Illegal Jaguar Trade in Latin America: An Evidence-Based Approach to Support Conservation Actions

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Declaration

I declare that this thesis is entirely my own work. Contributions by other authors are stated in section 1.4. None of the work has been submitted, in whole or in part, for any previous degree application.

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Dedication

To my father, Luis Antonio Arias Villalba, who always dreamed of calling me ‘Doctor’, and to the majestic *Panthera onca*.

Acknowledgements

I am eternally grateful to my supervisors, Professor E.J. Milner-Gulland and Dr. Amy Hinsley for their support throughout my DPhil. I was incredibly lucky to have been mentored by two brilliant female scientists who are pushing the boundaries of conservation science, while also being incredibly kind and human. Their lessons have made me a better researcher and conservationist, and will continue to have an impact on my career into the future. I owe so much to E.J. for being an inspiration as a conservation leader and optimist, a successful interdisciplinary scientist, and a highly efficient juggler of all things. I am amazed by everything you do and honoured to have been a part of it.

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Abstract

The Illegal Trade in Wildlife (IWT) is one of the most cumbersome threats currently facing biodiversity, with broad implications for the health and wellbeing of humans and nature. Over the past decade, reports of international illegal trade in jaguars (*Panthera onca*), with links to demand from Asian wildlife markets, have emerged throughout Latin America, raising the profile of jaguars as the emblem of Latin America's fight against IWT. This DPhil is among the first to explore the characteristics, prevalence, and drivers of this threat to jaguars, with the goal of providing scientific evidence in support of ongoing and future projects and policies aimed at addressing it. Data collection efforts centred in Mesoamerica and Bolivia, two areas with varying degrees of evidence of international trade, and were based on interviews with enforcement agents and conservation practitioners, and questionnaire surveys with rural communities coexisting with jaguars. In both study areas, the illegal jaguar trade was found to be a prevalent, domestically-focused, and opportunistic activity, driven largely by the confluence of cultural traditions surrounding wildlife uses, forest-dependent livelihoods, and negative perceptions and interactions with jaguars, manifested through human-jaguar conflict. To a lesser degree, the trade was also influenced by a more diverse set of external actors and drivers than originally expected, including tourists of diverse backgrounds, regional immigrants, and traders of Asian-decent. Enabling factors ranged from critical limitations in the enforcement capacity of wildlife authorities, to a high social acceptability of jaguar killing in rural communities. Additionally, the DPhil highlighted biases in how those in charge of addressing the illegal trade in jaguars perceive and use evidence on the trade, with a tendency to disregard its reliability and conservation relevance. To address this issue, the DPhil provides guidelines towards a more objective decision-making on the illegal wildlife trade, and reinforces the need for evidence-based, multifaceted, counter-trafficking approaches that consider the complex interacting domestic and international, cultural and commercial drivers behind the illegal trade in jaguars.

Resumen

El Tráfico de Vida Silvestre (TVS) es una de las principales amenazas que enfrenta actualmente la biodiversidad, con amplias implicaciones para la salud y el bienestar de los seres humanos y la naturaleza. Durante la última década, han surgido evidencias sobre el tráfico ilegal internacional de jaguares (*Panthera onca*), con vínculos a la demanda de los mercados de vida silvestre asiáticos, elevando el perfil del jaguar como el emblema del combate al TVS en América Latina. Este estudio es uno de los primeros en explorar las características, la prevalencia y las causas de esta amenaza para los jaguares, con el objetivo de proporcionar evidencia científica para apoyar a los proyectos y políticas destinados a abordarla. La recolección de datos se centró en Mesoamérica y Bolivia, dos áreas con diversos grados de evidencia de tráfico internacional, y se basaron en entrevistas con informantes clave, incluyendo autoridades ambientales y profesionales de la conservación, y encuestas con comunidades rurales que coexisten con los jaguares. En ambas áreas de estudio, se descubrió que el tráfico de jaguares es una práctica doméstica, oportunista y común, impulsada por la confluencia de tradiciones culturales, medios de vida dependientes en los recursos naturales, y las percepciones e interacciones negativas entre las personas y los jaguares, manifestadas a través del conflicto humano-jaguar. En menor grado, el tráfico también fue influenciado por un conjunto diverso de actores, incluyendo turistas de diversos orígenes, inmigrantes regionales y traficantes de ascendencia asiática. Las limitaciones críticas en la capacidad de aplicación de la ley por parte de las autoridades ambientales y la alta aceptabilidad social de la caza de jaguares en las comunidades rurales, fueron algunos de los factores que facilitaron el tráfico. Además, este estudio destacó sesgos en la forma en que los encargados de abordar el tráfico de jaguares utilizan la evidencia sobre TVS, con una tendencia a pasar por alto su calidad y relevancia para la conservación. Para abordar este problema, el estudio proporciona pautas para una toma de decisiones más objetiva sobre el TVS, y refuerza la necesidad de enfoques multifacéticos contra el tráfico de jaguares basados en la evidencia.

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List of Acronyms and Abbreviations

ACEAA	Asociación Boliviana para la Investigación y Conservación de Ecosistemas Andino-Amazónicos
BBM	Ballot Box Method
BRI	Belt and Road Initiative
CEPAL	Economic Commission for Latin America and the Caribbean
CI	Confidence Interval
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLT	Construal Level Theory
CMS	Convention on Migratory Species
CONAP	Consejo Nacional de Áreas Protegidas de Guatemala
COVID	Coronavirus 2019-nCoV
CRAVED	Concealable, Removable, Available, Valuable, Enjoyable, and Disposable
CUREC	Central University Research Ethics Committee
DGBAP	Dirección General de Biodiversidad y Áreas Protegidas de Bolivia
GDP	Gross Domestic Product
GLM	Generalized Linear Model
HWC	Human-Wildlife Conflict
ICCS	Interdisciplinary Centre for Conservation Science
ID	Identification reference or number
IDEA	Investigate, Discuss, Estimate, and Aggregate
INTERPOL	International Criminal Police Organization
IUCN	International Union for Conservation of Nature
IWT	Illegal Wildlife Trade
KAP	Knowledge, Attitudes and Practice
MMAYA	Ministerio de Medio Ambiente y Agua de Bolivia
NGO	Non-governmental Organization
NTFP	Non-timber Forest Product
OR	Odds Ratio
RRT	Randomized Response Technique
SD	Standard Deviation
SDG	Sustainable Development Goals
SENESCYT	Secretaría de Educación Superior, Ciencia, Tecnología e Innovación Ecuador
SERNAP	Servicio Nacional de Áreas Protegidas Bolivia
TCM	Traditional Chinese Medicine
TPB	Theory of Planned Behaviour
TVS	Trafico de Vida Silvestre
UCT	Unmatched Count Technique
UNODC	United Nations Office on Drugs and Crime
USD	United States Dollar
USFWS	United States Fish and Wildlife Service
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature

Chapter 1

Introduction

Myself standing in front of a jaguar skin tapestry at an interview site in rural Bolivia.

1.1 Problem statement

The Illegal Wildlife Trade (IWT) is one of the most pressing global conservation issues, affecting the populations of thousands of species of plants, animals and fungi across all of Earth's habitable continents, including critically endangered species (Scheffers et al., 2019). Due to the interconnectedness of the human and natural worlds, IWT also has a large impact on millions of people across the world, particularly vulnerable communities, who depend on wildlife for their nutrition, health and livelihoods (Booth et al., 2021a). As the fourth most profitable illicit sector after drugs, arms, and trafficking of human beings, IWT attracts a wide range of actors, from rural farmers to government officials and organized criminals (UNODC, 2020; Zimmerman, 2003). Its broad implications for biodiversity, human wellbeing, economic development and national security make IWT an issue of great policy resonance worldwide, mobilizing considerable funding from governments and international donors ('t Sas-Rolfes et al., 2019; World Bank Group, 2016). Because of its hidden and illegal nature, IWT is particularly difficult to study and address, leading to an overreliance on opportunistic seizures and anecdotal accounts as the main sources of information, even though these often fail to adequately represent the scale, characteristics, drivers, and impacts of IWT (Underwood et al., 2013). IWT policies or interventions that do not consider robust evidence or have a clear theory of change, may not only fail to deliver their goals by missing the underlying drivers of the trade, but may even result in negative outcomes for the wildlife involved by accidentally promoting trade in areas and markets where it doesn't exist, or by prejudicing actors who would have otherwise been amenable to conservation (Cooney et al., 2017; Milner-Gulland et al., 2018).

Even though Latin America is a highly biodiverse region and a key source of supply of legal and illegal wildlife specimens and products for domestic and international markets, it has received little IWT research or funding attention, when compared to other regions like Africa and Asia (Kahler and Gore,

2017; Reuter et al., 2018a). The illegal trade in jaguars is an emerging issue within the field of IWT in Latin America, which has brought much needed attention to the plight of jaguars and various other species threatened by IWT in the region. Since 2010, seizures of jaguar teeth, and other body parts like skins, skull and claws, have been reported throughout the region, particularly in countries like Bolivia, Brazil, Mexico, Peru and Suriname (Morcatty et al., 2020; Verheij, 2019). While the majority of seizures involved demand from domestic markets, a proportion were linked to demand from Asian wildlife markets, either by having China as a destination country of illegal jaguar body part shipments, or by involving traders of Asian descent (Morcatty et al., 2020; SERFOR and WCS, 2019). The association between the illegal jaguar trade and demand from Asian wildlife markets led jaguar conservation stakeholders to suspect that jaguars may be joining other big cats, like tigers (*Panthera tigris*), lions (*Panthera leo*), leopards (*Panthera pardus*), and snow leopards (*Panthera uncia)* as ingredients in Traditional Chinese Medicine (TCM) or as luxury collectible items (Nunez and Aliaga-Rossel, 2017; Villalva and Moracho, 2019). These uses were traditionally reserved for the tiger, but diversified to other species after consumption of tiger body parts became illegal in China in 1993, following a precipitous decline in tiger populations (Moyle, 2009; UNODC, 2020). Another assumption was that the illegal trade of jaguar body parts to China was enabled by the growth of Chinese-led infrastructure development in Latin America over the past decade, which facilitated access to trade routes and consumers (Morcatty et al., 2020; Verheij, 2019), and by the involvement of Chinese-diaspora trafficker groups linked to broader organized crime syndicates in China (Romo, 2021).

The increasing number of seizures of jaguar body parts across the species' range, along with the assumptions about jaguars replacing tigers in Chinese wildlife markets and about the involvement of Chinese corporations and organized criminal groups in the trade, captured the attention of the media. Nearly 300 media articles were written about the illegal trade in jaguars in Bolivia alone from 2015 to 2019, in the Spanish, English, and Chinese languages, the majority of which focused on the links

between the trade and demand from people of Chinese descent (Li, 2021). Despite lacking robust information or scientific studies about the illegal jaguar trade, the vast media coverage of the issue, based on limited information on seizures and anecdotal accounts, led to widespread concern about the jaguar from governments, non-governmental organizations (NGOs) and the public. In the First High Level Conference on the Illegal Wildlife Trade in the Americas, held in Peru in 2019, the jaguar was declared the region's emblem of the fight against IWT, and numerous regional agreements, legal reform plans, jaguar conservation projects, enforcement interventions, and communication campaigns, have been launched to address the illegal jaguar trade across the species' range. While undoubtedly necessary and well intentioned, many of these efforts have not been based upon a solid evidential foundation, and therefore may have suboptimal outcomes for jaguar conservation.

Even though the illegal trade has been portrayed as a new threat to jaguars by the media, jaguars have a long history of use and trade by indigenous societies throughout Latin America, and they were traded at commercial scales during the first three quarters of the 20th century, when their skins were in demand by the fashion industry in North America and Europe (Smith, 1976; Sugiyama et al., 2018). During that period, an estimated 180,000 jaguars were killed in the Brazilian Amazon alone, a number that exceeds the current estimate of the global jaguar population (Antunes et al., 2016; Jędrzejewski et al., 2018). Thousands of people across the continent became 'freelance' jaguar hunters, attracted by the high prices paid for jaguar pelts, causing internal migration into forested areas, and a large-scale abandonment of agricultural jobs (Matos and Caldarelli, 2017; Payan and Trujillo, 2006). Commercial international jaguar trade became prohibited through the listing of jaguars under Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1975. While the trade ban successfully slashed the pursuit of jaguars for the international skin market, allowing populations to recover, the killing of jaguars continued to occur for other reasons, such as in retaliation for livestock depredation by jaguars, or to obtain meat and body parts

for nutritional, medicinal, and cultural purposes (e.g. Castano-Uribe et al., 2016; Jędrzejewski et al., 2017a). Similarly, domestic, opportunistic markets for jaguar body parts continued to exist despite being illegal at the national level in many Latin American countries (e.g. Garcia-Alaniz et al., 2010; Jędrzejewski et al., 2017a). Before the links between the illegal jaguar trade and demand from Chinese wildlife markets were identified in 2010, these domestic markets for jaguar body parts were perceived as small and opportunistic, and were largely disregarded as the focus centred on other jaguar threats like habitat loss and retaliatory killing. Consequently, there is a lack of baseline understanding about those domestic jaguar markets, and how they have shaped the relationship between humans and jaguars over the past decades.

There are multiple knowledge gaps about the current illegal trade in jaguars that must be better understood, to support evidence-based decision making to address this threat. For example, it is necessary to understand the role of domestic markets and non-commercial jaguar killing motivations as drivers of current illegal trade in jaguars. Few studies have reported on the uses that are assigned to jaguar body parts, and how widespread demand for these products is in domestic markets (e.g. Garcia-Alaniz et al., 2010; Gonzalez-Maya et al., 2010; Jędrzejewski et al., 2017a). Similarly, it is not clear whether the recent illegal jaguar trade is an opportunistic endeavour, facilitated by retaliatory human-jaguar conflict or chance encounters associated with bushmeat hunting, as has been suggested by some (Reuter et al., 2018b), or whether it is a targeted economic activity. Additionally, the characteristics of the actors involved in the trade, whether national or foreign, have not been explored in detail. Recent investigations have indicated that in addition to traders of Asian descent, there are other actors involved, such as urban elites and tourists of diverse nationalities (Braczkowski et al., 2019; Kelly, 2018). Even though traders of Asian descent have received considerable media attention, their specific characteristics (e.g. nationality, socioeconomic status) have not been uncovered, nor have their motivations for consuming jaguar body parts, or their connections to illegal

big cat markets in China. Undercover investigations carried out by NGOs have found that members of the Chinese diaspora in Latin America consume jaguar meat domestically, and produce 'jaguar paste', a substance made with jaguar meat and bones for medicinal purposes, for alleged export, yet these items have been largely missing from official seizures (Kerman and Felix, 2010; Lemieux and Bruschi, 2019). Consequently these uses, which would theoretically build the case for the use of jaguars in TCM, remain unverified, as are the claims of involvement by Chinese corporations and organized criminal groups. Moreover, a paucity of confirmed jaguar seizures in China (Beijing People's Court, 2015; Xiamen News, 2014) raise questions about the existence of a formal market for jaguar body parts in the country and the scale of the demand, and there are no studies on consumer motivations or on the uses of jaguar body parts in China. Crucially, while much of the focus on the illegal jaguar trade has centred in countries like Bolivia and Suriname, which have a mix of anecdotal and official evidence on the involvement of Chinese wildlife markets in the jaguar trade, less is known about the existence of this threat elsewhere in the jaguar range. Robust research on the actors, characteristics, drivers, and scale of trade is urgently needed to address these key knowledge gaps, preventing overreliance on unconfirmed assumptions about the illegal trade in jaguars.

1.2 Aims and objectives

The overall aim of this DPhil is to support ongoing policies and interventions to address the illegal trade in jaguars by providing key evidence on the prevalence, drivers, and characteristics of the trade, reducing reliance on subjective beliefs and anecdotal accounts as the only sources of information. Ultimately, the goal is that more evidence-based decision-making on the illegal jaguar trade can lead to more successful outcomes for the conservation of jaguars in the long term.

The objectives of the study are the following:

Objective 1: To estimate the prevalence and sensitivity of the illegal jaguar trade, the actors involved, and the uses of jaguar body parts in north-western Bolivia, a hotspot of recent cases of illegal jaguar trade, with a particular focus on distinguishing between domestic and foreign markets.

Objective 2: To identify the key socioeconomic, experiential, psychological and market-related drivers of jaguar trade and related behaviours, including killing jaguars, owning, buying, or selling jaguar body parts in north-western Bolivia.

Objective 3: To characterize the status and characteristics, including presence, trade chain pathways, actors and their motivations, drivers and enabling factors of the illegal trade in jaguars in Mesoamerica, a region with vulnerable jaguar populations that has received little media attention on the trade in jaguars.

Objective 4: To gain insights into how conservation decision-makers and practitioners working to address the illegal trade in jaguars on the ground, perceive, use, and prioritize evidence on jaguar trade, and to generate guidance for improving evidence-based approaches to decision-making on IWT.

1.3 Study systems

This DPhil is based on data collected through fieldwork in two different regions of Latin America, including Belize, Guatemala and Honduras in Mesoamerica, and Bolivia in South America. The choice of these study areas was based on two main factors. First, these two areas have marked differences in the availability of evidence on the illegal trade in jaguars. When this research started, Bolivia had a

considerable number of jaguar seizures linked to demand from China and information obtained from investigative journalism, whereas Belize and Guatemala had only few emerging cases of jaguar killing and trade with no clear underlying causes. These different geographical contexts enabled assessing the status and characteristics of this threat in different portions of the jaguar range, providing a more representative and comprehensive understanding of the illegal trade in jaguars at a regional level. Second, these two areas had an active conservation community (e.g. NGOs, governments, academics) that had already started to pay attention and invest resources into understanding and addressing the illegal trade in jaguars, regardless of their differences in information. Studying the illegal trade in jaguars in countries where the issue was of active interest not only meant that there would be opportunities for collaboration, but also that the results of the study would be more likely to influence ongoing and future strategies to address IWT, which was the main goal of this DPhil.

1.3.1 Bolivia

Bolivia has become known as the hotspot of recent cases of jaguar trade linked to demand from Chinese wildlife markets. More than 600 jaguar teeth destined for China have been intercepted by local authorities at airports or postal companies through 22 seizure events from 2014 to 2017, implying the killing of at least 156 jaguars (Nunez and Aliaga-Rossel, 2017; WCS, 2018). Not only does Bolivia stand out due to its relatively large number of seized jaguar specimens and individual seizure events, but also because of the *modus operandi* used by traders of Asian descent to obtain and smuggle jaguar body parts through radio broadcasts and flyers posted in public spaces, and through the use of postal services (Nunez and Aliaga-Rossel, 2017). Bolivia is also one of the few countries where the involvement of traders of Asian descent has been verified by the authorities, and several instances of jaguar trade have been legally prosecuted and received penal sentences (Romo, 2021).

Bolivia has a widespread jaguar population (Fig. 1.1), inhabiting 16 national protected areas and five internationally recognized jaguar conservation units, including the world-renowned Madidi National Park, recognized as one of the most biodiverse areas in the planet (Identidad Madidi and SERNAP, 2017). Yet a large part of the jaguar population lies outside formally designated protected areas and is vulnerable to habitat conversion, particularly for large-scale cattle-ranching (MMAyA, 2020a). Jaguar killing as a result of conflict with cattle ranchers is a leading threat to jaguars in the country. Research carried out in 85 cattle ranches in the Bolivian lowlands reported 347 jaguars poached in a four year period (Arispe et al. 2009 in MMAyA, 2020). Another study of 30 cattle ranches in the Department of Beni, found that 93 jaguars were killed in a year, equivalent to 10.6 jaguars killed per 100 km2 in an area of 87,979 ha. (Inchauste Ibanez, 2015), which is higher than the estimated national jaguar densities of 1 to 7.5 individuals per 100 km^2 (MMAyA, 2020a). High rates of jaguar killing have also been found outside of cattle-ranching areas in Bolivia, largely associated to predominant negative attitudes towards jaguars by rural and indigenous communities (Knox et al., 2019). Such high levels of jaguar hunting could offer favourable conditions for illegal trade in their body parts to thrive.

Within Bolivia, I focused my data collection efforts in the Departments of Beni, northern La Paz and Pando. I chose these Departments with the advice of local NGO partners, Asociación Boliviana para la Investigación y Conservación de Ecosistemas Andino Amazónicos (ACEAA), because they constitute an important part of the jaguar distribution within the country, they have recent prominent cases of jaguar killing and trading in the context of human-jaguar conflict and trade, and they are at the centre of recent infrastructure development projects subcontracted to Chinese companies. Therefore, collecting data from these Departments would allow me to capture the role of Chinese demand in the broader landscape of jaguar killing and the body part trade in the country. These Departments, located in Bolivia's north-western lowlands, cover a range of different biomes, including tropical Amazon rainforests, 'Cerrado' grasslands, and flooded savannas, all of which are part of the jaguar habitat

(SIARH, 2021). A large portion of the Departments' human population resides in rural areas (27.9% in Beni, 33.5% in La Paz, and 47.4% in Pando), but human population densities are amongst the lowest in the country (INE, 2012). The main economic activities in these Departments are agriculture, cattle ranching, timber and non-timber silviculture, hunting, fishing and gold mining (INE, 2016). The collection of Brazilian nut (*Bertholletia excelsa*), is among the main economic sectors in these Departments, employing thousands of people and reaching exports worth nearly 200 million USD dollars in 2015 (INE, 2016). Cattle ranching is another key livelihood, and the Department of Beni stands out as the second largest producer of bovine cattle in the country, reaching 2.6 million cattle heads in 2013, most of which are free-ranging (INE, 2016). These forest and livestock-dependent livelihoods mean that rural inhabitants in my study areas are prone to jaguar encounters by virtue of their presence in forests, or from experiencing livestock depredation by jaguars. These Departments have high poverty indices, with around 40% and 14% of their population living in conditions of moderate and extreme poverty, respectively (defined as income levels that do not satisfy the requirements of the Basic Food Basket, valued at less than $79 and $45 USD per person per month, respectively, in 2014, INE, 2020). These high poverty rates may also have an influence on the appeal of IWT as an alternative income stream (Duffy et al., 2016). Access and road connectivity in these Departments has been increasing considerably over the past years, due to a growth in large infrastructure development projects like the Rurrenabaque-Riberalta and San Ignacio de Moxos-San Borja highways, and the Sena and San Buenaventura bridges, among others, undertaken by Chinese companies operating in Bolivia. These projects are among the many examples of the growing financial and commercial relationship between Bolivia and China over the past decade, particularly through loans and the provision of services in the transport, energy, industry and telecommunications sectors by Chinese companies, worth nearly 6 billion USD from 2008-2019 (Oporto et al., 2021). The influx of Chinese company workers in rural, low income areas that are part of the jaguar habitat has been hypothesized to increase commercial opportunities for the illegal jaguar trade (Morcatty et al., 2020).

1.3.2 Mesoamerica

In Mesoamerica, the focus was specifically on Belize, Guatemala and Honduras (Fig. 1.1), where my collaborating organization, Wildlife Conservation Society (WCS) – Mesoamerica, was developing a project to explore the status and characteristics of the illegal trade in jaguars, as part of a broader United States Fish and Wildlife Service (USFWS) project aimed at strengthening CITES implementation in the region. In these countries, previous studies had found a high incidence of jaguar killings in the context of human-jaguar conflict, which could supply body parts for the illegal trade (Mora et al., 2019; Soto-Shoender and Giuliano, 2011; Steinberg, 2016). In Belize, for example, poaching due to livestock depredation by jaguars led to an estimated annual offtake of 200 jaguar individuals nation-wide (Foster, 2008). Additionally, these countries began to see a rise in cases of illegal trade in jaguars since 2018, including repeated instances of mutilated jaguar carcasses found floating in waterways, or seizures of jaguar body parts found in street markets and tourist destinations (APAMO, 2018; Harmsen and Urbina, 2017; San Pedro Sun, 2013).

Moreover, these countries possess some of the characteristics that allow IWT to thrive, such as high levels of corruption and organized crime (van Uhm and Moreto, 2018; Zimmerman, 2003). Guatemala and Honduras, along with El Salvador, are referred to as the “Northern Triangle”, a region that has been severely impacted by poverty and violence due to the long-lasting effects of civil war in the 1990s and the rise in transnational drug, human and firearm trafficking in the mid-2000s (UNODC, 2012). The criminal activities of both local ‘territory-bound organized crime groups’ and ‘transnational trafficking groups’ have given the region some of the highest homicide rates in the world, and caused large-scale irregular migration to North America and related immigrant smuggling (UNODC, 2012). Land clearing in the form of cattle ranching, agro-industrial plantations, and timber extraction became a preferred way for criminal groups in the cocaine business to launder their illegally obtained money,

causing some the highest annual deforestation rates worldwide, reaching 15% to 30% in countries like Honduras, Guatemala and Nicaragua, from 2001 to 2013, a large portion (30-60%) of which occurred within protected areas (Rodríguez Mega, 2017; Sesnie et al., 2017). Criminal groups have diversified their income streams, and have been implicated in high-profile IWT cases, including scarlet macaws (*Ara macao*), rosewood (*Dalbergia spp*.), mahogany (*Swietenia macropylla*) and cedar (*Cedrela odorata*), which have displaced vulnerable communities from their lands or extorted them to partake in IWT (Guo, 2019; Sesnie et al., 2017; Soberanes, 2019). The pervasiveness of organized crime in this region has been enabled by systematic corruption at all levels, especially within law enforcement institutions and high-level politicians, undermining and actively competing with environmental governance structures (Wrathall et al., 2020). The established criminal networks in Guatemala, Honduras and Belize, could have a direct and indirect impact of the illegal trade in jaguars, facilitating it through their long-established trafficking channels and networks, and by increasing access to jaguars and other wildlife through deforestation.

Belize, Guatemala and Honduras are also critically important from a jaguar conservation perspective, containing critical habitats for remaining endangered Mesoamerican jaguar populations. The Maya Biosphere Reserve, found in northern Guatemala, is one of the last remaining large forest fragments for jaguars in Mesoamerica (Soto-Shoender and Main, 2013). Within its protected areas, Belize has one of the largest densities of jaguars in the entire range, acting as a source of genetic diversity for jaguars in neighbouring countries (Harmsen et al., 2017). Established in Belize in 1986, the Cockscomb Basin Wildlife Sanctuary stands out as the world's first jaguar preserve, attracting tourists and scientists to study and appreciate the importance of jaguars. Guatemala, Belize and Honduras are also part of the Mesoamerican Biological Corridor (MBC) and the Jaguar Corridor Initiative, a program spearheaded by the wild cat conservation NGO Panthera to preserve the movement of jaguars from the northern to the southernmost parts of their range (Zeller et al., 2013).

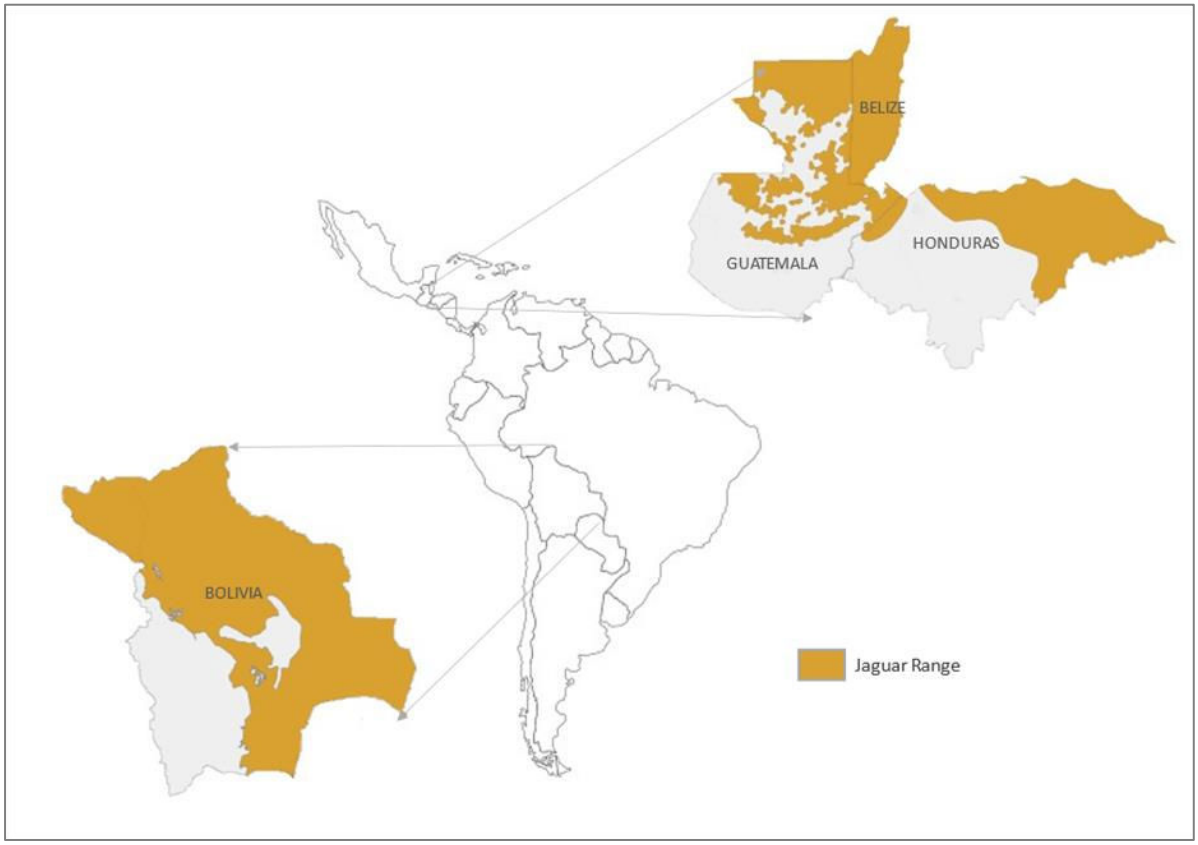

Figure 1.1: Jaguar range in DPhil study countries. Range Map Credit: Panthera 2017. *Panthera onca.* The IUCN Red List of Threatened Species. *Version 2021-1* https://www.iucnredlist.org

1.4 Thesis outline

Chapter 1: Introduction

In this initial chapter, I provide a general introduction to the thesis, including the problem statement describing the current status and knowledge gaps on the illegal trade in jaguars and the aims and objectives of this DPhil. This chapter also includes a short overview of the study systems where data collection took place, the thesis outline, other research and policy interventions that derived from this research project, and my positionality as a researcher.

<u>Chapter 2:</u> Theoretical Background

In the second chapter, I review the literature from which I drew key concepts and methodologies for my DPhil. Literature on IWT is included in this section, emphasizing global trends as well as those specific to Latin America and to the trade in big cats. I also include key literature on the links between science, policy and practice within the field of biodiversity conservation and IWT, due to its importance to achieving the main goal of this thesis, which is to provide evidence for actions to address the illegal trade in jaguars. Jaguar biology, conservation and relationships with humans are also discussed, to provide a background on the socio-ecological systems surrounding jaguars and illegal trade, drawing from the broader literature on human-wildlife interactions. Finally, I provide a background on the theoretical and technical considerations behind the methods I used in this research, including social science interview and surveying methods, the use of specialized sensitive questioning techniques, as well as the ethics of studying sensitive or illegal behaviours in conservation.

<u>Chapter 3:</u> Prevalence and characteristics of illegal jaguar trade in north-western Bolivia

In this chapter, I explore the prevalence and characteristics of the illegal jaguar trade in north-western Bolivia, a hotspot of recent seizures of illegally traded jaguar body parts linked to demand from Asian wildlife markets. Based on questionnaire surveys with 1107 rural household leads, and the application of a specialized sensitive questioning technique, the Ballot Box Method, I estimated the scale of people's engagement with illegal jaguar trade and related behaviours, and assessed the sensitivity of the issue. I also explored the uses that people give to jaguar body parts in the area, and the main sources of demand. Contrary to expectations that the illegal jaguar trade is mainly driven by demand from traders of Asian descent, the results of this investigation revealed a wider diversity of actors,

particularly non-Asian and regional visitors, as well as a neglected but thriving domestic market for jaguar body parts. These findings highlight the importance of grounding anti-trafficking policies in evidence from source areas in order to avoid misjudging the actors and characteristics of trade based on incomplete seizure data or simplistic narratives surrounding the field of IWT.

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Chapter 4: Complex interactions between commercial and non-commercial drivers of illegal trade for a threatened felid

This chapter is based on the same data collected through questionnaire surveys in north-western Bolivia as the previous chapter, but it dives deeper into an exploration of the drivers behind the illegal trade in jaguars. I start by describing human-jaguar relationships in the study area, including those involving passive and aggressive encounters, human-jaguar conflict, hunting and trading, as well as the perceptions and attitudes of local communities towards jaguars. I then provide a detailed overview of the different existing actor types, based on participants' varying levels of engagement with the illegal jaguar trade. I conducted generalized linear models to analyse the drivers of the different jaguar killing, trading (selling and buying), consuming, and recruitment (asking or being asked to kill)

behaviours, including participants' demographic and socioeconomic characteristics, past experiences with jaguars, attitudes and perceptions towards jaguars, market-related incentives, and costs from enforcement. The results exposed the importance of pre-existing livelihoods, particularly bushmeat hunting, and market incentives as predictors of engagement with jaguar trade, as well as the key role of domestic traditional markets. The complex interactions between non-commercial and commercial drivers of illegal jaguar trade emphasize the need for more integrated research on illegal wildlife trade, human-wildlife conflict, traditional practices, and market dynamics, and the need for multifaceted conservation approaches that address the different drivers of the trade.

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Author contributions: MA proposed, conceptualized, designed, collected and analysed the data, and drafted this chapter, with comments and supervision from AH and EJMG. PNA and PCB supported MA in fieldwork-based data collection in Bolivia. NN and JAG provided funding and contributed to the design and implementation of the fieldwork. All authors edited and reviewed the manuscript.

Chapter 5: Characteristics of, and uncertainties about, illegal jaguar trade in Belize and Guatemala

In this chapter, I present new insights about jaguar trade in Mesoamerica, resulting from an analysis of semi-structured interviews with 41 key informants in Belize, Guatemala and Honduras. I analysed examples of jaguar trade incidents collected through the interviews, to reconstruct the types of actors involved in illegal jaguar trade and their motivations, the pathways behind the jaguar trade chain and

the trade routes, as well as the drivers and enabling factors behind this emerging threat to jaguars. In addition to characterizing the illegal trade in jaguar body parts, throughout the interview analysis, I differentiated between jaguar trading incidents that were concrete examples versus strong beliefs or assumptions. This allowed me to identify areas of remaining uncertainty, and to ascertain that current examples of jaguar trade portray it as an opportunistic and domestically focused activity, whereas the roles of foreign actors and commercial motivations are unclear.

This chapter has been published as: Arias, M., Hinsley, A., & Milner-Gulland, E.J. (2020). Characteristics of, and uncertainties about, illegal jaguar trade in Belize and Guatemala. *Biological Conservation*. 250. https://doi.org/10.1016/j.biocon.2020.108765

Author contributions: MA proposed, conceptualized, designed, collected and analysed the data, and drafted this chapter, with comments and supervision from AH and EJMG. All authors edited and reviewed the manuscript. The Wildlife Conservation Society - Mesoamerica, supported this chapter financially and logistically.

Chapter 6: Use of evidence for decision-making by conservation practitioners in the illegal wildlife trade.

Here, I explore evidence use and decision-making by conservation practitioners working to address the illegal trade in jaguars, and illegal wildlife trade more broadly, in Belize, Guatemala and Honduras. I began by discussing the decision-making processes and information sources used by jaguar conservation practitioners, collected through semi-structured interviews. I then analysed how conservation practitioners assess jaguar trade evidence of differing qualities and attributes, identifying key implicit and explicit biases in their evaluation of evidence, including its prioritization

for reasons other than its quality, reliability or suggested impact on the species. Based on these findings, I propose an approach to guide conservation decision-makers to assess the relevance and uncertainty of IWT evidence, to identify evidence-based courses of action, and to improve the transparency of their decisions.

This chapter has been submitted to the journal People and Nature: Arias, M., Hinsley, A., & Milner-Gulland, E.J. Use of evidence for decision-making by conservation practitioners in the illegal wildlife trade. (Under review).

Author contributions: MA proposed, conceptualized, designed, collected and analysed the data, and drafted this chapter, with comments and supervision from AH and EJMG. All authors edited and reviewed the manuscript.

Chapter 7: Discussion and Conclusion

In this chapter, I synthesize the key findings of the previous chapters in the thesis, highlighting common emerging themes, remaining areas of uncertainty and research limitations. I also discuss the implications of the research for policies and actions to address the illegal trade in jaguars and IWT in Latin America and beyond.

1.5 Other research and policy

Throughout my DPhil, I was able to lead and contribute to other research projects related to the illegal trade in jaguars or to wider topics within biodiversity conservation, collaborating with other researchers and organizations. I was also actively involved in the formulation of scientific inputs for

policies and conservation projects led by intergovernmental bodies and non-governmental organizations, aimed at addressing the illegal trade in jaguars in Latin America. These efforts are the following:

Arias, M., & Lambert, A. E. (2019). Jaguar trafficking dynamics in Latin America: Analysis Report. Wildlife Conservation Society: New York.

Arias, M., Hinsley, A., & Milner-Gulland, E. J. (2020). Implementing the Ballot Box Method to reduce social desirability bias when researching sensitive behaviours in conservation. Oxford Martin Program on the Illegal Wildlife Trade Tools and Guidance. SocArXiv. https://osf.io/preprints/socarxiv/t3evh/

Veríssimo, D., Pienkowski, T., **Arias, M.,** Cugnière, L., Doughty, H., Hazenbosch, M., de Lange, E., Moskeland, A., & Grace, M. (2020). Ethical Publishing in Biodiversity Conservation Science. Conservation and Society. 18:3, 220. 10.4103/cs.cs_19_56

Booth, H., **Arias, M.,** Brittain, S., Challender, D. W. S., Khanyari, M., Kuiper, T., Li, Y., Olmedo, A., Oyanedel, R., Pienkowski, T., & Milner-Gulland, E. J. (2021). "Saving Lives, Protecting Livelihoods, and Safeguarding Nature": Risk-Based Wildlife Trade Policy for Sustainable Development Outcomes Post-COVID-19. Frontiers in Ecology and Evolution. 9. 10.3389/fevo.2021.639216

Li, Y., **Arias, M**., Hinsley, A., Milner-Gulland, E. J. International media coverage of the Bolivian jaguar trade. Submitted to People and Nature.

Polisar, J., Davies, C., Morcatty, T., Da Silva, M., Zhang, S., Duchez, K., Madrid, J., Lambert, A.E., Gallegos, A., Delgado, M., Nguyen, H., Wallace, R., **Arias, M.,** Nijman, V., Ramnarace, J., Pennel, R., Novelo, Y., Rumiz, D., Rivero, K., Murillo, Y., Nunez-Salas, M., Krester, H., Reuter, A. Multi-lingual multi-platform investigations of online trade in jaguar parts. Wildlife Conservation Society. Submitted to Plos One.

Arias, M. (2021). Illegal Trade in Jaguars (Panthera onca). A study in Support of CITES Decisions 18.251-18.253. Convention on International Trade In Endangered Species of Wild Fauna and Flora (CITES). Geneva, Switzerland.

1.6 Research positionality

Since its origins as 'conservation 'biology' in the 1970s and 1980s, conservation science has grown as a discipline, from emphasizing biological concerns to recognizing the importance of coupled social-ecological systems and interdisciplinarity (Kareiva and Marvier, 2012; Soule, 1985). A part of this evolution has been the incorporation of the social sciences as a means to understanding human behaviour, as a prerequisite to intervening in human-natural systems to prevent extinction (Bennett et al., 2017b). Despite the progress made in adopting interdisciplinarity and inclusiveness as principles, conservation science remains largely rooted in its natural science origins, having a strong reductionist and positivist influence, seeking to define, quantify, predict, and derive logical truths and certainty from complex socio-ecological systems (Moon et al., 2019a, 2019b). Conservation scientists that adopt an objectivist position often assume that their predictions can be confirmed empirically, and that an objective truth can be reached, irrespective of the researcher's mind (Moon et al., 2019b). However, such a philosophical standpoint towards conservation science not only minimizes the complexity of social-ecological systems, but also disregards the important role of the researcher in the production

of knowledge (Moon et al., 2019a, 2019b). Researchers' positionality, or their situated interactions with the world through their own perspectives shaped by their history, culture, geography, experience or embodiment, influence how they perceive the world, resulting in a partial understanding of reality (Williams, 2014). On the other hand, critical pluralism or constructionist perspectives understand that reality is created through peoples' experiences, and that subjectivity and positionality are inevitable in scientific enquiry (Moon et al., 2019a; Williams, 2014).

My position throughout my DPhil has been more aligned with a constructionist than an objectivist approach to conservation science. From the start of my research on the illegal jaguar trade, I realized that it would be impossible to understand all the factors that lead to lethal interactions between humans and jaguars. I was convinced, as I am still today, that such interactions vary strongly with context, being influenced by a suite of factors, from the specific traits and behaviour of each individual human and jaguar, to the broader environmental and governance landscape in which they occur, as described by the theory on human-carnivore socio-ecological systems (Carter et al., 2017; Lischka et al., 2018). Recognizing this high level of complexity, I struggled from the beginning to fit my research into any clear-cut criminological, psychological or economic theories seeking to explain wildlife crimes through instrumental, regulatory, normative, or situational frameworks. I have studied and drawn strongly from these theories, but have not attempted to empirically test their hypotheses through my research nor to suggest alternative theories to explain the human-wildlife interactions observed in my research. While I have followed a positivist approach in using a range of qualitative and quantitative methodologies to reach an 'improved' understanding of the drivers of the illegal jaguar trade, and attempted to simplify the system and its actors, I have been careful to denote the biases and limited scope of my findings. Moreover, I have recognized that my attempts to unravel this complexity are at best a snapshot of a wider picture, and one that varies in space and time.

