, N. (1993). Tropical forests: The main deforestation fronts. *Environmental Conservation* 20(1), 9–16. <https://doi.org/10.1017/S0376892900037176>
- Novaro, A.J., Redford, K.H. & Bodmer, R.E. (2000). Effect of hunting in source-sink systems in the Neotropics. *Conservation Biology* 14(3), 713–721. <https://doi.org/10.1046/j.1523-1739.2000.98452.x>
- Ormsby, A. & Mannie, K. (2006). Ecotourism benefits and the role of local guides at Masoala National Park, Madagascar. *Journal of Sustainable Tourism* 14(3), 271-287. <https://doi.org/10.1080/09669580608669059>
- Papworth, S., Milner-Gullan, E.J. & Slocombe, K. (2013). The natural place to begin: The ethnoprimateology of the Waorani. *American Journal of Primatology* 75(11), 1117-1128. <https://doi.org/10.1002/ajp.22173>
- Perasso, P., Christian, C. & Carvajal, D. (2018). Aprendiendo a hacer conservación-participativa: contribuciones de la antropología social. *Revista Austral de Ciencias Sociales* 35, 239-260. <https://doi.org/10.4206/rev.austral.cienc.soc.2018.n35-14>
- Peres, C.A. (1990). Effects of hunting on western Amazonian primate communities. *Biological Conservation* 54(1), 47-59. [https://doi.org/10.1016/0006-3207\(90\)90041-M](https://doi.org/10.1016/0006-3207(90)90041-M)
- Peres, C.A. (2005). Why we need Megareserves in Amazonia. *Conservation Biology* 19(3), 728–733. <https://doi.org/10.1111/j.1523-1739.2005.00691.x>
- Peres, C.A. & Lake, I.R. (2003). Extent of Nontimber Resource Extraction in Tropical Forests: Accessibility to Game Vertebrates by Hunters in the Amazon Basin. *Conservation Biology*, 17(2), 521–535. <https://doi.org/10.1046/j.1523-1739.2003.01413.x>
- Peres, C.A. & Palacios, E. (2007). Basin-wide effects of game harvest on vertebrate population densities in Amazonian forests: Implications for animal-mediated seed dispersal. *Biotropica* 39(3), 304–315. <https://doi.org/10.1111/j.1744-7429.2007.00272.x>
- Petroecuador (2007). *Diagnostico socioeconomico cultural y ambiental para la licitacion del Bloque 43*. Petroecuador, Quito, Ecuador.

- Portilla, I.A.S. (2016). *Comparación de perfiles de cacería en tres comunidades Waorani del Parque Nacional Yasuní entre el periodo 2002 y 2015*. Unpublished Dissertation. Pontifica Universidad Católica del Ecuador.
- Pozo-Rivera, W.E. (2004a). Agrupación y dieta de *Ateles belzebuth belzebuth* en el Parque Nacional Yasuní. *Anuario de la Investigación Científica* 2(1), 77–102. Retrieved May 20, 2020, from <https://www.researchgate.net/publication/263082933>
- Pozo-Rivera, W.E. (2004b). Preferencias de hábitat de seis especies de primates simpátricos del Yasuní, Ecuador. *Ecología Aplicada* 3(1,2), 128–133. Retrieved May 20, 2020, from <https://www.researchgate.net/publication/26446774>
- Presidencia de la República del Ecuador (2019). *Decreto Ejecutivo N° 751, firmado el 21 de Mayo de 2019 por Lenín Moreno Garcés, Presidente Constitucional de la República*. Retrieved March 7, 2020, from <https://www.registroficial.gob.ec>
- Prieto-Martín, P. (2014). *Participation Schemas: a tool to characterize collaborative participation*. PDD2014 Conference, NewCastle. Retrieved April 20, 2020, from <https://www.researchgate.net/publication/292977057>
- Puertas, P., Bodmer, R., Calle, A. & del Alquila, J. (2000). La importancia del manejo comunal para la conservación de la fauna silvestre en las áreas naturales protegidas del Nororiente Peruano. *Revista Peruana de Biología* 7(2), 211-216. <https://doi.org/10.15381/rpb.v7i2.6829>
- Redford, K.H. & Robinson, J.G. (1991). Subsistence and commercial uses of wildlife in Latin America. In J.G. Robinson & K.H. Redfort (eds.), *Neotropical wildlife use and conservation*, 6-23. Chicago, IL, University of Chicago Press.
- Registro Oficial 2008 (N°449). *Constitución de la República del Ecuador*, 20 de octubre de 2008.
- Registro Oficial 2014 (Suplemento N°180). *Código Orgánico Integral Penal*, 10 de febrero de 2014.
- Rival, L.M. (1992). *Social Transformation and the Impact of Formal Schooling on the Huaorani of Amazonian Ecuador*. PhD Dissertation. London School of Economics, University of London.
- Rival, L.M. (1996). Formal schooling and the production of modern citizens in the Ecuadorian Amazon. In B.A. Levinson, D.E. Foley & D.C. Holland (eds.), *The Cultural Production of the Educated Person: Critical Ethnographies of Schooling and Local Practices*, 153-167. Albany, NY, State University of New York Press.
- Rival, L.M. (2002). *Trekking through history: The huaorani of Amazonian Ecuador*. New York, Columbia University Press.
- Rival, L.M. (2015). *Transformaciones huaoranis: Frontera, cultura y tensión*. Quito, Ecuador, Universidad Andina Simón Bolívar, Latin American Centre-University of Oxford, Abya-Yala.
- Rivas, A. & Lara, R. (2001). *Conservación y petróleo en la Amazonia ecuatoriana: Un acercamiento al caso huaorani*. Quito, Ecuador, EcoCiencia, Abya-Yala.