Rather than choosing any particular theoretical lens, I chose to ground my research questions in the practical needs of conservation policies and actions to address the illegal trade in jaguars. At the start of my DPhil, I approached a wide range of stakeholders involved in jaguar conservation throughout Latin America, to learn about their key concerns and knowledge gaps on the illegal jaguar trade. These conversations evolved into research partnerships with local organizations, which guided my choice of questions and my areas of focus, in an effort to provide scientific inputs that would directly benefit existing efforts and policies to address the illegal trade in jaguars. Working with a broad range of stakeholders outside of academia was challenging. I had to learn quickly to manage the differing expectations and timelines between academia and conservation practice, and to understand organizational agendas, while also seeking to maintain research independence. Being embedded in the system of jaguar conservation in Latin America, and being an active player in the fight against the illegal trade in jaguars through my involvement with intergovernmental bodies, governments and non-governmental organizations working on the matter, while also striving to study it from the 'outside', affects my positionality towards the research. I have made a strong effort to remain objective about my research and technical advice, relying on my own data and results, regardless of whether they align with institutional discourses or not. My approach has also been to understand as many perspectives on the issue as possible, and to build professional relationships across jaguar conservation organizations and stakeholders as a way to maintain neutrality and to avoid one-sidedness.

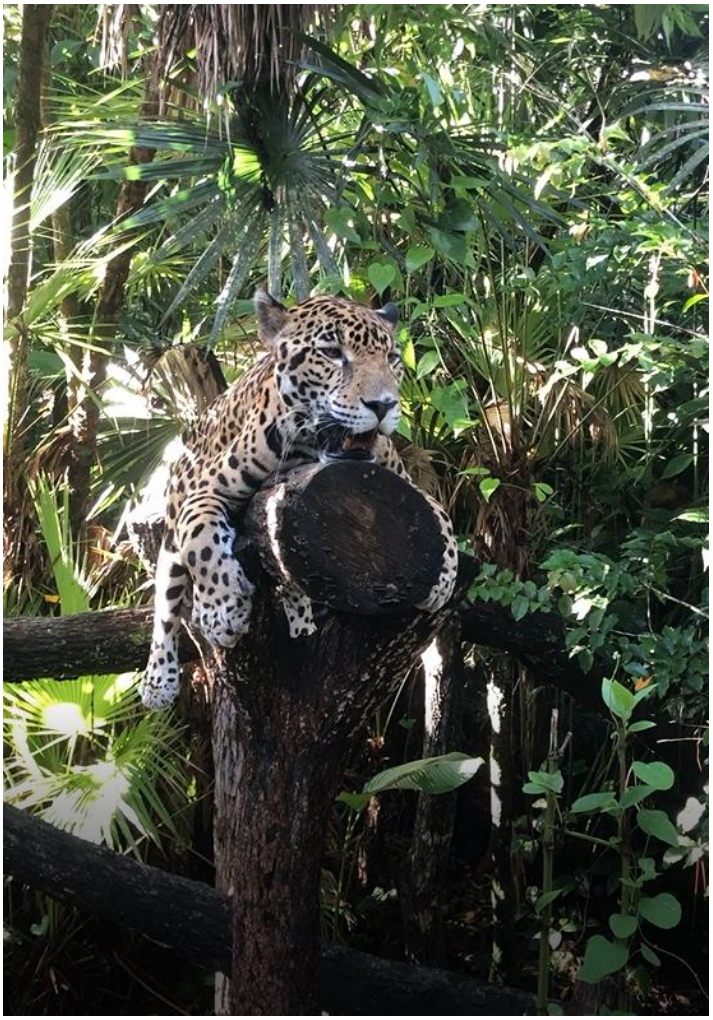
I also faced a personal philosophical challenge throughout my DPhil. I was drawn to conservation science at a more advanced stage in my career, after having obtained an undergraduate degree in a non-related discipline, International Relations, and worked on different topics, not because of a passion for science (which came later), but because of an overwhelming anxiety after learning about the deplorable state of nature and wildlife. I changed career paths and adopted a different lifestyle both because I was concerned about biodiversity collapse, and because I cared about individual

animals from a welfare standpoint. I became particularly interested in IWT, due to being deeply worried by its large-scale impacts on biodiversity just as much as by the intense suffering that it inflicts on individual animals. After strengthening my background in conservation over the past ten years, I have come to learn about the diversity of perspectives within the conservation community, and the wide spectrum that exists between those concerned with ecological collectives, such as population or species, and those interested in the welfare of individual animals (Johnson et al., 2019). Within this spectrum, I strive to subscribe to the consequentialist view that what is 'right' is determined by the balance of positive versus negative outcomes, understanding that some degree of animal suffering may be needed to sustain biodiversity conservation as a whole (Hampton et al., 2019). However, I recognize that I am also driven by emotive reactions to the killing of animals (wild and domesticated), and I am sympathetic to, and sometimes an advocate of, the appeals to morality and virtue ethics from the animal rights and compassionate conservation movements (Hampton et al., 2019). Standing in this conflicted position was particularly hard as a researcher of wildlife poaching. During my fieldwork in Bolivia, I personally interviewed hundreds of people who killed jaguars, a species that I deeply care about. I was also constantly presented with jaguar carcasses and body parts that appealed to my emotive side and produced feelings of anger and sadness. Despite these feelings, my role as a researcher was to avoid judging those behaviours towards jaguars, and instead to try to be understanding and respectful, and to inspire trust to my interviewees, acknowledging my ethical responsibility to them, their comfort, and their confidentiality. Although this was very difficult at first, it became easier with practice, as I began to develop a strong sense of empathy for my interviewees, and to understand the challenges they face from living close to dangerous predators, something that I never had to do. Unlike many conservation scientists who study socio-ecological systems outside of their region and language, I was lucky to conduct my research in a familiar setting, which allowed me to build a strong connection with my interviewees and to put myself in their shoes. Even so, I realized the many social, economic, cultural, and geographical factors that made their views towards jaguars

so different from mine, and which made it impossible for me to judge what was moral or immoral, right or wrong. I was humbled by these experiences, and they allowed me to see that outside consequentialist or compassionate philosophies, empathy with those who have to live with the consequences of our decisions is perhaps the most important value in conservation and the only way to achieve positive outcomes for wildlife in coupled human-natural systems. Although I still feel conflicted in regards to where I stand in the conservation-welfare spectrum as a conservationist, I am more aware of the nuance behind complex conservation issues, and clearer about the broader human and animal meanings of compassion. I have aimed to highlight that nuance throughout my chapters and publications, calling out for a less prejudiced understanding and representation of the actors and drivers behind the illegal trade in jaguars.

Chapter 2

Theoretical Background



Jaguar resting on a log at the Belize Zoo.

2.1 Linking science and policy/practice in conservation and IWT

As a mission-driven discipline, one of the goals of conservation science is to produce information that can directly support conservation policies and interventions to preserve biodiversity on the planet (Kareiva and Marvier, 2012; Soule, 1985). Even though the scientific literature on biodiversity conservation has increased considerably over the past decades, so have concerns about a growing disconnect between scientific evidence and conservation policies and actions (Pullin et al., 2004; Sutherland et al., 2004; Svancara et al., 2009). Such a gap is especially concerning in the field of IWT, not only due to its vast and rapid impacts on biodiversity, but because it also affects the livelihoods and traditions of communities across the world. Unevidenced IWT policies and interventions can have negative consequences for the wildlife involved and for the people that depend on it (Booth et al., 2021a; Cooney et al., 2017).

There are multiple reasons for the disconnect between biodiversity conservation science, policy and practice. In some cases, biodiversity conservation is simply not seen as a political priority due to a mismatch between long-term biodiversity outcomes and short-term electoral cycles (Rose et al., 2019). In other cases, scientific evidence may be lacking, such that biodiversity concerns never reach the public eye or the decision-making table (Bertuol-Garcia et al., 2018). For example, a myriad of traded species are both listed as Data Deficient on the IUCN Red Lists and unregulated by CITES, and with a few exceptions, even CITES-listed species lack robust ecological and trade monitoring systems (’t Sas-Rolfes et al., 2019). Relatively small-bodied, species-rich vertebrate taxa (e.g. reptiles, fish and amphibians), invertebrates, and plants are particularly lacking in both research and conservation attention, as the focus and resources tend to be sequestered by charismatic megafauna (Hughes et al., 2021; Margulies et al., 2019a). Aside from the biases in evidence availability, the representativeness of conservation research is further challenged by accessibility to resource systems

(Walsh et al., 2019). Despite improvements in the number and diversity of topics, and in the geographical representation of conservation science, there continue to be under-studied species and places, or conservation 'blind spots'. This is particularly concerning for those which are most threatened (Maas et al., 2019; Watson et al., 2017). Cryptic and elusive species, and those inhabiting remote ecosystems, may be disregarded due to logistical and financial challenges in studying them, a form of selection bias (Cooke et al., 2017). The same is true for regions or topics that are difficult to study, such as IWT, due to their hidden nature, safety risks, or because they require interdisciplinary training that is not available to all scientists.

Even when scientific evidence is available, challenges may arise from its lack of policy relevance and applicability (Walsh et al., 2019). Conceptual science that is too abstract for application, unrealistic, or not responsive to the temporal and spatial scales needed to deliver policy recommendations, may be disregarded as irrelevant for conservation practice (Cvitanovic et al., 2016; Hulme, 2014). Moreover, the conservation literature continues to be biased against the social sciences and dominated by disciplinary silos instead of adopting social-ecological systems thinking, which is crucial to understanding the relationships between people and nature that underpin key conservation policy and practice demands (Bennett et al., 2017b; Salomon et al., 2018). Such a reductionist approach is maintained by perverse reward systems in academia, which fail to reward policy impact, and which are increasingly relegating fieldwork studies that engage with local problems to second place, in favour of global, big data modelling studies that appear in high impact journals (Ríos-Saldaña et al., 2018; Rose et al., 2019). Scientific reductionism, the lack of interdisciplinarity, and the fragmentation of conservation research efforts, along with the persistence of research questions that are not designed for, or aligned with, conservation actions and policy interests, mean that conservation science remains far removed from application (Gore et al., 2020; Knight et al., 2008; Salomon et al., 2018).

The challenges in linking conservation science to policy and practice are further accentuated by issues surrounding evidence quality and the handling of uncertainty (Walsh et al., 2019). By nature, biological systems are uncertain, and scientific efforts to understand complex, multifaceted and data-deficient conservation problems like IWT, which are also fuelled by conflicting values and perspectives, are bound to reach a lack of consensus amongst the conservation community (Hulme, 2014; Toomey et al., 2017; Wright et al., 2020). The 'bitter divisions' in the conservation movement in reaction to the rise of the Covid-19 pandemic – where some conservationists' calls to ban wild meat consumption to reduce the risks of future zoonotic diseases were met with pushback from others in the movement concerned about the livelihood impacts of such an approach - illustrate the complexity of reaching agreement even amongst like-minded people (Milner-Gulland, 2021). Unfortunately, lack of consensus is the opposite of what policy-makers and practitioners seek when making decisions on controversial topics like IWT, which elicit strong emotive reactions as well as having large economic and social consequences (Cooke et al., 2017; Wright et al., 2020).

Related to the lack of consensus in science are the high levels of uncertainty and unpredictability of socio-ecological systems. Reducing uncertainty in scientific estimates and in the causal relationships between social and ecological drivers requires well-designed hypothesis testing, experimentation (minimizing selection, performance, measurement, detection and attrition bias), repetition, observation through time, and large sample sizes that enhance the external (generalisability) and internal (relevance) validity of scientific studies (Cooke et al., 2017). However, such quality standards are not always within the possibility, scope, time and budget of conservation scientists, and even when uncertainty can be minimized, it is rarely eliminated altogether. For example, studies on illegal behaviours surrounding IWT are prone to large amounts of uncertainty (e.g. large standard errors around prevalence estimates) due to the rarity of the trade events or their hidden nature, and due to a dependence on limited seizure data that fail to characterize the scale of the trade (Nuno and St.

John, 2015; Underwood et al., 2013). Yet decision-makers tend to disengage from uncertain information presented in probabilistic terms, or using models and hypothetical scenarios that are not always easy to understand, interpret, and use (Addison et al., 2013; Cook et al., 2013). Aside from uncertainty, another aspect of the quality of conservation evidence is its reliability and legitimacy (Cash et al., 2003). This is closely dependent on the trustworthiness of the source of the information, and whether it is perceived as being fair, inclusive of multiple perspectives, and unaffected by political suasion or institutional agendas (Cash et al., 2003; McNie et al., 2016).

Other factors that influence the uptake of conservation evidence by decision-makers, practitioners, and the public, relate to how the information is presented or framed. For example, people tend to react differently to the same information when it is presented in negative versus positive terms, paying more attention to negative frames due to a general tendency towards risk aversion, as suggested by Prospect Theory (Tversky and Kahneman, 1992). Messages can also be framed in terms of their attributes, whereby a particular aspect of the information is highlighted to increase its personal relevance (Levin and Gaeth, 1998; Spence and Pidgeon, 2010). According to Construal Level Theory (Trope and Liberman, 2010), people pay more attention to, and are better at making decisions about, events and situations that are framed as being psychologically closer to them in spatial, temporal and social terms, as well as those that appear to be real rather than hypothetical. Attribute framing can also emphasize a message's hedonic consequences (desirable or undesirable consequences of a behaviour), outcome sensitivities (the achievement of positive outcomes versus the avoidance of negative outcomes), regulatory concerns (appealing to growth vs. safety needs of the recipient), and goal pursuit strategies (proactive vs. vigilant avoidance) (Bertolotti and Catellani, 2014). The persuasiveness of a message can also vary depending on whether or not it is accompanied by imagery, as images are able to supplement messages by eliciting emotions (Fiedler, 2007; Seo et al., 2013).

Even in cases where biodiversity conservation is seen as a political priority and scientific evidence is available, relevant, robust, and convincingly framed, there may be difficulties in linking conservation science with policy and practice due to the characteristics of the actors involved in the exchange of information (Walsh et al., 2019). Personal attributes, such as education, personality, sense of control, values, political and world views, goals, cognitive biases, age, gender, emotions, pragmatism; and social attributes, such as religion, norms, social class, culture and ethnicity, are all influential in people's postures towards evidence and decision-making (Burgman, 2005; Gifford and Nilsson, 2014). Experts and decision-makers often believe that they are capable of making adequate decisions without the need for rigorous evidence, as explained by the social expectation hypothesis, being complacent towards the use of scientific evidence (Sutherland and Wordley, 2017). They may also think that relying on evidence reduces their autonomy, that they will not gain from using evidence, or that it takes too much time and effort to consult the evidence when other sources, such as personal experience, are readily available (Sutherland and Wordley, 2017). However, experience and qualifications tend to be poor guides to performance, and experts and decision-makers often fall victim to common biases in decision making such as anchoring (tendency to be influenced by initial estimates), availability (the influence of past experiences on memory), representativeness (single school of thought), groupthink and overconfidence (Burgman, 2005; Burgman et al., 2011; Hemming et al., 2018). Moreover, confirmation bias, or the inclination to retain a favoured hypothesis, is ubiquitous in decision making, and it affects how trained and untrained people search for, interact with, and decide upon, evidence (Busemeyer et al., 1995). As a result, decisions end up being made on the basis of individuals' experiences and subjective beliefs rather than aggregate knowledge (Burgman, 2015; Sutherland et al., 2004; Svancara et al., 2009).

The challenge of navigating the spaces between conservation science and policy may also be related to issues in the communication between scientists and decision-makers and in the wider decision

context (Walsh et al., 2019). Inadequate communication can be caused by disciplinary, geographic and language biases, and is deepened by the chronic underrepresentation of certain sectors of society, such as women, ethnic minorities or local communities (Maas et al., 2019; Toomey et al., 2017). Another challenge is that knowledge exchange is often perceived as a one-way process, in which scientific inputs are passively supplied (e.g. published in the peer review) and then automatically found and used for policy or practice (Cash et al., 2006). In practice, however, knowledge exchange is a circular and political process, involving a constant negotiation between multiple sectors of society with competing interests and more proactive ways of engaging with audiences (Bertuol-Garcia et al., 2018; Cash et al., 2006; Salomon et al., 2018). On both sides of the science-policy spectrum, there must be institutional incentives in place to encourage actors to engage with one another in such negotiations, as a requirement for career progression rather than as a side activity (Gore et al., 2020; Nutley et al., 2012). As with other negotiation processes, to get their messages across, scientists must learn about the governance structures behind conservation decision-making, including institutional cultures and agendas, organizational systems, chains of command and decision-making hierarchies (Hulme, 2014; Wright et al., 2020). Proficient negotiation or diplomacy requires a specific skillset, gained through years of training and practice, involving relationship building, creating trust and learning the values, vocabulary and practices of other fields (Gore et al., 2020). Yet such theoretical, methodological or empirical guidance on engaging with knowledge exchange and scientific diplomacy is often lacking, and those who have gained such an expertise, referred to as knowledge brokers or facilitators, are underappreciated (Cvitanovic et al., 2016; Rose et al., 2019).

While proactive engagement in knowledge exchange can go a long way towards increasing the uptake of scientific evidence in policy or practice, these efforts can still be thwarted in the absence of resources and incentives for the implementation of scientific recommendations, or when the timing of the knowledge exchange is not opportune (Maas et al., 2019; Rose et al., 2018). The uptake of

science tends to be faster when there are windows of opportunity, where expected or unexpected shifts in the political landscape occur, such as changes in governments' agendas or in practitioners' interests, staff rotations or election processes, public pressures, funding availability, among others (Rose et al., 2017). These events can be identified and seized by conservation scientists and decision-makers by planning ahead, and using a range of tools that promote participatory knowledge creation processes, such as stakeholder mapping, horizon scanning, scenario planning, and knowledge management systems (Gore et al., 2020; Rose et al., 2017). Efforts to map out and anticipate key emerging topics within IWT already exist (Esmail et al., 2020; Gluszek et al., 2020), and future research and policies to address IWT would benefit from tackling these pre-identified issues.

The challenges to bridging conservation science and policy/practice have been repeatedly identified in the literature, reaching an 'identification saturation' (Rose et al., 2019). Similarly, multiple solutions have been suggested to overcome them, from encouraging more transdisciplinary research and co-production of knowledge, to changing reward systems and investing in knowledge brokers, yet progress towards implementation has been slow and unpredictable (Rose et al., 2019). However, there is an increasing number of examples of positive engagement between conservation scientists and policy-makers, and of changes in the rewards systems within academia. For instance, the development of the Environmental Offsets policy in Australia, or the creation of a science-policy-society interface on biodiversity and ecosystem services in Europe (Eklipse Mechanism), represent successful efforts of knowledge co-production engaging multiple sectors (Rose et al., 2019). Similarly, academic funding schemes that emphasize policy impact and public engagement have been established in countries like Australia, Canada, the United States and United Kingdom, such as the grants provided by the United States' National Science Foundation or the UK's Research Excellence Framework (Boswell and Smith, 2017; Gore et al., 2020). A steady increase in these efforts would

deliver benefits and career opportunities for both conservation scientists and policy-makers, and lead to a faster and more effective resolution to the multiple challenges facing biodiversity on the planet.

2.2 The illegal wildlife trade (IWT)

From rosewood to caviar, and from lizards to elephants, the trade in wildlife is a large-scale and widespread economic activity that has important implications for biodiversity conservation. The trade in wildlife (legal or illegal) involves about 24% of all extant terrestrial vertebrate species, and occurs across all of Earth's habitable continents (Scheffers et al., 2019). Much of the trade in wildlife is legal and regulated by national legislations, sub-national rules governing private or community resource-holder rights, or by international laws, such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, Phelps et al., 2016). Over 35,000 species of animals and plants have been afforded with varying degrees of trade regulation under CITES; from international commercial trade bans for endangered species listed under CITES Appendix I (representing 3% of listed species), to authorized trade subject to a non-detriment finding report for species not yet threatened with extinction, listed under CITES Appendices II and III (representing 97%, Wijnstekers, 2018). High volumes of plants and animals, averaging 100 million whole organism equivalents, are legally traded under CITES on yearly-basis, with the highest overall volumes from 1975 to 2014 being for plants (1.80 billion), followed by reptiles (152 million), invertebrates (79.8 million), birds (24.1 million), mammals (13 million), fish (12.8 million) and amphibians (1.07 million) (Harfoot et al., 2018).

Sustainable and regulated trade in wildlife supports the health, diets and livelihoods of millions of people throughout the world, and it can also benefit biodiversity and drive species recoveries (Booth et al., 2021a). Banning wildlife trade and consumption would place 15 countries at risk of food insecurity, lead to large-scale habitat conversion to produce domestic protein alternatives, and drive

more than 260 species to extinction (Booth et al., 2021b). Consequently, the trade in wildlife is vital to the achievement of multiple Sustainable Development Goals (SDGs), from no poverty, zero hunger and decent work and economic growth (SDGs 1, 3 and 8, respectively), to sustaining life below water and on land (SDGs 14 and 15, Booth et al., 2021). However, not all trade in wildlife is sustainable or regulated. In many cases, traded species, including those protected by law or those inhabiting protected areas, have suffered steep declines in abundance due to overexploitation (e.g. exceeding a mean 60% across 506 studied taxa, Morton et al., 2021). Further, the trade in wildlife disproportionately affects large bodied species that naturally occur in low abundances, species that are evolutionarily distinct and rare, and those which are already threatened with extinction due to habitat loss, climate change, or disease (Scheffers et al., 2019). In the wake of Covid-19, it has become particularly clear that given the interconnectedness between people, animals, plants, and their shared environment, unsustainable and unregulated wildlife trade compromises biodiversity conservation and the livelihoods and health of humans across the world through the loss of life support systems and the potential emergence of zoonotic diseases (Booth et al., 2021a; Mackenzie and Jeggo, 2019).

The illegal wildlife trade (IWT) involves multiple actions pertaining to the harvesting, transportation, commercial exchange, and end use of live and dead wildlife (wild fauna and flora, including timber, and fungi, and their derivatives) that contravene domestic or international rules (’t Sas-Rolfes et al., 2019). Like other forms of wildlife trade, it is taxonomically and geographically diverse, and it has become one of the most profitable illicit sectors after the illegal trade in drugs, arms and humans, worth billions of dollars per year (May and Clough, 2017). IWT is often described as an organized crime, and in some cases (e.g. elephant and rhino poaching in Central Africa and Mozambique), it has been associated with other criminal activities, such as drugs or arms trafficking, and with non-state terrorist groups and criminal mafias (Nellemann et al., 2014; Wong, 2019; Zimmerman, 2003). In addition to using bribery, violence and corruption as a common *modus operandi* to trade wildlife across country

borders, these criminal groups have also been known to employ sophisticated smuggling strategies and expensive technologies designed to reduce the risk from enforcement (van Uhm and Moreto, 2018; Wasser et al., 2008).

The characterisation of IWT as a "serious organized crime", with implications for national security, has become a dominant discourse within the field of study and action against IWT, and a priority issue for foreign biodiversity conservation assistance, justifying the securitization of wildlife poaching and IWT (Duffy, 2014; Massé and Margulies, 2020). However, not all IWT is an organized criminal enterprise, and in fact, the evidence of its ties to criminal mafias and terrorism is restricted (Massé and Margulies, 2020; Milner-Gulland et al., 2018). Instead, much of the evidence on IWT networks characterizes them as either corporate crime groups, which merge legal and illegal businesses (e.g. registered animal traders), or as disorganized criminal groups, made up of a wide range of actors from rural farmers to urban consumers, who participate in the trade opportunistically, often without being aware of the illegality of their actions (Wyatt et al., 2020). This has led several researchers to question the validity and morality of equating IWT with organized crime, as such an approach has resulted in the criminalization of vulnerable communities, and taken the emphasis and funding away from more legitimate, ethical, and long-lasting strategies to engage local communities involved in poaching and reduce their reliance on IWT (Duffy et al., 2016; Mabele, 2017).

Involvement in IWT, and the consolidation of more or less organized trade networks, depends on context-specific actor purposes and motivations, trade opportunities, and market dynamics, as described by multiple theories spanning psychology, criminology, and economics (Oyanedel et al., 2020; von Essen et al., 2014). IWT actors are highly diverse, from rural harvesters and small-scale traders to large businesses, urban elites and people with political power, located within the resource system or thousands of miles away from it (Gore et al., 2021; TRAFFIC, 2008). Depending on their

specific context, IWT actors may be motivated by a wide range of factors. For example, their actions may respond to an analysis of the benefits (e.g. amount and immediacy of a reward) in relation to its costs (e.g. the loss of an alternative livelihood, likelihood and severity of punishment, moral costs), as described by the economic perspectives of the Instrumental Model and the Theory of Rational Choice (Becker, 1968; Cornish and Clarke, 1986). Adopting a socio-psychological approach, the Theory of Planned Behaviour (TPB) accentuates the importance of people's attitudes (positionality towards the behaviour), social norms (perceptions of social pressure to perform the behaviour) and perceived behavioural control (perceived ability to perform the behaviour) (Ajzen, 1985; St. John et al., 2014). Further, Cultural Risk Theory posits that risks from poaching and engaging with IWT are conceptualized and shaped by social context and culture, responding to the levels of affiliation between individuals in a group or community, the prescriptiveness of social norms and views towards regulations, which can vary with the existence of social institutions (Rizzolo et al., 2017). Other models and frameworks like the Knowledge, Attitudes and Practice (KAP) framework (e.g. Ali et al., 2020) and the Compliance framework (Ramcilovic-Suominen and Epstein, 2012) have been applied in conservation to explore the role of other factors, such as pre-existing knowledge, opinions and behaviours on people's interactions with the environment and wildlife, including poaching. There also multiple purposes behind actors' decisions to engage in the supply, trade and demand for wildlife products, such as financial needs or functional demands for basic goods (e.g. food, medicine, materials, Thomas-Walters et al., 2020). IWT actors are also driven by social, spiritual or experiential desires (e.g. recreation, religious/ritualistic or reputational benefits), by reactionary responses to problematic wildlife (e.g. human-wildlife conflict caused by livestock depredation or crop raiding) or to unfair or illegitimate wildlife protections or resource-use laws (Muth and Bowe, 1998; Phelps et al., 2016; Thomas-Walters et al., 2020). When engaging in IWT, actors may use rationalization and neutralization techniques to defend their position and reduce their culpability, such as denying responsibility or harm, claiming necessity, or declaring the injustice or lack of adequacy of the laws (Eliason, 2003; Rizzolo et al., 2017).

Aside from actor motivations, IWT networks and structures depend on contextual factors and situational opportunities (Oyanedel et al., 2020). Multiple criminological theories, such as the Rational Choice Model (Cornish and Clarke, 1986), the Routine Activity Approach (Cohen and Felson, 1979; Eliason, 2012) and Crime Pattern Theory (Brantingham and Brantingham, 1984), have been used to study the role that criminals' backgrounds and preparedness, guardianship factors (e.g. enforcement, fences), and spatial/temporal patterns play in generating opportunities for environmental crimes. Trade opportunities are also dependent on the specific attributes of the wildlife involved, including their concealability, removability, availability, value, enjoyability and disposability, as suggested by the CRAVED model, and on the accessibility of traders to resources, transport and smuggling routes, or to consumers (Nardo, 2011; Phelps et al., 2016; Pires and Clarke, 2012).

Additionally, the characteristics of IWT depend on market dynamics behind the supply and demand for wildlife products, reflected in the prices and quantities of traded wildlife. IWT markets that are 'demand-driven' focus on maximizing the utility or benefit of the consumer, with price signals influencing wildlife harvesting at levels that meet the demand (McNamara et al., 2016). On the contrary, in 'supply-driven' markets, suppliers' decisions to participate in the market are not always dependent on the price, but on other factors that constrain consumers' utility, such as resource availability or suppliers' opportunity costs (McNamara et al., 2016). These dynamics are dependent on information exchanges between the supply and demand, which are not always straightforward in illegal markets where the availability and price of products is concealed, leading to large information asymmetries. In recent decades, the internet has offered unprecedented business opportunities for wildlife traders, facilitating their access to market information, lowering the barriers to entry, enabling communications and control over processes and trade networks across large distances, allowing for fluid networks that are highly adaptive to new criminal opportunities, and reducing the risks of

enforcement (Lavorgna, 2014). While many illegal wildlife products continue to be sold openly in physical markets, often due to lack of awareness about the illegal nature of the products by both the sellers and the buyers, IWT is increasingly being observed in the virtual space, facilitated by several e-commerce platforms and social media (Lavorgna, 2014; Di Minin et al., 2018).

Over the past decades, increased investments in the fight against IWT have enhanced efforts to detect and monitor the trade, to protect wildlife habitats and mitigate poaching, and to reduce demand for wildlife products by implementing behaviour change interventions (’t Sas-Rolfes et al., 2019). However, IWT continues to escalate and expand into new markets, enabled by a wide range of drivers and enabling factors like the lack of evidence and institutional capacity, poverty, corruption, inappropriate legislation, enforcement and incentive deficiencies, and limited public awareness and engagement (Harrison et al., 2015; Nellemann et al., 2014; UNODC, 2016). These issues are particularly pervasive in highly biodiverse developing countries that supply much of the illegally traded wildlife, and which do not have the resources to control IWT (Wong, 2019). At the same time rising affluence and increasing disposable income in consumer countries are increasing demand for wildlife products and exerting pressures on their habitats (TRAFFIC, 2008). International governance structures designed to address IWT, such as CITES, have achieved some gains in regulating international wildlife transactions, but much of IWT lies outside of the international sphere, and requires enforcement and implementation of domestic laws (Wiersema, 2017). Efforts to understand and address IWT by focusing on the complete supply chain are necessary, particularly in countries that have limited resources and capacity to detect, monitor and address it, and those that have been neglected in research and conservation efforts on this issue.

2.3 The illegal wildlife trade in Latin America

To date, most efforts to understand and address IWT have focused on Africa and Asia, where megafauna such as elephants and tigers are declining due to demand from Asian wildlife markets (Sanderson et al., 2010; Wittemyer et al., 2014). Less attention has been given to the issue in Latin America, which represents less than 10% of peer-reviewed literature on illegal wildlife harvesting published between 1990-2014 (Kahler and Gore, 2017), leaving important gaps in our understanding of IWT in the region. Most known cases of IWT in Latin America involve timber and ornamental plants, birds, reptiles and fish (Goyenechea and Indenbaum, 2015). Illegal logging of high value hardwood species like rosewood (*Dalbergia spp.)* or mahogany (*Swietenia macrophylla*) for export to Asia, North America and Europe, to produce a range of furniture and wood products, occurs throughout Central and South America, and accounts for 40-60% of all logging in countries like Peru, and up to 80% in some areas of Brazil, representing millions of dollars of losses in revenue for governments (INTERPOL, 2019). Operation Amazonas, a large-scale enforcement operation carried out by the International Criminal Police Organization (INTERPOL) in Central and South America in 2015, seized approximately 47 million dollars' worth of timber and led to the arrest of over 300 individuals (INTERPOL, 2019). Beyond the environmental and economic losses, illegal logging in Latin America has been linked to other crimes, such as drug trafficking, and it involves high levels of corruption by forest officers, customs and government authorities, as well as human rights abuses (Tacconi, 2008; Vardeman and Runk, 2020). Non-timber forest products, such as orchids and other epiphytic plants, palm leaves (e.g. 'xate' leaves *Chamaedorea ernesti-augusti*) and cacti are also illegally traded in high volumes for ornamental, medicinal or cultural uses in domestic and international markets (Ticktin et al., 2020; Williams et al., 2012).

The illegal trade in live animals, particularly birds, reptiles and ornamental fish, for domestic and international illegal pet markets, is another issue in Latin America. The illegal trade in Neotropical psittacines, mainly for the domestic illegal pet market, is one of the key drivers of population decline for this sub-family of birds (Mercado et al., 2020). Psittacines are traded at large scales, reaching an estimated 18,334, 78,500 and 90,000 individuals per year in Venezuela, Mexico and Peru, respectively (Cantu et al., 2007; Gastanaga et al., 2011; Mercado et al., 2020). Though psittacines are particularly desired household pets due to their aesthetic attributes and mimicry ability, more than 400 species of birds are illegally traded in countries like Peru and Brazil, including a wide diversity of songbirds and other endangered species like condor (*Vultur gryphus*) and penguins (*Spheniscus humboldti*) (Daut et al., 2015; Nóbrega Alves et al., 2013). Several countries, like Guatemala, Honduras, Ecuador, El Salvador and Mexico have been implicated in the illegal trade of live reptiles for foreign markets, including threatened species of spiny-tailed iguanas (*Ctenosaura spp*.), turtles (e.g. *Trachemys* and *Kinosternon spp*.), snakes (*Boa imperator*), arboreal alligator lizards (*Abronia spp*.) and Galapagos marine (*Amblyrhynchus cristatus*) and terrestrial iguanas (*Conolophus subcristatus*) and giant tortoises (*Chelonoidis spp*.) (Auliya et al., 2016). Latin American countries also play a role in the export of freshwater and marine ornamental fish, representing 7.5% of global exports in 2014, valued at USD $18.5 million and USD $12.3 million in Brazil and Colombia, respectively (Evers et al., 2019). Some highly traded species, like the wild zebra pleco (*Hypancistrus zebra*), endemic to the Xingu River in the Amazon, are valued in black markets in China, and more than 100,000 specimens are trafficked on an annual basis, severely affecting wild populations despite CITES regulations (de Sousa et al., 2021).

The illegal trade in wild meat, relating to terrestrial bushmeat species for domestic food markets, or marine delicacies for Asian markets, has also brought attention to IWT in Latin America in recent years. The few studies on wild meat consumption and trade in Latin America have traditionally focused on small-scale hunting by indigenous communities, while the participation of non-indigenous,

'campesino' communities and urban residents has been largely ignored or considered insignificant due to the availability of protein alternatives (Petriello and Stronza, 2020; Van Vliet et al., 2014). However, towns in the border between Colombia, Peru and Brazil have been found to illegally trade over 473 tons of wild meat per year, particularly paca (*Cuniculus paca*), collared peccary (*Pecari tajacu*), red brocket deer (*Mazama americana*), and vulnerable species like tapir (*Tapirus terrestris*), a volume comparable to those found in Central African urban settings (Van Vliet et al., 2014). Similarly, recent estimates suggest that over 45 million people across Central and South America hunt and rely to some extent on wild meat, and that mean reliance on wild meat is higher in Latin America than in West and Central Africa and Asia, which have received most research attention on wild meat hunting, trade and consumption (Nielsen et al., 2018). On the marine side, several Latin American countries have experienced increased pressures in recent years from illegal shark finning operations from Asian countries in their territorial waters, including threatened species protected by CITES like the scalloped hammerhead shark (*Sphyrna lewini*), silky sharks (*Carcharhinus falciformis*) and pelagic thresher sharks (*Alopias spp*.) (Cardeñosa et al., 2020; Fields et al., 2020). Some of the largest seizures of shark fins in history, such as the 2020 seizure of 21,000 kg of shark fins in Hong Kong, have originated in Latin American countries like Ecuador (Cardeñosa et al., 2020). Moreover, genetic testing of shark fin samples collected from markets in the two largest shark fin trade hubs in the world, Hong Kong and Guangzhou, mainland China, from 2014-2017, revealed that Latin American countries in the Eastern Pacific contributed 85% of analysed samples and constituted a major supply area of pelagic thresher shark fins (Cardeñosa et al., 2020). Other marine species, like the totoaba (*Totoaba macdonaldi*) and sea cucumber (e.g. *Isostichopus badionotus* and *Holothuria floridana*) have been illegally harvested in Latin American coastal areas, and particularly in Mexico, to supply Asian markets, involving transnational organized crime cartels and leading to fisheries collapse and to social unrest and assassinations (Aceves-Bueno et al., 2021).

While largely missing from the research focus, examples of IWT in Latin America portray it as a thriving illegal activity, of a scale comparable to that of other regions, and with potentially huge impacts to biodiversity worldwide. The underestimation of the role of the region in international IWT is concerning; a recent study of wildlife seizures in Oaxaca, one of 32 states in Mexico, revealed that this state alone contained 2.8 times more vertebrate seizures than those attributed to the entire country by the United Nations Office on Drugs and Crime (UNODC) from 2004 to 2018, and that these seizures represented 13% of the estimated global trade in vertebrate species (Masés-García et al., 2021). Such numbers contextualize the hidden magnitude and conservation importance of IWT in Latin America. Consequently, IWT in Latin America has been recognized as a key knowledge gap to address within the field of conservation in decades to come (Esmail et al., 2020).

2.4 The illegal trade in big cats for Asian markets

Even though commercial international trade in all big cat species (*Panthera spp.*) is forbidden under Appendix I of CITES (with the exception of African lions – *Panthera leo*), poorly regulated captive breeding and illegal international trade is a leading threat to wild populations of tigers (*Panthera tigris*), lions, leopards (*Panthera pardus*), snow leopards (*Panthera uncia*), jaguars (*Panthera onca*), as well as smaller felids like clouded leopards (*Neofelis spp.*) and cheetah (*Acinonyx jubatus*) (UNODC, 2020). Trade in tiger body parts is of particular concern, not only because of their small and critically endangered remaining wild populations, ranging from 3,855 to 4,892 individuals, but also because demand for tiger body parts, such as bones and teeth, stretches to other big cats that can be passed off as tiger products (UNODC, 2020; Villalva and Moracho, 2019). Tiger body parts are used for a wide range of purposes in demand countries such as China, Vietnam and Thailand. Tiger bones, in the form of plasters, wine, or glue/paste (a black substance made by boiling the bones and flesh for several days), were an official ingredient in Traditional Chinese Medicine (TCM) before being banned from use

in the country in 1993 (Nowell and Xu, 2007). TCM is a widely popular medical practice that has evolved in China for over 5,000 years, based on the use of a wide range of plant and animal ingredients encompassed within an official compendium of accepted drugs and therapies – the Pharmacopeia of the People's Republic of China (Gratwicke et al., 2008; Mainka et al., 1995; Still, 2003). Despite domestic and international bans, tiger body parts continue to be illegally used in China and other countries like Vietnam for a wide range of purposes (Davis et al., 2020; Villalva and Moracho, 2019). Bone-derived products are used to treat severe bone and joint diseases like arthritis and rheumatism, and they are believed to replenish calcium, provide anti-inflammatory benefits against pain, and increase vitality (Moyle, 2009; UNODC, 2020). Additionally, tiger skins, teeth, claws, meat and reproductive organs are also wanted for decorative, spiritual and therapeutic purposes (Moyle, 2009; UNODC, 2020). The rarity of the tiger has meant that tiger products are not only desired for their functional use (medicinal, spiritual or decorative), but also as prestige-granting objects that are gifted to business partners or family members as symbols of status and respect (Davis et al., 2020; UNODC, 2020). Tiger teeth, bones and claws are also used as part of the Chinese subculture of 'Wenwan', which involves the accumulation of collectible items like ornaments, jewellery, and trinkets to show an owner's taste, discernment and status (Stannard, 2019; Y.K. Lam, 2018).

Due to the scarcity and illegality of tiger products, the body parts of other big cats have been used either as tiger substitutes, or as novel commodities in a market that was traditionally occupied by tiger products (Moyle, 2009; Villalva and Moracho, 2019). Following the 1993 domestic ban on tiger products in China, leopard bones were adopted as official substitutes within TCM, until being banned in 2006 (UNODC, 2020), although they remain in the 'patented medicine' section of the Chinese Pharmacopeia. Nevertheless, leopards, snow leopards and clouded leopards continue to be poached throughout their range to supply body parts to Asian felid markets. For example, 83 leopard and clouded leopard body parts, including skull bones, skins, teeth and claws, were seized along with tiger

body parts during enforcement efforts focused on dismantling tiger poaching rings in Indonesia from 2011-2019 (Gomez and Shepherd, 2021). Similarly, the number of illegally traded snow leopards increased by 62% from 2003 to 2012 compared to the previous decade, reaching 447 individuals throughout their range, the majority of which were traded in China as skins, bones, and skulls (Maheshwari and Niraj, 2018). Moreover, genetic traces of snow leopards have been identified in TCM samples, while live clouded leopards have been found in clandestine 'tiger farms' in Southeast Asia that supply tiger products (Coghlan et al., 2015; D'Cruze and Macdonald, 2015). Since 2008, lion bones from captive South African lion populations have joined those of other big cats in Asian felid markets, being legally exported to China and Southeast Asia (Lao People's Democratic Republic), with the authorization of the South African Government and CITES through export quotas (Williams et al., 2017a). A steady increase in legal lion bone exports to Asia appears to have spurred poaching and lion body part exports in other African countries like Uganda, to meet a growing demand (Williams et al., 2017a, 2017b). Moreover, recent discoveries of shipments of jaguar teeth and of the production of jaguar bone glue, which were destined to, or produced for, China's felid markets in countries like Bolivia and Suriname, respectively, have raised concerns that jaguars may be yet another alternative to tiger products (Nunez and Aliaga-Rossel, 2017; Verheij, 2019).

The actual interchangeability between tiger and other big cat products in Asian markets remains poorly understood from a manufacturer and consumer perspective. Initial exploratory surveys of preferences between lion and tiger bone wine in China and Vietnam suggest that there remains a marked preference for tiger products among urban residents in both countries, weakening support for the hypothesis of substitutability among these two big cats (Coals et al., 2020). However, the same study found that a smaller fraction of people prefer lion products over tiger products, possibly as a result of barriers to the acquisition of tiger products and the wider availability of legal lion alternatives, or due to an actual preference for the animal (Coals et al., 2020). Similarly, leopard bone products

have been openly marketed as containing leopard ingredients, rather than tiger, and jaguars have been advertised in China and Vietnam as South American tigers or leopards, in the absence of a specific word for jaguar in those languages (EIA, 2019; UNODC, 2020). It should be noted that due to the challenges of distinguishing between big cat body parts, particularly in processed products without proper genetic testing capabilities, consumers may be unaware of their actual origins or composition, and in some cases, products that have been marketed as containing wild felids have been found to be fake (Wetton et al., 2002). More research on the potential and actual substitutability between big cats, and the degree to which demand for tiger products is driving transcontinental trade in big cat species is required. This is particularly necessary in the context of the expansion of the influence of China and TCM across the world through the Belt and Road Initiative (BRI), China's ambitious infrastructure project aiming to connect China to the world. As it creates new access to wildlife supply chains, the BRI has been considered an emerging risk factor for carnivores in Asia, Africa, Latin America and beyond (Farhadinia et al., 2019).

2.5 Human-jaguar dynamics and conservation importance

The jaguar is the largest native felid in the Americas, and third largest in the world, following the tiger and lion. Its range of distribution goes from south-western United States to northern Argentina, crossing 8.42 million km² and 19 countries (de la Torre et al., 2017). In this vast landscape, jaguars occupy a wide range of habitat types, including tropical moist lowland forests, tropical moist montane forests, tropical dry forests, deserts, herbaceous lowland grasslands, herbaceous montane grasslands, temperate forests and mangroves, showing a high degree of ecological adaptability (Sanderson et al., 2002). Even though there is limited support for the existence of jaguar subspecies throughout this large continental range due to a lack of phylogenetic differentiation, 34 geographically independent subpopulations have been identified (de la Torre et al., 2017; Eizirik et al., 2001). The Amazon

subpopulation, which is the largest, covers 79% of the species global range (de la Torre et al., 2017). Overall, the estimated global wild jaguar population is estimated to lie somewhere between 62,000 and 208,000 individuals (de la Torre et al., 2017; Jędrzejewski et al., 2018). This large difference in population estimates highlights the challenge of robustly monitoring jaguar populations.

Jaguars as a species are classified as Near Threatened on the IUCN Red List (Quigley et al., 2017). This global classification, which is the second lowest risk category in the IUCN Red List after Least Concern, is largely due the remaining large habitat and large population of the Amazonian jaguar subpopulation (de la Torre et al., 2017). However, subpopulations outside the Amazon have been assessed as Endangered or Critically Endangered due to their small size, isolation and deficient protection (de la Torre et al., 2017). A wide range of threats affects jaguar population numbers. Deforestation caused by agricultural expansion for the production of commodities like soybean or palm oil, cattle ranching and the growth of human settlements and infrastructure, is a key persisting threat to jaguars and it also affects prey availability (Quigley et al., 2017). Poaching by humans is another key threat, and it is driven largely by conflict over livestock depredation, which is widespread throughout the jaguar range (Castano-Uribe et al., 2016). Human-jaguar conflict can cause substantial economic losses (Tortato et al., 2017), and reinforces negative attitudes and intolerance to jaguars by local communities (Knox et al., 2019; Marchini and Macdonald, 2012). In addition to conflict, cultural and commercial interests behind the trade in jaguar body parts are increasingly adding to the motivations to poach jaguars across Latin America, with a likely impact on jaguar populations (Morcatty et al., 2020).

Jaguars have a strong social and cultural value, being embedded in the identity and cultural symbolism of several past and present indigenous and non-indigenous societies in Latin America (Saunders, 1998). Jaguars and their body parts have been utilized and traded for centuries across vast terrestrial and maritime distances by pre-Columbian civilizations in the Americas, as documented in a rich body

of archaeological and anthropologic literature (Saunders, 1998; Sugiyama et al., 2018; Valdes Valverde, 2005). The cultural importance of jaguars is still manifest in the identity, artistic traditions, myths, and rituals of multiple modern indigenous societies. For instance, in rural areas of the Bolivian tropical lowlands, indigenous communities of the Tsimane ethnicity tell the legend of the "tigre-gente" or "tiger-human" ('tiger' is a common local name for jaguars), a mythical character who has the ability to switch forms from human into jaguar to hunt (Salinas, 2010). Similarly, the Kogi people of northern Colombia, whose name means "jaguar people" in Kogi language, hold the jaguar at the centre of their identity and continue to evoke the symbolism of the jaguar to perform curative rituals by shamans (Gómez and Payán, 2017).

The cultural importance of the jaguar is not limited to indigenous societies, but it can also be found today amongst mixed ethnicity communities throughout the jaguar range. Ranchers in the Pantanal of Brazil see jaguar killing as a matter of group identity associated with bravery, prestige, and with their economic role in society as ranchers (Marchini and Macdonald, 2012). Similarly, jaguar hunting, and the subsequent use of jaguar body parts, is a manifestation of masculinity amongst indigenous and non-indigenous rural villagers in some areas of Costa Rica (Kelly, 2018). These symbolic values of the jaguar, whether indigenous or not, position jaguars as a high-value species within domestic markets in Latin America. The cultural and commercial value of jaguars is currently being amplified due to a diversification in jaguar consumers, including foreigners who have an interest in Asian big felid markets as well as tourists, which have increased the price and desirability of killing and trading jaguars (Braczkowski et al., 2019; Morcatty et al., 2020).

Regardless of its strong cultural and commercial value, jaguar hunting and the use of and trade in their body parts is currently illegal in most countries that are part of the jaguar range, and it is also banned at the international level by CITES. There are a few exceptions in countries like Bolivia, Belize, and

French Guiana, which allow jaguar killing (but not trade) in the context of self-defence and to protect property (e.g. livestock), or in case that the killing happens in the hands and territories of indigenous communities whose practices precede colonial times (e.g. MMAyA, 2020). However, jaguar killing continues to take place illegally for a range of reasons that exceed their cultural desirability or commercial value. As with other carnivores, jaguars may be killed because of real or perceived danger risks from encountering wild carnivores (Dickman et al., 2013). Such risk perceptions tend to be greater for fear-inspiring species, like jaguars, and produce negative attitudes and intolerance (Carter et al., 2012; Dickman et al., 2013; Teixeira et al., 2020). Emotional responses like fear are often a factor of people's lack of knowledge about carnivores, and this knowledge depends on people's education levels and culturally assigned beliefs, spirituality and religious world views (e.g. taboos or animal-related moral codes) and values towards nature (e.g. utilitarian, mutualistic) (Herrmann et al., 2013; Johansson and Karlsson, 2011; Pooley et al., 2017). Risk perceptions of jaguars and other carnivores are also heightened by risk factors like poverty, which diminish people's ability to cope with carnivore related losses (Dickman et al., 2013). Moreover, human reactions to carnivores and carnivore killing in particular, are not necessarily related to the animals themselves, but rather a manifestation of tensions between groups of people (Linnell and Alleau, 2015; Peterson et al., 2010). For example, tolerance to carnivores is lower when their protection is deemed illegitimate or when wildlife management interventions are inequitable or fail to achieve their goals (Dickman, 2010; Inskip and Zimmermann, 2009; Pooley et al., 2017). The historical, geographic, economic, political, institutional, social and technological setting of human behaviours, coupled with carnivore ecology and dynamics in space and time, create feedbacks that ultimately give way to illegal carnivore killing (Carter et al., 2017; Lischka et al., 2018). Several studies have uncovered the importance of negative attitudes as drivers of jaguar intolerance (e.g. Knox et al., 2019; Marchini and Macdonald, 2012b) which are worsened by lack of knowledge about the species (e.g., Engel et al., 2017) and by inadequate responses by authorities (Conforti and De Azevedo, 2003). Norms and cultural factors like group

identities and traditions have been found to influence jaguar killing (Harvey, Briggs-Gonzalez, and Mazzotti, 2017), while broader economic and landscape factors affect retaliatory responses (e.g., Cavalcanti et al., 2010).

Addressing the killing and trade in jaguars is necessary, not only from a biodiversity conservation perspective, but also from a cultural and societal standpoint. Jaguars are commonly referred to as an umbrella species because their habitats and corridors overlap with those of other co-occurring threatened species of plants and animals, such that their conservation can indirectly benefit other species (Thornton et al., 2016). They are also a flagship species in Latin America, as their charisma is able to draw society's support, funding and attention towards conservation and a wider range of environmental and social causes (Verissimo et al., 2011). In recent years, the jaguar has become a symbol for the preservation of cultural heritage and traditional livelihoods, the conservation of biodiversity, and the fight against climate change, and its conservation is aligned with the achievement of the Aichi Biodiversity Targets, the Sustainable Development Goals, and the Paris Agreement on Climate Change (Panthera et al., 2019; WWF, 2019). Moreover, at the First High-Level Conference on Illegal Wildlife Trade in the Americas, held in Lima, Peru in October 2019, the jaguar became officially recognized as Latin America's emblem for the fight against IWT.

2.6 Methodological approach and ethics

Wildlife conservation requires a wide-range of interdisciplinary methods that go beyond exploring the biological traits and ecological dynamics of threatened wildlife, to understanding the characteristics, motivations, attitudes and perceptions of the people who are part of conservation or affected by it, and the broader socio-ecological systems in which they operate. Because conservation is largely about people, their actions and decisions, the social sciences offer a theoretical foundation and a diverse toolkit of methods and approaches for collecting information and achieving a robust understanding of these systems (Bennett et al., 2017b). Derived from the social sciences, interviews and questionnaire surveys are popular methods that are increasingly applied in conservation science (Newing, 2011), and they constituted the core of the data collection strategy of my DPhil. Because IWT is a sensitive issue within the field of conservation, I complemented my interviews and questionnaire surveys with specialized sensitive questioning techniques or indirect questioning methods, which are specially designed to reduce underreporting of illegal behaviours (Cerri et al., 2021; Nuno and St. John, 2015). The combination of these methods allowed me to gain a deep understanding of the illegal trade in jaguars, and provided me with the necessary tools to obtain each of my chapter's objectives.

2.6.1 Key informant interviews

Key informant interviews, as a form of expert elicitation, are considered a valuable tool to improve decision-making within the field of conservation and beyond (Hemming et al., 2018; Sutherland and Burgman, 2015). Key informants or experts are those who have specialized knowledge on an issue of interest, gained through their life experience, education or training (Garthwaite et al., 2005). Key informant interviews are particularly recommended for exploratory studies that aim to identify questions that deserve further research attention, for studies that deal with complex topics (e.g. non-

compliant behaviours) or topics that have a high level of uncertainty or scarce data availability (Newing, 2011). As with other methods in conservation science, the interview process must follow a set of steps to ensure robustness, starting with identifying a suitable research question, selecting the interview type, designing an initial set of interview questions, sampling participants, undertaking ethical review, piloting and refining the interview questions, conducting the interview, and finally, analysing and writing up the results (Young et al., 2018). The choice of interview type, from structured (set of pre-determined questions) to unstructured (spontaneous conversation), or a mixture of both, is important, as it determines whether interviews will be comparable across participants, or whether they will reach an in depth perspective on an issue (Young et al., 2018). The analysis of interviews normally requires a qualitative assessment of the interview transcript by one or more researchers, to identify units of meaning (words, phrases, paragraphs) in the interview, or codes, that can be grouped according to particular themes (Braun and Clarke, 2006; Newing, 2011; Saldana, 2016).

Key informant or expert elicitation processes that seek to achieve quantitative results, or a probabilistic understanding of environmental processes, may instead adopt a structured elicitation approach, such as the Delphi method or IDEA Protocol (Hemming et al., 2018; Mukherjee et al., 2015). These methods encourage respondents to reflect on, or investigate, an issue before the interview, provide their best guesses on estimates or processes, discuss and compare those estimates to those provided by others, and recalibrate their responses accordingly, making reference to their degree of certainty (Martin et al., 2012). The analysis is then based on the construction of quantitative categories or values, the identification of the mean and variance around the estimates, and statistical modelling (Martin et al., 2012). Regardless of the interview type or choice of analysis, it is necessary to highlight that results obtained from interviews are based on the perspectives and knowledge of the selected interviewees, which are constrained by their own experience, background, and geographical area of focus. Therefore, they are not necessarily transferable beyond their jurisdictions, and they are subject

to biases stemming from their motivations and stakes in decision-making, their overconfidence, or even from the lack of knowledge (Martin et al., 2012). These biases must be put into perspective and adequately reported in studies based on interviews.

2.6.2 Questionnaire surveys

Unlike qualitative interviews, that obtain in-depth knowledge and perspectives from a limited number of people, questionnaire surveys are ideal for collecting standardized information from a large number of people (typically over 100), in potentially large geographical spaces (Newing, 2011). They usually involve some type of statistical sampling that is representative of the population of interest, such as random, clustered or stratified sampling, which enable drawing inferences from the sample to the wider population (Browne-Nuñez and Jonker, 2008). Increasingly, questionnaire survey methods rely on satellite imagery or large socio-economic databases to produce a sampling design that minimizes selection bias (Zanello et al., 2018). Questionnaire surveys can be implemented through a face-to-face interview, with an interviewer asking a predetermined set of questions (usually short, structured questions) to participants, or they can be self-administered or filled by each participant in written or electronic form (Newing, 2011). The data collected through these surveys is usually analysed quantitatively through descriptive statistics, or by using some questions as predictors of other questions in analyses of correlation or causation implemented through statistical models (Browne-Nuñez and Jonker, 2008; Newing, 2011). Questionnaire surveys have been widely implemented in the field of biodiversity conservation, particularly to collect information on views, attitudes and behaviours from human participants (Browne-Nuñez and Jonker, 2008; Drury et al., 2011).

2.6.3 Sensitive questioning techniques

Conservation scientists are increasingly using interviews and questionnaire surveys to explore human interactions with wildlife (Bennett et al., 2017a). However, in the cases where those interactions are socially perceived as negative, controversial, or illegal, even experienced social scientists can find it difficult to uncover people's real attitudes and behaviours towards wildlife through such direct questioning methods (Nuno and St. John, 2015). This is because respondents have a natural tendency to protect themselves from any legal consequences or social stigma associated with their actions, while also seeking to please the interviewer by providing socially acceptable answers instead of the truth (Grimm, 2010). Social desirability bias reduces the validity of direct questioning (Fisher, 1993), and may give conservation researchers a false picture of the threats to wildlife.

A wide range of specialized indirect questioning techniques have been recently used in conservation to minimize the effects of social desirability bias and participant non-response, and to reach a more accurate understanding of people's relationships with wildlife (Nuno and St. John, 2015). Many of these methods provide confidentiality to respondents by eliminating their risk of identification by the interviewer, through the introduction of random noise to participants' responses, by randomly blocking respondents into treatment and control groups, or by allowing a private disclosure of information by means other than an interview (Arias et al., 2020). These methods vary greatly in their design, implementation, analysis and cognitive burden on participants, and their feasibility and effectiveness depend on the study's context, including its cultural setting, audience literacy, sample size, time and resources available for data collection, among others (Bova et al., 2018; Hinsley et al., 2018; Ibbett et al., 2021). Given the lack of previous studies on the sensitivity of the illegal jaguar trade and the performance of sensitive questioning techniques in my specific study areas, I piloted a selection of sensitive questioning techniques, including the Randomized Response Technique, the

Crosswise Technique, the Unmatched Count Technique, the Nominative Technique and the Ballot Box Method (Table 2.1). The pilot study highlighted the Ballot Box Method (BBM) as the most suitable sensitive questioning method for my specific study context, based on respondents' responses to questions about the method's ease of understanding, perceived confidentiality and degree of comfort (based on Nuno, 2013). The BBM, which is based on the principle of secret voting, requires participants to admit to their involvement with sensitive or illegal behaviours through an anonymous and confidential ballot, placing their response inside a sealed ballot box that contains the responses from all survey respondents (Arias et al., 2020). I wrote a pre-print article on the design and implementation of this method based on my DPhil's experiences (Arias et al., 2020), drawing attention to its multiple advantages, including its simple design and analysis, its cost-effective implementation, its low participant burden, and its flexibility to be applied alongside other methods.

Table 2.1: Sensitive questioning techniques piloted during my fieldwork in Bolivia (Chapters 3 and 4).

Technique	How it works	Key references
Randomized Response Technique (RRT)	Eliminates risk of identification through the introduction of random noise to participants' responses, forcing a "yes", "no", or "truthful" answer to sensitive questions depending on the flip of a dice. By knowing the probability of each response given by the flip of the dice beforehand, it is then possible to estimate the prevalence of the truthful responses to the sensitive behaviour.	Ibbett et al., 2021; St. John et al., 2010; Warner, 1965
Crosswise Model	Requires participants to provide conjoint answers to a pair of sensitive and non-sensitive questions, stating whether their answers to both question are identical or different. The surveyor cannot know whether the participant actually engaged in a sensitive behaviour, but the overall prevalence of that action can be estimated by knowing the distribution of the non-sensitive question for the population.	Heck et al., 2018; Jann et al., 2012
Unmatched Count Technique (UCT)	Separates participants into a control and treatment group, and asks participants in both groups to mention the number (but not the type) of behaviours (or activities) that they have done from a pre-determined list of non-sensitive behaviours. The list of behaviours is identical for both groups, except that the treatment group is exposed to a single extra sensitive item on the list. The difference in means among the groups can then reveal the prevalence of the sensitive behaviour.	Hinsley et al., 2018; Nuno et al., 2013
Nominative Technique	Protects the confidentiality of participants by asking them to answer sensitive questions pertaining to their close friends or family rather than to themselves, assuming that it is easier for people to talk about the illegal behaviour of others.	Davis et al., 2019

Ballot Box Method (BBM)	Requires participants to give their answer to the sensitive questions by secretly and anonymously marking a piece of paper with "yes" or "no" and placing their response inside a sealed ballot box. Participants are assured that the ballot box will not be opened until the end of the survey, and that their anonymous answers are mixed with those of all other participants.	Arias et al., 2020; Bova et al., 2018

2.6.4 Ethical considerations for studying sensitive behaviours

As with all research involving humans, conservation scientists using interviews, questionnaire surveys or sensitive questioning techniques have an obligation to reflect on the ethical implications of their work, and to protect their research participants from any adverse consequences from their involvement in the research (Arias et al., 2020; Brittain et al., 2020). A key element of complying with this ethical responsibility is to have all research protocols and questioning materials reviewed and approved by an authorized ethical review board (Brittain et al., 2020). This process ensures adherence to certain principles such as informed consent, voluntary participation, right to withdraw, no harm to participants, no use of deception, preservation of anonymity and confidentiality, data protection, among others (Arias et al., 2020; Vanclay et al., 2013). This is particularly important for research about sensitive, stigmatizing or illegal behaviours, such as IWT, that may have social or legal consequences. It is also necessary that those transitioning from the natural sciences towards interdisciplinary conservation research take the social sciences seriously and undergo specific training on social science methods and research ethics to ensure that any potential negative implications from their research are avoided. Piloting the research protocols can help to identify and act upon any unforeseen ethical risks, highlight problems in the design or delivery of the questions, reveal logistical challenges, as well as provide an opportunity to train the elicitation approach and to ensure that the interaction with participants is positive and culturally appropriate (Medeiros and Diniz, 2012).

My research protocols for the implementation of key informant interviews, questionnaire surveys and sensitive questioning techniques were reviewed and approved by the University of Oxford's Social Sciences and Humanities Research Ethics Committee (Reference: R63986/RE001 and R59134/RE001). They were also reviewed and received approval from the relevant national research authorities in each of my study countries, including the Bolivian Ministry of Environment (Ref: MMAYA/VMABCCGDF/DGBAP/MEG No. 0251/2019), the Belize Forest Department (Reference Number: WL/2/1/18(34)) and Guatemala's Council of Protected Areas (Of.DMBVS-585-2018).

Through the review process, I specified how my research would ensure informed consent from all participants, and how the confidentiality of participants would be protected. This included preparing protocols for the storage, management and disposal of personal and confidential data. For the case of my household surveys in Bolivia, which included the application of sensitive questioning techniques to enquire about personal illegal behaviours of my participants, which could be subject to legal consequences, I undertook a more complex and rigorous process of ethical review, taking specific measures to avoid the identification of participants. This included increasing the sample size of my study, obtaining and providing specialized training to my research assistants, informing participants of the protocols used to protect their anonymity and of the risks of their participation, and not collecting or disclosing the names of the specific locations I visited or any other identifiable information. These measures helped to follow the "do no harm" principle in research with humans.

Chapter 3

Prevalence and characteristics of illegal jaguar trade in north-western Bolivia

Views while crossing a river to reach a surveying community in rural Bolivia.

Abstract

Recent seizures of jaguar body parts in Bolivia have prompted concern about illegal trade to China, but a detailed understanding of this emerging trade continues to be lacking. I interviewed 1107 people in a rural area implicated in the trade, using direct and indirect questions through the Ballot Box Method (BBM) to explore the prevalence and characteristics of the illegal jaguar trade and its links to foreign demand. Jaguar trade is a common, and mostly non-sensitive practice; 46% of respondents reported some involvement over the past 5 years through the BBM. The most common behaviour was owning jaguar body parts, such as skins, fat and teeth for decorative, medicinal, and cultural purposes. The most mentioned traders were Bolivian, followed by traders of Asian descent. However, regression analysis shows that the presence of traders of European descent was more significantly and positively associated with jaguar trade related behaviours, ahead of Asian descent and regional traders. Overall, jaguar trade in Bolivia has more diverse actors and drivers than seizures may suggest. Therefore, conservation interventions, in addition to targeting demand from Asian wildlife markets, should address other foreign and domestic markets and trade chains.

3.1 Introduction

Illegal wildlife trade (IWT) is among the most pressing threats to biodiversity. Due to IWT's concealed nature, those working to address it must often make decisions under high levels of uncertainty (’t Sas-Rolfes et al., 2019). However, given its complex local and global drivers, strategies to address IWT should be rooted in cross-scale evidence in order to be effective (Milner-Gulland et al., 2018). This is particularly important in the case of wild felids, many of which are highly threatened by IWT due to domestic and international demand for their body parts (Nijman et al., 2019), adding to the pressures that they face from habitat loss and prey depletion (Macdonald and Loveridge, 2010). The illegal trade in tiger (*Panthera tigris*) bones and other body parts to supply Asian traditional medicine markets is of particular concern, having caused precipitous declines in wild tiger populations (Davis et al., 2020; Nowell, 2010; Sanderson et al., 2010).

The trade in tiger parts is also having repercussions for other felids that act as tiger substitutes (Villalva and Moracho, 2019). Since 2008, there has been an increase in legal exports of lion (*Panthera leo*) bones from captive-breeding facilities in South Africa to Asia for medicinal purposes (Williams et al., 2017a). Similarly, leopards (*Panthera pardus*), clouded leopards (*Neofelis spp.*) and snow leopards (*Panthera uncia*) are being hunted or commercially bred to meet Chinese demand in addition to local traditional uses (Coghlan et al., 2015; D’Cruze and Macdonald, 2015; Stein et al., 2016). Since 2013, seizures of jaguar (*Panthera onca*) body parts destined for China in countries like Bolivia and Suriname suggest that Chinese demand for felids has reached Latin America (Nunez and Aliaga-Rossel, 2017; Verheij, 2019). Most of the seizures involved jaguar teeth, but the production of ‘jaguar paste’, a suspected alternative to tiger paste in traditional Asian medicines has also been reported (Lemieux and Bruschi, 2019).

However, despite the current attention to Chinese demand for jaguar body parts, jaguar hunting and trading at the domestic level for cultural, commercial and safety reasons is longstanding and significant (Swank and Teer, 1989). Symbolizing war, kingship, and status, jaguars were traded across long distances by Latin American indigenous societies as early as the Pre-Ceramic Age (ca. 500 BC to AD 600) (Laffoon et al., 2014). Throughout most of the 20th century, thousands of rural communities in Latin America based their livelihoods on the commercial trade in jaguar skins for the occidental fashion industry (Antunes et al., 2016; Matos and Caldarelli, 2017; Smith, 1976). Although jaguar trade officially ended in 1975 with their listing on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, jaguar killing and trading continued in retaliation for livestock depredation and to supply households and craft markets with decorative, spiritual and medicinal jaguar-based products (Jędrzejewski et al., 2017; SERFOR and WCS, 2019).

Like other countries in the region, jaguar killing is common in rural Bolivia, mainly as a response to depredation of livestock and domestic animals by jaguars and due to fear of attacks on humans, and it its facilitated by negative attitudes towards the species (Knox et al., 2019; Negroes et al., 2016). However, since 2013, Bolivia has become the epicentre of jaguar body part seizures linked to demand from Chinese felid body part markets (Nunez and Aliaga-Rossel, 2017). The increase in seizures of jaguar body parts in Bolivia and elsewhere in the region has been associated with the growth of Chinese infrastructure investments in Latin America, along with poverty and corruption (Morcatty et al., 2020). As concerns over the role of foreign demand in the targeted illegal killing of jaguars grow, other studies have highlighted the importance of domestic markets for jaguar body parts, over a more uncertain international demand (Kelly, 2018; Reuter et al., 2018b). Consequently, the relationship between jaguar killing, domestic use and the international trade in felids remains a contested issue, while the drivers of jaguar trade in Bolivia remain poorly understood. Policies and interventions to address jaguar trade are being drafted and implemented at the domestic and international levels; it is

important that these are based on evidence from source areas, rather than solely on seizures that risk misrepresenting the trade. Here, I report on a study of jaguar trade in rural communities in north-western Bolivia, in which I explored the prevalence and characteristics of people's engagement with jaguar killing and trading, focusing on their links to foreign and local markets.

3.2 Methods:

3.2.1 Study site, village and participant selection:

Within Bolivia, I selected study areas with jaguar presence and reported cases of jaguar killing or trading, where livestock ranching or hunting are common livelihood activities, and where there currently are or recently have been Chinese infrastructure investments, in order to capture the role of Chinese demand within the broader landscape of jaguar killing and the body part trade. An initial list of potential study areas that met these criteria was discussed with stakeholders from the Bolivian government and NGOs, resulting in the prioritization of four study areas, encompassing the rural lands surrounding key urban areas in the Departments of Beni, Pando and northern La Paz, namely, the cities of Cobija, Riberalta, Rurrenabaque and Trinidad (Fig. 3.1). This choice of study areas meant that my study, while not being generalizable beyond these areas in terms of specifics, should give a picture of the role of international jaguar trade in the context of an area with a long and currently active history of interactions between humans and jaguars.

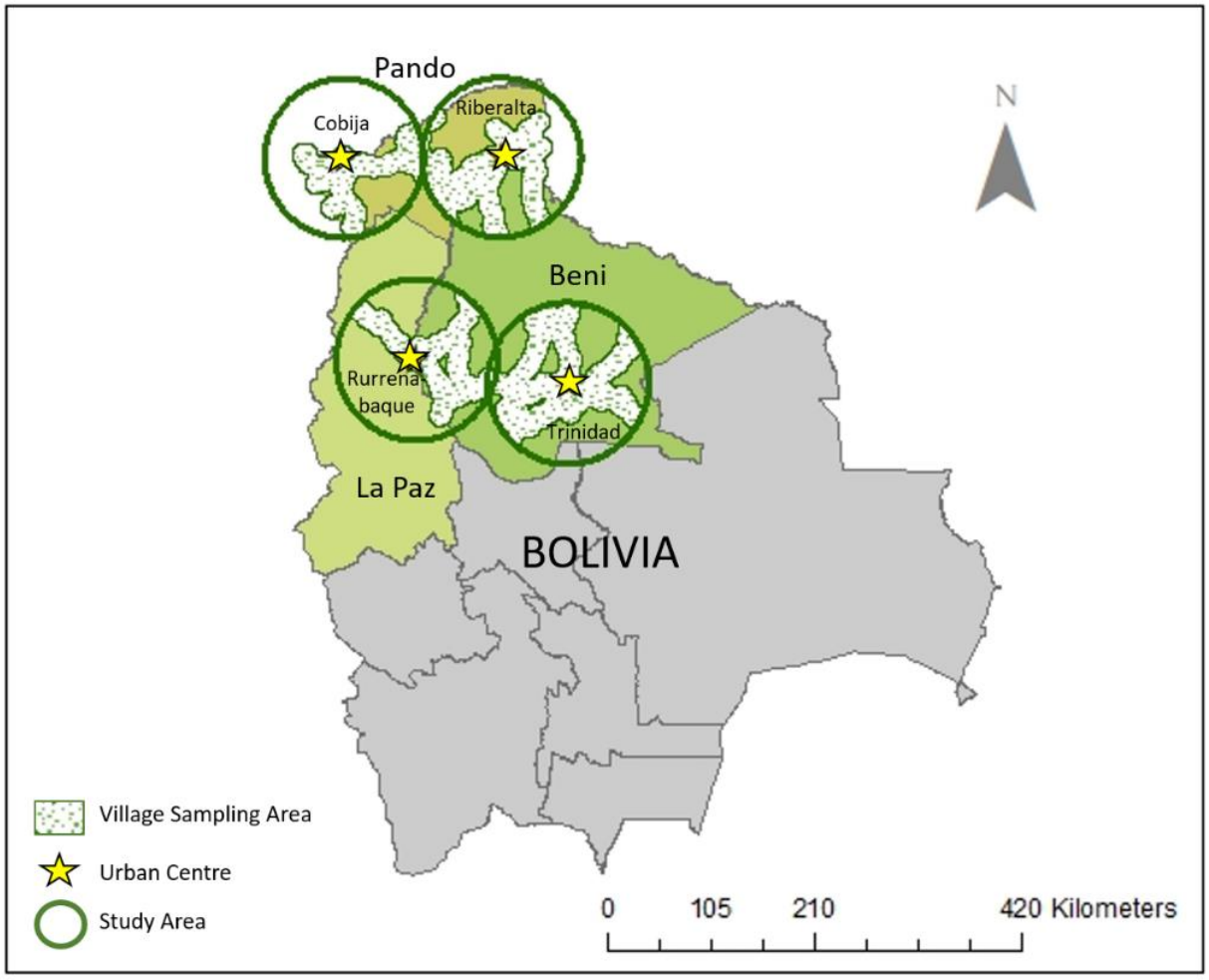


Figure 3.1: Map of Study Areas in north-western Bolivia, based on a prioritisation of rural lands around the main urban areas in the Departments of Beni, Pando and northern La Paz.

I based my village sampling efforts around the main cities in the chosen departments in order to capture the trade flows from rural areas towards the urban markets where jaguar body parts seizures have been made. Within my four chosen study areas, I sampled my study sites, which refer to specific villages, from a georeferenced layer of human settlements in Bolivia, based on the 2012 national census, which includes population numbers per settlement (GeoBolivia, 2015). I then selected all settlements with a population greater than or equal to 250 inhabitants and fewer than or equal to 2000 inhabitants. The rationale for this population range was based on the Bolivian census's definition of "rurality" (CEPAL, 2005), and a trade-off between having a large enough adult population for cost-

effective surveying, while also including settlements with low human densities and potentially more encounters with jaguars.

In order to further restrict study sites to settlements that were logistically feasible to reach, I then applied a 150 km buffer from the main urban areas (Cobija, Riberalta, Trinidad, Rurrenabaque) and filtered out all settlements that were not within 25 km of a primary, secondary or tertiary road and accessible by land. This left 103 eligible communities, with an average population size of 477 and a total population of 49,148 inhabitants, spanning an area of 103,926 km^2 or nearly 10% of Bolivia's area. Finally, I randomly sampled 30% of the eligible communities in each of the four study regions, based on my desired sample size and surveying capacity. It should be noted that while I considered all sampled sites (villages) and study areas as a single population, my statistical analyses reflect the nested structure of my observations using random effects.

I used the 'pwr' package on R (Champely, 2018) to calculate the minimum sample size needed to detect an effect size of at least 10% under a significance level of 0.05 and a power of 0.9, which was 1051 participants. As I only interviewed one participant per household, the terms household and participants are equal. Sampling of villages within study areas and the number of household surveys per village were proportional to the population size of each study region and community, respectively. However, I endeavoured to always achieve a minimum of 30 surveys per location or 50% of the available adult population (whichever was smaller), to justify the effort needed to reach each community and to gain enough intra-community variation.

I used a satellite image of each sampled community from the GeoBolivia Portal to identify the number of parallel and perpendicular streets. I considered each street a sampling stratum, and each household a potential sampling unit. All streets were distributed among the surveying team and each member

was responsible for semi-randomly selecting the households to survey by drawing random house numbers from an envelope and tossing a coin to determine the side of the street to survey. If the sampled house was empty, or if the house resident did not wish to participate, I would move to the next available house. If a large number of houses was uninhabited, I approached every other inhabited household, distributing my effort evenly along the street. I made an effort to reach the communities outside of working hours in order to find working people, and conducted my surveys also on the weekends to reach that same group.

3.2.2 Survey Instrument and Questioning Techniques

I showed participants photos of all felids present in my study area, and highlighted repeatedly that the focus was on the jaguar (including the melanistic variant). As part of a larger survey, I asked participants eight direct yes/no questions concerning their engagement with jaguar killing and trading (1 - owned body parts, 2 - been asked to kill, 3 - asked others to kill, 4 - killed, 5 - bought, 6 - sold, 7 - raised a live jaguar, 8 - killed more than 5 jaguars), along with semi-structured questions on the methods used to kill jaguars, the body parts that are traded and their uses, their awareness of the law regarding jaguar killing, and their knowledge about local and foreign traders (Appendix 1). The larger survey contained questions about the potential drivers of jaguar killing and trading behaviours (e.g. attitudes towards jaguars, experiencing depredation by jaguars), reported in Chapter 4.

In addition to direct questions, I implemented the Ballot Box Method (BBM), aiming to reduce social desirability bias in participants' responses and explore the sensitivity of jaguar trade-related behaviours. The BBM requires respondents to provide their answers to secret or sensitive questions through an anonymous ballot, placing their response inside a sealed ballot box that contains the responses from all survey respondents, without the interviewer seeing the answer. The BBM has been

used to research public opinions to sensitive issues on several topics. Some examples include voting preferences in the U.S. (Benson, 1941), the frequency of induced abortion in Brazil (e.g. Anselmo Olinto and De Carvalho Moreira Filho, 2004; Diniz et al., 2017; Diniz and Medeiros, 2010), Colombia (Zamudio et al., 1999) and México (Lara et al., 2004), and the non-marital behaviours of men in Bangladesh (Chowdhury et al., 2012). The BBM has also been used in the field of environmental economics to test the appropriateness of contingent valuation surveys (Carson et al., 2005) and to determine peoples' willingness to pay for natural resources or ecosystem services in the US (Leggett et al., 2003) and the Philippines (Francisco, 2015). Only recently has the BBM made its way into the field of wildlife conservation, through a study on rule non-compliance among anglers in South Africa's marine based shore fishery (Bova et al., 2018) and bushmeat hunting in the Serengeti (Nuno, 2013).

I chose the BBM after conducting a pilot study involving other sensitive questioning techniques including the Randomized Response Technique, Crosswise Technique, Unmatched Count Technique and Nominative Technique (Nuno and St. John, 2015, described in Chapter 2). The pilot study had a sample of 100 participants (20 per method), and was carried out in villages of similar characteristics to my sample in the Department of Pando, Bolivia. I selected the BBM over the other methods based on participants' and interviewers' responses to questions at the end of the survey instrument concerning each method's ease of understanding, perceived confidentiality and degree of comfort, following Nuno (2013).

After the pilot, I applied direct questioning and the BBM to each sampled individual. The direct questions were placed towards the end of the survey, and were meant to be asked only to participants who had not explicitly responded to them earlier in the survey (e.g. when describing their past interactions with jaguars, jaguar body parts or with jaguar traders). The BBM was implemented at the end of the survey. I explained to participants how the BBM works, and provided an example by filling

in a mock ballot. I assured participants that the ballot box was not going to be opened until the end of the data collection process of the study, and that their anonymous answers would be mixed with those of all other participants. Each numbered question was read to participants aloud, while the surveyor turned their back to the respondent, who was additionally protected by the ballot box being positioned in between the two. Participants were given enough time to provide their answer to each question, by marking a ballot with “yes” or “no”, either circling the word or ticking a box next to it (Fig. 3.2) and they were welcomed to ask the surveyor to repeat the question, as the question was not written directly on the ballot for extra security. Upon responding to all questions, participants were asked to fold the ballot and place it inside the sealed wooden ballot box. Each ballot had a unique identification code (Fig. 3.2) which enabled matching the responses to the broader non-sensitive questions asked during the interview, to allow for assessing the factors (or predictors) that influence the sensitive behaviours though multivariate analysis. Ballots and questionnaires were matched at the end of the data collection process, and no personal, geographical, or other identifiable details were collected at any time, making it impossible to link responses to participants. Participants were informed of how the data they provided would be handled, and the steps taken to ensure their anonymity and confidentiality prior to granting their consent for participation, following the ethics protocols approved by the Central University Research Ethics Committee of Oxford University (Reference: R63986/RE001).

		Code:###
1.	YES ☐	NO ☐
2.	YES ☐	NO ☐
3.	YES ☐	NO ☐
4.	YES ☐	NO ☐
5.	YES ☐	NO ☐

Figure 3.2: Ballot and Box used to implement the Ballot Box Method in jaguar trade surveys in north-western Bolivia.

The semi-structured interviews, which were conducted from June to August 2019, took 20 to 40 minutes to complete, and were carried out by a team of five Bolivian and international researchers with experience investigating human-jaguar interactions. The Bolivian Ministry of Environment and Water granted permission to conduct this study (Reference: MMAYA/VMABCCGDF/DGBAP/MEG No. 0251/2019).

3.2.3 Data analysis

I calculated the prevalence of jaguar killing and trading actions by obtaining the proportion of 'yes' to 'no' answers for each action, removing missing responses. I estimated 95% confidence intervals using package 'prevalence' (Devleesschauwer et al., 2014) in R version 3.6.2 (R Core Team, 2019). I used a binomial GLM using the package 'stats' (R Core Team, 2019) to determine whether there was a significant difference between the BBM and direct questioning for each jaguar killing and trading

behaviour. In this model, the binary answers for each behaviour constituted a single response variable while the method used (BBM vs. direct questioning) and its interaction with the question were set as the predictors. Using BBM responses, I ran another GLM using the study area and its interaction with each question as a predictor, to identify differences in behaviours by study area. In a different analysis, I identified cases where participants admitted to any of the behaviours of interest using the BBM but not through direct questioning (an indication of the sensitivity of the questions) and vice versa (an indication of non-adherence to the instructions of the BBM). Coding these differences as binary response variables (e.g. participants who found the questions sensitive and participants who did not adhere to the BBM), I examined the factors associated with these differing responses to the questioning method used. I used participants' socioeconomic characteristics, including gender, age, livelihood (hunting/fishing, home activities, agriculture, small business, public services, ranching), education and income; awareness about jaguar protection, study area and surveyor id as predictors. Of these, age and years in education were considered numerical variables, while the remaining predictors were either binary or categorical factors. All categorical and continuous dependent and independent variables used in the models were tested for association applying Cramer's V (for categorical variables) and point-biserial correlation (for continuous and categorical variables) through the packages 'DescTools' in R (Signorell, 2021) and 'ltm' (Rizopoulos, 2006), in R version 3.6.2 (R Core Team, 2019). Medium and low levels of association (<0.5) were found, ruling out collinearity. To determine the association between jaguar killing and trading actions (response variables) and the mention of traders of different nationalities (separate dummy variables for each nationality), I applied separate mixed effects binomial GLMs using package 'lme4' (Bates et al., 2015) to the BBM responses, with community within study area as random effects.

3.3 Results

3.3.1 Socioeconomic characteristics of participants

I interviewed 1107 people across my four study areas (Cobija: 212, Rurrenabaque: 231, Trinidad: 375 and Riberalta: 379), with varying socioeconomic characteristics (Table 3.1). All participants were of Bolivian nationality. Sixty percent of participants were originally from villages in the Bolivian lowlands and highlands rather than the study villages, but had been in the surveyed village for an average of 11 years. Households had an average size of five people, with two children and three adults.

Table 3.1: Socioeconomic characteristics of survey participants. Total percentage is >100% for livelihood as people could mention livelihood types. Total sample size = 1107.

Category	Type	Percentage of Total Sample
Gender	Female	54.7
	Male	45.3
Livelihood	Hunting/Fishing	44.4
	Home activities	38.4
	Agriculture/NTFPs	30.3
	Business	17.3
	Public services	8.9
	Ranching	5.8
Income ($ Bolivians)	500	39.9
	No response	25.0
	1000	25.0
	1500	5.5
	2000	4.5
Age	Min-Avg-Max	18-42-89
Education (# of Years)	Min-Avg-Max	0-10-18

3.3.2 Jaguar killing and trading prevalence

Forty-six percent of my sample had personally engaged with at least one of the jaguar killing and trading behaviours of interest during the past 5 years (Fig. 3.3). Additionally, 6% of the 1107 respondents stated that their partners had engaged in jaguar killing or trading in the past 5 years, and

9% that they had themselves done so more than 5 years ago (both categories are not included in Fig. 3.3). The most prevalent activity was owning jaguar body parts, followed by being asked to kill a jaguar and asking others to kill a jaguar. I did not quantify what proportion of these requests was of a commercial nature, as compared to other motivations, such as retaliation for livestock losses. Killing, selling, and buying jaguars were less prevalent, while raising a live jaguar, and killing more than five jaguars were the least common actions. When combining direct and BBM responses provided by the same participant, owning jaguars (including live animals and body parts) reached 42.1% of the sample (n=1107), followed by being asked to kill (24.3%), killing (18.6%), asking others to kill (15.5%), selling (14.6%), and buying (13.1%) jaguar body parts (discussed further in Chapter 4). There were no statistically significant differences in the prevalence of jaguar killing and trading actions between study areas, with the exception of owning jaguar body parts, which was significantly higher in Trinidad (OR 2.56, 95% CI 1.06-6.15, $p<0.05$) than in the other study regions.