- Robarchek, Cl. & Robarchek, Ca. (1998). *Waorani: The Contexts of Violence and War*. For Worth, TX, Harcourt Brace College Publishers.
- Roberge, J.-M. & Angelstam, P. (2004). *Usefulness of the Umbrella Species Concept as a Conservation Tool*. *Conservation Biology* 18(1), 76-85. <https://doi.org/10.1111/j.1523-1739.2004.00450.x>
- Robinson, J.G. & Redford, K.H. (1986a). Body size, diet, and population density of Neotropical forest mammals. *The American Naturalist* 128(5), 665-680. <https://doi.org/10.1086/284596>
- Robinson, J.G. & Redford, K.H. (1986b). Intrinsic rate of natural increase in neotropical forest mammals: relationship to phylogeny and diet. *Oecologia* 68(4), 516-520. <https://doi.org/10.1007/BF00378765>
- Robinson, J.G. & Redford, K.H. (1991). Sustainable harvest of Neotropical forest mammals. In J.G. Robinson & K.H. Redford (eds.), *Neotropical wildlife use and conservation*, 415-429. Chicago: The University of Chicago Press.
- Roser, M. (2014). Human Development Index (HDI). In *Our World in Data*. Retrieved February 16, 2020, from <https://ourworldindata.org/human-development-index>
- Sánchez, G. & Guzmán, J. (2007). *Proyecto comunitario "Aweidi Lodge" Guiyero*. Unpublished Dissertation. Universidad de Especialidades Turísticas UCT.
- San Sebastián, M. (2003). *El impacto de la explotación petrolera en la salud de poblaciones rurales de la Amazonia del Ecuador*. Especial para SIIC. Retrieved March 25, 2020, from <http://www.siicsalud.com/des/expertoimpreso.php/20140>
- Sawyer, S. (1996). Indigenous Initiatives and petroleum politics in the Ecuadorian Amazon. *Cultural Survival Quarterly* 20(1), 26-30. Retrieved March 19, 2020, from <https://www.culturalsurvival.org/publications/cultural-survival-quarterly/indigenous-initiatives-and-petroleum-politics-ecuadorian>
- Sirén, A.H., Cardenas, J.C. & Machoa, J.D. (2006). The relation between income and hunting in tropical forests: an economic experiment in the field. *Ecology and Society* 11 (1), 44. Retrieved May 22, 2020, from <http://www.ecologyandsociety.org/vol11/iss1/art44/>
- Sirén, A.H., Hambäck, P. & Machoa, J. (2004). Including spatial heterogeneity and animal dispersal when evaluating hunting: a model analysis and an empirical assessment in an Amazonian community. *Conservation Biology* 18(5), 1315-1329. <https://doi.org/10.1111/j.1523-1739.2004.00024.x>
- Stearman, A.M. (1996). On common ground: The Nature Conservancy and traditional peoples: The Rio Chagres, Panama workshop. In K.H. Redford & J.A. Mansour (eds.), *Traditional Peoples and Biodiversity Conservation in Large Tropical Landscapes*, 237-250. The Nature Conservancy, Arlington, VA.
- Stevenson, P.R. (2000). Seed dispersal by woolly monkeys (*Lagothrix lagothricha*) at Tinigua National Park, Colombia: dispersal distance, germination rates, and dispersal quantity. *American Journal*