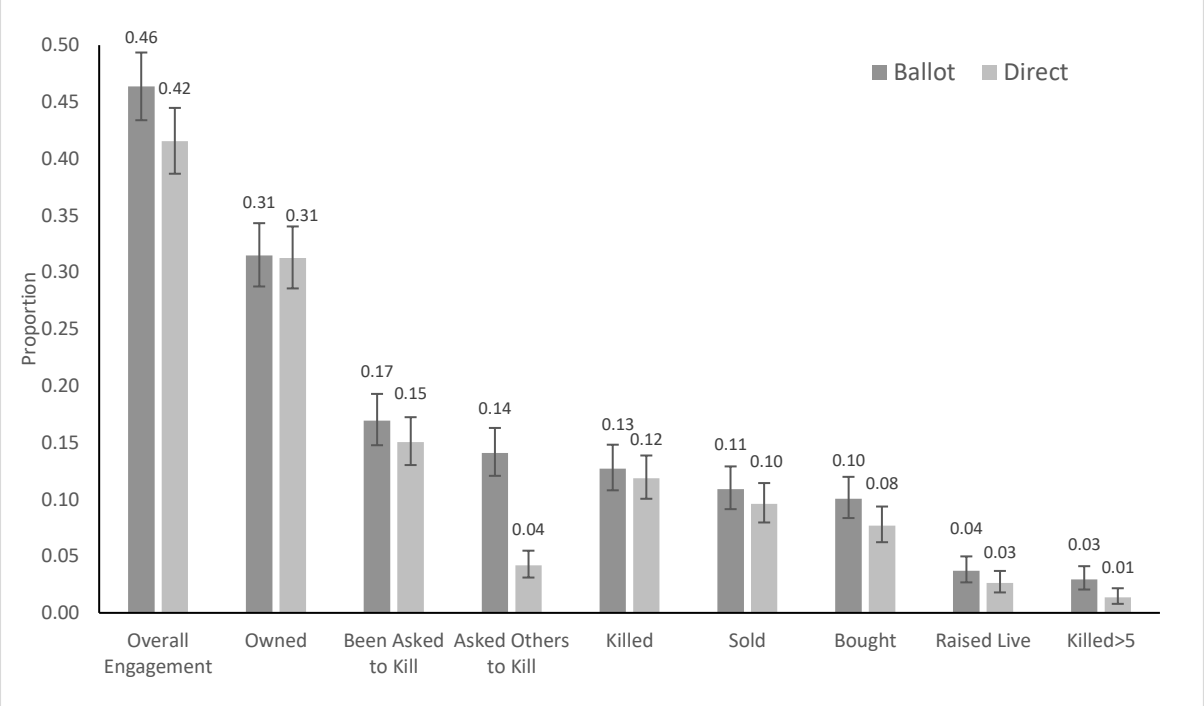


Figure 3.3: Proportion of participants that engaged in jaguar killing and trading actions in my study areas. Sample size varies per question, ranging from 1044 to 1064 participants who answered both directly and through the ballot box method (BBM). 95% confidence intervals calculated using the Jeffrey's interval method for binomial proportions.

3.3.3 BBM versus Direct Questioning

The BBM resulted in a higher prevalence of all jaguar killing and trading actions than direct questioning. Averaging across actions, 6.7% of respondents admitted to actions through the BBM but not directly, suggesting they found the question sensitive, while 4.3% admitted to actions directly but not through the BBM, suggesting that they did not understand, trust or feel comfortable with the BBM. However, the only action for which the BBM led to a significantly higher prevalence than the direct question was asking others to kill a jaguar (OR 3.27, 95%CI 2.17-4.97, $p<0.001$). Older participants were less likely to find the questions sensitive (OR 0.99, 95%CI 0.97-1.00, $p<0.01$), contrary to those with agricultural livelihoods (OR 1.49, 95%CI 1.05-2.12, $p<0.05$). Participants who did not know the legal status of jaguars were less likely to find questions sensitive (OR 0.37, 95%CI 0.31-0.43, $p<0.001$) than those who were aware of their protected status. The predictors of the behaviours of participants who admitted to undertaking the different jaguar killing and trading actions through both methods are presented in Chapter 4.

3.3.4 Traded Jaguar Body Parts and their Uses

The majority (78%) of survey respondents were aware that jaguar body parts are traded and used in their communities, and were able to describe their uses (Table 3.2). The most commonly used jaguar body part was the skin, followed by jaguar fat, teeth, meat, claws and tails, skulls, live animals, bones and other jaguar body parts. Most body parts were locally used for decorative, medicinal, nutritional or cultural purposes (Fig. 3.4). However, jaguar teeth, skulls and bones were also mentioned in the context of foreign demand. Three participants living near Trinidad had witnessed the preparation of 'jaguar paste' (gelatine made with jaguar bones and meat), while one participant near Rurrenabaque had seen refrigerators filled with jaguar corpses at the residence of an Asian trader.

Table 3.2: Jaguar body part uses in participant's communities, described by percentage of participants in the sample (n=1107) who mentioned each part and use.

Body Part	Use Category	Percentage of Sample	Use detail
Skin	Accessories	53.7	Home decoration: tapestries, rugs, chairs, hammocks; personal accessories: belts, wallets, purses, hats, shoes, saddles, briefcases
	Cultural	5.3	Costumes and drums for traditional dances
	Medicine	0.3	Treatment for headaches (by burning the pelt)
Fat	Medicine	35.9	Rubbing ointment: rheumatism, arthritis, welling, muscle pain, cramping, burnt or inflamed skin, varicose veins, complicated child births; Drinking syrup: common cold, pneumonia, embolism, asthma, bronchitis, uric acid, kidney disease
	Repellent	5.2	Repellent for crop-raiding animals (by scattering the fat in crops); to keep cattle in their corrals; to manage untamed cattle
Teeth	Accessories	24.3	Jewellery and key chains; sold to locals and foreigners
	Medicine	1.9	Treatment for facial paralysis caused by a spell of misfortune (by grinding and burning the teeth); dental fillings
	Cultural	0.9	Necklaces worn at traditional festivals; amulets to protect against bad luck or evil spirits
Meat	Nutrition	20.6	Food for humans and domestic animals like dogs
	Cultural	0.4	Consumed for vitality and strength, particularly amongst hunters
Tail & Claws	Accessories	16.9	Jewellery and key chains; recipients to hold small objects (paws)
	Cultural	1.5	Amulet for good luck and strength
Skull	Accessories	13.4	Trophies; painted and turned into lamps; sold to foreigners
	Cultural	2.3	Amulet for good luck in business; witchcraft; traditional dance masks
	Repellent	0.3	Repellent for crop raiding animals; prevents encounters with jaguars
	Studies	0.8	Purchased by students to conduct studies on jaguar strength
Live	Pets	6.1	Pets; attractions for zoos or circuses
Bones	Medicine	0.9	Medicine for strength; sell to foreigners
	Cultural	0.7	Kept at home for luck; keeps thieves away
	Studies	0.5	Purchased by students to conduct studies on jaguar strength
	Repellent	0.2	Repellent for crop raiding animals
Others	Medicine	0.6	Eyes are used as a treatment for poor eyesight
	Cultural	0.3	Brain and heart are used for rituals
	Other	0.1	Whiskers and penis can be sold to foreigners

Figure 3.4: Jaguar body parts found at participants' households in north-western Bolivia. A) Jaguar chair, B) Jaguar wallets for sale at local markets, C) Jaguar fat, D) Jaguar face mask, E) Jaguar skull. Photo credits: Melissa Arias, Paola Nogales-Ascarrunz and Miguel Fernandez.

3.3.5 Jaguar killing methods

By far the most common method used to kill jaguars in my study areas, as described by 97% of participants, was to shoot them with firearms whenever an opportunity arose. Opportunities included cases of jaguars being caught predating livestock, or chance encounters with jaguars while hunting, walking in jaguar habitat, or navigating waterways. Thirty-six percent of participants mentioned the use of baits, which tended to be domestic animals that had been previously attacked by jaguars, or wild jaguar prey. Baits are hung from trees or left in an open space, allowing hunters a clear shot when the jaguar arrives. Baits may also be injected with poison, as was indicated by 3% of participants. Using hunting dogs to find and chase jaguars was also common, being mentioned by 28% of participants. Twenty one percent of my sample also mentioned the use of jaguar traps, which can be either wire snares placed on the ground, or more commonly, gun snares that activate when the jaguar passes by.

Gun snares are placed on recently cleared forest paths, which tend to be used by jaguars. Sound lures, made with natural materials to imitate the jaguar's call or simply using a human's voice, continue to be used (mentioned by 8% of participants). Six percent of participants mentioned other methods to find, attract or kill jaguars, including arrows, machetes or sticks, knifes, harpooning them while they cross rivers, and following vultures to areas where the jaguar has made a kill.

3.3.6 Prices of jaguar body parts

The prices of jaguar body parts were highly variable (Table 3.3). As has been suggested in other studies (e.g. Kelly, 2018a), variation in prices may be indicative of differences in supplier location with respect to the market, the level of the trade chain at which the prices are quoted, or informational constraints about the price. Interestingly, the prices of jaguar teeth, skulls, bones, which were of particular interest to foreigners, were almost always provided in US dollars instead of the Bolivian currency.

Table 3.3: Jaguar body parts' prices in north-western Bolivia in August 2019 (exchange rate, $1 USD = $6.90 Bolivianos)

Item (Number of Participants mentioning the price)	Min. Price (USD)	Avg. Price (USD)	Max. Price (USD)
Skin (n=136)	2	89	900
Teeth (n=104)	1	75	750
Fat (n=74)*	0	11	60
Skull (n=117)	15	133	750
Paws/Claws (n=9)	2	33	75
Tail (n=9)	3	16	53
Live (n=2)	30	53	75
Bones (n=3)	11	155	300

*Jaguar fat is generally sold in small plastic bottles for ~$3 USD, but larger containers of up to a litre can reach $60 USD.

3.3.7 Actors in the jaguar body part trade:

Sixty seven percent of participants were aware of the existence of jaguar traders in and around their communities and were able to comment on their characteristics and interactions with them (Table 3.4). Forty four percent of respondents reported that Bolivian nationals (local or from major cities) traded jaguar body parts. Seventeen participants from the Trinidad study area mentioned that jaguar body parts are sold to local prisons, where convicts use them to make crafts to pay for prison fees. During an ad hoc visit to the 'El Campesino' market in Trinidad on August 2019, I was able to confirm the presence of these crafts, and sellers said that these came from prisons in Beni Department.

The next most mentioned trader group was people of Asian descent, which included mainly people with Chinese background but also Japanese, Korean and Thai background (note: the actual nationality or migratory status of this traders was not known). Asian-descent buyers, some of whom were described as workers at Chinese infrastructure companies or long-term residents in Bolivia approached villagers directly, speaking Spanish or with the help of a translator. Nine percent of participants had had direct interactions with people of Asian descent, and 29% of those interactions specifically involved jaguar trade. Another 4.5% of participants mentioned that someone else in their community had been approached by jaguar traders of Asian descent. These traders also requested other species, particularly snakes, caiman, psittacines, and dogs.

Participants provided details about their perceptions towards people of Asian descent. Perceptions were mainly negative (47%), followed by neutral (32%) and positive (21%). The main causes for negative perceptions among participants were that people with Asian backgrounds take away employment opportunities from Bolivians, treat employees poorly, extract money and natural resources from the country, have bad behaviour and morals, are difficult to understand, eat dogs,

have unclear motives for being in the country, destroy nature, treat Bolivians with inferiority, illegally trade jaguars and other wildlife, are above the law and do projects of low quality without consulting local communities. Meanwhile, positive perceptions originated from the belief that people of Asian descent are helping to build the country's infrastructure, opening up job opportunities, interesting to meet because they are from a different culture, that they follow through with their work, teach new technologies, are intelligent and nice people, and that they are just like anybody else.

Foreigners of European descent, described as tourists, wildlife collectors and religious missionaries were the next most mentioned traders, followed by regional foreigners from Latin American countries (including Brazil, Peru, Argentina, Chile, Paraguay, Venezuela, and Colombia).

Some participants mentioned that the requests for jaguar body parts came from local radio advertisements asking people to deposit the items at specific locations such as hotels in urban centres; while others said that university students of Chinese descent had been purchasing jaguar bones and skulls to conduct a study on the strength of the jaguar (Table 3.4).

Table 3.4: Jaguar body part trader types, and the percentage of respondents mentioning these people. Total percentage is >100% as people could mention multiple trader types. Total sample size = 1107.

Trader types and interactions	Characteristics	Percentage of Total Sample
Jaguar trader types as reported by participants*	Bolivian	44.4
	Asian-descent	21.3
	European-descent	14.5
	Regional	6.0
	Radio advertisements	3.3
	Universities/Students	2.4
Participants who had interacted with people of Asian descent	No	91.2
	Yes	8.9
Sources of information about traders of Asian descent purchasing jaguar body parts	Unaware	79.9
	Word of Mouth	13.1
	Family and Community	4.5
	Personal	2.5

* These percentages are based on participants' accounts of the ethnicities of jaguar traders, which can be anecdotal or second-hand accounts, and should therefore not be considered the actual prevalence of different trader groups. Moreover, I highlight that ethnicity does not equate to nationality, and traders of

Asian or European descent could in fact be Bolivian nationals, particularly since China does not allow dual citizenship.

Even though the most often-mentioned traders were Bolivian, awareness of the existence of traders of regional and European descent increased participants' odds of engaging in almost all jaguar killing and trading actions (Table 3.5). Conversely, awareness of the existence of traders of Asian descent played a significant role in increasing the likelihood of being asked to kill a jaguar, selling jaguar body parts, and asking others to kill a jaguar; while awareness of Bolivian traders was only significantly associated with ownership of jaguar body parts.

Table 3.5: Odds Ratios of the association between a respondent being aware of the existence of a particular type of trader in and around their communities and them reporting having carried out a jaguar killing or trading action based on responses provided to the BBM. Estimates based on a mixed effect binomial GLM, with community and study area as random effects. 95% confidence intervals in parenthesis. Values above and below one indicate whether traders are associated with higher or lower odds of jaguar trading actions, respectively. Values in bold represent statistical significance ($p<0.05$).

	Jaguar Killing and Trading Actions							
Traders	**Raised Live (n=1053)**	**Owned Body Parts (n=1064)**	**Bought Body Parts (n=1054)**	**Been Asked to Kill (n=1057)**	**Killed (n=1055)**	**Killed>5 (n=1049)**	**Sold Body Parts (n=1054)**	**Asked Others to Kill (n=1044)**
Asian-descent	0.71 (0.03-1.54)	1.34 (0.94-1.80)	1.19 (0.73-1.90)	**2.22 (1.50-3.09)**	0.96 (0.58-1.46)	1.77 (0.66-3.46)	**2.09 (1.31-3.11)**	**1.53 (0.97-2.20)**
European-descent	**3.44 (1.63-6.94)**	**2.19 (1.58-3.22)**	**2.41 (1.47-3.89)**	**2.37 (1.48-3.31)**	**2.25 (1.43-4.50)**	1.44 (0.58-3.52)	**3.18 (1.95-4.86)**	**1.92 (1.28-3.07)**
Regional	**4.88 (1.97-10.8)**	**2.47 (1.46-4.15)**	**3.00 (1.66-5.91)**	1.68 (0.88-2.98)	1.24 (0.55-2.46)	0.55 (0.03-2.51)	**2.38 (1.14-4.34)**	1.75 (0.87-3.19)
Bolivian	0.84 (0.43-1.63)	**1.41 (1.18-2.01)**	0.86 (0.58-1.33)	0.95 (0.71-1.39)	1.23 (0.88-1.86)	1.29 (0.74-3.19)	0.82 (0.55-1.24)	1.18 (0.83-1.69)

3.4 Discussion

I found that jaguar killing and trading is a common and mostly non-sensitive activity throughout my study areas. These results mirror those of Knox et al. (2019) who found that jaguar killing is common and socially acceptable in nearby locations in Bolivia. While recent seizures of jaguar body parts destined to China raised awareness about illegal jaguar trade in Bolivia, one of the most significant outcomes of my study was the scale of illegal domestic possession, use, and trade in jaguar body parts. Domestic wildlife markets in Bolivia are not well understood in the scientific literature, even though a large scale trade in parrots, lizards, turtles and tortoises, for companionship and consumption, has been reported and deemed unsustainable, despite national level prohibitions on wildlife trade (Herrera and Hennessey, 2007; MMAyA et al., 2013). The significance of illegal domestic trade in jaguar body parts had already been raised in Mesoamerica (Reuter et al., 2018b), but I was able to uncover an unexpectedly high level of local ownership of jaguar body parts and awareness of their traditional uses. This may be indicative of poor law awareness and enforcement, as has been reported for other species (Herrera and Hennessey, 2007), or a reflection of a problematic interpretation of laws concerning wildlife use in the country, which prohibit the trade of nationally protected species like the jaguar, while also granting traditional wildlife use rights to indigenous communities (MMAyA, 2020b). This may have led some of my participants, who were predominantly of mixed ethnicity (with some degree of indigenous background); to believe that laws protecting jaguars and other wildlife did not apply to them. Moreover, the use of jaguar body parts appeared to be engrained in rural people's cultural practices, from typical dances to therapeutic beliefs and hunting identities. In particular, the high number of participants who mentioned the use of jaguar fat for medicinal and pest control purposes was surprising. Studies elsewhere in the jaguar range have also reported the use of jaguar fat, suggesting that more conservation attention should be directed towards this use (Garcia-Alaniz et al., 2010; Gonzalez-Maya et al., 2010). Bolivians were also the most mentioned traders of jaguar body

parts, and while some may act as intermediaries for other trader groups, the possession of jaguar body parts and their commercialization in physical markets within Bolivia stresses the importance of domestic demand for jaguars, as has been shown in other countries like Peru (SERFOR and WCS, 2019). Local uses and traditional beliefs have also been identified as an important threat for other felid species throughout the world (Alves et al., 2013; Williams et al., 2017b) and they should be a key component of efforts to address the illegal jaguar trade.

Another noteworthy finding was the presence of foreign traders of European descent or from other countries in the region, and its association to participants' engagement with jaguar trade. This had already been suggested by studies on the links between tourism and jaguar trade in other countries (Braczkowski et al., 2019; Reuter et al., 2018), but my results indicate that Bolivia's jaguar trade may have a wider geographical distribution of international demand than originally thought. It is worth considering that Europe and North America, like Asia, are important IWT demand regions for a range of taxa (Rosen and Smith, 2010), and that their nationals' interest in purchasing jaguar items has been reported in recent years in countries like Costa Rica (Kelly, 2018).

As expected, given recent seizure events in Bolivia, I corroborated the involvement of individuals of Asian descent in the illegal jaguar trade. In addition to teeth, traders of Asian descent in my study areas were reportedly also interested in buying jaguar skulls and bones, suggesting that jaguar paste may be being made in Bolivia, as has been documented for the case of Surinam (Lemieux and Bruschi, 2019; Verheij, 2019). However, given the small number of participants who mentioned jaguar paste in my surveys, I recommend more research into this potential market. As China's international cultural influence and investments expand across the world through the Belt and Road Initiative, there are increasing concerns about its potential risks to wildlife overseas (Farhadinia et al., 2019; Hinsley et al., 2019). For example, there are reports of in-country Chinese demand for bushmeat and high value

items like elephant ivory and rhino horn in several African countries (Cao & Cao, 2015; Mambeya et al., 2018). The connection between Chinese foreign investments and jaguar trade in Latin America has begun to be explored (Morcatty et al., 2020), and its potential impacts on jaguars and other wildlife, including bushmeat species, should continue to be investigated.

The wider significance of these findings is that counter-trade interventions for jaguars and other felids need to disentangle domestic and international forms of trade, and consider local behaviours and cultural drivers just as much as international ones. While the role of Asian wildlife markets in the illegal jaguar trade should continue to be explored, my results reinforce the message of Margulies et al. (2019) of being cautious about mainstream discourses in IWT, such as that of the "Asian super-consumer", which may deflect focus away from the diversity of players and complex feedbacks between IWT drivers across scales, including in source areas.

In this chapter, I described the prevalence of jaguar killing and trade-related behaviours in north-western Bolivia, as well as the wide range of uses that are given to jaguar body parts domestically. I also analysed the descriptions of jaguar traders provided by my participants, and the extent to which different trader types are associated to the trade. The next chapter explores the socioeconomic, experiential, psychological and market-related drivers of these behaviours, and provides greater detail about the complex relationships between humans and jaguars in north-western Bolivia.

Chapter 4

Complex interactions between commercial and non-commercial drivers of illegal trade for a threatened felid

Free-ranging cattle at a study site in rural Bolivia with human-jaguar conflict.

Abstract:

Illegal trade and human-wildlife conflict are two key drivers of biodiversity loss, and are recognized as leading threats to large carnivores. While human-wildlife conflict involving jaguars (*Panthera onca*) has received significant attention in the past, less is known about traditional use or commercial trade in jaguar body parts, including their potential links with retaliatory killing. Understanding the drivers of jaguar killing, trade and consumption is necessary to develop appropriate jaguar conservation strategies, particularly as demand for jaguar products appears to be rising due to Chinese demand. I interviewed 1107 rural households in north-western Bolivia, an area with an active history of human-jaguar conflict, which has also been at the epicentre of recent jaguar trade cases. I collected information on participants' experiences with jaguars, their jaguar killing, trading and consuming behaviours, and potential drivers of these behaviours. I found that the relationships between local people and jaguars are complex, and are driven largely by traditional practices, opportunism, human-jaguar conflict and market incentives from foreign and domestic demand, in the absence of law awareness and enforcement. Addressing jaguar trade and building human-jaguar coexistence will require a multifaceted approach that considers the multiple drivers of jaguar killing, trade and consumption, from foreign and local demand to human-jaguar conflict.

4.1 Introduction

The relationship between humans and wildlife is complex, varying across locations, cultures and taxa, and evolving along with societies' changing values towards nature (Frank and Glikman, 2019). The study of these relationships has been dominated by an anthropocentric focus, which separates humans from the natural world and defines their interactions with wildlife as 'human-wildlife conflict' (HWC), or the 'struggles that emerge when the presence or behaviour of wildlife poses actual or perceived, direct and recurring threat to human interests or needs' (IUCN, 2020). Although the expanding scholarship on human-wildlife interactions continues to emphasize HWC, its definition has evolved over time, acknowledging that many instances of HWC are in fact disagreements between groups of people over wildlife (IUCN, 2020; Peterson et al., 2010; Redpath et al., 2013). There is also a greater recognition of the various benefits that emerge from the presence of, and interactions with, wildlife, and of the importance of participatory stakeholder involvement for harnessing those benefits, increasing tolerance, and achieving sustainable coexistence with wildlife (Frank and Glikman, 2019; König et al., 2020; Morzillo et al., 2014).

Large carnivores are prominent in the study of human-wildlife interactions, particularly in those focussed on conflict. Although many large carnivores have symbolic meanings and practical values for human societies around the world (Alves et al., 2013), their negative impacts on human interests and needs have led to widespread persecution, turning human-wildlife conflict into a leading cause of large carnivore decline (Inskip and Zimmermann, 2009; Ripple et al., 2014). These negative interactions are accentuated by a wide range of co-occurring, multi-scale environmental and social factors (Carter et al., 2017; Lischka et al., 2018; Morzillo et al., 2014). Landscape-level habitat degradation can affect wildlife community assemblages and prey availability, which can in turn influence individual large carnivore distribution, behaviour and propensity towards conflict (e.g. Miller 2015; Carter et al. 2017).

Societal values towards nature and cultural beliefs can also influence people's tolerance or intolerance of carnivores (e.g. Dickman and Hazzah, 2015), as do carnivore management policies (Linnell and Alleau, 2015; Peterson et al., 2010). Moreover, individual hunters respond to social norms (e.g. Marchini and Macdonald, 2012b), and to range of socio-psychological motivators of attitudes and behaviours towards carnivores (e.g. Kansky et al., 2014).

As with other large carnivores, lethal responses to human-jaguar conflict are one of the main threats to jaguars (*Panthera onca*), and have been the subject of considerable research attention (de la Torre et al., 2017). Experiences of livestock depredation, together with fear of attacks on humans, have led to negative attitudes towards jaguars throughout their range (e.g. Knox et al., 2019; Marchini and Macdonald, 2012a). These perceptions are intensified by a lack of knowledge about jaguars (e.g. Engel et al., 2017), inadequate responses by authorities (Conforti and De Azevedo, 2003), group identities and traditions (Harvey et al., 2017), perceived behavioural control (e.g. an actor's perceived ability to conduct a behaviour and the extent to which doing the behaviour is the actor's choice - Ajzen, 1985; Marchini and Macdonald, 2012a), and socioeconomic characteristics (e.g. Amit and Jacobson, 2017; Carvalho, 2019). Broader economic and landscape factors also influence the likelihood of jaguar depredation on domestic animals and of retaliatory responses (e.g. Cavalcanti et al., 2010).

Less is known about the drivers of non-retaliatory human-jaguar interactions, including jaguar killing for traditional or commercial purposes, even though these have also shaped the relationship between humans and jaguars. Jaguars have played a longstanding role in the cultural life of numerous indigenous societies in Latin America (e.g. Gómez and Payán, 2017), and became an important economic resource for rural communities involved in the supply of the spotted-cat fashion industry throughout the 20th century (Antunes et al., 2016). While large-scale commercial jaguar trade stopped following their listing on CITES Appendix I, killing and trading continued, with traditional and

commercial motivations sometimes outweighing retaliatory ones (Garcia-Alaniz et al., 2010; Jędrzejewski et al., 2017). The past decade has seen an increase in the evidence of jaguar trade, with seizures occurring throughout their range, some of which have been associated with a new demand from people of Asian descent (Morcatty et al., 2020; Verheij, 2019).

While conflict, domestic use, and trade (domestic or foreign) are all important threats to jaguar populations, the relationship between these threats is not well understood. As the evidence of jaguar trade increases, potential links between trade, retaliatory killing and domestic use have been suggested (Reuter et al., 2018b), but have so far been overshadowed by a growing concern about the role of foreign markets driving the demand for jaguar products (Lemieux and Bruschi, 2019; Morcatty et al., 2020), a narrative that has caught the attention of the media and which has guided recent jaguar conservation actions. Here, I use the example of human-jaguar interactions in north-western Bolivia, a region with an active history of interactions between humans and jaguars, which has also been at the epicentre of recent jaguar trade cases involving foreign demand (Knox et al., 2019; Nunez and Aliaga-Rossel, 2017), to answer the following question: how do foreign and domestic markets for jaguar products interact to drive jaguar killing, trade and consumption, in the context of complex social, cultural and economic relationships between humans and jaguars?

North-western Bolivia is an ideal location to test the hypothesis that, even in areas where foreign demand and strong market incentives may motivate engagement in jaguar trade, the relationships between local people and jaguars, particularly involving human-jaguar conflict and cultural practices, play an equal or greater role in determining people's behaviours towards jaguars. Based on theoretical and empirical evidence from previous research (Table 4.1), I further hypothesized that actors' socioeconomic and socio-psychological characteristics that reduce tolerance to carnivores and that

enhance perceived behavioural control and the odds of encountering jaguars, would increase engagement with jaguar killing, trade and consumption.

4.2 Methods

4.2.1 Household, village, and study area sampling methods

The household, village, and study area sampling methods are the same as those detailed in Chapter 3. A summary is presented here for reference. I selected four rural study areas neighbouring urban centres in the Departments of Beni, Pando and northern La Paz, north-western Bolivia (Fig. 3.1). These study areas had confirmed jaguar occurrence, reported cases of jaguar killing and trading, strong livestock ranching and hunting livelihoods, and Chinese infrastructure investments, all relevant to my hypotheses. This purposive choice of study areas meant that my study, while not being generalizable beyond these areas in terms of specifics, should give a picture of the role of international jaguar trade in the context of locations with long and active histories of interactions between humans and jaguars.

Within my four study areas, I randomly sampled villages (study sites) with populations of 250-2000 inhabitants, located <150 km from urban centres (the cities of Cobija, Riberalta, Rurrenabaque and Trinidad; Chapter 3). I semi-randomly sampled households (my study units) from pre-numbered households along all village streets. When the selected household was uninhabited or unwilling to participate, I approached the neighbouring household instead. I interviewed one adult per household, prioritizing the household head, such that household and participants refer to the same study unit. Sampling intensity for villages within study areas and households per village was based on a power analysis, and was proportional to the population size of each study area and village (Chapter 3). While

I considered all households, sampled sites (villages) and study areas as a single population, my statistical analyses reflect the nested structure of my observations through random effects.

4.2.2 Questionnaire and survey

My semi-structured survey instrument comprised 32 open and closed questions (Appendix 1), divided into the following sections: 1) socioeconomic characteristics; 2) perceptions of jaguars, their population sizes and the risks of attacks on humans; 3) attitudes towards jaguars and jaguar killing and knowledge of killing methods; 4) experiences with jaguars, including attacks on humans and domestic animal depredation; 5) jaguar body parts uses and prices; 6) awareness of jaguar protection laws; and 7) awareness of, and interactions with, traders. These sections corresponded to my predictor variables. Additionally, I asked participants whether in the past 5 years they had been personally involved in jaguar killing, trading (selling) and consuming (owning and buying) behaviours, and whether in the same period they had been requested by others to kill jaguars, or whether they had themselves asked others to do so. I asked these sensitive questions directly and using the Ballot Box Method (Arias et al., 2020), with the goal of reducing social desirability bias in participants' responses (Fig. 3.2). To capture the intentions of those who had not directly engaged in these behaviours, I asked participants what they would do in a hypothetical scenario of encountering a jaguar. These actual and hypothetical behaviours corresponded to my response variables.

I conducted the surveys from June to August 2019, following two weeks of piloting in villages of similar characteristics. The pilot study used a preliminary version of the same questionnaire as the full survey, but differed in that it tested different indirect questioning techniques (Table 2.1). The interviews took 20 to 40 minutes to complete, and were carried out by a team of four Bolivian and one foreign researchers with experience investigating human-jaguar interactions. The study was approved by the

Central University Research Ethics Committee of Oxford University (Reference: R63986/RE001) and the Bolivian Ministry of Environment and Water (Reference: MMAYA/VMABCCGDF/DGBAP/MEG No. 0251/2019).

4.2.3 Data analysis

For binary, multi-level categorical and Likert-type questions, I analysed the percentage of participants in my sample that mentioned each response category (Table 4.2). Where relevant, I converted open and continuous questions into categorical variables (perceptions about, and interactions with, jaguars and jaguar abundance). I used a word cloud as a preliminary visualisation of jaguar perceptions (Fig. 4.1) using NVivo software (QSR International Pty Ltd. Version 12 Pro, 2018). I first identified all possible combinations of jaguar killing, trading and consuming behaviours (n=64) and then developed a typology of actors by grouping these combinations (Table 4.3).

To restrict the number of predictors of jaguar killing, trading and consuming behaviours, I hypothesized the direction of the effect that each potential predictor would have on behaviour, based on the literature and my understanding of the data (Table 4.1). I selected predictors that had stronger support in the literature and, which represented potentially important relationships to the behaviours. These were gender, livelihood, income, age, education, perceived jaguar abundance, perceived risk of an attack on humans, opinion towards jaguar killing, experience of attacks on humans or livestock, awareness of jaguars' legal status, awareness of jaguar traders and of prices.

Table 4.1: Hypothesized effect direction of predictors on jaguar trade-related behaviours. Red arrows mean that the given predictor category is more likely to be associated to the behaviour (response variables), while the opposite is the case for green arrows. Yellow arrows mean that the relationship could go in either direction.

Type of Predictor	Predictors	Levels	RESPONSE VARIABLES											Hypothesis rationale
			Killing behaviours				Commercial behaviours		Consumer behaviours			Passive behaviours		
			Killing	Being Asked to Kill	Asking others to	Intention to Kill	Selling	Intention to Sell	Buying	Owning	Intention to Own	Passive encounter	Passive intentions	
Socioeconomic	Gender	Male	↑	↑	↓	↑	↑	↑	↑	↑	↑	↓	↓	Women have been found to be more fearful of jaguars than men (Knox et al., 2019), which leads them to lower tolerance and negative attitudes towards jaguars (Fort et al., 2018) and a stronger intentions or desire to kill jaguars (Harvey et al., 2017). However, given that men represent a larger proportion of hunters and ranchers in my sample, and thus possess more behavioural control, I hypothesize that they will be more likely to encounter opportunities to react lethally to jaguar encounters than women. Moreover, they may be more likely to engage in commercial and consumer behaviours because of greater access to jaguar products, and due to a desire express masculinity or to possess trophies, as shown by Kelly (2018).
	Livelihood	Hunting/Fishing	↑	↑	↓	↑	↑	↑	↑	↑	↑	↓	↓	As shown by Knox et al. (2019), hunters may have higher odds of killing jaguars than non-hunters. This could be due to their increased chances of finding jaguars from spending time in forested areas and near water bodies, and also their higher perceived behavioural control (from being armed and skilled). They are also more prone to experiencing conflictive interactions with jaguars, such as attacks or humans or domestic animals (when hunting with dogs, Garcia-Alaniz et al., 2010). They may be more likely to engage in commercial and consumer behaviours as a result of greater access to jaguar products, and also due to a desire express masculinity or to possess trophies.
		Ranching	↑	↑	↓	↑	↑	↑	↑	↑	↑	↓	↓	While ranchers vary in their responses to jaguars (Amit and Jacobson, 2017, Zimmermann et al., 2005b), they are often less likely to react passively and more likely to react lethally to jaguar encounters than non-ranchers due to experiencing direct losses from jaguars, and because killing jaguars is part of their accepted social norms (Marchini and Macdonald, 2018). They are also more at risk of attacks from encountering jaguars in the context of depredation, when they are more aggressive. They may be more likely to have commercial and consumer behaviours because of greater access to jaguar products, and also due to a desire express masculinity or to possess trophies.

		Agriculture/NTFP	↑	↑	↑	↑	↑	↑	↑	↑	↑	↓	↓	Agriculturalists and NTFP collectors have high odds of encountering jaguars due to the large amount of time they spend in forested areas, and they have been found to hold negative attitudes towards jaguars (Knox et al. 2019, Soto-Shoender and Main, 2013). Therefore, they could be less likely to react passively and more likely to react lethally to jaguar encounters due to enhanced safety risks to themselves and domestic animals. If lacking the perceived control to kill jaguars themselves, they may ask others to do so. Agriculturalists with domestic animals or livestock may be more prone to experiencing conflictive interactions with jaguars. They may be more likely to have commercial and consumer behaviours as a result of greater access to jaguar products.
		Other jobs	↓	↓	↓	↓	↕	↕	↕	↕	↕	↑	↑	People with other jobs (business, public services or technical jobs) could be more likely to react passively and less likely to react lethally to jaguar encounters than those with different livelihoods, due to having less chances of being negatively affected by jaguars (less conflictive interactions), and potentially due to higher levels of income and education. They may be more likely to have commercial and consumer behaviours because of having established commercial networks, higher purchasing power, and a desire for status. However, the opposite might also hold, as a result of being more aware of the laws and environmental protections.
	Income	$500 (Low)	↑	↑	↑	↑	↑	↑	↓	↓	↓	↓	↓	Income and wealth have been found to be positively correlated with more favourable attitudes towards carnivores (Dickman et al., 2013, Fort et al., 2018). Therefore, people with lower incomes could be less likely to react passively and more likely to react lethally to jaguar encounters, due to financial need and higher perceived risks. If possessing domestic animals or livestock, they may be less tolerant of those losses (Amit and Jacobson, 2017). They may be more likely to have commercial behaviours due to financial need, but less likely to have consumer behaviours as a result of a lower purchasing power and a lower incentive to keep items that can be sold.
		1000	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	People with medium incomes could be more or less likely to react passively or lethally to jaguar encounters, to have conflictive interactions, and commercial or consumer behaviours.
		$2000 (High)	↓	↓	↓	↓	↓	↓	↑	↑	↑	↑	↑	People with higher incomes could be more likely to react passively and less likely to react lethally to jaguar encounters, due to having less chances of being negatively affected by jaguars (less conflictive interactions), and potentially due to higher levels of education. They may be less likely to engage in commercial behaviours because they lack the need, but they probably have higher odds of engaging in consumer behaviours having higher purchasing power, and a desire for status.
	Age (Years)		↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	Negative attitudes towards jaguars have previously been associated with older age (Porfirio et al., 2016 and Zimmerman et al 2005), as has the likelihood of past jaguar killings (Knox et al 2019), possibly because older people have had more experiences with jaguars, or due to shifting attitudes towards jaguars in younger generations. Older people could be less likely to react passively and more likely to react lethally to jaguar encounters because of less environmental education, awareness of the law, and due to previous experiences with jaguar persecution in the times when commercial jaguar killing was allowed. However, older people may be less likely than younger people to encounter jaguars due to reduced visits to forested areas, and may have less perceived behavioural control and physical ability to kill jaguars.
	Education (Years)		↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↑	Higher levels of education have been found to increase people's tolerance and positive attitudes towards jaguars (Fort et al., 2018, Porfirio et al., 2016). People with higher education levels could be more likely to react passively and less likely to react lethally to jaguar encounters, or to engage in commercial and consumer behaviours than those with lower education levels, due to increased awareness about laws and environmental protections, as well as having less need and vulnerability due to potentially higher incomes and livelihood alternatives.

Perceptions and Attitudes	Abundance	Decreas	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	Perceptions of jaguar abundances can influence perceived jaguar impacts and consequently, negative attitudes towards jaguars (Cavalcanti et al., 2010). Therefore, people who believe that jaguar populations are decreasing may be more tolerant of jaguars, but at the same time, they could perceive jaguars as a scarce resource that must be exploited at higher prices.
		Increased	↑	↑	↑	↑	↕	↕	↕	↕	↕	↓	↓	People who think that jaguar populations are increasing could be less likely to react passively and more likely to react lethally to jaguar encounters, due to a perceived need to control populations and limit conflictive interactions. However, high-perceived jaguar population numbers could positively or negatively influence commercial and consumer behaviours, depending on personal circumstances and prices.
	Op. Killing	Bad	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↑	Opinion about killing is a proxy of attitudes towards jaguars. People who believe that killing jaguars is a bad thing (positive attitudes) could be more likely to react passively and less likely to react lethally to jaguar encounters (Engel et al, 2017; Fort et al, 2018). Believing that killing is bad could also make it less likely for people to engage in commercial or consumer behaviours. People with this perception probably have experienced less conflictive interactions with jaguars.
		Good	↑	↑	↑	↑	↑	↑	↑	↑	↑	↓	↓	People who believe that killing jaguars is a good thing could be less likely to react passively and more likely to react lethally to jaguar encounters. Believing that killing is good could also make it more likely for people to engage in commercial or consumer behaviours. People with this perception probably have experienced more conflictive interactions with jaguars.
	Risk of attack	Low	↓	↓	↓	↓	↕	↕	↕	↕	↕	↑	↑	People with low risk perceptions (of jaguars attacking humans) are more likely to react passively and less likely to react lethally to jaguar encounters, due to reduced fear of negative or conflictive interactions (Dickman et al., 2013; Johansson and Karlsson, 2011; Kansky et al., 2014). However, low perceived risks of an attack could positively or negatively influence commercial and consumer behaviours, depending on personal circumstances and prices.
		Medium	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	People with medium risk perceptions (of jaguars attacking humans) could be more or less likely to react passively or lethally to jaguar encounters, to have conflictive interactions, and commercial or consumer behaviours, depending on their personal circumstances.
		High	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	People with high risk perceptions (of jaguars attacking humans) could be more or less likely to react passively or lethally to jaguar encounters, and commercial or consumer behaviours, depending on their personal circumstances. A higher risk perception can lead to lethal responses due to fear and reduced tolerance, but it can also lead to more passive responses due to higher vulnerability or less perceived behavioural control. People who think that they have a higher risk of jaguar attacks may also have experienced more conflictive interactions.
Past	Attacks	Yes	↑	↑	↑	↑	↕	↕	↑	↑	↑	↓	↓	People who have experienced jaguar attacks on humans (either themselves or their families) could be less likely to react passively and more likely to react lethally to jaguar encounters due to fear of more attacks (Dickman et al., 2013; Marchini and MacDonald, 2012). They could be more or less likely to engage in commercial behaviours, but probably more likely to become consumers or possessors due to a traditional belief that keeping jaguar body parts can prevent future encounters with the animals, or as trophies from surviving an attack.

	Depredation	Yes	↑	↑	↑	↑	↑	↑	↑	↑	↑	↓	↓	People who have experienced jaguar depredation events (either themselves or their families) could be less likely to react passively and more likely to react lethally to jaguar encounters as a way to control depredation events (Dickman et al., 2013; Marchini and MacDonald, 2012). Experiencing depredation makes them more likely to also be attacked by jaguars, as they become more aggressive when they are with prey. Having access to jaguar body parts probably makes them more likely to engage in commercial behaviours, probably as a way to compensate for the financial losses from losing livestock. They may have an incentive to become consumers, keeping the body parts as trophies, or to show predator control to superiors.
Enforceme	Legality	Illegal	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↑	People who are aware that killing jaguars is illegal, or who are aware of previous cases of law enforcement surrounding jaguars and IWT, could be more likely to react passively and less likely to react lethally to jaguar encounters (Carter et al., 2017; St John et al., 2012). They could also be less likely to engage in commercial or consumer behaviours due to the potential costs of law enforcement.
Market Opportunities	Trader aware	Yes	↑	↑	↑	↑	↑	↑	↕	↓	↓	↓	↓	People who are aware of the presence of traders (of any nationality) in their communities could be less likely to react passively and more likely to react lethally to jaguar encounters, and they are also more likely to engage in commercial behaviours. They could be more or less likely to purchase jaguar body parts (they might purchase them with the intention of reselling them), and less likely to own body parts due to an added incentive to sell.
	Price aware.	Yes	↑	↑	↑	↑	↑	↑	↕	↓	↓	↓	↓	People who are aware of the price of jaguar body parts in their communities could be less likely to react passively and more likely to react lethally to jaguar encounters, and they are also more likely to engage in commercial behaviours. They could be more or less likely to purchase jaguar body parts (they might purchase them with the intention of reselling them), and less likely to own body parts due to an added incentive to sell.

I conducted multivariate imputation for missing values in the predictors when these represented less than 5% of the sample, otherwise missing values were analysed as a level in a categorical variable, using the package "mice" (van Buuren and Groothuis-Oudshoorn, 2011). My response variables (jaguar killing and trading actions) were based on the responses to the BBM. Missing values in the response variables caused by missing BBM responses were imputed using the responses to direct questioning from the same respondent. Predictor categories that represented less than 5% of the sample were collapsed with the next most relevant category. All categorical and continuous dependent and independent variables were tested for association applying Cramer's V (for categorical variables) and point-biserial correlation (for continuous and categorical variables) through the packages "DescTools" in R (Signorell and Al., 2020) and "ltm" (Rizopoulos, 2006), in R version 3.6.2 (R Core Team, 2019). Medium and low levels of association (<0.5) were found, ruling out collinearity. For each lethal (killing, being asked to kill, asking others to kill, hypothetical killing), commercial (selling, hypothetical selling), consumer (buying, owning, hypothetical owning), and tolerant behaviour, I ran logistic mixed effects generalized linear models, implemented through the package lme4 in R (Bates et al., 2015), with study area and village as nested random effects, and estimated 'Wald' confidence intervals (Fig. 4.3, Appendix 2). Estimates are presented for each specific behaviour and no grouping of behaviours was undertaken.