of *Primates* 50(4), 275–289. [https://doi.org/10.1002/\(SICI\)1098-2345\(200004\)50:4<275::AID-AJP4>3.0.CO;2-K](https://doi.org/10.1002/(SICI)1098-2345(200004)50:4<275::AID-AJP4>3.0.CO;2-K)

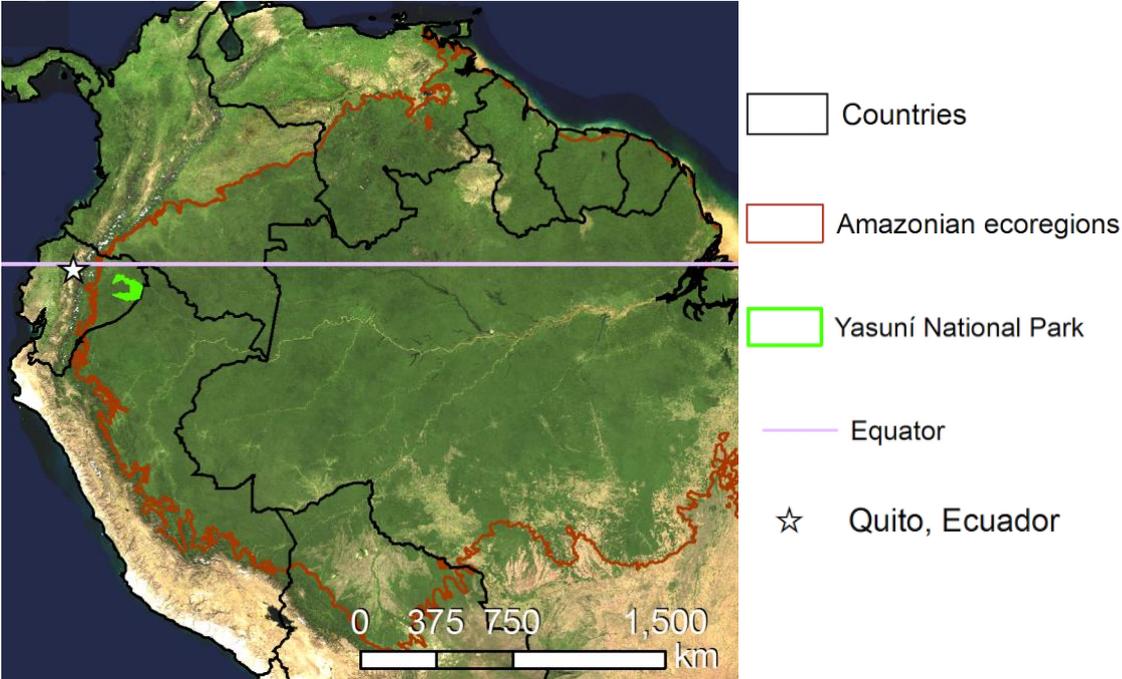
- Stocks, A., Noss, A., Bryja, M., & Arce, S. (2012). Deforestation and Waodani Lands in Ecuador: Mapping and Demarcation amidst Shaky Politics. In P. Moutinho (ed.), *Deforestation Around the World*, 187-202. <https://doi.org/10.5772/35851>
- Suárez, E., Morales, M., Cueva, R., Utreras, B., V., Zapata-Ríos, G., Toral, E., ...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. <https://doi.org/10.1111/j.1469-1795.2009.00262.x>
- Suárez, E., Zapata-Ríos, G., Utreras, V., Strindberg, S. & 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. <https://doi.org/10.1111/j.1469-1795.2012.00592.x>
- Tardif, J. (2003). Écotourisme et développement durable. *VertigO – la revue électronique en sciences de l'environnement* 4(1). <https://doi.org/10.4000/vertigo.4575>
- Tchakatumba, P.K., Gandiwa, E., Mwakiwa, E., Clegg, B. & Nyasha, S. (2019). Does the CAMPFIRE programme ensure economic benefits from wildlife to households in Zimbabwe? *Ecosystems and People* 15(1), 119-135. <https://doi.org/10.1080/26395916.2019.1599070>
- Terborgh, J., Nuñez-Iturri, G., Pitman, N.C.A, Valverde, F.H.C, Alvarez, P., Swamy, V., ...Paine, C.E.T. (2008). Tree recruitment in an empty forest. *Ecology* 89(6), 1757-1768. <https://doi.org/10.1890/07-0479.1>
- Tirira, D.G. (ed.) (2011). *Libro Rojo de los Mamíferos del Ecuador*. 2a edición. Fundación Mamíferos y Conservación, Pontificia Universidad Católica del Ecuador y Ministerio del ambiente del Ecuador. Publicación especial sobre los mamíferos del Ecuador 8. Quito.
- Tirira, D.G. & de la Torre, S. (2018). Saki ecuatorial. In D.G. Tirira, S. de la Torre & G. Zapata-Ríos (eds.), *Estado de conservación de los primates del Ecuador*, 125-129. Grupo de Estudio de Primates del Ecuador / Asociación Ecuatoriana de Mastozoología. Publicación especial sobre los mamíferos del Ecuador 12. Quito.
- Tirira, D.G., de la Torre, S. & Zapata-Ríos, G. (2018a). *Estado de conservación de los primates del Ecuador*. Grupo de Estudio de Primates del Ecuador / Asociación Ecuatoriana de Mastozoología. Publicación especial sobre los mamíferos del Ecuador 12. Quito. Retrieved November 13, 2019, from <https://ecuador.wcs.org/es-es/Recursos/Biblioteca.aspx>
- Tirira, D.G., de la Torre, S. & Zapata-Ríos, G. (2018b). *Plan de acción para la conservación de los primates del Ecuador*. Ministerio del Ambiente del Ecuador (MAE) / Grupo de Estudio de Primates del Ecuador (GEPE) / Asociación Ecuatoriana de Mastozoología (AEM). Quito. Retrieved from <https://ecuador.wcs.org/es-es/Recursos/Biblioteca.aspx>

- Trujillo, P. (2001). *Salvajes civilizados y civilizadores: La Amazonía ecuatoriana. El espacio de las ilusiones*. Quito, Ecuador, Fundación de Investigaciones Andino Amazónicas (FIAAM), Abya-Yala.
- UNESCO (2019). Yasuní Biosphere Reserve, Ecuador. In *Biosphere Reserves in Latin America and the Caribbean*. Retrieved May 6, 2020, from <https://en.unesco.org/biosphere/lac/yasuni>
- Vickers, W.T. (1983). Indian-White labor relations in Ecuador. *Cultural Survival Quarterly* 7(4), 39-41. Retrieved January 21, 2020, from <https://www.culturalsurvival.org/publications/cultural-survival-quarterly/indian-white-labor-relations-ecuador>
- Vickers, W.T. (1994). From opportunism to nascent conservation. The case of the Siona-Secoya. *Human Nature* 5(4), 307-337. <https://doi.org/10.1007/bf02734164>
- Voss, R.S. & Emmons, L.H. (1996). Mammalian diversity in Neotropical lowland rainforests: A preliminary assessment. *Bulletin of the American Museum of Natural History* 230.
- Wallace, R.B. (2008). Factors influencing spider monkey habitat use and ranging patterns. In C.J. Campbell (ed.), *Spider monkeys: The behavior, ecology and evolution of the genus Ateles*, 138–154. Cambridge University Press. <https://doi.org/10.1017/CBO9780511721915.005>
- Washu (n.d.a). The brown-headed spider monkey. Our flagship species. In *Washu*. Retrieved April 8, 2020, from <https://www.proyectowashu.org/washu-2>.
- Washu (n.d.b). Participatory conservation. Working alongside local people. In *Programs*. Retrieved April 21, 2020, from <https://www.proyectowashu.org/participatory-conservation>
- Washu (2017). *Washu. Eat Chocolate, Save the Rainforest*. Retrieved May 30, 2020, from <http://www.washuchocolate.com/#>
- WCS (2007-2020). Yasuní. In *Landscapes*. Retrieved from <https://ecuador.wcs.org/en-us/Landscapes/Yasun%C3%AD.aspx>
- WCS (2010). *Greater Yasuní-Napo Moist Forest landscape conservation area (Ecuador)*. The global conservation program. Retrieved from <https://rmportal.net/library/content/global-conservation-program/gcp-closeout-reports/greater-yasuni-napo-moist-forest-landscape-conservation-area-ecuador>
- WCS (2006). Efectos de las carreteras sobre la fauna silvestre en el Parque Nacional Yasuní. *WCS-Ecuador, Boletín N° 1*. Retrieved from <https://www.portalces.org/biblioteca/areas-protegidas/efectos-de-las-carreteras-sobre-fauna-silvestre-parque-nacional-yasuni>
- Wierucka, A. (2015). *Huaorani of the Western Snippet*. Palgrave Macmillan, New York. <https://doi.org/10.1057/9781137539885>
- Wunder, S. (2000). Ecotourism and economic incentives – an empirical approach. *Ecologic Economics* 32(3), 465-479. [https://doi.org/10.1016/S0921-8009\(99\)00119-6](https://doi.org/10.1016/S0921-8009(99)00119-6)