4.3 Results

4.3.1 Sample characteristics:

I interviewed 1107 people in 36 villages of my four study areas. Thirty five percent of my participants lived in villages in the Rurrenabaque study area, followed by Trinidad (33.9%), Riberalta (20.4%) and Cobija (11%). Village distance from the main urban centres ranged from 11 to 150 km, averaging 70

km, and from two to 196 km from protected areas, averaging 80 km. Over half of my participants were women (55%), and their age ranged between 18 and 89, averaging 42. The most common economic activity was hunting and fishing (44.4%), followed by employment in small businesses or public services (e.g. village health or education workers) or technical jobs (31.%), small scale agriculture and non-timber forest product collection (predominantly Brazilian nut - *Bertholletia excelsa, 30.3%*), and cattle ranching (5.8%). Education and income levels were predominantly low, with 35% having only primary education, and 40% having salaries below the minimum wage (Table 4.2).

Table 4.2: Percentages of categories corresponding to response and predictor variables used in logistic mixed effects generalized linear models relating to jaguar killing, trading and consuming. Categories do not add up to 100% for non-mutually exclusive categories.

Type	Variable	Category	Percentage (n=1107)
Response variables			
Behaviours	Owned	Yes	42.1%
	Killed	Yes	18.6%
	Sold	Yes	14.6%
	Bought	Yes	13.1%
Requests to Kill	Being Asked to Kill	Yes	24.3%
	Asking Others to Kill	Yes	15.5%
Intended Reactions to an Encounter	Hide and do nothing	Yes	51.9%
	Kill and sell	Yes	21.3%
	Just kill	Yes	16.8%
	Kill and keep	Yes	9.9%
Predictors			
Socioeconomic and Demographic Characteristics	Gender	Female	54.7%
		Male	45.3%
	Livelihoods	Hunting or Fishing	44.4%
		Other jobs	31.3%
		Agriculture or NTFP	30.3%
		Livestock	5.8%
	Income ($Bolivians/week)	$500 (Low)	39.9%
		Prefer not to respond	25.0%
		$1000 (Med)	25.0%
		$2000 (High)	10.0%
	Age (Years)	Average(SD)	42(16)
	Education (Years)	Average(SD)	10(3.6)
Perceptions and Attitudes	Perceived changes in abundance	Decreased	47.4%
		Same	12.1%
		Increased	40.5%
	Perceived risk of an attack on humans	Don't know	19.4%
		Low	47.3%
		Medium	18.0%
		High	15.3%

	Opinion about killing	Good	52.1%
		Neutral	29.7%
		Bad	18.2%
Past Experiences	Attacks on humans	Never heard	40.5%
		Attacked strangers	33.8%
		Attacked community	15.1%
		Attacked Family/Self	10.7%
	Depredation	No depredation	22.3%
		Affected community	52.9%
		Affected Family/Self	24.8%
Market opportunities and costs	Trader types	Bolivians	44.4%
		Asian-descent	21.3%
		European-descent	14.5%
		Neighbouring countries	6.0%
	Price Awareness	Yes	27.4%
	Legality of killing	In self defence	61.5%
		Always	23.8%
		Never	14.7%

4.3.2 Local people's relationships with jaguars:

Participants held predominantly negative perceptions towards jaguars (75%), as shown by their choice of words to describe jaguars (Fig. 4.1). 'Fear' was the most common word, mentioned by 29% of my sample, followed by 'dangerous' (15%). Though less frequent, common positive words included 'pretty' (5%) and 'beautiful' (2%), while common neutral words included 'fierce' and 'wild', each representing 4% of the sample.

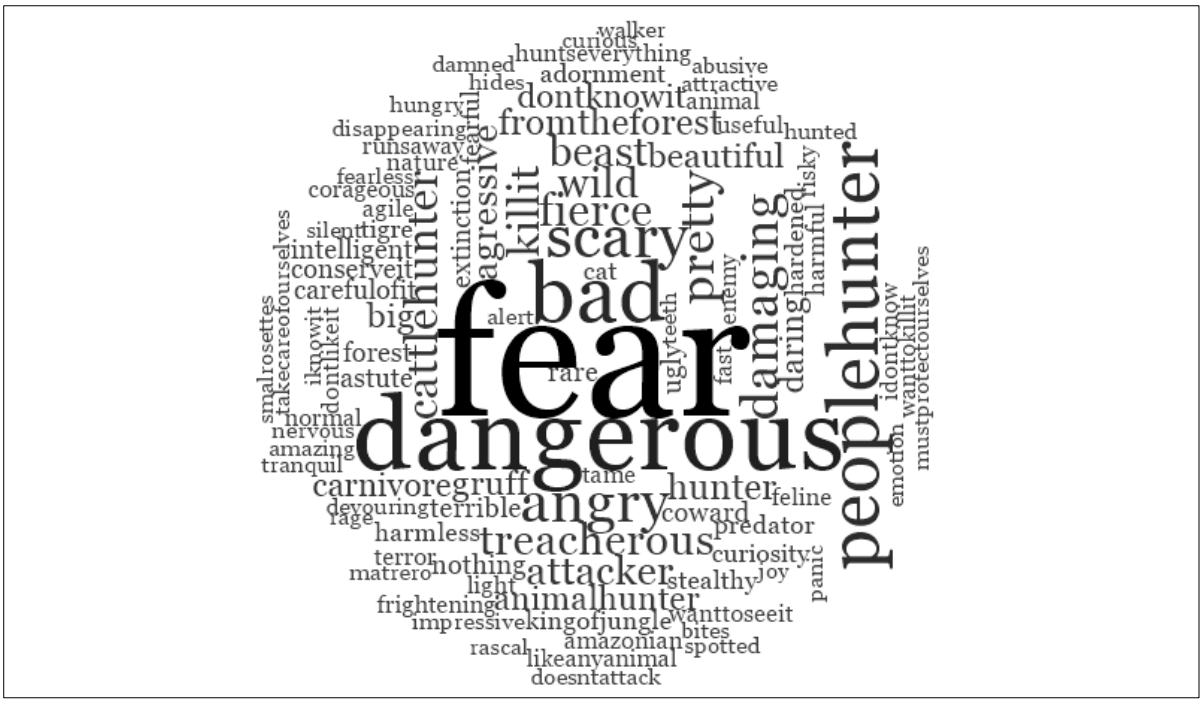


Figure 4.1: Word cloud of most common words concerning perceptions towards jaguars, meant as a preliminary visualisation rather than an empirical analysis.

I asked participants how many jaguars they thought existed in their community's territory. Thirty-four percent of participants thought that abundance was low (just one or two to about fifty individuals); 19% thought abundance was high (from 50 to over a thousand individuals); 15% thought there were no jaguars left while 31% did not know. While the concept of community territory is subjective and these numbers may or may not be in line with actual jaguar abundance estimate (Bolivia has an estimated mean density of 1.73 (CI 95% 1.38-2.08) individual jaguars per 100 km2, Jędrzejewski et al., 2018), they show the level of perceived threat and opportunity that local jaguar populations represent to people. Nearly half of respondents (47.4%) believed that jaguar populations are declining compared to previous years for reasons such as hunting, habitat loss, and human population expansion, while 40.5% felt they were increasing due to hunting prohibitions and jaguar reproduction (Table 4.2).

Negative perceptions translated into negative attitudes towards jaguars, with more than half participants (52.4%) preferring that jaguar populations decrease, due to fear and the harmfulness of jaguars (Table 4.2). While there was little support for an increase in jaguar populations (10.4%), participants who preferred this outcome referred to the jaguar's intrinsic right to live as part of nature and as an adornment to the forest, and its ecological role as a predator of dangerous or crop-raiding animals. Thirty-seven percent of participants said they would prefer jaguar populations to stay the same. More than half of participants (52.1%) thought that killing jaguars is a good thing, but some people (18.2%) mentioned that jaguar killing is unjustifiable when the animals do not pose a direct threat to humans or have not caused any damage (Table 4.2). Those against killing referred to the illegality of doing so, or stated that they felt sorry for the animals when they were shot.

The majority of participants (59.6%) were aware of incidents concerning jaguars attacking people within the past 10 years (Table 4.2). Most of these had happened to strangers (33.8%), and participants found out through word of mouth or through the radio. A smaller percentage described recent attack events involving members of their families (7.9%) or themselves (2.7%). Given that I cannot account for duplicates (e.g. many participants reporting a single incident, which is likely to occur in the small communities that I visited), the most precautionary estimate of attack rates is that related to the participants themselves. The reported jaguar attacks occurred while people were hunting for wild meat or harvesting Brazil nuts or other non-timber forest products. Participants who survived an attack mentioned that they were able to defend themselves by shooting the jaguar or using machetes or sticks. Despite the overall high level of awareness of jaguar attacks, about half of participants (47.3%) believed that the risk of an attack is low (Table 4.2).

Similarly, the majority of participants (77.7%) were aware of livestock depredation incidents involving a jaguar over the past 10 years. More than half of the events described had occurred to community

members or close acquaintances (52.9%), followed by the participant's families and themselves (24.8%, Table 4.2). Forty seven percent of the total reports of human-jaguar conflict involved cows, 33% involved pigs, 13% involved dogs, and 7% involved other animals like chicken, ducks, horses, goats and sheep (Fig. 4.2). Participants mentioned that the most common way of coping with depredation is through lethal control of jaguars. Livestock owners reported to have waited for the jaguar to return to feed on the attacked livestock carcass in order to shoot it from a short distance or to use dogs or gun traps to find and kill livestock-eating jaguars. Two percent of participants also reported knowing that wealthier ranchers pay from USD $100 to $300 to kill jaguars, requesting the skulls as proof. Several of the attacks on livestock, and particularly pigs, occurred while the animals were penned or corralled, and participants complained about the inefficiency of physical barriers in stopping attacks. Giving up on livestock, moving livestock to other areas, and even hiring traditional "healers" to repel jaguars, were other mechanisms used to keep jaguars away.

Figure 4.2: Negative interactions between people and jaguars. A) Jaguar killed due to depredation of pig and dogs and surveyed village in north-western Bolivia, B) Dog that survived jaguar attack. Photo credit: Melissa Arias and Anonymous.

I asked survey respondents whether they had experienced other kinds of contact with jaguars, in addition to attacks or depredation-related incidents in the past 10 years. Fifty-seven percent had seen a live jaguar in the wild, 38% had seen a dead jaguar that had been killed by a third party, while 5% had indirect experiences such as hearing a jaguar or seeing their tracks. Chance encounters with jaguars occurred inside forested areas, followed by water bodies and roads.

4.3.3 Awareness of market opportunities and costs

According to the 67% of participants who were aware of the existence of jaguar traders in and around their communities, the most common trader group was Bolivian nationals (including local radio broadcasters requesting jaguar body parts, 44.4%), followed by traders of Asian descent (including Chinese, Japanese, Korean and Thai backgrounds, as well as people described as Asian students, 21.3%). European-looking foreigners (described as tourists, wildlife collectors and religious missionaries) were the next most mentioned traders (14.5%), followed by regional foreigners from Latin American countries (including Brazil, Peru, Argentina, Chile, Paraguay, Venezuela, and Colombia, 6%). Awareness about the prices of jaguar body parts was also common amongst participants (27.4%).

The jaguar is listed as a 'vulnerable' species under Bolivian legislation, which makes it illegal to kill or trade jaguars and their body parts (Ayala and Wallace, 2009). However, the majority of participants (61.5%) believed that killing jaguars is legally allowed for self-defence and to protect domestic animals. The next largest percentage believed that there are no legal restrictions to killing jaguars (23.8%), followed by those who were aware of legal prohibitions to kill jaguars (14.7%, Table 4.2). The majority of participants (64%) were unaware of any authorities who handle jaguar-related issues, and only a few participants (12.2%) had heard of penalties or consequences related to killing or trading jaguars. According to those who were aware, a possible consequence for trading jaguar body parts is to have the body parts and weapons confiscated at road inspections, and to receive a warning. There was also awareness among this group about prison and financial penalties, after hearing news stories about the sentences given to Chinese jaguar traders in 2018.

4.3.4 Prevalence of jaguar killing, trading and consuming behaviours

When combining BBM and direct questioning answers, the most prevalent jaguar killing, trading or consuming behaviour was possessing jaguar body parts or live animals (42.1%), followed by killing (18.6%), selling (14.6%) and buying (13.1%) jaguar body parts. Additionally, some participants (24.3%) had been recruited to kill jaguars, or had asked somebody else to do so (15.5%). Although 51.9% of participants said they would react passively to a hypothetical jaguar encounter, other common reactions included wanting to kill jaguars to either sell or keep the body parts (48.1%).

The largest percentage of participants (27.6%) engaged in behaviours that can be classified as non-commercial because they involve no financial transactions, including possessing jaguar body parts or live animals ("possessors"; those who own jaguar body parts without purchasing them or without having personally killed a jaguar, described in greater detail in Chapter 5), those killing for non-commercial reasons or both (Table 4.3). The majority of possessors (73%) were aware of the presence of jaguar traders in or around their communities but chose to keep the jaguar body parts for themselves regardless. Those who act commercially represented 23.4% of my sample (Table 4.3). Meanwhile, messengers or recruiters who received or passed on requests to kill jaguars without undertaking any other actions represented 6% of my sample.

Table 4.3: Typology of actors behind jaguar killing, trading and consuming behaviours. These are not exhaustive categories, but cover all the main types of interactions in my dataset.

Type	Category	Description	Percentage (n=1107)
Not involved	Not involved	Does not engage in jaguar killing, owning, purchasing, selling or recruiting.	42.8%
Non-commercial	Possessor	Owns jaguar body parts without purchasing or killing (e.g. gifts, inheritance).	17.2%
	Killer	Kills jaguars but does not extract body parts (e.g. retaliation, self-defence killing).	6.2%

	Killing possessor	Kills jaguars and keeps the body parts for personal use (e.g. subsistence, cultural, retaliatory).	1.8%
	Indirect killer	Asks others to kill a jaguar for reasons other than trade or use (e.g. retaliation, fear).	2.4%
Commercial	Killing trader	Buys and sells jaguar body parts from others, while also killing jaguars.	9.0%
	Consumer	Buys jaguar body parts for personal use (e.g. cultural, medicinal).	7.3%
	Trader	Buys and sells jaguars body parts from others.	5.6%
	Killing consumer	Kills jaguars and buys the body parts for personal use (e.g. decoration, trophy).	1.5%
Messengers	Attempted recruit	Has been asked by others to kill a jaguar, but has not undertaken the action.	4.5%
	Messenger	Has been asked by others to kill a jaguar, and has asked others to do so, without undertaking the action.	1.5%

Although a larger percentage of participants was involved in non-commercial than commercial purposes, of the people who had killed jaguars (18.6%), more than half (56.4% of 116) had probably killed a jaguar for commercial reasons, as they had also sold jaguar body parts (Table 4.3). Nine percent of my sample (n=99) were traders who also killed jaguars. These may be key players because they participate throughout the jaguar trade chain. Killing traders were predominantly male (72% of 99) bushmeat hunters and fishers (75%). Thirty-six percent of them had experienced jaguar depredation events, 78% of them were aware of traders of multiple nationalities in their areas, and 70% of them had received a specific request to kill a jaguar (of which only 3%, or three individuals, had received requests from Asian traders). All killing traders reported that jaguars are killed by shooting, and 75% of them mentioned the use of targeted methods such as baiting, trapping, sound luring or poisoning.

4.3.5 Drivers of jaguar killing, trading and consuming

I found several similarities, but also important differences in the drivers of behaviours pertaining to jaguar killing, trading and consuming (Fig. 4.3). Of the socioeconomic variables, men were more likely to engage in killing (OR 2.36, CI 1.50-3.70) and selling (OR 1.83, CI 1.12-2.97) behaviours, and were also more likely to be asked to kill a jaguar (OR 1.76, CI 1.19-2.61), and to have the intention to kill (OR

2.66, CI 1.72-4.14), sell (OR 2.11, CI 1.38-3.21) or possess (OR 2.74, CI 1.55-4.85) jaguar body parts (Appendix 2). Bushmeat hunting and fishing livelihoods increased the odds of killing (OR 2.11, CI 1.43-3.12, and of related behaviours such as being asked or asking to kill) and selling (OR 1.89, CI 1.22-2.92), but significantly reduced the odds of buying jaguar body parts (OR 0.58, CI 0.37-0.92). This suggests that bushmeat hunters and fishers act as suppliers of jaguar body parts in my study areas. Agricultural and livestock ranching livelihoods led to higher odds of killing (OR 1.61, CI 1.03-2.51), but were not strong predictors of any commercial jaguar uses. Ranchers were also more inclined to want to possess jaguar body parts (OR 2.24, CI 1.06-4.70), and less likely to react passively to a hypothetical encounter with a jaguar (OR 0.47, CI 0.24-0.91). Low incomes led to a reduced likelihood of purchasing (OR 0.54, CI 0.32-0.90) and to an increased interest in selling (OR 1.58, CI 1.02-2.46) jaguar body parts, but income did not significantly affect any other behaviours, and neither did education levels (Fig. 4.3). Age had a significant negative relationship with selling (OR 0.74, CI 0.60-0.92) and with both recruiting behaviours (being asked, OR 0.75, CI 0.63-0.89, or asking to kill, OR 0.76, CI 0.62-0.94), which suggests that younger participants were more likely to be suppliers of jaguar body parts.

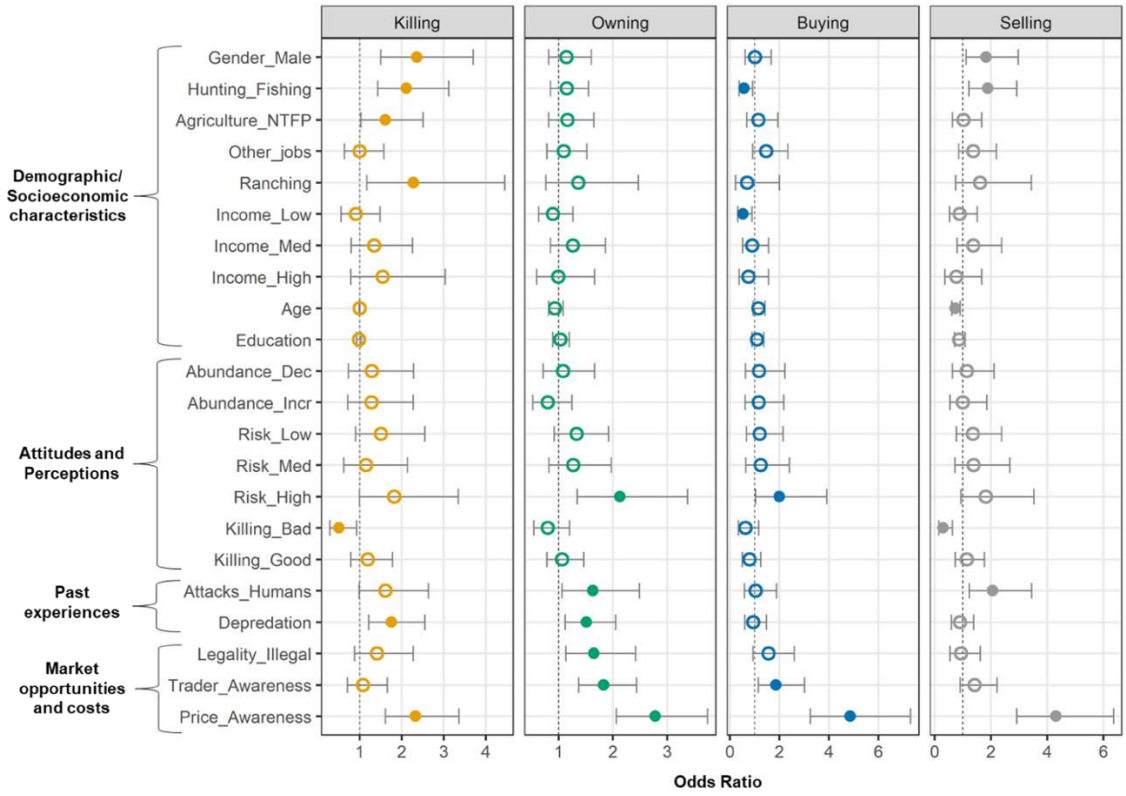


Figure 4.3: Odds Ratios and 95% confidence intervals of predictors of jaguar killing, owning, buying and selling behaviours. Values above or below one indicate whether predictors are associated with higher or lower odds of each behaviour, respectively. Solid circles represent statistical significance ($p<0.05$).

Socio-psychological factors like perceptions and attitudes towards jaguars were generally not strong predictors of any of these behaviours, with a few exceptions (Fig. 4.3). For example, the perception that there are high risks of jaguar attacks on humans was associated with higher odds of owning (OR 2.13, CI 1.34-3.38) and buying (OR 2.01, CI 1.04-3.92) jaguar body parts. Participants who perceived the killing of jaguars as wrong, were also less likely to kill a jaguar and sell jaguar body parts (OR 0.30, CI 0.14-0.62), and more likely to have tolerant behaviours towards jaguars (OR 1.66, CI 1.11-2.47, Fig. 4.3).

Of the predictors pertaining to past experiences with jaguars, participants who had been previously attacked by jaguars (themselves or their families) were significantly more likely to have sold (OR 2.06,

CI 1.23-3.45) or possessed (OR 1.63, CI 1.06-2.49) jaguar body parts than those who had not (Fig. 4.3). Similarly, those who experienced jaguar depredation events were significantly more likely to have killed (OR 1.76, CI 1.22-2.55) and possessed (OR 1.51, CI 1.12-2.05) jaguar body parts, and less likely to have reacted passively (OR 0.71, CI 0.51-0.99) to jaguar encounters. However, the fact that they were not significantly more likely to engage in trading behaviours suggests that not all retaliatory jaguar killing leads to trade.

Variables related to market costs and opportunities were important predictors of the behaviours of interest. Awareness of the presence of jaguar traders in and around participants' communities was significantly associated with buying (OR 1.86, CI 1.15-3.01) and owning (OR 1.83, CI 1.37-2.44) jaguar body parts and it stimulated messenger or recruiting behaviours (being asked to kill, OR 1.99, CI 1.36-2.92, asking others to kill, OR 1.71, CI 1.12-2.63). However, the fact that it was not associated with a higher likelihood of lethal or trade behaviours suggests that awareness of the opportunity for trade is not in itself enough to lead to trade in my study areas. On the other hand, awareness of the price of jaguar body parts was strongly and significantly associated with all jaguar killing (OR 2.33, CI 1.61-3.36), trading (OR 4.31, CI 2.92-6.36) and consuming (OR 4.87, CI 3.25-7.30) behaviours. Awareness of the illegality of engaging in any of the behaviours of interest did not affect participants' reported actions, except that those who were aware of illegality were more likely to own jaguar body parts (OR 1.65, CI 1.13-2.42) and also more likely to tolerate jaguars (OR 0.43, CI 0.27-0.68) if encountered.

4.4 Discussion

Previous studies have suggested that human-jaguar conflict caused by livestock depredation by jaguars may be an underlying cause of jaguar trade because farmers and ranchers who resort to lethal control may have an added incentive to sell the parts as compensation for their losses (Jędrzejewski

et al., 2017; Reuter et al., 2018b). The link between commercial and retaliatory killing has also been proposed for other felids (Everatt et al., 2019; Li and Lu, 2014). The high value of felid body parts in domestic and foreign markets, and their simultaneous status as threats to livestock and humans, mean that these two drivers of felid killing are often intertwined (Jędrzejewski et al., 2017). Commercial trade can act as both a by-product of retaliatory killing and an incentive for it, but the pathways of causality can be difficult to untangle. In separating the different behaviours related to jaguar trade (killing, trade and consumption), I began to unfold this relationship. I found that even though ranching livelihoods and livestock depredation by jaguars strongly explained jaguar killing, and about a third of killing traders had killed jaguars in the context of retaliation, both ranching and conflict were not strong predictors of commercial behaviours in my sites. This means that conflict is just one aspect of jaguar trade, rather than its underlying cause. I call for a more integrated investigation of the links between felid trade and conflict, considering that their interrelatedness may vary across species and geographies, influencing the effectiveness of conservation efforts to reduce felid mortality.

I show that, commercial behaviours are likely to be more strongly driven by a combination of opportunism and market incentives than human-jaguar conflict. Whether they kill jaguars intentionally or opportunistically, bushmeat hunters and fishers were strongly associated with trade in jaguar body parts in my study sites. Bushmeat hunters, in particular, possess the necessary skills, experience, capacity and equipment (e.g. shotguns) that enable them to kill jaguars. As providers and protectors in local communities, they are also likely to count with the social acceptability and legitimacy to kill wildlife that is perceived as dangerous or damaging (Carvalho, 2019). Given their knowledge of, and time spent in, jaguar habitat, bushmeat hunters have increased opportunities of encountering jaguars, having prime access to the resource, which may otherwise be restricted. While a large portion of the trade may be rooted in chance encounters between bushmeat hunters and jaguars (opportunism), I also found signs that market incentives might be leading to targeted hunting

of jaguars. Not only were bushmeat hunters and other killing traders more likely to be aware of the presence of jaguar traders (both foreign and local) in their villages, and to know the prices of jaguar body parts, but many of them had been specifically recruited to kill jaguars, and mentioned the use of targeted jaguar hunting methods such as baits and traps. These behaviours took place in the absence of law awareness, as shown in my survey, but also due to deficiencies in law enforcement, coinciding with Knox et al. (2019). This combination of actor and opportunity-based drivers coincides with the Routine Activity Theory (Eliason, 2012), which explains that crimes are likely to occur when capable and motivated offenders (e.g. bushmeat hunters incentivized by the market) meet suitable targets (e.g. jaguars) in the absence of guardianship factors (e.g. ineffective enforcement, Carter et al., 2017). Thus, my study sites appear to have the optimal conditions for jaguar killing and trading to thrive if these drivers are not addressed.

The dominant role of non-commercial behaviours in my study areas emphasizes the domestic, cultural and traditional side of jaguar trade. Most jaguar body parts have traditional uses, which may be related to decorative, medicinal, cultural or nutritional purposes (as shown in Chapter 3). This broad range of longstanding values position jaguars as 'cultural keystone species' (Garibaldi and Turner, 2004). This cultural relationship with jaguars, manifested through the use of jaguar body parts, also means that a large portion of the demand for jaguar body parts is domestic. In particular, the large amount (17.2%) of possessors in my sample, many of whom were simultaneously aware of the existence of a market for jaguar body parts, shows that the desire to keep jaguar body parts may sometimes outweigh the need or interest to sell. This is in contrast to studies that have characterized jaguar trade as Chinese-driven based on seizure data (e.g. Morcatty et al., 2020; Nunez and Aliaga-Rossel, 2017). Although these seizures remain a concern, and may indicate an emerging trend of externally driven commodification and export of jaguars, this discrepancy reiterates the importance of considering multiple evidence sources and of investigating these behaviours on the ground.

My findings highlight topics that deserve further research and conservation attention to address jaguar killing, trade and consumption. Given the preponderance of non-commercial behaviours, investigating contemporary jaguar uses from both an anthropological and an ecological perspective is necessary. Traditional uses threaten hundreds of species worldwide (de Vasconcellos Pegas et al., 2015), but they can also play an important role in species protection by incentivizing sustainable and long-lasting use of wildlife resources (Dickman and Hazzah, 2015). As traditional jaguar uses are currently illegal for non-indigenous communities in Bolivia (Ministry of Environment and Water, 2020), which include most of my participants, achieving conservation gains may require opening a more inclusive dialogue about the cultural importance and conservation implications of these behaviours. Since most human-wildlife conflict has roots in human-human conflict, such as the establishment of illegitimate or unrealistic prohibitions (Peterson et al., 2010), failing to account for these traditional jaguar uses, or criminalizing them, can hinder the path towards human-jaguar coexistence by alienating local communities (Duffy et al., 2016).

Given that jaguar trade was closely linked to wildlife hunting more generally, working with local communities is also necessary to reduce their reliance on wildlife hunting and trading. Increasing the benefits and financial gains from conserving wildlife in contrast to those from engaging in illegal wildlife trade are potential ways forward (Cooney et al., 2017). It is also worth highlighting that, while most participants held negative perceptions and attitudes towards jaguars, positive attitudes (e.g. believing that killing jaguars is wrong) led to reduced engagement with jaguar killing and trading, and increased tolerance to jaguars. This suggests that shifting attitudes through awareness and education, taking advantage of the already strong cultural and symbolic meaning of jaguars in these communities, may be an effective way to address these behaviours, as shown by other studies (Engel et al., 2017; Marchini and Macdonald, 2020). However, the simultaneous existence of commercial and non-

commercial interests behind the jaguar trade, and of domestic and foreign markets, means that further efforts should also focus on understanding market dynamics. Determining whether the system is supply or demand driven is necessary, and requires exploring the temporal variation in the price and quantity of the traded parts, in hunting effort, in trader networks, and in the condition of jaguar populations (McNamara et al., 2016). While increasing awareness and enforcement of laws may go a long way (given that many of my participants were unaware about jaguar protections), it may not be enough to stop jaguar killing and trading due to strong market incentives, a high prevalence of human-jaguar conflict, financial need, and the potential ties between trade and corruption (Challender and MacMillan, 2014; Morcatty et al., 2020). Future research would also benefit from adopting a socio-ecological systems approach, as suggested by Carter et al. (2017) and Lischka et al. (2018), to explore the role of the wider social and institutional context (such as social norms, as considered by Knox et al., 2019), as well as of jaguar behaviour, ecology and landscape dynamics.

To conclude, my findings suggest that jaguar killing, trading and consuming behaviours are related but also separate actions, which are often carried out by different individuals and influenced by different underlying drivers, including human-jaguar conflict, opportunism, market incentives and culture. I highlight that these drivers, and their interactions, must be considered together to more effectively understand and address jaguar trade, and to enable coexistence with jaguars over the long term.

In this chapter, I described the relationship between humans and jaguars in north-western Bolivia, and the multiple and complex drivers behind engagement with the illegal trade in jaguars in the communities I visited. The next chapter takes us to my second study region, Mesoamerica, and explores the characteristics of the illegal trade in jaguars at the other extreme of the jaguar range, from the perspective of key informants.

Chapter 5

Characteristics of, and uncertainties about, illegal jaguar trade in Belize and Guatemala

Tikal Temple I, also known as the “Temple of the Great Jaguar” of the pre-Columbian Maya civilization, located near a study site in the Maya Biosphere Reserve, Guatemala.

Abstract

Recent reports of jaguar trade have emerged throughout Latin America, but, although trade is now considered a high-priority threat to jaguars, its characteristics remain largely unknown. I aimed to gain a deeper understanding of the status of jaguar trade in Mesoamerica, focusing on Belize and Guatemala. I used key-informant interviews to explore the pathways behind the jaguar trade chain, identify the characteristics and motivations of the actors involved, and investigate the drivers and enabling factors behind jaguar trade. I distinguished between concrete evidence and strong beliefs or assumptions, thereby highlighting key areas for conservation action and of uncertainty. My results suggest that jaguar trade is present in Belize and Guatemala, although current examples suggest it is a domestically-focused and opportunistic activity, rather than an organized international trade. Key drivers included human-wildlife conflict, opportunistic hunting, Chinese demand, drug trafficking, migration, and tourism. The areas of higher uncertainty are the role of external actors and drivers, and of commercial motivations. The main legal and institutional challenges to address this threat include the lack of resources, ineffectiveness of law enforcement, animosities between communities and the government, corruption, outdated legal systems, missing evidence, the lack of mandate of wildlife authorities and safety concerns. Key priorities for conservation interventions and research to prevent jaguar trade from escalating in these countries are to invest in local communities living in proximity to jaguars, while also investigating the role of external actors in jaguar trade, which remained largely uncertain throughout this study.

5.1 Introduction

Illegal Wildlife Trade (IWT) is one of the most pressing global conservation issues, affecting thousands of species worldwide, with repercussions for biodiversity, the environment and human health and wellbeing (’t Sas-Rolfes et al., 2019). IWT has become one of the most profitable illicit sectors, worth billions of dollars per year (May and Clough, 2017). It is often associated with criminal networks, with important implications for national security (Nellemann et al., 2014; Zimmerman, 2003). Despite increased investments to strengthen enforcement and curb the demand for wildlife products, IWT continues to escalate and expand into new markets (UNODC, 2016), enabled by factors like poverty, corruption, and a lack of institutional capacity, legislation, enforcement and community engagement (Harrison et al., 2015; Nellemann et al., 2014). To date, most efforts to understand and address IWT have focused on Africa and Asia, where megafauna such as elephants and tigers are declining due to demand from Asian markets (Sanderson et al., 2010; Wittemyer et al., 2014). Less attention has been given to the issue in Latin America, which represents less than 10% of peer-reviewed literature on illegal wildlife harvesting published between 1990-2014 (Kahler and Gore, 2017), leaving important gaps in our understanding of IWT in the region (Reuter et al., 2018a).

Among these gaps is the recent trade in jaguars (*Panthera onca)* for domestic and international markets. Jaguars have had a long history of exploitation and trade by numerous indigenous civilizations in Central and South America, being part of their cultural symbolism since pre-colonial times (Laffoon et al., 2014; Saunders, 1998). Beyond their traditional value, jaguars were legally hunted through most of the 20th century for the international fur industry, until they were listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1975, thereby halting legal commercial international trade (CITES, 2017). Even though killing, possessing or commercializing jaguars and their body parts is prohibited in most of the jaguar range

(Quigley et al., 2017), it still occurs, mainly in the context of retaliation to livestock depredation by jaguars (which I refer to as human-jaguar conflict in the remaining of the text). While human-jaguar conflict has become a fairly well documented threat to jaguar populations (Inskip and Zimmermann, 2009), the trade in jaguar body parts has received less attention. Most existing reports of jaguar use and trade are secondary findings in studies of human-jaguar conflict or jaguar distributions (e.g. Briones-Salas et al., 2012; Figel et al., 2016).

Recently, however, jaguar trade has begun to draw the interest of conservation researchers, practitioners and governments following the emergence of evidence linking the trade with Asian demand. In Bolivia, authorities intercepted hundreds of jaguar teeth destined for China between 2014 and 2017 (Nunez and Aliaga-Rossel, 2017). Soon afterwards came reports of Chinese demand for jaguar bone-paste medicine in Suriname (Lemieux and Bruschi, 2019; Verheij, 2019). These high-profile cases revealed widespread evidence of trade of jaguar body parts (Morcatty et al., 2020). In Mesoamerica, Harmsen & Urbina (2017) found concrete evidence of jaguar body part ownership in the main cities of Belize. Kelly (2018) identified links between possession of jaguar body parts, wealth and masculine identity in urban areas of Costa Rica, and Reuter et al. (2018b) hypothesized that human-jaguar conflict and Chinese presence may be acting as drivers of jaguar trade throughout Mesoamerica. However, these authors highlighted information gaps concerning the drivers, enabling factors and characteristics of jaguar trade in Mesoamerica.

I therefore aimed to gain a deeper understanding of the status of jaguar trade in Mesoamerica. Focusing on Belize and Guatemala as case studies, I analysed recent examples of jaguar trade from key informant interviews to delineate the pathways behind the jaguar trade chain, develop typologies of trade actors, and explore their motivations. I also investigated the broader drivers and enabling factors of jaguar trade, to pinpoint key opportunities for conservation interventions in these countries.

Throughout this exploratory analysis, I placed a particular emphasis on distinguishing between concrete evidence and strong beliefs or assumptions, thereby highlighting critical points of uncertainty about the jaguar trade.

5.2 Methods

5.2.1 Study sites

I selected Belize and Guatemala due to anecdotal and official reports of jaguar trade. In addition, they contain critical fragments of Mesoamerican jaguar habitat. Moreover, high levels of corruption and organized crime, linked to drug trafficking, may facilitate IWT (van Uhm and Moreto, 2018; Zimmerman, 2003). Both countries have recently been implicated in high-profile IWT cases, including scarlet macaws (*Ara macao*) and rosewood (*Dalbergia spp.;* Guo, 2019; Soberanes, 2019). I focused on the main urban centres of Belize's Cayo, Toledo and Belize districts (Belmopan, Punta Gorda and Belize City, respectively), and Guatemala's Petén, Izabal and Guatemala departments (Flores, Puerto Barrios and Guatemala City, respectively), where most key informants were based (Fig. 5.1).

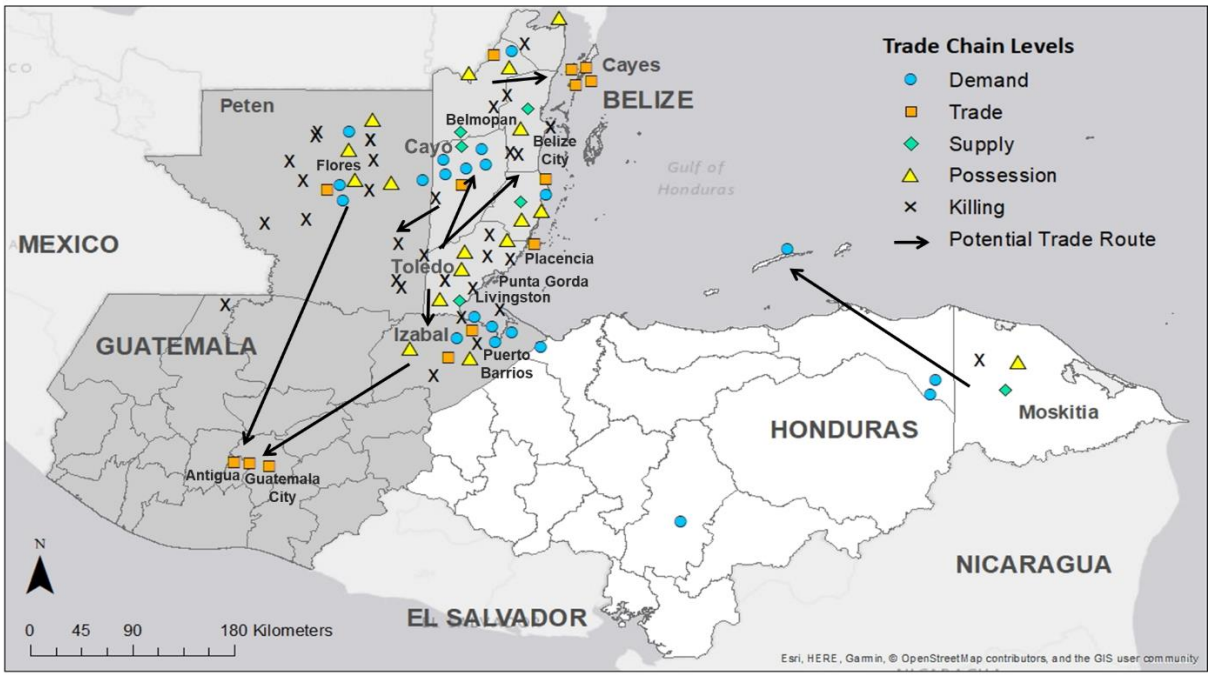


Figure 5.1: Map of geographically-specified (with point offset) concrete and anecdotal jaguar trade incidents according to the levels of the jaguar trade chain, with arrows showing potential jaguar trade routes. Interviews took place in Guatemala City, Flores, Belmopan, Belize City, Punta Gorda and Puerto Barrios.

5.2.2 Key informant interviews

I conducted 41 semi-structured key informant interviews with conservation specialists who were likely to have access to information about jaguar trade and IWT. Key informant interviews are recommended for exploratory studies like this one (Newing, 2011), where the goal was to determine the existence of jaguar trade in these countries, while also obtaining an in-depth understanding on how jaguar trade is viewed and described by conservation specialists. This means that my results are based on the perspectives and knowledge of my interviewees in their geographical areas, and therefore not transferable beyond these locations, and are subject to interview biases (Martin et al., 2012). I used semi-structured interviews with a standard interview guide (Appendix 3) to maintain comparability across interviews, while also retaining the flexibility to ask follow up questions relevant to each interviewee's expertise (Newing, 2011; Young et al., 2018).

I interviewed key informants from Belize (n=17) and Guatemala (n=22), including jaguar scientists (n=3), wildlife rescue centre directors (n=4), NGO staff involved in jaguar conservation (n=19), protected area managers (n=5), as well as government and law enforcement representatives (n=10), from 20 different institutions. I also interviewed two people based in Honduras through Skype to gain a broader picture of the position of Belize and Guatemala in regional trade. I first identified key informants through an internet search of IWT cases and jaguar conservation initiatives in both countries, focusing on academic publications, grey literature and news reports. I also consulted my local partners, WCS Mesoamerica, to ensure that I had a comprehensive list of participants working on these topics. I approached 48 potential key informants by email and invited them to suggest additional people within their network who may be knowledgeable on the subject under investigation, adding five people to the list through snowball sampling. Out of 53 people contacted, 41 agreed to participate and were interviewed in person (n=36) or via Skype (n=5) from September-November 2018. The one-hour interviews were audio-recorded upon obtaining written or oral consent from participants, but participant identity is kept confidential. The study was approved by the Central University Research Ethics Committee of Oxford University (Reference number: R59134/RE001).

I began the interviews with an open-ended discussion of the key informant's experience working with jaguars, human-jaguar conflict, or IWT more generally. Then, interviewees discussed jaguar trade incidents that they were aware of, making specific reference to; the circumstances leading to jaguar killing, the routes and markets for jaguar items, as well as the characteristics and motivations of those involved in jaguar trade. I also asked interviewees to describe the law enforcement processes relating to IWT in their geographic areas of expertise, as well as the institutional strengths and weaknesses affecting this issue (Appendix 3). Interviewees were prompted to state how certain or uncertain they felt about each specific answer.

5.2.3 Interview analysis

I annotated, transcribed and coded all interviews using NVivo qualitative data analysis software (QSR International Pty Ltd. Version 12 Pro, 2018). I created an initial set of hierarchical thematic nodes (also referred to as thematic codes), based on the interview questions, while other thematic nodes and sub-nodes were added inductively through the iterative coding process based on the interview responses. In order to test the reliability of my coding, another member of the research team coded a randomly selected 10% of the interviews. Following initial independent coding, the two coders discussed reasons for any discrepancies and then independently recoded the sample. I used the Cohen's Kappa statistic to test for inter-coder consistency in this recoding, which had a value of 0.89 or excellent agreement. Following the guidelines for thematic analysis offered by Braun and Clarke (2006), Newing (2011) and Saldana (2016), I then searched for patterns and emerging themes in the data, merging or separating thematic nodes as necessary. My main top-level thematic categories, which reflect how my interviewees understood the trade and my interpretation of their examples based on key IWT literature, included jaguar trade characteristics (e.g. body parts used, methods used to kill and trade, and routes), actor types and motivations (with reference to published IWT typologies, including; Muth and Bowe, 1998; Phelps et al., 2016; Thomas-Walters et al., 2020), drivers and enabling factors of jaguar trade. I defined the latter two as "forces, conditions or factors that lead people to behave in a particular way" (TRAFFIC, 2008) and that influence jaguar trade directly and indirectly, respectively.

Where relevant, I present results in terms of number of participants who mentioned a specific theme, or the number of references made by the interviewees on a particular theme. A "reference" is an individual comment, opinion, or a specific instance of jaguar trade given by an interviewee. This definition remained consistent throughout the analysis. I ensured that all references that described

specific jaguar trade examples were independent of each other by using details like dates, numbers, locations, and product descriptions to exclude any duplicates. By prompting participants to state their certainty in their answers throughout the interview, I was able to separate references into concrete examples or strong beliefs. Concrete examples refer to recent jaguar trade incidents that interviewees personally witnessed or heard about from a trusted source (e.g. work colleagues or the local communities where they work). I defined "recent" as less than 10 years ago. Strong beliefs are anecdotal accounts, or assumptions made from personal experience without providing specific examples. Whenever the incidents contained geographical information, I geo-referenced them to the nearest town (Fig. 5.1).

5.3 Results

5.3.1 Jaguar trade actors

One set of key players are jaguar body part 'possessors', which broadly encompass subsistence, opportunist, recreational or reactionary harvesters found in Phelps et al. (2016). When they obtain jaguars or their body parts (either actively by harvesting or passively by inheriting or gifting), possessors choose to retain them for their own use, generally as decoration, trophies, or food, without undertaking any financial transaction. Although possessors own jaguar body parts, they are not involved in the jaguar trade chain because they do not sell or buy the body parts. Based on 39 concrete references (Fig. 5.2), possessors are primarily rural villagers, including farmers, ranchers, hunters and indigenous communities (which sometimes overlap). Although unsubstantiated, one interviewee also strongly believed that members of the Chinese diaspora and regional immigrants acted as possessors. If possessors sell their jaguar body parts, they enter the trade chain, becoming commercial harvesters (suppliers) or intermediaries.

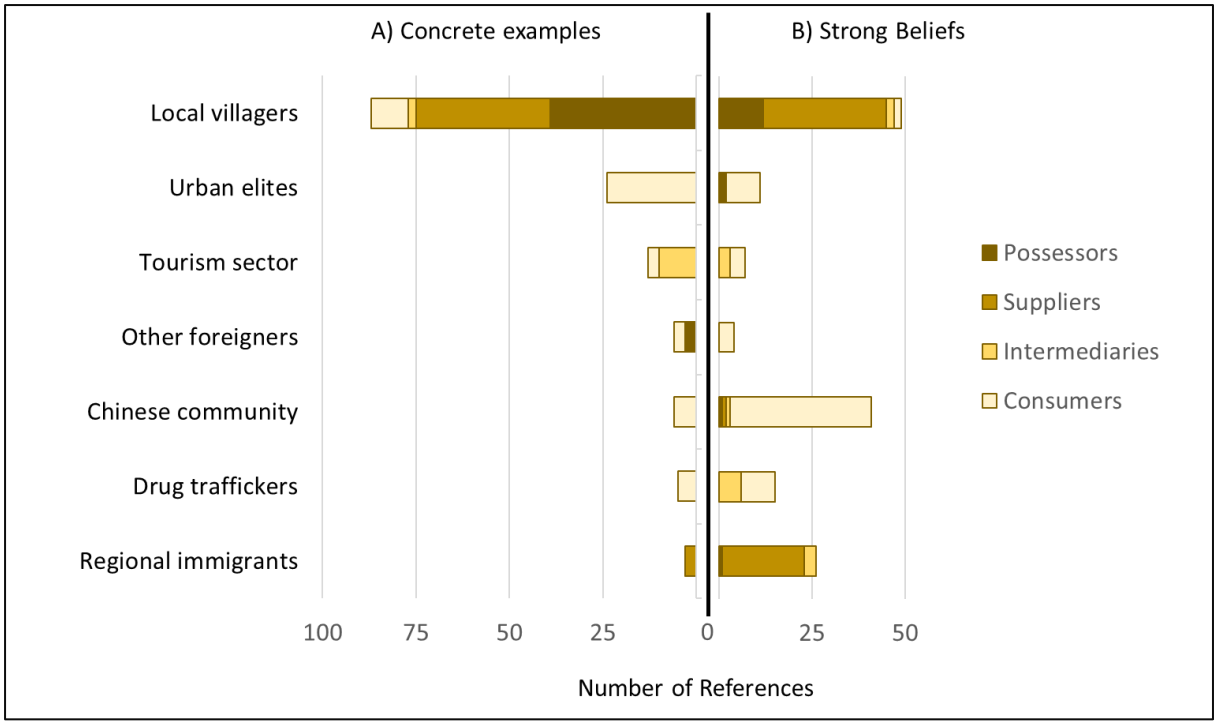


Figure 5.2: Number of references (independent comments, n=297) made by 38 interviewees to the characteristics of jaguar body part possessors, suppliers, intermediaries and consumers, separated by concrete examples (Panel A) and strong beliefs (Panel B).

Commercial harvesters or 'suppliers' are people who kill jaguars (or capture live jaguars) and then trade them or their body parts, rather than keeping them. Suppliers belong to similar actor groups as possessors (e.g. rural villagers), but unlike for possessors, regional immigrants (immigrants from neighbouring countries like Honduras, El Salvador) were also included in the supply of jaguar body parts (n=3; Fig. 5.2). Meanwhile, 'intermediaries' transfer jaguar body parts from suppliers to consumers. Although in the majority of the events described, jaguar trade chains were simple, involving a direct transaction between suppliers and consumers (network type "b" in Phelps et al., 2016), there were a few cases which included intermediaries. For example, the tourism sector (including tourist guides, souvenir shops, and resorts) was confirmed to act as a logistical intermediary based on 10 concrete examples, although the demographics of tourist consumers remain unknown (Table 5.1). In contrast, regional immigrants and drug traffickers were suspected to act as intermediaries (n=6), without concrete evidence. 'Consumers' of jaguar body parts purchase the items

from a supplier or intermediary. Although most of the concrete examples of demand for jaguar body parts involved urban elites and wealthier villagers (n=24), the consumer group to which the largest number of references made was the Chinese community (n=44), even though only 14% of those references were concrete examples. Another often-mentioned consumer group was other foreigners (n=7), drug traffickers in Guatemala (n=14), as well as tourists (n=7), with varying certainty levels (Fig. 5.2).

5.3.2 Motivations for trade

The jaguar trade chain starts with the death or trade of a jaguar (n=232 references, of which 52% were concrete examples), which can occur for commercial (13%) or non-commercial purposes (41%), or with no explicit motivation (46%; Fig. 5.3). When a jaguar is specifically targeted and killed for commercial gain, its body parts are intentionally traded. Non-commercial targeted killing (n=96) includes protection of self and property (e.g. animals killed in retaliation for livestock losses, 58%), recreational satisfactions, trophy poaching or thrill killing (6%) or due to fear (4%). Jaguars can also be killed during opportunistic encounters with hunters (31%). Those involved in non-commercial targeted or opportunistic jaguar killing must then decide whether to: abandon the carcass or report it to the authorities (n=23); engage in opportunistic trading, becoming suppliers (n=107); or keep the parts for personal use, becoming possessors (n=69).

According to the interviews, the motivations for either purchasing or keeping jaguar body parts are quite similar (shared motivations, n=176). In most cases, jaguar teeth and skins are used for ornamental purposes such as personal and home decoration, as trophies and symbols of bravery and power (64%). Other shared motivations include food consumption (19%), spiritual or cultural beliefs (such as traditional dances, 5%), medicine for muscle pain and rheumatism (jaguar fat, 3%), or

relational purposes (9%). Motivations that were unique to consumers (n=31) were keeping jaguars in private collections or zoos (52%), purchasing gifts or souvenirs (42%), or 'rescuing' cubs out of pity (6%). Meanwhile, the only motivation that was unique to possessors (n=2) was using jaguar fat for repelling crop-raiding animals. Commercial jaguar killing, trading and purchasing were not only less common than their non-commercial equivalents, but also more uncertain, having a larger proportion of strong beliefs than concrete examples (Fig. 5.3).

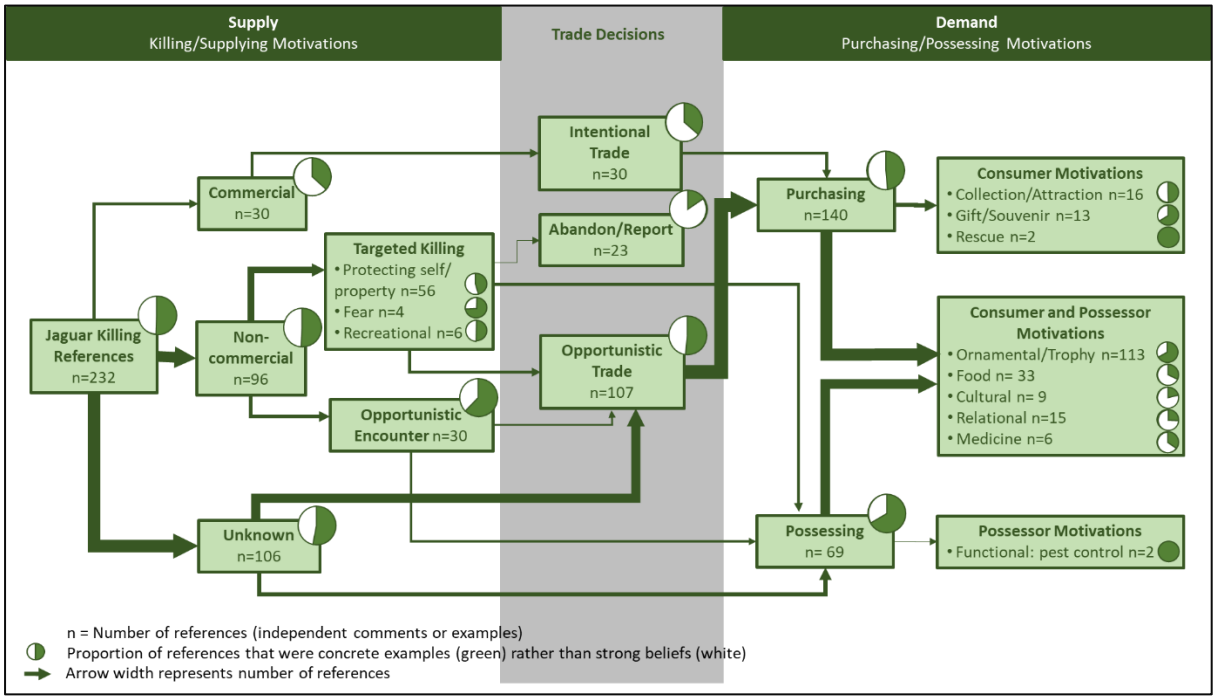


Figure 5.3: Flowchart of jaguar trading motivations based on the number of recent (<10 years), independent jaguar killing references (n=232) made by interviewees (n=35), including uncertainty, represented in circles.

5.3.3 Body parts used

Of the 232 references in Fig. 5.3, 34% referred to teeth, followed by skin (20%), live animals (20%), meat (16%), complete carcasses (6%), claws and paws (2%), fat (1%) and bones (1%) (Fig. 5.4). The prices of jaguar body parts, which were described by 13 interviewees, were highly variable. Jaguar

teeth ranged from US$5 to US$250, depending on whether they were raw or worked (e.g. carved or set), their geographical distance to markets and buyers, and on the supplier's understanding of the market. This vast price difference indicates that a large portion of the profits from selling jaguar teeth is likely to accrue to the intermediaries rather than to the rural suppliers. Eight interviewees had either personally witnessed a jaguar-skinning event or had confiscated jaguar skins, which had an average price of US$120. Jaguar meat consumption was also mentioned, with five interviewees having witnessed villagers selling jaguar meat, and one having personally eaten jaguar organs (more than 10 years ago);

"as a blessing, so that nobody will try to harm you, and you will be brave enough, and nobody will let you down. You will speak up and become a good leader and roam the area without being afraid of anything that you encounter" (I34).

One interviewee also mentioned that Maya communities traditionally use jaguar paws and bones to heal rheumatism and joint pain, and jaguar fat to keep crop raiding wildlife away from farms. Although unconfirmed, six interviewees had heard that specific Chinese restaurants in Belize sell jaguar meat and pay hunters up to US$1000 for a jaguar carcass. Finally, six interviewees provided recent concrete examples of wild-origin jaguar cubs that were traded as pets or kept as attractions in private collections, zoos or circuses. Only one interviewee was familiar with the price of live jaguar cubs, which was US$325.

Figure 5.4: Jaguar body parts seized by authorities in Mesoamerica. A) Jaguar taxidermy seized in Izabal, Guatemala, in 2016, B) Jaguar skin found in Rio Platano Reserve buffer zone, Honduras in 2015, C) Jaguar skulls found Rio Platano Reserve buffer zone, Honduras in 2016, D) Jaguar claws fashioned into earrings, seized in Placencia, Belize, in 2018. Photo credits: Melissa Arias, Anonymous.

5.3.4 Strategies for killing and trading jaguars

According to my interviewees, the methods used to kill jaguars include shooting them during bushmeat hunting trips, especially when hunting dogs are used (n=30 interviewees), using the carcasses of previously-attacked livestock as bait (n=11), poisoning (n=4) and trapping (n=1). Seven interviewees anecdotally stated that when ranchers are unable to kill jaguars themselves, they hire professional jaguar hunters.

Many interviewees felt that trade in jaguar body parts is mostly opportunistic (Fig. 5.3), with suppliers or intermediaries approaching potential buyers on the streets, at home, or in physical or online markets. In fact, 14 interviewees had themselves observed or seized jaguar body parts at physical

markets or from street vendors. Additionally, nine interviewees had been actively monitoring social media groups after finding offers of jaguar body parts online. Another strategy is for consumers to place an order with intermediaries, or directly with suppliers, with eight concrete examples of this behaviour. There were also six confirmed instances where jaguar body parts were exchanged as gifts or inheritance among networks of friends or relatives.

Nine interviewees believed that the trade in jaguar body parts is likely to follow the same routes as other species like macaws or rosewood. Interviewees suspected that jaguar trading routes include the roads coming out of Petén and Izabal to Guatemala City, and from Belize's southern district of Toledo towards the central and northern districts (Fig. 5.1). An interviewee provided a concrete example highlighting southern Belize as a source of jaguar body parts for Guatemala. Given that several jaguar body part seizures have taken place on tourist islands off the coast of Belize and Honduras, there must be a trade route from mainland ports to the islands. Interviewees mentioned only two unconfirmed examples of international trade of jaguar body parts. However, the fact that jaguar body parts are sold to foreign tourists suggests that the items are transported overseas.

3.3.5 Main drivers and enabling factors of jaguar trade

My thematic analysis revealed several perceived drivers and enabling factors of jaguar trade. In order of reference frequency, the two main drivers of jaguar trade were human-jaguar conflict and opportunistic hunting (while hunting for bushmeat), although concrete examples comprised only 23% of the conflict-related references (n=115) and 29% of hunting events (n=22; Table 5.1). Human-jaguar conflict was strongly believed to be a gateway to jaguar trade, with local communities using lethal control of livestock-eating jaguars to prevent future attacks and to receive financial compensation by selling the jaguar's body parts. While jaguars are not a targeted bushmeat species, interviewees

believed that jaguars are likely to be killed whenever they are found by bushmeat hunters. Bushmeat hunting was also thought to drive jaguar trade indirectly by accentuating human-jaguar conflict due to prey depletion. Asian demand was the third most referred-to driver (n=38), but with only 13% concrete examples (pertaining to requests from people of Chinese descent to local communities).

Table 5.1: Drivers of jaguar trade, listed in order of the number of interviewees who mentioned the theme. Number of interviewees and number of references (comments, opinions or examples) to the theme are given in parentheses. Uncertainty in the references is presented within the circles as the proportion of concrete examples (green) vs. strong beliefs (white).

DRIVERS (# of interviewees, # references)	Key Quotes (Interviewee number)
1. Human-jaguar conflict (40, 115) 	*"I believe that jaguar trade here is more reactive. I think it's because the jaguar is giving problems in the farms, and the residents will hire someone to kill the jaguar. They use human wildlife conflict as an opportunity to do trade, because the market is there, the demand is there, so if they have it available, they can definitely find the market" (I6).* *"We have a lot of jaguars and the amount of conflict is very high. What is reported is really just the tip of the iceberg. A lot of them (ranchers) have an attitude of 'I'll go back to shooting because I can actually get some money for it" (I13).*
2. Opportunistic Hunting (33, 76) 	*"In rural areas it's opportunistic, there is no one to do enforcement or do awareness, so they'll take the chance to take the body parts and sell it and make some kind of profit off of the jaguar just because they found it while hunting" (I29).* *"Here people consume jaguar prey and if there are no more prey the animal (jaguar) will go hunt animals at people's houses and that's how the conflict begins and they get killed and that's how the selling of the teeth and skulls begins. It's a connected chain" (I39).*
3. Chinese demand (21, 48) 	*"We were getting reports that there was a Chinese guy asking for the meat. We made the investigation and we knew where the restaurant was. It wasn't for sale, it was more for their own consumption as a delicacy. If I remember well there were actually hunters going out to catch jaguars for this Asian" (I6).* *"We responded to a call near the border where people were killing jaguars because they attack livestock and because of IWT because the Chinese were paying good money for jaguar teeth or for the whole jaguar" (I32).*
4. Drug trafficking (18, 36) 	*"Something very common in my country is that these men (drug traffickers) love wildlife and they like having their own zoos. Here we had a case where the largest zoo in the country belonged to a famous narco. So when I think about their (narco) presence around protected areas, surely there are people who have been paid to fetch a jaguar" (I21).* *"Where I work, the people have told me that they are killing jaguars. What they want are the teeth and the skins to have as trophies. They like to wear the teeth in golden chains. That's what narcos like the most" (I41).*

5. Migration (12, 34) 	*"The demographics of the population have changed. It was traditionally Mayan communities, but we have a massive influx of immigrants from Guatemala, Honduras, El Salvador, so they have a totally different ethic and culture. In Mayan culture, the jaguar is a revered entity and not for consumption but we are having a loss of tradition" (I22).* *"With the population growing and an influx of other Central American people, the people who hunt these animals. I don't know if they hunt them specifically for the teeth or the skin but once they kill an animal they will take those things because those have value and they like to wear the collars" (I28).*
6. Tourism (12, 18) 	*"The resorts, they will call people in the farms and ask them for jaguar skins. We have just been informed that it works like that, but we are not sure which resort it is. People tend to keep that to themselves. He said that there was multiple resorts is not just one" (I3).* *"I clearly remember because it was very intriguing to me, there was a particular person that did report selling jaguar tooth to tourists and he was a tour guide" (I17).*

Drug trafficking was the fourth most-cited driver of jaguar trade (n=36), particularly in Guatemala, where five concrete examples of drug traffickers owning jaguars or jaguar body parts (including the seizure of a taxidermied jaguar during a 2016 drugs raid, Fig. 5.4) were provided. The majority of Guatemalan respondents strongly believed that drug traffickers are involved in jaguar trade because jaguar trophies are a symbol of status, and because they have been involved in financing other types of IWT. The fifth driver of jaguar trade was human migration from neighbouring Central American countries (n=34). These immigrants were perceived as having a stronger hunting and ranching culture, which may lead them to play a role in the jaguar trade chain as suppliers and traders, although this remained largely unsubstantiated (Fig. 5.2). Interviewees also emphasized the potential role of illegal incursionists along the border as suppliers of jaguar body parts. Finally, tourism was the sixth most prevalent (n=18) driver of jaguar trade. It was the most evidenced driver, mainly because the majority of actual seizures of jaguar body parts occurred in well-known tourist destinations.

Overall, except for tourism, drivers of jaguar trade were based more on strong beliefs than concrete examples, but those involving Chinese traders, drug traffickers, and regional immigrants were considerably less well-evidenced (Table 5.1).

I identified eight enabling factors of jaguar trade (Table 5.2), which make the trade feasible and limit the ability of conservation institutions to respond effectively. The main challenge to conservation institutions was felt to be a lack of financial, human and physical resources (n=75). Interviewees perceived that wildlife authorities in both countries did not receive enough attention or financial resources from the central government and were critically underfunded and understaffed. Lack of simple resources like vehicles and fuel constantly jeopardized effective law enforcement. Interviewees also mentioned the ineffectiveness of the law enforcement system (n=60), which is disrupted to the point of inaction by lack of political will, interests behind political decision-making, administrative bureaucracy and excessive staff rotations. A third enabling factor is the animosity in the relationship between the government and local communities (n=47). In particular, interviewees claimed that, given a history of prohibitive policies, there is no trust between local communities and wildlife authorities, and attempts to mitigate human-wildlife conflict or conduct enforcement activities often end in violence. The fourth issue identified was corruption among law enforcement authorities, who were believed to collaborate with wildlife traders (n=45).

Table 5.2: Factors enabling jaguar trade, listed in order of the number of interviewees who mentioned the theme. Number of interviewees and number of references (comments, opinions or examples) to the theme are given in parentheses. Table 5.2 was not coded in terms of the uncertainty of references because very few interviewees gave concrete examples to support their comments on enabling factors, speaking about the issues more generally.

Enabling factors (# of interviewees, # of references)	**Key Quotes (Interviewee number)**
1. Lack of financial, human and physical resources (30, 75)	*"If we get a call about a jaguar, we cannot go and it's difficult because here we have limited fuel. We get a small amount of fuel per month and only one vehicle and nationally we can't do everything because of the fuel limitation" (I20).* *"Sometimes we get informed about cases of hunting or illegal wildlife trade, and even in the cases when we receive an early warning, we have problems to react and we only get to 5-8% of the cases given our current resources and capacity to respond" (I27).*

2. Ineffectiveness of Law Enforcement Systems (28, 60)	*"We have authorities that work for conservation but they are not even aware of the issues because those jobs are politicised and they are seen as a political favour. IWT affects so many people that when they address it, they lose votes" (I18).* *"The administrative systems have become extremely bureaucratic so to respond to a jaguar case you need to get fuel and you need to do an immense amount of bureaucracy to respond to those emergencies because those systems are built on lack of trust" (I30).*
3. Government-community relationships (22, 47)	*"Given the lack of governance in protected areas, it is very difficult to act without the Ministry of Defence because whenever we capture a trader or we seize any wildlife, the communities rise up and don't allow the authorities to exit. They are very strong" (I1).* *"Ranchers are simply killing jaguars and we only find out because we have a large network. We are trying to address that but we cannot do it directly, because ranchers don't want to have anything to do with the wildlife authorities. There is simply no trust and we have to act as silent partners of other organizations" (I39).*
4. Corruption (21, 45)	*"The border control staff have had a lot of training on how to detect products being transported, including wildlife, but the big problem is that there is a lot of corruption and if you want to get something out it is possible to do that with the right kind of connections and a payment of a bribery, and I am confident to say that is the case" (I15).* *"My concern here is how can you make the law personnel, the guys on the ground, the police, the rangers, uphold the law. If those guys are corrupted, you have a problem. You will find that the authority is sometimes colluding with the illegal wildlife traders" (I28).*
5. Outdated legal systems and disregarding wildlife trade as a non-serious crime (12, 22)	*"To reduce IWT the installation of environmental courts is not the absolute recipe because even if the judges have the will to give strong sentences, the inconsistencies in the law don't allow it. We need legal reforms to typify environmental matters more seriously" (I7).* *"It is difficult with the court system. We have court prosecutors, magistrates, who just completely refuse to speak with you, because they would say they don't see an interest, and why would you take someone to court for hunting. They don't see it as an issue" (I20).*
6. Lack of evidence and intelligence investigations (10, 20)	*"We have created fake accounts on social media to get more information from traders, and we give that to the prosecution office but sometimes they want too many details like full names, address, ID number, and many processes are dropped because we can't get all that. We try to investigate, but that is really the responsibility of other agencies" (I5).* *"One of the main challenges would be that if you find teeth, you can prove that it's a jaguar. We were always lobbying to get some sort of genetic lab to actually test these things. We can only go by experience but in court you have to go with evidence for this case to be properly prosecuted and be successful" (I6).*
7. Lack of mandate to enforce the law (9, 16)	*"A weakness is that to do law enforcement, you need to bring the prosecution office and other organizations, but they are never on the ground in the protected areas. It's not like in other countries where the rangers can carry out the seizures. We can only write a technical report but we cannot seize, we lack the mandate" (I2).* *"The problem is once we have done everything in our hands, it is the responsibility of the authorities to enforce the law. We don't have jurisdiction and we cannot implement the law, and it means that sometimes the issues just keep recurring again and again" (I16).*
8. Lack of safety for the conservation community (7, 9)	*"We have good people in the government, but many times they are tied due to political interference and that discourages people, because you don't want to go through all this effort, and when you get there the person (trader) will laugh at you and walk away. Then you are the bad guy and you create an enemy for yourself and put yourself at risk" (I10)*

> *"In our country, there is a lot of fear from the authorities to act and there's a lot of organized crime inside protected areas and the authorities know it but they can't do anything because of fear. In fact, 3 years ago, a wildlife officer that was actively working on environmental crimes was murdered, and that crime remains unpunished" (I21).*

Outdated legal systems and the lack of seriousness with which IWT cases are treated was the fifth enabling factor (n=22). Laws were not only deemed antiquated, but filled with loopholes and with weak penalties. IWT is not typified as a serious crime, limiting the types of evidence that can be presented to court, and bounding the range of action of judges. The sixth enabling factor was the lack of capacity of wildlife authorities and conservation organizations to conduct intelligence investigations to enable successful sentencing (n=20), given the technical challenges of identifying the origins of confiscated items. NGOs and wildlife authorities constantly had to go beyond their responsibilities and expertise to aid prosecutors in their investigations. The seventh enabling factor was the lack of mandate of unarmed park rangers, wildlife authorities and NGOs to enforce the law (n=16), including conducting seizures or apprehending wildlife traffickers. Interviewees regretted spending too much time and effort trying to mobilize partner institutions with a stronger mandate such as the police, the military, the Ministry of Defence or the Public Ministry. The final enabling factor was the lack of safety for those conducting law enforcement operations on the ground (n=9). Given that enforcement efforts are unlikely to lead to imprisonment of traffickers, many interviewees feared retaliation from criminals, highlighting previous assassinations of conservationists and park rangers.

5.4 Discussion

While jaguar trade is certainly present in Belize and Guatemala, my interviews suggest that it is mainly an opportunistic activity, enabled by domestic socioeconomic and institutional factors more than driven by international trade. This is in contrast with the discourse that dominates the broad field of

IWT, characterising it as a transnational organized crime, involving criminal rings with complex, mafia-style hierarchical structures parallel to those for drugs and human trafficking. This characterisation has served as justification for the militarisation of conservation (Duffy, 2014), and is mainly based on the sophisticated and expensive strategies and technologies sometimes used by illegal ivory and rhino horn traders (Wasser et al., 2008). This narrative has been applied to a range of traded species, even when there is no conclusive evidence (Pires et al., 2016). It may be appealing because it establishes the severity of the problem, helping to attract attention and resources into combating IWT (Runhovde, 2018). However, it often conflates subsistence and commercial forms of "extra-legal" hunting, ignoring the root drivers and enabling factors of IWT, breaching human rights, criminalizing local livelihoods, and turning local communities against wildlife (Duffy et al., 2016; Mabele, 2017).

Even though jaguar killing and trading is not a new phenomenon, it was not until its ties with Chinese demand became evident that the media and the conservation community started to pay attention, decrying its potential ties to tiger trade, Chinese investments, and organized crime (Morcatty et al., 2020; Navia, 2018; Yagoub, 2016). While jaguar trade may be more akin to organized crime or more linked to Chinese investments in other Latin American countries, my findings do not corroborate this hypothesis for Belize and Guatemala. Indeed, jaguar trade in these countries does not appear to meet any of the proposed criteria of 'organized crime', including criminal sophistication (planning and skill), structure (division of labour), self-identification, and authority of reputation (intimidation; Finckenauer, 2005; Pires et al., 2016). Instead, the majority of concrete examples provided by my interviewees portrayed jaguar trade as a domestic, sporadic and opportunistic endeavour, carried out primarily by non-specialized, self-recruited rural villagers with no apparent affiliations to wider criminal networks. However, I acknowledge that my results are based on a small sample of key informants who, despite working with these issues on the ground, may have a restricted or biased understanding of jaguar trade in their areas. Therefore, a more comprehensive characterisation of

jaguar trade in these countries would require further studies targeting actors involved in the trade, with larger sample sizes.

Also contrasting with the general perception that consumers drive IWT, jaguar trade in Belize and Guatemala appears to be supply-driven. In supply-driven markets, few barriers to entry, resource scarcity, and opportunity costs influence suppliers' decisions to participate in the market independently of price signals, constraining consumer choice (McNamara et al., 2016). Sharing a vast landscape with the species, jaguar suppliers have few barriers to enter the market, requiring no special skills aside from those already possessed by communities with a strong hunting and ranching tradition. Jaguars occur at low densities (around 2.5 individuals per 100 km2 in Belize and Guatemala; Jędrzejewski et al., 2018a), potentially limiting suppliers' participation in the market and accessibility of products to consumers. However, in contrast to typical supply-driven wildlife markets, in which resource scarcity leads to higher prices to the detriment of the consumer (McNamara et al., 2016), the prices of jaguar body parts varied widely and were often lower than reported in other Latin American countries. Low prices suggest that the demand may itself be limited, while price variation suggests that jaguar suppliers and traders may be unaware of market prices, or even the existence of markets. However, the increasing recognition of the potential role of people of Chinese descent, drug traffickers, regional immigrants and tourists in jaguar trade, which was reflected in my interviews, might be indicative of a transition towards a demand-driven system. A larger, wealthier and steadier consumer base may encourage intermediaries into the jaguar trade chain and spread price information to suppliers, pushing more people to intentionally search for jaguars, potentially using specialized jaguar traps or baiting methods previously employed to hunt jaguars at a commercial scale.

The contrast between the discourse about IWT and the characteristics of jaguar trade in Belize and Guatemala suggested by my interviews, speaks to the importance of separating real evidence from

assumptions. My analysis distinguished between events witnessed by participants or their trusted sources, and assumptions originating from second-hand or anecdotal information. This distinction uncovered the central role of local actors and opportunistic motivations in the jaguar trade, despite the largely-unsubstantiated weight given to external actors and organized crime structures during the interviews. My results suggest that conservation efforts and investments should consider uncertainty and target well-evidenced actors, motivations and drivers of trade in order to have an impact.

Conservation actions to reduce jaguar trade in Belize and Guatemala should focus on building incentives for local jaguar conservation amongst rural villagers, who were identified as major actors at multiple levels of the trade chain. Drawing on Cooney et al. (2017), approaches could include promoting jaguar tourism (Tortato et al., 2017), reducing the costs of human-jaguar conflict (Quigley et al., 2015), reducing the social acceptability and prestige of killing (Knox et al., 2019), or increasing the costs of jaguar hunting by addressing the enabling factors that I have outlined. The assumptions made by my interviewees may be indicative of unfolding processes which deserve attention. The potential role of the Chinese community, drug traffickers and regional immigrants in transforming jaguar trade into a profitable demand-driven endeavour should be further explored, but taking care not to make oversimplified judgements about the 'other', which have proliferated within the field of IWT (Margulies et al., 2019b).

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In this chapter, I explored the characteristics of the illegal trade in jaguars in Guatemala and Belize, including its drivers and enabling factors, from the perspectives of key informants working to address this threat on the ground. Based on the second half of the interview with key informants, my next chapter explores how jaguar conservation practitioners and decision-makers use and perceive IWT evidence, and proposes an approach for guiding future decision-making on jaguar trade and IWT.

Chapter 6

Use of evidence for decision-making by conservation practitioners in the illegal wildlife trade

Photos of communication campaigns against illegal jaguar trade taken at touristic destinations in Belize and Bolivia.

Abstract

There are calls to ground interventions and policies aimed at addressing the illegal wildlife trade (IWT), and conservation more generally, on the best available evidence. However, evidence on IWT can be hard to obtain and contains high levels of uncertainty due to the illegal nature of the trade. Even when the evidence exists, there are numerous barriers to its uptake by conservation decision-makers, pertaining to the evidence itself and to the characteristics and decision contexts of those using it. The surfacing of the illegal trade in jaguars (*Panthera onca*) is an example of how evidence is, and is not, used for decision-making on IWT. I interviewed 38 conservation practitioners in Belize, Guatemala and Honduras, who had knowledge about, or experience dealing with, the illegal jaguar trade. Interviewees described their information sources and decision-making processes, and explicitly and implicitly evaluated and prioritized jaguar trade information, based on attributes like the source, the scale and purpose of the trade, its temporal and spatial dimensions, and the nationality of offenders. Even though interviewees stated that they used scientific evidence in their decision-making processes, they gave more weight to information involving foreign actors and commercial purposes than local and non-commercial ones, regardless of the potential impact on jaguars or the validity of the source of the information. They were also more inclined to favour events that were closer to their own reality in spatial and temporal terms. My results show that the interpretation and uptake of evidence are subject to multiple contextual constraints and personal biases, even amongst experienced conservation practitioners. I propose an approach for evaluating evidence and informing decision-making within IWT and biodiversity conservation. My approach aims to guide conservation decision-makers and practitioners to assess the relevance and uncertainty in the evidence, to recognize their own interpretation biases, to identify the types of actions that are appropriate based on the evidence, and to improve the transparency of their decisions. I aim for this approach to contribute towards more

evidence-based practice within the field of biodiversity conservation, with applications to the illegal jaguar trade and beyond.

6.1 Introduction

Biodiversity loss is one of the most pressing environmental issues of our time. The unprecedented anthropogenic decline in biodiversity across the world threatens the life support systems on which humans depend (WWF, 2020). As a mission-driven discipline tasked with addressing this impending crisis, the role of conservation science extends beyond monitoring this decline, to informing conservation policies and management strategies and having a practical impact on the preservation of biodiversity and on the improvement of human well-being (Kareiva and Marvier, 2012; Toomey et al., 2017). However, a growing body of literature has highlighted the lack of evidence-based conservation, and associated it with the continued decline in biodiversity (Cook et al., 2013; Sutherland et al., 2004; Sutherland and Wordley, 2017).

Studies on the use of evidence in conservation have identified multiple challenges in navigating the space between research, decision-making, and implementation in conservation (Maas et al., 2019; Toomey et al., 2017; Wright et al., 2020). The first hurdle arises from the multiple definitions of the term “evidence”, which depending on the context, can refer to a physical item, a set of accumulated facts about a situation, an assessment of the validity of the facts, a body of relevant theory, or confidence that an assertion about a situation is true (Salafsky et al., 2019). For the case of conservation science and practice, Salafsky et al. (2019) defined evidence as “relevant information used to assess one or more hypotheses related to a question of interest”, with “information” varying in complexity and quality, from basic, unfiltered data or raw observations, to a critically appraised evidence base (e.g. systematic reviews). However, the lack of a widely-accepted definition of evidence

in conservation science and practice poses challenges to producing a standard guidance on the use of evidence (Salafsky et al., 2019). Other challenges have to do with the availability and characteristics of the evidence itself. To be relevant, the evidence must match the temporal and geographical scales at which decisions are made and meet certain quality standards (e.g. reliability, accuracy and legitimacy) to be considered trustworthy (Cash et al., 2003; Cooke et al., 2017; McNie et al., 2016). Further complications relate to the process of communicating science, from one-way knowledge flows from science to practice, to more dynamic participatory processes that include different voices, and which address power imbalances through mediation (Bertuol-Garcia et al., 2018; Nguyen et al., 2017). How the evidence is framed or packaged to achieve a desired result also influences its communication and uptake (Elliott and Nisbet, 2018; Nutley et al., 2012). Decision-makers are more likely to react to information that they perceive as being personally relevant, than that which appears distant from their own reality (Newell et al., 2014; Spence and Pidgeon, 2010; Trope and Liberman, 2010). This also depends on the individual characteristics of those involved in knowledge exchange, such as their experience and values, and on the wider governance structures and socio-political contexts of decision-making, including the incentive systems motivating scientists and decision-makers to engage with each other (Walsh et al., 2019; Wright et al., 2020). While these (and other) challenges to evidence-based decision-making have been repeatedly identified in the conservation literature, implementation challenges (e.g. lack of resources) continue to hamper evidence-based conservation (Maas et al., 2019; Rose et al., 2018).

The illegal wildlife trade (IWT) is a key driver of biodiversity decline, and it has great policy resonance worldwide, drawing considerable attention and financial resources (’t Sas-Rolfes et al., 2019; Massé and Margulies, 2020). However, like other topics in conservation, IWT is affected by the multiple challenges to evidence-based conservation, particularly the lack of evidence surrounding its prevalence, characteristics and drivers (Milner-Gulland et al., 2018; Symes et al., 2018). Due to its

covert nature, most of the available information on IWT is restricted to seizure events reported by national authorities or documented by the media (UNODC, 2020). Seizure data on its own cannot adequately represent the magnitude of or trends in IWT, being subject to numerous biases including: unknown proportions of seized items; unidentified seizure rates; varying enforcement effort, effectiveness, and reporting across countries; taxonomic and product biases; and lack of accessibility to the data, among others (Symes et al., 2018; Underwood et al., 2013; UNODC, 2020). In the absence of robust estimates and context-specific analyses of the characteristics of IWT for many illegally traded species, decision-making on IWT is often subject to misinformation, lobbying, and emotionally and geopolitically appealing narratives about its potential links with terrorism, national security, and foreign demand (Duffy, 2014; Massé and Margulies, 2020). These dominating narratives have perpetuated stereotypical representations of the actors involved in IWT, particularly of marginalized rural communities in source areas and of consumers of Asian descent, making ungrounded generalizations and failing to account for their motivations and cultural specificities (Margulies et al., 2019b). As these narratives dominate the IWT policy space, often facilitated by the media, there could be unintended consequences for the wildlife concerned, resulting from a lack of nuanced interventions, the criminalization of local livelihoods, and the neglect of key organisms with respect to policy attention and funding (Duffy, 2014; Milner-Gulland et al., 2018).

The recent surfacing of the illegal trade in jaguar (*Panthera onca*) body parts is an example of how evidence is, and is not, used for decision-making on IWT. While the trade in jaguar body parts is a longstanding practice, rooted in the cultural traditions of numerous indigenous societies throughout Latin America (Saunders, 1998), it has recently gained particular visibility following the discovery of its links with demand from Chinese wildlife markets (Nunez and Aliaga-Rossel, 2017). An apparent increase in seizures of jaguar body parts over the past decade, a portion of which involved China as a destination country or traders of Chinese descent, sounded the alarm that a new market may be

emerging for jaguars (Fraser, 2018). Although investigations on the drivers of jaguar trade are starting to emerge (Braczkowski et al., 2019; Morcatty et al., 2020), the lack of timely and robust evidence beyond seizures allowed for the spread of unsubstantiated assumptions about the trade. This included fears that jaguars may be replacing tigers in Traditional Chinese Medicine (TCM), and that jaguar trade may be driven by Chinese mafias and China's corporate investments in Latin America (e.g. Romo, 2020). Regardless of the continued uncertainty around these narratives and the magnitude of the trade, the combination of a highly charismatic species, threatened by an archetypal "Asian Super Consumer" (Margulies et al., 2019b), employing cruel and criminal tactics (e.g. Romo, 2020; WAP, 2018), captured the attention of the conservation community. This resulted in the mobilization of substantial resources and conservation efforts to address jaguar trade, and the positioning of the jaguar as the emblem of Latin America's fight against IWT in 2019 (High Level Conference on IWT in the Americas, 2019). While these efforts are a clear manifestation of the precautionary principle in conservation, which aims to anticipate, monitor, prevent and mitigate potential threats to biodiversity in cases of uncertainty (Cooney and Dickson, 2012), the decision to prioritize international jaguar trade without understanding its drivers or impacts comes with trade-offs that must be considered.

Here, I explore the use of evidence by conservation practitioners working to address illegal jaguar trade, and IWT more broadly, in Mesoamerica. I sought to understand how evidence is used to make decisions on IWT, the types of IWT evidence that are commonly consulted, how different types of evidence are prioritized, and what challenges exist in transforming evidence to action on the ground. I conducted semi-structured interviews with key conservation actors, discussing their views on, and experiences with, evidence and decision making on IWT and jaguars specifically. Additionally, I implemented a jaguar trade evidence evaluation exercise, which required practitioners to implicitly and explicitly assess certain attributes in illegal jaguar trade evidence, including its source, the temporal and spatial setting of the events described, the actors and purposes of the trade and its

scale. Based on Construal Level Theory (CLT, Trope and Liberman, 2010), a contemporary theory in social psychology with applications in decision-making science, I hypothesized that these attributes would affect the perceived 'psychological distance' of the evidence, or in other words, how removed the evidence is from participants' personal experience. The temporal, spatial, social and hypotheticality dimensions of psychological distance impact how people represent events (concretely or abstractly), ultimately influencing their perceptions, reactions and behaviours towards information (Trope et al., 2007). I hypothesized that participants would prioritize events and information:

1) Involving local or current events that are closer to their reality and more feasible for them to personally respond to;
2) Involving foreign actors, commercial drivers and large scales of trade, assuming they may involve a higher risk due to their recent, uncertain and unfamiliar nature;
3) Originating from official sources that increase the plausibility and trustworthiness of the information.