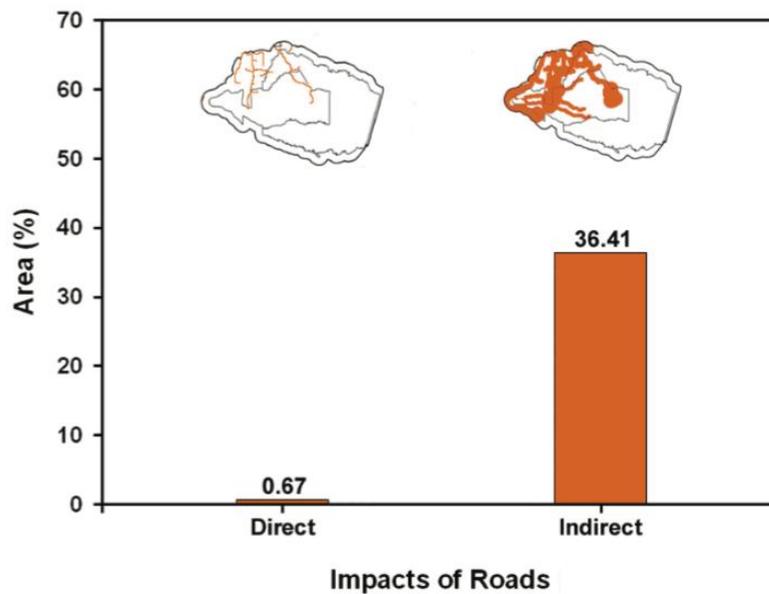
- Wunder, S. (2003). *Oil wealth and the fate of the forest: A Comparative Study of Eight Tropical Countries*. New YorkNY, Routledge.
- Yost, J.A. (1981). Twenty years of contact: The mechanisms of change in Wao (“Auca”) culture. In E. Noman E. & Jr. Whitten (eds.), *Cultural Transformations and Ethnicity in Modern Ecuador*, 677-704. Urbana, University of Illinois Press.
- Yost, J.A. (1991). People of the forest: The Waorani. In M. Acosta-Solis (ed.), *Ecuador in the Shadow of Volcanoes*, 95-115. Quito, Ecuador, Libri Mundi.
- Yost, J.A. & Kelley, P.M. (1983). Shotguns, blowguns, and spears: An analysis of technical efficiency. In R.B. Hames & W.T. Vickers (eds), *Adaptive Responses of Native Amazonians*, 189-224. New York, Academic Press.
- Zapata-Ríos, G. (2001). Sustentabilidad de la cacería de subsistencia: el caso de cuatro comunidades Quichuas en la Amazonía nororiental ecuatoriana. *Mastozoología Tropical/ Journal of Neotropical Mammals* 8(1), 59–66. Retrieved April 8, 2020, from <https://www.researchgate.net/publication/237602863>
- Zapata-Ríos, G., Suárez, E., Utreras, B.V. & Vargas, J. (2006). Evaluación de Amenazas Antropogénicas en el Parque Nacional Yasuní y sus Implicaciones para la Conservación de Mamíferos Silvestres. *Lyonia* 10(1), 31-41. Retrieved from <https://www.lyonia.org/viewarticle-411>
- Zapata-Ríos, G., Suárez, E., Utreras, B.V. & Cueva, R. (2011). Uso y conservación de fauna silvestre en el Ecuadr. In A. Krainer & M.F. Mora (ed.), *Retos y amenazas en Yasuní*, 97-116. Quito-Ecuador, FLACSO-Sede Ecuador. Retrieved March 28, 2020, from <https://www.researchgate.net/publication/257921057>
- Zapata-Ríos, G., Urgilés, C. & Suárez, E. (2009). Mammal hunting by the Shuar of the Ecuadorian Amazon: Is it sustainable? *Oryx* 43(3), 375-385. <https://doi.org/10.1017/S0030605309001914>

Annexes

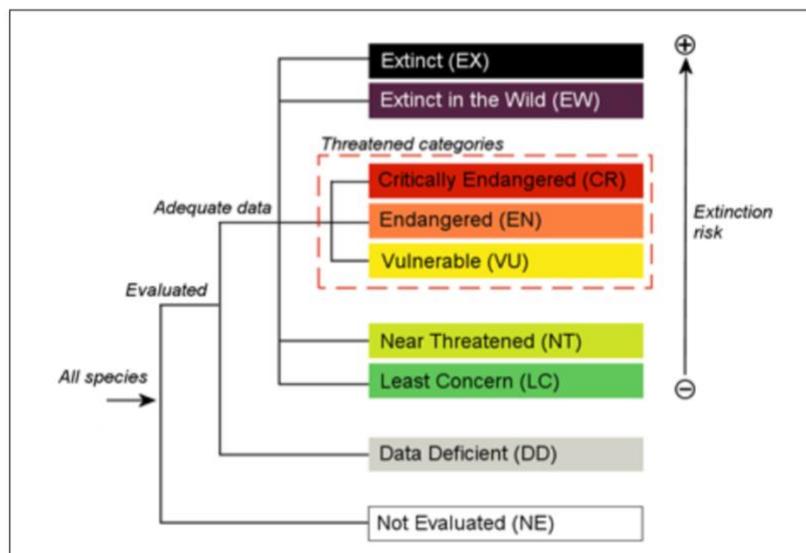
Annex 1: Map showing the location of YNP at the crossroads of the Amazon rainforest, Andes and the Equator (Modified from Bass *et al.*, 2010).



Annex 2: Area affected by direct and indirect environmental impacts of road construction in Yasuní. Indirect impacts are defined as those that occur removed in distance or time from the actual construction of the road, namely, clearing forest to plant crops and graze cattle. Direct impacts were mapped as a 100-m strip along the existing roads, only to include the removal of natural vegetation and topsoil for the actual construction of the road. Land cover was studied over a total area of about 28 000 km² (WCS, 2010).