My goals are threefold: To gain a deeper understanding of evidence use and decision-making by conservation practitioners working to address IWT on the ground; to determine whether there are any intrinsic biases in evaluating and prioritizing IWT evidence; and based on these insights, to propose an approach for evaluating and prioritizing IWT evidence of varying types and qualities to support evidence-based conservation actions.

6.2 Methods

I interviewed 38 conservation practitioners in Belize (n=15), Guatemala (n=21) and Honduras (n=2) as part of a larger study on the illegal trade in jaguar body parts (Chapter 5). I selected these countries

due to anecdotal and official reports of jaguar trade, and their important role in IWT more broadly, with high-profile cases involving scarlet macaws (*Ara macao*) and rosewood (*Dalbergia spp*) (Gluszek et al., 2020).

Interviewees were either actively or recently (within the past 5 years) involved in the response to IWT in their countries, including jaguar trade. They included jaguar scientists (n = 3), wildlife rescue centre directors (n = 4), NGO staff involved in jaguar conservation (n = 16), protected area managers (n = 5), as well as government and law enforcement representatives (n = 10), from 19 different institutions. I used a three-step approach to identify potential interviewees using both purposive and snowball sampling. First, I listed individuals involved in IWT cases and jaguar conservation initiatives in my study countries, based on manual key word internet searches, focusing on academic publications, grey literature, news reports as well as institutional websites (belonging to national and regional governments and NGOs). Second, I reviewed this initial list of contacts with my local partners, WCS Mesoamerica, to ensure that I had a comprehensive list of participants working on these topics. Third, I approached 48 individuals in the list by email and invited them to suggest additional people within their network who may fit my criteria, adding five people to the list through snowball sampling. Out of 53 people contacted, 41 agreed to participate in the interview and 38 completed the full interview (the sample size of this study). Interviews were in person (n = 35) or via Skype (n = 3), and were conducted by myself in September–November 2018. The portion of the interview on which this study is based took 15 to 20 minutes to complete, and followed a 45 minute discussion about the characteristics of illegal jaguar trade (reported in Chapter 5). Interviews were audio-recorded upon obtaining written or oral consent from participants, but participant identity is kept confidential. The study was approved by the Central University Research Ethics Committee of Oxford University (Reference number: R59134/RE001).

I asked interviewees a standardized set of semi-structured questions about how they make decisions on what topics and activities to prioritize within their IWT-related work, their information sources, their responses to evidence on jaguar trade and IWT, and the challenges that they face when using evidence. Following this discussion, interviewees participated in a short exercise in which they were asked to read 10 cards containing short extracts (1-3 sentences) of different types of jaguar trade information, and to rank them in terms of their priority for conservation action (Table 6.1). The cards were presented to them in a random order, and the extracts were designed so that they varied in source (government, media, acquaintances, and research), nationality of the perpetrator (national or foreign), drivers of the trade (commercial or non-commercial), scale (quantitative or undefined), location (domestic or foreign country) and time (current or past).

Table 6.1: Jaguar trade evidence cards and their attributes.

Card	Nationality	Source	Scale	Purpose	Location	Time
An international magazine recently published photos of an indigenous festival that occurs annually in a neighbouring country, which showed 3 indigenous leaders wearing jaguar skins and jewellery made with jaguar fangs.	Local	Media	Quantitative	Non-Commercial	Foreign	Current
A friend from childhood told you that, in the countryside where he has a farm, poor villagers who depend on agriculture and subsistence hunting for protein, often encounter jaguars during their hunts and kill them in order to consume their meat.	Local	Acquaintance	Undefined	Non-Commercial	Local	Current
A trusted colleague from work, who lives in your same city, told you that he currently knows 4 people in his neighbourhood who own jaguar products for decoration, including jaguar skins, teeth and claws.	Local	Acquaintance	Quantitative	Undefined	Local	Current
An academic study conducted 2 years ago by a researcher from a foreign university, who interviewed 35 ranchers and farmers in rural villages across the country, found that 4 of the respondents (11% of the sample) had been involved in the trade of jaguar skins, teeth and claws.	Local	Research	Quantitative	Commercial	Local	Past
A conservation NGO surveyed 50 cattle ranchers in the nearby countryside and found that 10 ranchers (20% of the sample) had killed a jaguar within the past 5 years in retaliation for cattle losses. Upon questioning, the ranchers confessed that they had retained the skins of the jaguars as trophies.	Local	Research	Quantitative	Non-Commercial	Local	Past
A researcher from a local university conducted an online trade analysis focusing on illegal wildlife trade in the country and found that a few months ago, 10 people were advertising jaguar products, including skins, teeth and claws, on Facebook and other social media.	Local	Research	Quantitative	Commercial	Local	Current
A reputable local newspaper reported that, within the Chinese communities in this country, jaguar bone is currently being used in replacement of tiger bone in medicine used to treat arthritis and rheumatism.	Foreign	Media	Undefined	Undefined	Local	Current
A study that was recently published by a conservation NGO in a neighbouring country revealed that 60 jaguar fangs (equivalent to about 15 jaguars) have been seized just across the border of this country.	Foreign	Research	Quantitative	Commercial	Foreign	Current
The Minister of Tourism just announced the seizure of 60 jaguar fangs (equivalent to about 15 jaguars) at the city's airport. The fangs were being transported by a group of European tourists, who visited local markets in the city and purchased the fangs as souvenirs.	Foreign	Government	Quantitative	Commercial	Local	Current
The local police recently found 12 jaguar fangs (equivalent to about 3 jaguars) at the residence of a Chinese citizen who migrated to this city a few years ago.	Foreign	Government	Quantitative	Undefined	Local	Current

My extract design was inspired by Multi-Criteria Decision Analysis (e.g. Burgman, 2005) and choice experiments (e.g. Hinsley et al., 2015), which evaluate outcome decisions or product choices based on a structured and systematic comparison of their attributes. These methods commonly employ orthogonal designs and repeated pairwise comparisons to isolate the effects of individual attributes and to reach optimal attribute combinations that reflect the preferences of decision-makers or consumers. My card design followed a similar approach, but I did not present my interviewees with all potential attribute combinations to reduce the cognitive demand on participants, and because my sample size of relevant interviewees with key expertise on jaguars and IWT in these countries was inevitably small. I did not emphasize a balanced design, placing more weight on the hypotheses that were of most interest (which pertained to the source, trader nationality and purpose attributes), and because my intention was to use the cards as props to encourage a discussion about evidence, rather than to reach an optimal card arrangement. Once interviewees organized the cards, I took photographs of the physical (or virtual, for Skype interviews) card arrangement, and asked interviewees to explain how they prioritized the cards, without giving them any details about the attributes that were encoded in them. Follow up questions focused on eliciting additional details about the prioritization process, by comparing sets of cards that shared similar attributes but differed in others, and later by openly asking them about their thoughts on the different evidence attributes found in the cards.

I transcribed the interviews and coded the answers to the semi-structured questions of the interview into question-answer categories and sub-categories (or themes) using NVivo qualitative data analysis software (QSR International Pty Ltd. Version 12 Pro, 2018) and following the guidelines for thematic analysis (Newing, 2011). Four randomly selected interviews were also coded by another researcher in the team to test the reliability of my coding, reaching a Cohen's Kappa of 0.86, or excellent agreement.

I analysed the card ranking exercise following two different approaches. In the first one, I identified the attributes that interviewees described as being important when explaining their card ranking process without being told about the attributes encoded in the cards. Drawing from the literature on social psychology and consumer explicit and implicit preferences (Friese et al., 2006; Perugini, 2005), I considered these attributes as the 'explicit' criteria employed by interviewees for prioritizing evidence, which are a manifestation of their deliberate and conscious evidence evaluation efforts. In the second approach, I evaluated the actual physical arrangement of the cards, recording the order given to each card (from 1-10, with 10 being the highest priority) from photographs that were taken of the card organization. I considered this ordering as the 'implicit' criteria employed by interviewees for prioritizing evidence, representing their spontaneous reactions to the evidence. I used card rank as the response variable, and the binary or multi-level factor evidence attributes (source, nationality, purpose, scale, location, time) as predictors in a cumulative link mixed model (or ordered logistic generalized linear model) with interviewee ID as the grouping variable, using the function 'clmm' in package "ordinal" (Christensen, 2019) in R version 3.6.2 (R Core Team 2019). I calculated 'Wald' confidence intervals. Model variables were tested for association prior to inclusion in the model applying Cramer's V through the package "DescTools" in R (Signorell & Al., 2020). Medium and low levels of association (<0.7) were found, allowing us to keep all attributes of interest in the model. However, it should be noted that the attributes in the cards are not fully independent and that my sample size is small, which means that the associations between evidence attributes and prioritization are indicative only, and meant to be examined in relation to the deeper qualitative discussion with interviewees. I also tested whether interviewees' characteristics (nationality, education level, gender, organization or profession) influenced their choice of 'explicit criteria' in the discussion of the card prioritization, through single attribute logistic Bayesian generalized linear models, implemented through function 'bayesglm' in the "arm" R package (Gelman and Su, 2020).

6.3 Results

6.3.1 Factors influencing decision-making processes

Interviewees discussed the processes and factors involved in decision-making surrounding IWT within their institutions (Table 6.2). Most (78% out of 38) interviewees said that their work is highly reactive; being largely focused on addressing emerging needs and threats originating from the interactions between people, protected areas and wildlife. Many of those emerging needs and threats have a temporal component, fluctuating with the reproductive stages of particular species or with weather-dependent accessibility to wildlife habitat (for both rangers and poachers). When addressing these emerging needs, interviewees also considered the safety of their staff and equipment (e.g. camera traps), due to the presence of armed poachers. Sixty percent of my interviewees mentioned that their IWT actions depend on emerging funding or partnership opportunities to start new projects or to sustain ongoing initiatives. Meanwhile, 55% said that they follow pre-established organizational agendas, focused on targeting key vulnerable species or areas covered under the institutional mandate, or on providing inputs for policy. Forty eight percent of interviewees stated that their decision-making follows research recommendations, while personal experiences and interests were mentioned by 20%.

Table 6.2: Factors influencing decision-making. Categories add up to more than 100% due to non-exclusiveness. Sample size=38.

Factor	% of Interviewees	Key Quotes
Threats and needs	78%	"When it comes to prioritising, we focus on what is most urgent and a lot of the times it's either enforcement or conflict issues because sometimes we get a call, 'if you don't come today, that jaguar dies tonight'. Sometimes it is that serious and that's when we have to prioritise that. It's not that we don't have priorities, but we have to live day by day" (I20).

Funding and Partnership Opportunities	60%	"Our decisions are dependent on funding. When I was working with jaguars, we only had two months' worth of funding to focus on the species, so then I moved on to macaws because we won new funding for a project. Then we wrote a proposal to focus on communities, and so on" (I38).
Organizational agenda	55%	"In our institution we have a manual of procedures with the lines of action of our department with regards to wildlife. Sometimes we have the willingness to address the trade of a certain species like jaguars, but we do not have that activity in our annual or monthly operative plan, and so we cannot act" (I12).
Research and monitoring	48%	"When I began to work with the issues of wildlife trafficking, there was not a lot known… We managed to do a few studies to gather some data of what was the situation and which were the main species being trafficked. Along that path we had a few incidents which made us realise that the jaguar was one of the species needing to be considered" (I15).
Personal experience and interests	20%	"It's complicated because in the end all priorities depend on the interest of each person. I leave all administrative work for last, and answer to requests from public institutions or courts first, or rescue wildlife first. Those are my priorities because we are dealing with living beings" (I36).

6.3.2 Commonly consulted IWT evidence sources

Interviewees discussed the sources of evidence that they commonly use for decision-making surrounding IWT topics (Table 6.3). Most (73% out of 38) interviewees said that they rely on data collected through research and monitoring activities. These included site patrols monitoring illegal activity, biological and ecological studies, studies on community livelihoods and socioeconomic indicators, as well as national-scale surveys on wildlife use. Sixty percent said that they base their decision making and daily actions on information received from the public, especially social media posts or phone calls reporting illegal activities concerning wildlife. Conservation institutions were another important source of information for 58% of my interviewees, many of whom were part of institutional working groups on matters related to IWT in their countries and used their periodic meetings to share information, while others described more informal communication channels among institutions such as WhatsApp groups. Forty five percent of my interviewees worked closely with local communities, and received information on illegal activities from them. Information from government agencies, particularly from enforcement operations carried out by the police or military, was another

important IWT evidence source (40%). Meanwhile, 10% used information from the media or from personal experience (5%).

Table 6.3: Information sources used in decision-making. Categories add up to more than 100% due to non-exclusiveness. Sample size=38.

Sources	% of interviewees	Key Quotes
Research and monitoring	73%	"We have conducted several studies, some based on interviews with hunters and local communities, some with camera trapping, and we have also done studies on DNA samples. So based on that scientific data we decide what to do and what the priorities are" (I21).
The public	60%	"We get the data from the public. It is mostly a response to information that arrives from calls of people seeing illegal activities, or from activism groups, or because the neighbour told a friend, or the chairman of the community, or even coming from outside the community" (I8).
Conservation institutions	58%	"Whichever member of the working group encounters wildlife trade, they share the information communally within the group. Sometimes we get reports about a demand for body parts of jaguars and other wildlife, if there's been any incidents of them being kept in captivity, or lethal measures for removing the jaguars and that sort of thing. Because there are several organizations, you get a lot more information about what is going on the ground" (I29).
Local communities	45%	"I work with around 300 people who are local informants. They are people that are worried about the damages that people cause to natural resources, and especially to animals. It's a network of people from local communities that look for information for us, because otherwise, if you are a stranger, people won't say anything" (I27).
Authorities	40%	"I work a lot with police officers and the military. If the police is doing whatever activity and they come around wildlife they will give us the information, and then we would do a little investigation and so on. The military does have an intelligence unit and they have officers that are not in uniform, so I would ask them to do a little investigation for us and they would go into the area and ask around and report back to us" (I37).
Media	10%	"Asian demand is a problem and the topic of jaguars is starting to arrive to this country. We have heard it in the news. We know that it is coming from South America and that they are moving in this direction" (I38).
Personal experience	5%	"There is very little information published in this country about wildlife trafficking, all the information we have is based on our experiences, what we have seen, what we have heard, what we have seized" (I25).

6.3.3 Evidence Prioritization

While participants described using information from multiple sources, not all evidence is considered equally. The card ranking exercise revealed how the different attributes encoded in the cards (time, space, nationality, purpose, scale, and source) play a role in evidence prioritization. Taken together as a group, interviewees recognized and referred to all of the evidence attributes that I hypothesized as being important for evidence evaluation when independently describing their prioritization process (e.g. explicit criteria). However, not all interviewees noticed all attributes encoded in the cards without being prompted. The criterion that most interviewees independently noticed and used for prioritizing the evidence was the purpose or motivation behind the trade (68%), followed by how long ago the event took place (time, 58%), the nationality of the offender (45%), the location of the events (32%), the scale or number of body parts or traders (32%) and the source of the information (29%, Fig. 6.1).

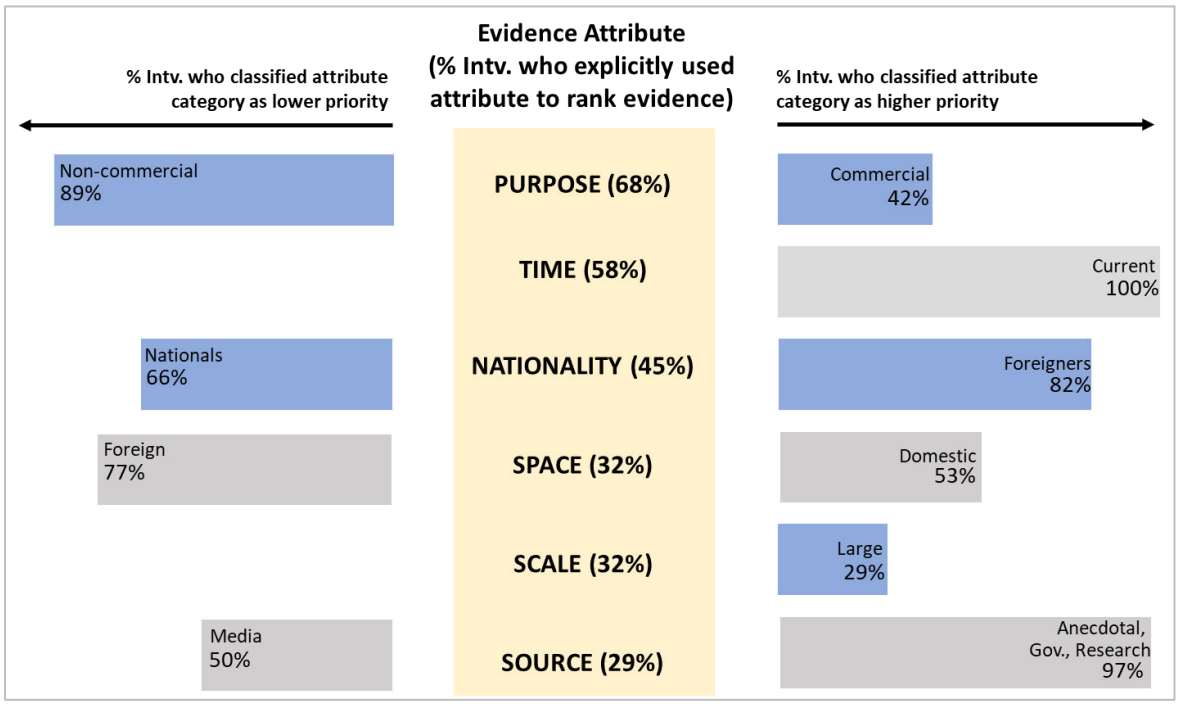


Figure 6.1: Percentage of interviewees (n = 38) who explicitly used the different attributes (purpose, time, trade nationality, space, scale and source) to prioritize evidence, and attribute categories responsible for higher or lower prioritization (horizontal boxes) when prompted. Attributes and their categories are not mutually exclusive and may sum up to more than 100%.

When prompted to discuss the evidence-prioritizing attributes in more detail (including those that they did not initially notice on their own), interviewees revealed some of their opinions behind them. Concerning the purpose of the trade, the majority of my interviewees (89% out of 38) mentioned that non-commercial motivations behind the killing and trading of jaguars, such as cultural, subsistence or retaliation-related uses, are 'understandable' because they involve longstanding traditional practices, they emerge from the urgent needs of vulnerable communities, and they are "probably sustainable". Therefore, these non-commercial purposes or motivations would warrant a lower priority level than commercial purposes, which were regarded as more detrimental and deserving of more attention, as stated by 42% of my interviewees.

All interviewees agreed that events happening in real time are a priority, because they require immediate action that can lead to an arrest or a seizure, which would allow them to demonstrate their ability to respond effectively to IWT, a key factor for their job security. These took priority over past events, because according to interviewees, the chances of achieving results diminish with time. The importance of the timeliness of the information also meant that information from studies that took place in the past was less valuable than anecdotal accounts on current events, regardless of the differences in the quality of the information.

The nationality of the traders was an important attribute for interviewees, and 82% of them specifically believed that foreign traders deserve a greater focus, particularly traders of Chinese descent. This concern was explicitly related to the impact of Chinese demand on tiger populations in Asia, as stated by 26% of my interviewees.

With regards to the location, for 53% of interviewees the highest priority went to events occurring within their country and/or area of jurisdiction. As with time, the spatial proximity of events affected

interviewees' ability to intervene, as trade happening across the border fell outside their mandate. On the other hand, 77% of interviewees described how, while international and transboundary trade is important, particularly if it concerns neighbouring countries which share similar IWT routes and trade chains, addressing these events requires strong partnerships, which are not always in place.

Although not all interviewees noticed the quantities encoded into the cards or prioritized the cards in terms of the numbers of jaguars affected or traders involved, when prompted, 29% mentioned that larger scale trade mattered most. The scale of the trade was closely associated to the nationality of the trader and purpose of the trade. For example, events related to foreign demand or to commercial purposes were perceived by 21% of interviewees as representing a larger potential impact on jaguars, involving large markets and high prices that could ultimately affect jaguar population sizes, while non-commercial uses were perceived to happen at small scales only (as suggested by 45% of interviewees).

Even though the source of the evidence was the least important attribute for interviewees, based on their explicit prioritization discussion, when prompting them to speak more about the source of the evidence interviewees mentioned that anecdotal accounts, government reports and research information are all important sources. This was in contrast to the media, which was described by 50% of interviewees as 'sensationalist' or 'unreliable'. Five interviewees shared personal experiences of being misquoted or misinterpreted by journalists. The most important sources of information for participants were their networks of friends and colleagues and social media (82%). This was not so much related to the reliability of the information, as 45% of interviewees mentioned that anecdotal information requires additional work to validate, but because these sources were perceived as being more timely and directly actionable by themselves personally. Information from interviewees' network was also described as being trustworthy. Official sources like the government or research carried out by NGOs or academics was considered highly valuable by 47% and 39% of participants,

respectively, but 18% expressed concerns about official sources being unreliable as they respond to institutional agendas.

Interviewees' characteristics, such as gender, profession, affiliation, education or nationality did not influence how the evidence was explicitly prioritized, except that men were more likely than women to focus on the nationality of the traders (β=2.65; CI= 0.74-4.57; p=0.007) and less likely to notice the source of the evidence (β=-1.78; CI=-3.33-(-0.21); p=0.03, Fig. 6.2).

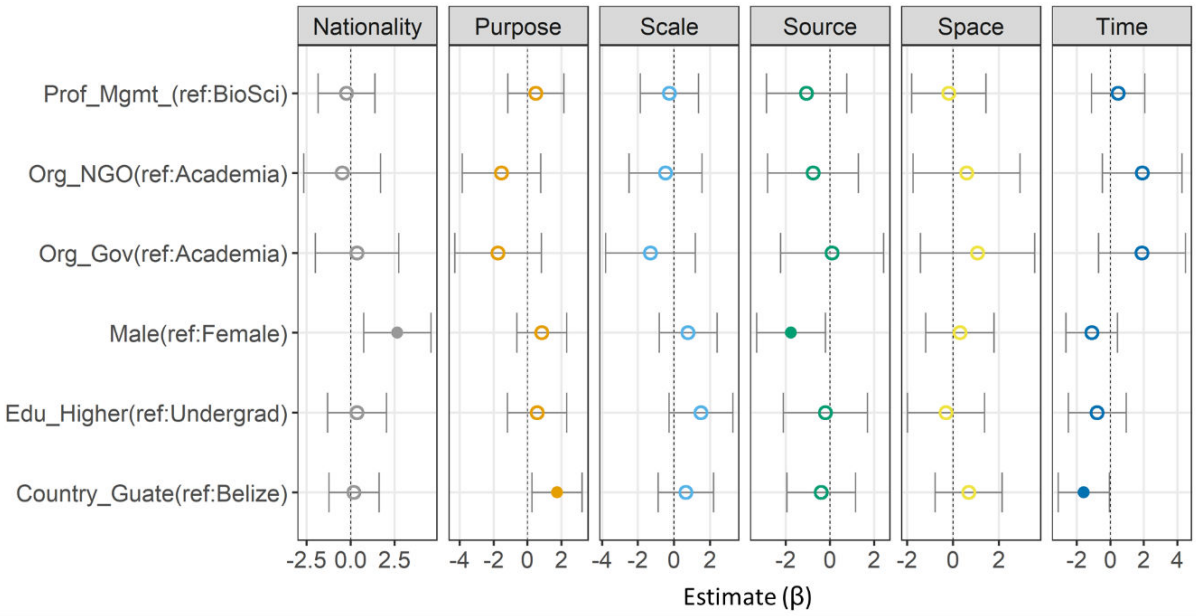


Figure 6.2: Explicit prioritization of evidence attributes as explained by interviewee's (n=38) background characteristics. Estimates of a single attribute logistic Bayesian generalized linear models with 95% Wald confidence intervals. Solid circles represent significance (p-value = 0.05).

The explicit criteria that interviewees used in prioritizing the evidence, and the detailed discussion about the evidence attributes, differed from the implicit attribute ranking based on the physical card arrangement. Whereas interviewees explicitly prioritized the purpose of the trade and the timeliness of the information (Fig. 6.1), the physical card arrangement revealed that higher-ranking cards were significantly more likely to be those which described foreign traders, and events happening at the

national level (Fig. 6.3). This shows that trader nationality and the location of the events were more implicitly important than interviewees admitted to during the discussion. However, the direction of the effect aligns with the discussion, confirming that concerns over the role of foreign traders supersedes those related to local traders, and that domestic events take priority over transboundary or international ones. Other attributes encoded into the cards, such as the scale, purpose or time did not influence the card ranking significantly, with the exception of the source. In particular, evidence coming from acquaintances ranked higher than those originating in other sources (e.g. research, government), but only media sources led to a significantly lower ranking. This also coincides with the discussion, highlighting the important value of anecdotal information to interviewees, particularly when it comes from within a trusted network of friends and colleagues.

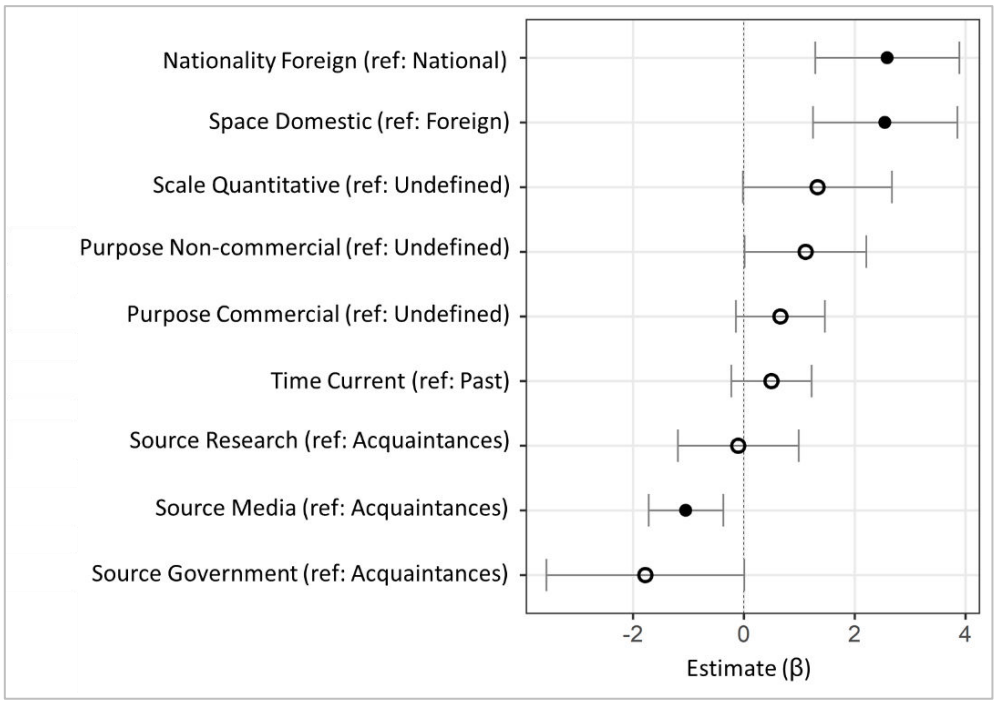


Figure 6.3: Implicit evidence prioritization by interviewees (n = 38) based on physical card arrangement. Estimates of a cumulative link mixed model with 95% Wald confidence intervals. Solid circles represent significant effects (p-value = 0.05). Ref: the reference level for a factor.

Based on both types of evidence prioritization, I was able to find support for my hypotheses that local and current events are prioritized over distant and past ones, as are foreign-driven commercial events over domestic and non-commercial ones, partly due to their perceived impact on the scale of the trade. Contrary to my hypothesis, official sources were not prioritized over anecdotal ones, and interviewees appeared to prefer direct and actionable over high quality information.

6.3.4 Reactions to the evidence

Several interviewees explicitly stated that ultimately what matters to them is whether the information is plausible given their own understanding of the local context (e.g. hypotheticality, 42%) and whether the information lies within their specific mandate (34%). Interviewees stated that evidence that did not match their contextual understanding of their areas, or which extends beyond their duties would simply lead to concern (24%) or inaction (21%). For jaguar trade evidence that is considered relevant, interviewees' most common stated potential reactions would be to develop projects to address the trade at the community level (76%), to investigate (66%), to enhance response capacity by searching for funds and building partnerships (55%) and to conduct enforcement operations (45%).

As described in Chapter 5, the main challenges to carrying out these actions for the specific case of jaguar trade include the lack of financial, human and physical resources (73%, n=41, including responses of three additional interviewees who did not participate in the evidence evaluation), the ineffectiveness of law enforcement systems (68%), animosities between actors (54%), corruption (51%), outdated legal systems (29%), lack of evidence (24%), lack of mandate to enforce the law (22%) and insecurity (17%).

6.4 Approach for evaluating and prioritizing IWT evidence action

My discussions about decision-making and evidence use with conservation practitioners working to address illegal jaguar trade in Mesoamerica provided valuable insights into some of the challenges of implementing evidence-based conservation. Even though interviewees explicitly stated that they use scientific evidence in their decision-making processes, they were susceptible to the implicit attribute configurations of the evidence. In general, interviewees gave more weight to evidence involving foreign actors and commercial purposes than local and non-commercial ones, and to events closer to their reality in space and time, over more distant ones, regardless of their implied impact on jaguars or the validity of the source of the information. These biases do not mean that conservation practitioners are not driven by evidence, but rather that the definitions and interpretations of evidence are subjective, even amongst trained and experienced decision-makers, as pointed out by previous conservation literature (Adams and Sandbrook, 2013; Salafsky et al., 2019). Achieving a more evidence-based conservation practice will require guiding conservation decision-makers and practitioners to critically assess evidence and to recognize their own evidence interpretation biases. At the same time, conservation scientists must aim to produce evidence that is more aligned with decision-makers' evidence preferences and priorities.

I propose an approach for evaluating evidence and informing decision-making within IWT and biodiversity conservation more broadly (Fig. 6.4). My approach can support IWT decision-makers and practitioners to judge when there is enough ground to invest in an IWT response (e.g. increasing enforcement or implementing behaviour change campaigns); when the inconclusiveness, uncertainty or irrelevance of the evidence merits continued research or monitoring efforts, and when to safely dismiss IWT evidence in order to centre efforts elsewhere. My approach can be applied to any species threatened by IWT (and other threats) and it can be used to evaluate single units of IWT evidence or

a body of evidence. Beyond supporting decision-making and action on IWT, my approach can also guide conservation scientists to ask research questions and produce research outputs that are more likely to be relevant to conservation actions.

My evidence evaluation approach is based on four out of the six evidence attributes that I used in this study, namely, the scale, source, time and location of the information. Even though the purpose of the trade and the nationality of the traders were among the main attributes considered by my interviewees for prioritizing jaguar trade evidence, I purposely did not include them in my evidence evaluation approach, as their importance should be assessed in light of the other attributes. For example, the purposes behind IWT or the nationality of offenders, should only matter in relation to their potential impact on the species, and only if the evidence is reliable, timely and spatially relevant.

In my approach, evidence that merits immediate action or intervention is relevant in terms of its scale, source, time and space. Here, scale should be understood as the potential impact of illegal trade on the species of concern, as suggested by the evidence. Whether the scale or impact is considered high, medium or low will depend on several factors, including offtake quantities, species population numbers and life histories, as well as other bio-ecological and socio-economic factors which may influence the level of threat posed by trade to the species, in a given space and time (Bennett et al., 2021). These can be assessed qualitatively or quantitatively through expert elicitation or through models of varying complexity, parametrised with as little or as much data as is available, reflecting the uncertainty around the predicted impact (e.g. Weinbaum et al., 2013). If the scale or impact of trade on a species is determined to be low, such that it does not compromise its current conservation status, the trade evidence is unlikely to justify an intervention other than continued research and monitoring to determine whether the impact is likely to grow in the short, medium, or long term. If it is unlikely

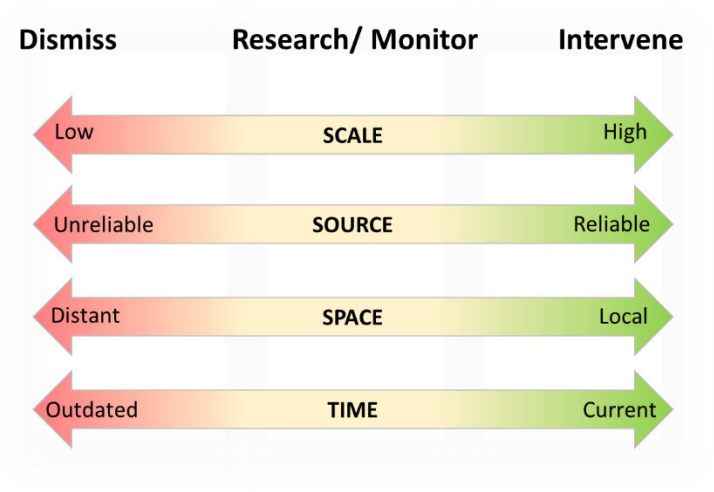
that the impact will grow in the foreseeable future, the threat merits monitoring over time to detect any changes, after which it can be safely be dismissed.

To become an intervention priority, the evidence must also be reliable. Reliability is a measure of bias minimization and it is often assessed against the steps taken to reduce common biases in experimental design, such as selection, performance, measurement or attrition bias (Cooke et al., 2017). Drawing from the medical sciences, high levels of reliability or certainty are often assigned to randomized control experiments, and decrease for observational or qualitative studies (Morgan et al., 2016). However, considering that IWT evidence rarely comes from experimental studies, I suggest that the trustworthiness of the source can be considered a proxy of reliability. Evidence originating from official sources, such as government reports or academic studies, may be considered more reliable than anecdotal accounts or information from non-official sources. I recognize that this will vary strongly with the context (e.g. even peer-reviewed literature can be strongly biased, Cooke et al., 2017), and that other variables should also be considered (e.g. legitimacy, Cash et al., 2003). It is therefore up to the assessor to justify the classification of a source as reliable or unreliable, and to be accountable for that decision. If the source is not deemed reliable, the evidence deserves further research and monitoring to establish whether the issue or hypothesis can be reliably proven with more evidence. If not, monitoring efforts should take place periodically to determine whether new evidence has surfaced, followed by dismissal of the evidence if it cannot be corroborated.

Whether or not the evidence is current (time) and local (space) also influences its relevance for intervention. IWT is highly dynamic, and quickly adapts and responds to new market trends, changing prices, and enforcement efforts. Although timescales are context-specific, outdated evidence can lead to inappropriate IWT responses. Before investing in actions to address IWT, decision-makers should determine whether the evidence is an accurate representation of the current reality, and if it is not,

the research priority should be to assess its representativeness or the likelihood of recurring trade incidents. Recurrence of IWT should be monitored over time, and the evidence can be safely dismissed it if is deemed untimely or no longer representative. Similarly, evidence that is not pertinent to the geographical jurisdiction and range of action of those in charge of the IWT response is unlikely to warrant its classification as a priority for action. However, the potential for IWT to spread should flag it as a research priority. Even if IWT does not appear to be spreading, changes in its movement (e.g. the reach of its trade chain networks) and density (e.g. trade hotspots) should be monitored over time, until the evidence can be safely dismissed.

Panel A. Approach for assessing IWT evidence



Panel B. Hypothetical examples of implementation of the evidence assessment approach

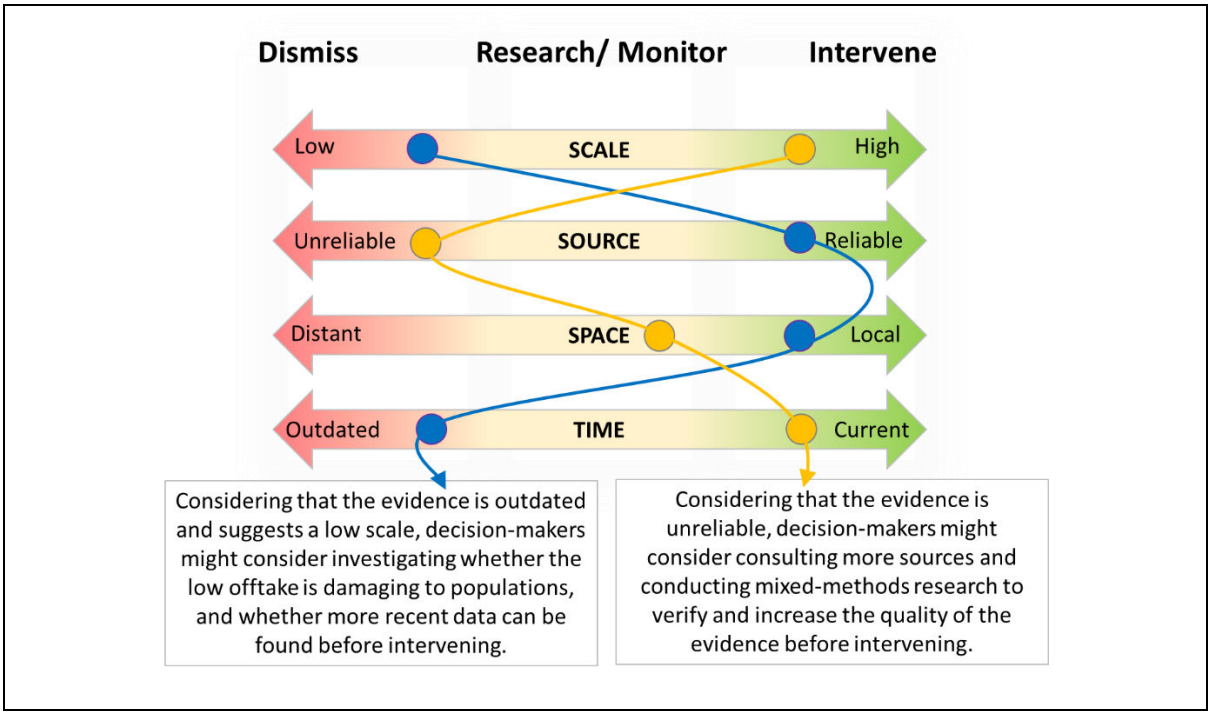


Figure 6.4: Approach for assessing IWT evidence priority. Panel A) Variation in the scale of the trade or impact on populations suggested by the evidence (high to low), its reliability (reliable to unreliable), space (local or distant) and time (current or outdated), in no particular order, determine whether there is enough ground to intervene to address the trade, when to prioritize research and monitoring instead, and when it is possible to safely dismiss evidence. Panel B) Hypothetical examples of approach implementation with combinations of evidence attributes. Yellow and blue circles represent two pieces of evidence with different attribute configurations.

Not all evidence attributes need be at their highest level (green area in Fig. 6.4 A) to warrant an intervention. A single piece of evidence can combine attributes at different levels (Fig. 6.4 B), and it will be up to decision-makers to assess whether it is the right moment to intervene, assuming that resources and capacity are available, or whether it might be more appropriate to delay an intervention. Rather than providing prescriptive cut-offs for action, my approach can serve as a tool to reflect upon the attributes of the evidence, and to facilitate transparency behind decision-making. For example, if all evidence attributes are judged to be at their highest level of relevance (green area in Fig. 6.4 A), it would be difficult to justify inaction. On the contrary, if all evidence attributes are at their lowest level of relevance (red area in Fig. 6.4 A), any efforts aside from research or monitoring could run the risk of being unjustified or not evidence-based. Evidence combining low, high and middle level relevance attributes can be more complicated to decide upon. In these cases, decision-makers

can rely on research and monitoring to determine whether any of the attributes have changed and to increase confidence in their decisions. For all attributes, just as the evidence can move from intervention priority to dismissal depending on its evolving characteristics, it can move in the opposite direction following changes at the monitoring or research stages.

6.5 Discussion

Given the vast uncertainty in IWT, decision-makers face the difficult task of sifting through evidence of varying types and qualities to identify priorities for action and investment. Regardless of their good intentions, they face multiple challenges to conducting evidence-based conservation, from managing the uncertainty in the evidence, to navigating the complex governance processes influencing evidence communication, interpretation, socialization, and uptake (Bertuol-Garcia et al., 2018; Nutley et al., 2012; Walsh et al., 2019). In this process, the objectivity of the evidence may get lost, and IWT priorities may be established on the basis of assumption, lobbying, or on the grounds of dominant IWT narratives (e.g. Margulies et al., 2019). This may lead to ineffective interventions that fail to target the actual drivers of IWT, or to the dismissal of topics and taxonomic groups that fail to capture policy interest (e.g. "plant blindness").

I propose an approach that can help decision-makers to distinguish between actionable evidence and evidence of lesser value to decision-making, on the grounds of its temporal and spatial relevance, reliability, and suggested impact on wildlife populations. The approach can also guide conservation scientists to produce evidence that is more likely to be used for conservation actions due to its high relevance and quality. While my approach does not solve all the challenges of evidence-based decision-making on IWT, it encourages a critical assessment of evidence, including the management of uncertainty. Being based on the evidence prioritization process of real conservation practitioners

and decision-makers working to address IWT on the ground, my approach highlights the attributes that matter most when prioritizing evidence in real-world contexts, serving as guidance for future research efforts. It also aims to promote self-reflection amongst decision-makers about their own implicit and explicit biases, and to help them to identify pieces of evidence, or specific attributes in the evidence, that are likely to receive an unjustified weight. My approach can also increase the transparency and accountability of decision-makers' choice to take a given course of action based on the evidence, from intervening to address IWT, to commissioning research on a new threat, to monitoring IWT threat levels over time, and to the safe dismissal of evidence. My approach would benefit conservation practitioners making day-to-day decisions to address IWT at specific sites, just as much as policy-makers working on IWT at national or international levels. It can also support conservation scientists seeking to produce research that is more relevant for conservation policy and practice.