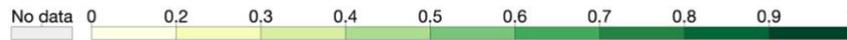
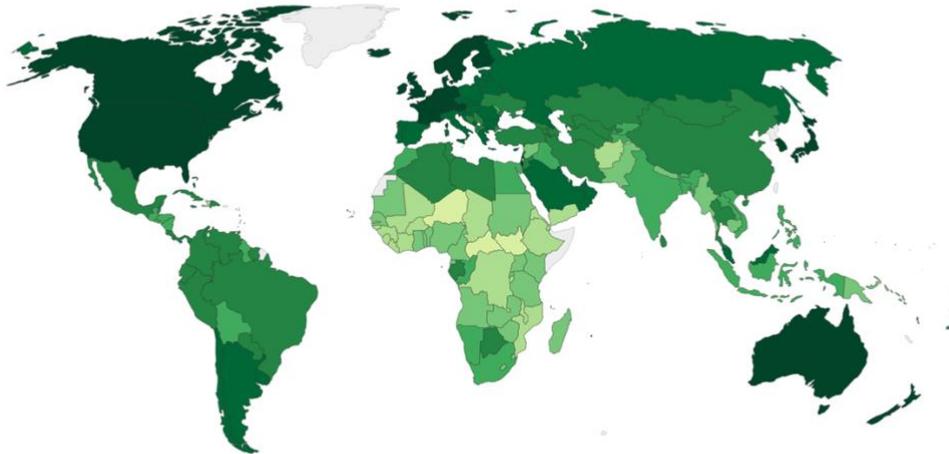
Annex 3: Conservation Status categories according to IUCN categories. The IUCN classifies taxa in several categories according to their extinction risk. Five criteria are used to determine if a species is CR, EN or VU; A. Population size reduction; B. Geographic range (extend of occurrence and/or area of occupancy); C. Small population size and decline; D. Very small or restricted population; E. Quantitative Analysis (IUCN, 2012).



Annex 4: Global Map of the Human Development Index (Roser, 2014). This map is used together with Annex 5 to show that the countries with the lowest HDI globally correspond to the places with the major biodiversity richness.

Human Development Index, 2017

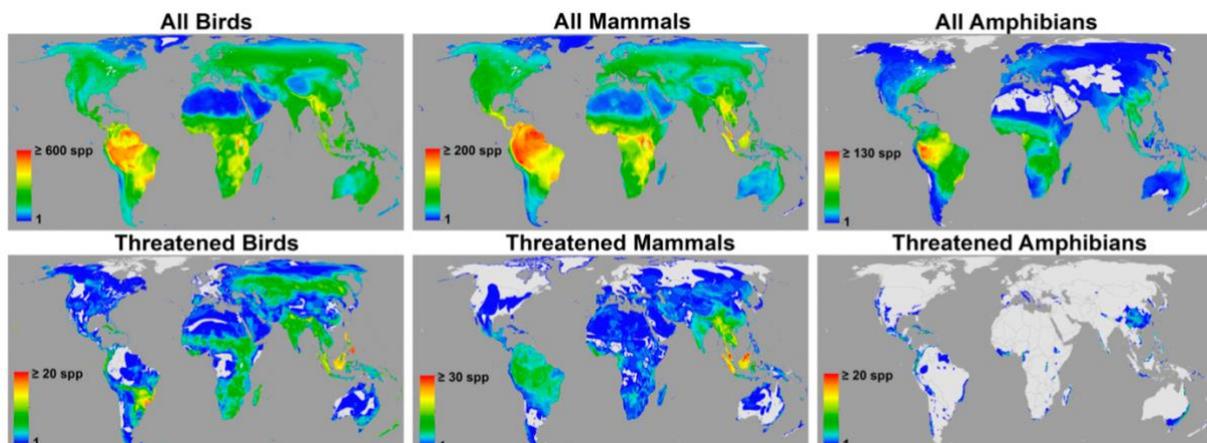
The Human Development Index (HDI) is a summary measure of key dimensions of human development: a long and healthy life, a good education, and having a decent standard of living.



Source: UNDP (2018)

OurWorldInData.org/human-development-index/ • CC BY

Annex 5: Global maps of species richness for different categories of species (Jenkins *et al.*, 2013). The top row shows the richness of all species in the taxon and the bottom row shows the richness of threatened species (vulnerable, endangered, or critically endangered). This map is used together with Annex 4: to show that the countries with the lowest HDI globally correspond to the places with the major biodiversity richness.



Annex 6: Participation Schemas – Intensive collaboration (Prieto-Martín, 2014). This scale of participation can be used as a tool evaluate the level of participation of local populations in participatory conservation initiatives. The objective of such projects would be to reach the higher levels of participation on the scale. It could be used in the same way to develop tourism in Waorani communities.