My interviews with practitioners and decision-makers working on illegal jaguar trade, and other types of IWT in Mesoamerica, elucidated some of the practicalities of using evidence for decision-making on IWT and biodiversity conservation. I found that decision-making in the region is highly reactive, responding to urgent needs and threats that arise as species become threatened, and to emerging funding opportunities. In this context, the most valuable evidence for practitioners is not necessarily the most robust or ecologically pressing, but the one that draws attention, collaborations and funding, and for those working on the ground, the one with a potential to reach a tangible outcome, like a seizure or arrest. The use of evidence is therefore closely related to the incentives that are in place for decision-makers to engage with the evidence (e.g. seizing a high profile species or gaining a funding grant), and to the specific implementation constraints that they face in carrying out their duties (e.g. Bertuol-Garcia et al., 2018; Cvitanovic et al., 2015). Similarly, interviewees recognized that long term planning and evidence stemming from research and monitoring efforts is less likely to inform their

action priorities when compared to information from their networks, their own experiences, and from non-official sources like the public, social media and the news. This diversity of sources aligns with the notion that conservation evidence can take multiple forms, and that decision-making in conservation is evidence-informed rather than evidence-based (Adams and Sandbrook, 2013).

While there have been criticisms of decision-makers' complacency about using evidence (Sutherland and Wordley, 2017), about scientists' passive science communication efforts (Cash et al., 2006), and about the lack of engagement on both sides (Cvitanovic et al., 2015), my results suggest that evidence use may also be hampered by decision-makers' own implicit and explicit biases. Even though interviewees explicitly valued research, and many of them had a scientific training, they were influenced by implicit subjectivities and pre-existing beliefs about IWT. As indicated by the social expectation hypothesis (Burgman et al., 2011), experience and qualifications are not necessarily good guides to performance, and decision-makers often fall victim to common biases such as anchoring (tendency to be influenced by initial information), availability (the influence of past experiences on memory), representativeness (single school of thought), groupthink and overconfidence (Burgman et al., 2011). Moreover, confirmation bias, or the inclination to retain (or disinclination to abandon) a favoured hypothesis, is ubiquitous in decision making, and it affects how trained and untrained people search for, interact with, and decide upon, evidence (Busemeyer et al., 1995). My results also speak to the influence of message framing in conservation (e.g. Newell et al., 2014; Toomey et al., 2017). Therefore, overcoming the challenges to the use of evidence in conservation may require a greater focus on dismantling or counterbalancing dominant conservation narratives when unsupported by the evidence, and on further exploring the psychology of decision-making in conservation more generally. In particular, I recommend further research into the implicit and explicit biases in the use of conservation evidence by different people, under different contexts of data availability and

uncertainty. Moreover, I suggest providing specific training and guidance in how to evaluate evidence and how to handle uncertainty in conservation to those making conservation decisions.

In the case of the illegal jaguar trade, fears about the role of China as a new market for jaguars have compelled several individuals and organizations across the jaguar range and abroad to act on the precautionary principle and to intervene to stop international illegal trade in jaguars. The justification is often to prevent jaguars from following the same path as tigers, which became endangered by Asian-driven IWT. However, the slowly growing evidence on the matter shows inconsistencies in how the trade is portrayed, from a predominantly international, Chinese demand- and corporate investment-driven (Lemieux and Bruschi, 2019; Morcatty et al., 2020; Verheij, 2019), organized trade (Romo, 2020; WAP, 2018), to an opportunistic and largely domestic issue, associated with cultural practices and human-wildlife conflict (Reuter et al., 2018b). Moreover, demand for jaguars in Asia is not yet understood, and the impacts of illegal trade on jaguar populations have not been estimated. Due to this remaining uncertainty, research and monitoring efforts to determine the context-specific characteristics, drivers and impacts of the illegal jaguar trade should be a favoured course of action at the moment. Acting without enough evidence poses several risks that may frustrate the good intentions of the conservation community. For example, spreading information and raising awareness about jaguar trade could have the unintended effect of incentivizing it in areas where it currently does not exist. It could also spur a demand locally and internationally for objects that are perceived as trendy, endangered or rare (Hall et al., 2008). A lack of nuanced understanding of the trade could damage relationships with local communities that are vital for wildlife conservation (Cooney et al., 2017; Duffy, 2014), or even have implications for the economic relationship between jaguar range countries and China. Additionally, the already limited conservation funds and efforts focused on addressing human-jaguar conflict and habitat loss, two well documented threats for jaguars (Castano-Uribe et al., 2016; Olsoy et al., 2016), could be instead re-directed to a threat with unknown impacts

on the species. Moreover, classifying the jaguar as the emblem of Latin America's fight against IWT could dismiss the trade in other wildlife, including timber, orchids, sharks, birds and reptiles, despite their large seizures and more concerning population declines (UNODC, 2020).

IWT is a key concern for biodiversity conservation, and due to its illegal nature, it can be particularly hard to understand and address, especially for species that are recently affected by it. Decision-makers at the forefront of IWT face the difficult task of undertaking timely actions to protect species while also dealing with the large uncertainty that is inherent to IWT evidence. My interviews with decision-makers working to address jaguar trade in Mesoamerica revealed some of the practical challenges of on-the-ground IWT decision-making, including how to prioritize evidence of varying types and qualities. Based on these insights, I propose an approach that can guide decision-makers to recognize evidence of high relevance to conservation action from evidence of lesser quality that merits further research, monitoring, or dismissal. I aim for this approach to contribute towards a more evidence-informed practice within the field of IWT, and biodiversity conservation more broadly.

Chapter 7

Discussion

Panoramic view of the Maya Biosphere Reserve, a stronghold for jaguars in Central America.

7.1 Meeting the aims of my DPhil

In the past decade, the illegal trade in jaguars has emerged as a growing concern for the survival of the species, which is already threatened by high rates of habitat loss and conflict with humans. If unimpeded, trade-motivated targeted killing of jaguars could quickly reverse the progress that has been made over the past four decades to recover jaguar populations from the past century's commercial trade in spotted cats, prior to the implementation of CITES trade bans. The jaguar, through its charisma and strong cultural and ecological value, has successfully mustered the attention of governments, conservation organizations, the media and the public towards this threat, and policies and actions are being implemented to prevent the escalation of the illegal trade in jaguar body parts. My aim through this DPhil has been to support these ongoing and future actions to conserve jaguars, by providing key scientific evidence on the prevalence, drivers and characteristics of the illegal trade in jaguars. Beyond building the scientific evidence on a threat that was poorly understood, I worked closely with NGOs and intergovernmental bodies (CITES) to ensure that these scientific inputs would be taken into consideration by conservation decision-makers, reducing their previous reliance on incomplete or biased seizure data or anecdotal accounts. Thanks to, and building on, my DPhil's research efforts, I authored CITES' first study on the illegal trade in jaguars, an evidence-based instrument that will guide future intergovernmental discussions on the issue and pave the way for coordinated action to address the illegal trade in jaguars by source and destination countries. I am honoured and humbled to have had a unique chance through my DPhil to witness and be a part of the fast development of the response to the illegal trade in jaguars, and to have personally experienced the challenges and huge rewards of linking science to policy and action. I am immensely grateful to my supervisors and collaborators for helping me to choose a fascinating and policy-relevant research topic and for supporting me to engage with others outside the walls of academia.

In addition to meeting the overall aim of my DPhil, the specific objectives that guided each chapter in the thesis were also met, contributing to knowledge on the illegal trade in jaguars, IWT, and biodiversity conservation more broadly. The first objective was to estimate the prevalence and sensitivity of the illegal jaguar trade, the actors involved, and the uses of jaguar body parts in north-western Bolivia, with a particular focus on distinguishing between domestic and foreign markets. Based on questionnaire surveys with 1107 participants from rural households in north-western Bolivia, Chapter 3 described the unexpectedly high prevalence of jaguar killing (including of killing more than 5 jaguars), trading (selling and buying), possessing (owning jaguar body parts or live jaguars) and of recruitment (asking or being asked to kill a jaguar) behaviours within the past five years. The possession of jaguar body parts, including skins, teeth, skulls and fat, was particularly prevalent, comprising nearly half of the sample. Chapter 3 also describes the wide range of uses that are locally assigned to jaguar body parts in domestic markets, and how they are tightly linked to cultural and traditional practices within indigenous and non-indigenous communities in the area. The medicinal use of jaguar fat was highlighted as a widely known popular practice, despite it hardly ever being discussed in the academic literature. Through the implementation of the Ballot Box Method (BBM), a specialized sensitive questioning technique, in addition to direct questioning, it was possible to determine that despite being illegal, jaguar trade and related behaviours are not particularly sensitive in the minds of rural participants. Moreover, people were generally comfortable to share their experiences of interacting with jaguars and engaging with jaguar trade, being also largely unaware of its illegality. The characteristics of jaguar traders were also discussed, noting the importance of traders of European descent (e.g. tourists, missionaries, volunteers, etc.) and traders from neighbouring countries (e.g. Argentina, Brazil, Peru) in promoting engagement with jaguar trade, more so than traders of Asian descent, unlike the suggestions in the media. In terms of its contribution to knowledge, this chapter is one of the first examples of the implementation of the BBM within the field of biodiversity conservation, following Nuno (2013) and Bova et al (2018). Additionally, along with

Carvalho (2019), this thesis is among the few to explicitly estimate the prevalence of jaguar killing in a way that minimizes social acceptability bias, and the first to do so for illegal jaguar trade with a large and semi-randomly selected sample.

The second objective was to identify the key socioeconomic, experiential, psychological and market-related drivers of jaguar trade and related behaviours in north-western Bolivia, including killing jaguars, owning, buying or selling jaguar body parts. I met this objective by conducting a robust statistical analysis of the predictors associated with greater engagement in jaguar killing, trading and consuming behaviours, based on data collected through questionnaire surveys in the Departments of Pando, Beni and Northern La Paz in Bolivia (Chapter 4). Multiple generalized linear models with mixed effects accounting for the nested structured of the data (villages nested within study areas), revealed that jaguar killing, trade and consumption have different drivers. For example, while experiences of human jaguar conflict and cattle ranching livelihoods are strongly associated with jaguar killing, they are not as relevant for explaining the trade in jaguar body parts. Similarly, hunting livelihoods tend to be highly associated with jaguar killing and selling behaviours, but they are less likely to play a role in consumption-related behaviours (either possessing or buying). On the other hand, almost all behaviours were related to market opportunities and awareness of the existence of a market for, and prices of, jaguar body parts in the area. Chapter 4 also provided greater descriptive detail about the interactions between humans and jaguars in the study area, and the perceptions and attitudes that people have towards the species, which are key to implementing interventions to promote human-jaguar coexistence. The analysis presented in this chapter contributes to knowledge on IWT by being the first to statistically investigate the drivers of the illegal trade in jaguars from data collected at source areas, and from a large number of people directly involved in the trade. Other studies have inferred potential associations based on qualitative observations or anecdotal accounts (Braczkowski et al., 2019; Reuter et al., 2018b; Verheij, 2019), or by modelling national-level macroeconomic

indicators (e.g. gross national income and corruption indices) against jaguar seizures (Morcatty et al., 2020). These two different approaches do not necessarily explain localized behaviours or account for observational biases and confounding factors. Along with Knox et al. (2019), my work is one of the few pieces of research to highlight the close and highly conflictual relationship between humans and jaguars, including the finding of an unexpectedly high incidence of jaguar attacks on humans, which were previously thought to be almost non-existent.

The third objective was to characterize the status and characteristics of the illegal trade in jaguars in Mesoamerica, including locations, trade chain pathways, actors and their motivations, drivers and enabling factors. Chapter 5 specifically addresses this goal, by presenting the results of an exploration of examples of illegal jaguar trade obtained from interviews with key informants in Belize, Guatemala and Honduras, including enforcement agents, wildlife authorities, park rangers, jaguar scientists and conservationists and wildlife rescuers. These examples revealed the broad diversity of actors involved in illegal jaguar trade, from rural farmers to urban elites, and their profit and non-profit motivations, as well as the pathways behind the jaguar trade chain, potential trade routes, drivers and enabling factors. Realizing that even the most knowledgeable experts and key informants may be subject to a wide range of biases in how they perceive and interpret events, I conducted an innovative thematic analysis, separating all of the interview content into, i) concrete examples backed by evidence or ii) strong beliefs and assumptions. This permitted identification of characteristics of the illegal jaguar trade that were based on verifiable facts, such as the importance of domestic markets, bushmeat hunting and human-jaguar conflict as drivers of jaguar trade, versus opinion-based beliefs informed by anecdotal accounts or dominant IWT narratives, such as the involvement of foreign actors in the trade. This analytical approach not only elucidated the key characteristics of the trade in jaguars in a region that had not previously received much research attention, but also contributes to the wider

conservation literature by providing an example on how to increase the robustness of inferences from key informant interviews, particularly for topics with high uncertainty levels.

The fourth objective of this DPhil was to gain insights into how conservation decision-makers and practitioners working to address the illegal trade in jaguars on the ground perceive, use and prioritize evidence on jaguar trade, and to generate guidance for improving evidence-based approaches to decision-making on IWT. I achieved this objective in Chapter 6, by interviewing decision-makers and practitioners working on IWT and jaguar trade on the ground in Belize and Guatemala about their IWT related decision-making processes, the types and sources of information that they normally use in their work, and the challenges that they face in adequately addressing cases of IWT. I then carried out an evidence evaluation exercise, in which interviewees were asked to physically arrange and prioritize excerpts of jaguar trade evidence, which varied in their attributes (source, location, time, nationality of traders and purpose of the trade), and to discuss their rationale behind the prioritization process. Through a qualitative and quantitative analysis of the evidence ranking and the associated discussion, I was able to uncover some of the explicit and implicit biases that decision-makers have when they confront IWT evidence, including a tendency to disregard the source and suggested biological impact of the evidence, and to overemphasize foreign traders and commercial purposes behind the trade. Decision-makers also cared more about events happening closer to them in time and space, and those that they felt they could personally act on, as well as information coming from close acquaintances. Based on these findings, I contributed to the literature on linking science and decision-making in conservation by proposing an approach for determining the types of actions that are appropriate (between intervening, researching/monitoring, or ignoring) in response to evidence of different types and qualities, through a more explicit consideration of the evidence's attributes and uncertainty. If implemented by decision-makers, the proposed approach could increase the accountability behind decisions to act on IWT, on more solid grounds than simply invoking the precautionary principle.

7.2 Cross-cutting and emerging themes

As I collected, analysed, and wrote the findings of my research, several thematic patterns emerged, inspired by my data and findings, the different geographies where I worked, the methods I used, and my evolving thinking about jaguar trade. In this section, I discuss some of these patterns, placing them in the context of my different study areas and their similarities and differences, and within the broader IWT and conservation literature.

7.2.1 Deconstructing the myth of 'low impact' local domestic jaguar trade

Following the CITES-mandated prohibition of international trade in jaguar skins and other body parts in 1975, trade ceased to be a key concern for jaguar conservation. In the past four decades since, the main lines of action for jaguar conservationists became combating habitat loss, maintaining genetic connectivity, and mitigating conflict with humans due to livestock depredation (Quigley et al., 2017). However, despite no longer being a priority, the trade in jaguar body parts at the domestic level was never completely eliminated. Several studies have documented the use of, and trade in, jaguar body parts across the jaguar range in the aftermath of the listing of jaguars under CITES. For example, Srbek-Araujo (2015), Balaguera-Reina & Gonzalez-Maya (2007) and Garcia-Alaniz, Naranjo, & Mallory (2010) had previously highlighted the use and commercialization of jaguar body parts as a common element of traditional and subsistence practices amongst rural, multi-ethnic communities in Brazil, Colombia and Mexico, respectively. In Costa Rica, Kelly (2018) highlighted the existence of illegal trade in jaguar and other felid derivatives from rural to urban areas by indigenous and non-indigenous communities, for use as symbols of masculinity. Similarly, Jędrzejewski et al. (2017a) noted that the extraction, use and trade of body parts followed almost every case of retaliatory or subsistence jaguar killing recorded in Venezuela over the past 80 years. The existence of jaguar body parts in craft markets throughout

Peru was identified as a common occurrence currently and in past decades (SERFOR and WCS, 2019). My fieldwork offered additional support to the existence of a thriving domestic market for jaguar body parts in Mesoamerica and Bolivia, showing that regardless of the presence or absence of international markets, indigenous and non-indigenous rural communities, as well as urban dwellers, partake in the trade in and consumption of jaguar products, for a wide range of medicinal, cultural, decorative and functional purposes (Chapters 3 and 5). Although these studies are proof of the long-term existence of domestic illegal jaguar trade across the jaguar range, it was not until the links to demand from Chinese wildlife markets were highlighted just a few years ago that trade re-gained conservation significance as a threat to jaguars.

Why was the illegal domestic trade in jaguars largely ignored until recently? A potential explanation is that domestic jaguar trade may have been disregarded as a small-scale threat, limited to the subsistence needs and cultural traditions of small and secluded indigenous communities. The underrepresentation of hunting and wildlife use and trade in Latin America on these grounds is not exclusive to jaguars. Instead, it is a common trend within the hunting literature on the region, which has generally focused on indigenous hunting practices and their sustainability, usually in remote Amazonian communities, while disregarding the much broader range of actors involved in hunting and wildlife use across the continent (Ojasti and Dallmeier, 2000; Petriello and Stronza, 2020). Unlike for other actors, wildlife use by indigenous communities is not only legally permitted across many Latin American countries as part of their traditional rights, but it is also believed to be largely 'sustainable' due to the 'ecologically noble savage' narrative, which defends the notion that native communities are culturally predisposed to live in harmony with the environment (Hames, 2007; Petriello and Stronza, 2020). However, such discourse not only homogenises highly diverse indigenous societies, but it also fails to consider that their practices and traditions are not frozen in pre-colonial times, and that indigenous peoples should not be expected to meet currently unrealistic sustainability

standards of caricature stereotypes (Rowland, 2004). Several studies have questioned the validity of the sustainability assumption behind hunting and cultural use of wildlife by indigenous peoples in modern times, noting that cultural and demographic change, greater market integration, and the adoption of guns as hunting tools have altered what were previously described as 'harmonious', or 'sustainable' indigenous wildlife use practices, leading to wildlife overexploitation (Shepard et al., 2012; Sirén, 2015; Wilkie et al., 2011). Consequently, even if jaguars were only targeted by indigenous communities (which is not the case), assumptions of sustainability of such practices may be unrealistic.

Moreover, jaguar exploitation by indigenous communities may have been disregarded by jaguar conservationists due to moral relativism surrounding cultural wildlife uses (Dickman et al., 2015). It has been observed that in value-laden conservation contexts, like trophy hunting, human-wildlife conflict or IWT, conservationists who carry 'Western' or 'positivistic' views about nature conservation often avoid condemning practices that threaten biodiversity when they are carried out by people with culturally distinct values, under the justification that they cannot be objectively judged (Dickman et al., 2015). The fact that the jaguar is a species of particular cultural importance for many indigenous societies, some of which even hold it at the centre of their identity (e.g. the Matis people of Brazil or the Kogi people of Colombia), may have further increased the moral relativism behind cultural uses of the jaguar. Therefore, associating jaguar use and trade with the subsistence and cultural traditions of indigenous communities may have automatically led to assumptions of sustainability and cultural autonomy, curtailing further questioning of its potential biological impacts on jaguars. This positionality became apparent in the evidence ranking exercise that I implemented with jaguar conservation practitioners and decision-makers in Chapter 6, in which pieces of jaguar trade evidence involving indigenous communities and traditional uses were immediately described as a low priority for conservation action.

Another potential explanation for the dismissal of domestic jaguar markets from the jaguar conservation agenda over the past decades may be related to an overall underrepresentation of the role of multi or mixed-ethnicity communities in wildlife hunting, use and trade across Latin America. Hunting, consumption, and reliance on wild meat and wildlife products by multi-ethnic 'campesinos', 'colonos' or 'interculturales' living in rural areas and towns, is not well understood, even though these communities represent the most numerous wildlife hunters and users in the region (Nielsen et al., 2018; Ojasti and Dallmeier, 2000; Petriello and Stronza, 2020; Van Vliet et al., 2014). These groups have varied social identities, but they are generally described as post-land reform settlers of multi-ethnic backgrounds, who occupied 'empty' lands and developed strong ties to farming and ranching as key components of their social class and occupational identity (Ojasti and Dallmeier, 2000; Petriello and Stronza, 2020). Environmental discourses have framed these multi-ethnic communities of agriculturalists and ranchers as the opposite of the culturally-driven nature stewards that indigenous peoples are believed to be, instead depicting them as poor, uneducated people who lack local traditional knowledge or cultural values towards wildlife (Petriello and Stronza, 2020). These narratives have constrained understanding of the cultural significance of hunting by multi-ethnic communities, reducing it to opportunistic endeavours, resulting from greed or poverty (Petriello and Stronza, 2020). This depiction has been further supported by wildlife laws in several Latin American countries, which allow hunting and wildlife use by indigenous societies, while criminalizing such uses by any other groups despite of their similar subsistence, food security, and cultural demands (Antunes et al., 2019; van Vliet et al., 2019). As shown in Chapters 3, 4, and 5, mixed-ethnicity communities, which represented the core of my survey participants, play a very important role in the supply of and demand for jaguar body parts, driven partly by their hunting and ranching livelihoods, which increase their chances of finding jaguars, but also by their cultural interests in the possession and use of jaguar body parts. The multi-ethnic 'campesino' communities that I studied were active players in the jaguar trade, and they desired jaguar products for subsistence (e.g. meat or income), but also for a wide

range of cultural purposes, including as amulets for the protection against evil, as costumes to wear at special occasions, or as medicine to heal multiple diseases, among many other uses (Chapter 3). Apart from Garcia-Alaniz et al. (2010), to the best of my knowledge there are hardly any studies tracing the origins and characteristics of cultural uses of jaguar body parts outside of indigenous communities. Multi-ethnic communities also assign a symbolic value to jaguars. In some areas of Brazil, jaguar hunting has been described as part of the cultural identity of multi-ethnic farmers and cattle ranchers (Marchini and Macdonald, 2012), and the possession of skins and jaguar trophies has been linked to masculinity, status and bravery amongst both indigenous and non-indigenous Costa Ricans (Kelly, 2018). Yet, just as the extent of jaguar hunting, use and trade could have been minimized with respect to indigenous societies on the grounds of its limited scale or 'sustainability', it could have also have been dismissed for multi-ethnic 'campesino' communities due to a lack of consideration of the subsistence and cultural importance of wildlife and jaguars for these societies beyond simple opportunistic use.

Domestic trade may have also been overlooked as merely a by-product of human-jaguar conflict over livestock depredation, which would justify spending efforts on conflict rather than trade, as the root cause of jaguar mortality. Several jaguar scientists, NGO reports and media articles have highlighted this potential association between trade and conflict, suggesting that recent cases of illegal jaguar trade originate from ranchers' accumulated stocks of jaguar body parts obtained from past and present retaliatory killings, which have now surfaced into markets in an effort by ranchers to gain financial compensation for their losses (Jędrzejewski et al., 2017; Reuter et al., 2018b; Romero-Muñoz et al., 2020; Romo, 2020). While there is evidence that in many cases ranchers do in fact choose to keep and sell the parts of jaguars that have been killed in conflict, for consumption, as trophies, or as proof of effective predator control (e.g. Jędrzejewski et al., 2017a; Valsecchi do Amaral, 2012) there are also examples in which body parts are discarded (e.g. Harmsen and Urbina, 2017). Additionally, in

some areas, the majority of cases of jaguar killing were linked to chance encounters or subsistence hunting rather than conflict (Jędrzejewski et al., 2017; Paviolo, 2010). Therefore, while human-jaguar conflict could be an important source of trade in jaguar body parts, it is not necessarily the only or even the main one. Indeed, Chapter 4, which discusses the drivers of jaguar trade in north-western Bolivia, found that while ranching livelihoods and experiences of conflict with jaguars increase the likelihood of jaguar killing, they are not strong predictors of trade-related behaviours (selling or buying jaguar body parts). Similarly, only one third of survey respondents who actively killed and traded jaguar body parts ("killing traders", 9% of n=1107) had experienced livestock depredation by jaguars. That means that the majority of killing traders obtained jaguar body parts through circumstances other than conflict. The links between conflict and trade have received little scientific attention and deserve further exploration, but it is clear that dwelling on the potential synergies between these threats and focusing exclusively on conflict as a way to also reduce trade is not guaranteed to reach an effective outcome.

The potential impact of domestic jaguar killing, consumption and trade by indigenous or multi-ethnic societies in Latin America has not been directly measured or estimated, but it is likely to be highly detrimental to jaguar populations even under the most conservative scenario of the trade being limited to domestic drivers (chance encounters, human-jaguar conflict or subsistence and cultural demands). Existing jaguar population viability analyses have shown that jaguar offtake levels exceeding 6-8% of the population per year can severely reduce the odds of jaguar survival in the medium to long term (50 to 100 years), particularly if poached individuals are female (De Carvalho and Desbiez, 2013; Foster, 2008; Miller, 2014). Considering that 24 out of the 34 (71%) jaguar subpopulations throughout the range have been reduced to small and fragmented populations containing 200 jaguar individuals or less (de la Torre et al., 2017), annual offtakes of 20 individuals per population would be enough to drive significant population declines across the range. While it was

beyond the scope of my DPhil to estimate the impacts of jaguar poaching and trade on jaguar populations, Chapters 3 and 4, which describe the prevalence and drivers of jaguar killing, use and trade in north-western Bolivia, suggest that current levels of jaguar exploitation, associated mainly with domestic markets, may be driving a downward jaguar population trend. More than 40% of my respondents (465 people in a sample of 1107 across 36 villages) had possessed jaguar parts in the past five years, and nearly 20% had killed at least one jaguar. Participants and villages were semi-randomly sampled from a total 103 eligible villages in four study areas, with a total population size of 49,148 people (Chapter 3.2.1). Had my sample been fully random, it would be reasonable to estimate that the actual number of people who had killed a jaguar in the past five years in my study area was around 10,000 people (excluding urban residents or rural villages not meeting the selection criteria; Chapter 3.2.1). Considering that Bolivia has an estimated mean density of 1.73 (CI 95% 1.38-2.08) individual jaguars per 100 km2 (Jędrzejewski et al., 2018), this would translate to a mean population size of 1,797 (CI 95% 1,434-2,161) jaguars in the 103,926 km^2 that make up my study area, assuming that all the area is occupied by jaguars, which is unlikely the case. Based on the 6-8% estimated annual offtake levels that cause jaguar population declines according to population viability assessments, severe jaguar declines in my study area would be expected to occur in the medium to long term as a result of the killing of 108-144 jaguars per year (roughly 500-700 over a 5 year period), suggesting that current offtake levels are considerably above sustainability levels. More detailed and dynamic bioeconomic assessments of the impacts of trade on jaguar populations are needed, relative to other threats, but these simple estimates are indicative of a potentially alarming scenario that requires urgent attention if jaguars are to be sustained in Bolivia beyond the near future.

Other studies have also documented alarming jaguar offtake levels across the range, lending further support to my results and to the large hypothesized impact of killing, use and trade on jaguar populations. Also in Bolivia, Knox et al. (2019) found that 26.7% (n=533) of participants in a survey of

human-jaguar interactions in protected areas and indigenous reserves in the country had killed jaguars, and 16.7% within the past five years, a value that is very close to my findings of jaguar killing prevalence (Chapters 3 and 4). Other studies have found similar offtakes associated with human-jaguar conflict in other areas of Bolivia, and elsewhere in the jaguar range. Research carried out in 85 cattle ranches spread over the Pantanal, Chaco, Chiquitania and Beni ecoregions, covering 656,000 hectares in Bolivia, reported 347 jaguars poached in a 4 year period due to conflict (Arispe et al. 2009 in MMAyA, 2020). Similarly, another study of 30 cattle ranches in Beni, Bolivia, reported the poaching of 93 jaguars in a single year, equivalent to 10.6 jaguars poached per 100 km2 in an area of 87,979 ha., a value that greatly exceeds estimated jaguar densities in the country (Inchauste Ibanez, 2015). In a single year (2003-2004), 110-150 jaguars and pumas were killed due to conflict in a single municipality in Brazil (ICMBio, 2013; Michalski et al., 2006). In Belize, poaching in response to livestock depredation by jaguars led to an estimated annual offtake of 200 jaguar individuals nation-wide (Foster, 2008). These numbers may be an underestimate of the actual scale of jaguar offtake, as they were collected through small, purposive surveys using direct questioning, which may lead to underreporting.

These numbers suggest that, regardless of whether consumption and trade are the primary or secondary drivers of jaguar killing, even small-scale, opportunistic, subsistence, conflict-based jaguar killing carried out by indigenous or multi-ethnic societies can quickly exceed the limits of sustainability. It is then reasonable to assume that any additional pressures on jaguars, brought forth by rising jaguar body part prices caused by growing demand from foreign markets like China, would only speed up an extinction process that is already unfolding at the hands of domestic actors. Improved jaguar population viability models, coupled with realistic offtake and jaguar abundance parameters, incorporating uncertainty and confounding variables, are urgently needed to determine the actual impact that domestic jaguar killing, use and trade. Moreover, domestic drivers of the trade must be urgently incorporated into anti jaguar trafficking interventions, and local actors should become target

audiences for awareness building and behaviour change initiatives to conserve jaguars. Failing to consider domestic drivers and actors, and focusing only on international demand from foreign markets, is unlikely to reduce jaguar poaching and trade to the levels needed to sustain jaguar populations into the future.

7.2.2 Counterbalancing dominant narratives within IWT: the case of Asian wildlife markets

While the domestic illegal trade in jaguars has been minimized despite its continuous and widespread presence and high potential impacts on jaguar populations, the illegal jaguar trade for international markets, particularly in China, has been overemphasized by the media and conservation decision-makers despite having a more limited evidentiary weight. Through a discourse analysis of international media coverage of the illegal jaguar trade in Bolivia, which I co-supervised, Li (2021) found that nearly 300 media articles were written about the topic in Spanish, English and Chinese languages from 2015 to 2019, the majority of which (64%) attributed the trade directly to Chinese demand. The large media coverage of the illegal trade in jaguars since 2015 originated from reports of jaguar teeth seizures in Bolivia and China. In 2015, 119 jaguar teeth were seized at Beijing airport in China from a passenger travelling from Bolivia (Beijing People's Court, 2015). In Bolivia, around 600 jaguar teeth were confiscated in 22 seizure events at local airports and mailing companies from 2014 to 2016, all of which had China as country of destination (Nunez and Aliaga-Rossel, 2017; Verheij, 2019). Criminal charges were also brought against three traders of Chinese descent residing in Bolivia, who were found in possession of a total of 190 jaguar teeth in 2017 and 2018 (Berton, 2018; Verheij, 2019). These seizures and apprehensions constitute the bulk of the confirmed evidence of the involvement of China and traders of Chinese descent in the illegal trade in jaguars, which inspired much of the media coverage on the matter.

Aside from these well-known examples, other unconfirmed reports linking the illegal jaguar trade to Chinese demand have emerged from across the jaguar range in the past few years, further fuelling the media's depiction of the trade as a Chinese-driven enterprise. Through a range-wide review of online seizure reports, Morcatty et al. (2020) found that other countries like Brazil, Colombia and Peru also had recent jaguar seizures linked to demand from China, but at lower scales. Similarly, the authors found that Latin American countries with increased Chinese corporate investments were more likely to have a greater number of jaguar seizures, concluding that greater financial ties to China and the presence of Chinese company workers in Latin America may offer the conditions for illegal trade in jaguars to thrive (Morcatty et al., 2020). In Suriname, undercover investigations carried out by journalists and conservation organizations revealed that members of the Chinese diaspora in the country were involved in the production of jaguar bone paste for local consumption and export, although no official seizures were made (Lemieux & Bruschi, 2019). Investigative reporters have also commented on the alleged existence of Chinese cartels dedicated to the illegal trade in jaguars, other wildlife, and drugs, operating through organized criminal networks in Bolivia and neighbouring countries (Romo, 2021). While many of these reports have been repeatedly mentioned by the media and referred to as evidence of Chinese-driven jaguar trade, many of their allegations have not been verified through enforcement operations or seizures, nor recognized and validated by national authorities. For instance, the production of jaguar paste, as well as the alleged use of jaguar bones, meat and organs within TCM, are lacking in seizure evidence altogether (Li, 2021). Similarly, claims about the involvement of Chinese companies and of organized Chinese mafias in the illegal trade in jaguars are based mainly on non-official undercover investigations or statistical correlations that may not reflect actual events. Additionally, none of those examples clearly describe the precise nationality of jaguar traders of Asian descent, automatically assuming that they are Chinese citizens. However, the few actual apprehensions of jaguar traders involved nationalized members of the long established Chinese diaspora in Latin America, without necessarily having ties to China or dual nationality (which

is not allowed by China; Li, 2021). Holding on to unconfirmed but potentially appealing story-lines about jaguar trade and its links to organized crime, private corporations, and Chinese wildlife markets, the media helped to raise the profile of jaguar trade as an international issue, driving a regional and international response, while largely ignoring domestic markets or national drivers of the trade.

There are multiple potential reasons why the media, and later, jaguar conservation stakeholders (e.g. governments, NGOs, multi-lateral organizations) stressed the international, corporate and criminal dimensions behind the illegal trade in jaguars. On the one hand, it could have been a strategic decision aimed at increasing the policy attention and funding streams available to combat the illegal trade in jaguars. For example, elevating the illegal jaguar trade as an international issue immediately puts the issue into the jurisdiction of CITES, while highlighting the criminal aspects of the trade invokes the mandate of the United Nations Office on Drugs and Crime (UNODC) and the International Criminal Police Organization (INTERPOL), all of which can leverage the attention of and investment from governments and international donors. Appealing to international conservation governance structures may be particularly advantageous when considering that many Latin American countries lack the resources and capacity to address IWT single-handedly (Ungar, 2017; Vizeu Pinheiro et al., 2020; Wiersema, 2017). On the other hand, underscoring the role of China, traders of Chinese descent, Chinese companies and Chinese mafias in the illegal trade in jaguars may have been regarded as a messaging strategy to engage audiences. Messages that effectively capture the attention of policy-makers and the public, and which have higher odds of 'going viral' or being socially amplified, are those which evoke physiological arousal by inciting positive or negative emotions such as awe, anger or anxiety (Berger and Milkman, 2012). In the context of IWT, feelings of anger or frustration with poaching can be more effectively elicited by the media and other "institutional sponsors" (e.g. conservation organizations) through the creation of deviant identities or common enemies that increase risk perceptions towards wildlife crimes, and which help to socially construct poaching as a

serious problem (Brisman and South, 2013; Rizzolo et al., 2017). The use of simplistic representations of Asian identities and ethnicities to attribute blame and build anti-IWT messages, has been a common strategy employed by IWT demand reduction and behaviour change campaigns (Margulies et al., 2019b). The construction of an undifferentiated portrait of the Chinese "Asian super consumer", a character who does not know or care about wildlife and who is only concerned about wealth and status, is rooted in a long history of tension and division between the Western and Eastern hemispheres over cultural hegemony, in which western imperialism deployed racial stereotypes such as "yellow peril" or "yellow terror" to villainize people of Asian descent (Margulies et al., 2019b). Such representations are not only insensitive but also inaccurate, as they fail to consider the wide diversity of Asian cultures, grouping them all (even those born outside of Asia) as Chinese or broadly Asian. They also overlook the fact that only a minority of the population in Asian countries are wildlife consumers, and that their preferences vary widely by gender, socioeconomic status and motivations (Hinsley and 't Sas-Rolfes, 2020; Margulies et al., 2019b). The Asian super-consumer narrative was embedded in the discourse surrounding the illegal trade in jaguars, showing a lack of consideration of Asian identities in the trade (Li, 2021). The blame fell on the "Chinese", regardless of their actual nationality (Chinese nationals vs. range country nationals), ethnicity (e.g. Chinese, Japanese, Korean, Thai), and their role in or motivations for trade. Such homogenization may have served to position jaguars within the broader IWT policy context, which focuses largely on Asian wildlife markets, and to strengthen the link to TCM and to the symbolism of the critically endangered tiger, brought near extinction due to Asian demand.

Responding to the policy and media relevance of demand from Asian wildlife markets, and the limited confirmed information about its role in the illegal trade in jaguars, my DPhil sought to fill this knowledge gap, by both allowing the topic to arise naturally in my key informant interviews and surveys with rural villagers, and by explicitly enquiring about it. In chapters 3, 4 and 5, I verified the

existence of jaguar traders of Asian descent in Mesoamerica and Bolivia, but contrary to how it has been described by the media, I highlighted that these traders had a weaker involvement in and association with jaguar trade than traders of other nationalities and ethnicities. My fieldwork in Bolivia, the country with most jaguar body part seizures linked to China, showed that while many survey participants (20.1%, n=1107) were aware of the presence of traders of Asian descent around their communities, a lower number of people (2.5%) had been personally approached by such traders, and the presence of traders or consumers of European descent or those from neighbouring countries (e.g. tourists, missionaries, volunteers, crafts vendors) was more strongly associated with jaguar killing and trading behaviours amongst survey participants (Chapter 3). Based on my surveys, I also provided more details on the characteristics of Asian traders, who were described as people of Chinese, Japanese, Korean and Thai ethnicities, and who had varying migratory status in the country, corresponding to long-term immigrants who were established members of the Asian diaspora in Bolivia and who spoke Spanish, and more recent immigrants associated with Chinese infrastructure projects and who spoke with the help of a translator. However, these results are subject to the interpretation and understandings of my survey participants, and while they serve to expand the simplistic narratives behind "Chinese jaguar traders" spread by the media, they should be treated with caution, particularly as I detected that a large percentage (47%, n=1107) of my survey participants held negative perceptions towards people of Asian descent, mainly on the grounds of them taking employment opportunities away from locals (Chapter 3.3.7).

My interviews with key informants in Mesoamerica further showed that while the presence of jaguar traders of Chinese descent was a commonly discussed issue, and Asian demand was perceived as a key driver of jaguar trade, most of the references or comments that key informants made about the topic were based on assumptions and strong beliefs rather than concrete facts (Chapter 5). As revealed through my thematic analysis of those interviews, part of the concern surrounding Asian

demand was rooted in the belief that Asian wildlife markets are very large in scale, corresponding to their large populations, such that even the lowest per capita demand from Chinese consumers could easily destabilize wildlife populations. Similarly, through the evidence ranking exercise conducted in Chapter 6, it became evident that those working to address the illegal jaguar trade in the region had a tendency towards prioritizing information involving foreign actors, such as traders of Chinese descent, irrespective of the quality of the information. While not minimizing the importance of continuing monitoring of foreign demand for jaguar body parts, my results balance the narrative surrounding the role of Asia (and China in particular) in the jaguar trade, by bringing forth the wider variety of drivers and actors involved in the trade, and the importance of questioning the evidence on IWT with respect to its objectiveness, relevance, quality and impact, regardless of the actors involved. In doing so, my work has brought the focus back to the national level, highlighting that much of the responsibility to address the illegal trade in jaguars should lie with national governments and relevant stakeholders, to enhance their response capacity and address domestic markets, including those from the resident Chinese diaspora, rather than transferring the blame and responsibility to external actors and nations.

7.2.3 Politics, uncertainty, and windows of opportunity for addressing IWT

The illegal trade in jaguars is an example of how politics, evidence and uncertainty interact to shape the discourses behind, and to leverage actions to address, IWT. Even though evidence on the characteristics and impacts of the illegal jaguar trade is only starting to emerge following the first high-profile seizures of jaguar body parts in Bolivia, the issue has received unprecedented media and policy attention within Latin America. While IWT is not a new problem in the region, and steep, noticeable population declines in several species of plants and animals have been attributed to it (Chapter 2), arguably it was not until the recent exposure of jaguars as victims of international, organized, Chinese-

driven trade that IWT in Latin America gained greater political and public relevance at the national, regional and international levels. This was reflected in the inauguration of the first-ever High-Level International Conference on Illegal Wildlife Trade in the Americas, held in Lima, Peru, in 2019, in which jaguars were officially declared the region's emblem of the fight against IWT (I High Level Conference on IWT in the Americas, 2019; Lieberman, 2019). Other national and regional, public and private initiatives have underpinned the political and symbolic importance of the illegal jaguar trade. Some examples include multiple regional, national, and subnational alliances or manifestos against the illegal jaguar trade and IWT (CITES, 2019a; Hoogeslag, 2020), the addition of jaguar trade as a key element of landscape jaguar conservation projects like the Jaguar 2030 Roadmap (Panthera et al., 2019), the inclusion of jaguars under the Convention on Migratory Species partially on the grounds of an increase in trade-related offtake (CMS, 2020), the prioritization of jaguar trade research under CITES (CITES, 2019b), proposals to revise the jaguar conservation status from "Near Threatened" to "Vulnerable" under the IUCN (IUCN World Conservation Congress, 2020) and to update national jaguar and IWT laws (International Rights of Nature Tribunal, 2018). Similarly, the jaguar trade has inspired multiple efforts to catalyse funding and implement projects for jaguars and IWT in Americas led by NGOs like the Wildlife Conservation Society, the World Wildlife Fund for Nature, Panthera and IUCN, among others, and it has also mobilized large-scale public demonstrations and communication campaigns focused on eliminating jaguar trade and IWT (e.g. WCS, 2020). Moreover, addressing the illegal jaguar trade and promoting jaguar conservation has recently become part of range countries' strategies to advance the achievement of wider environmental and biodiversity goals, such as the Aichi Biodiversity Targets, the Sustainable Development Goals, and climate objectives under the United Nations Framework Convention of Climate Change (Jaguar 2030 High Level Forum, 2018), further exemplifying the political value assigned to jaguars in light of cases of international demand for their body parts.

Moreover, the narrative about the plight of jaguars as a result of Chinese-driven IWT may be symbolic of a wider geopolitical environmental debate surrounding the increasing role of China in the control of Latin America's natural resources (e.g. oil, minerals and agricultural commodities). The media representation of the jaguar trade was frequently accompanied by fears of the expansion of China's reach to Latin America through immigration and corporate investments that cause deforestation and natural resource grabbing, as well as the potential impacts of Chinese culture, in particular TCM, on wildlife overexploitation (Bale, 2020; Farhadinia et al., 2019; Li, 2021). Therefore, the illegal trade in jaguars speaks to the wider influence of geopolitics in conservation; how countries and their representatives behave with regards to national resources, territory, and security, and in response to other countries (Hodgetts et al., 2019). The emphasis on China's wildlife markets, corporate investments and mafias may therefore have links to nationalism and wider geopolitical agendas of importance to the region's national security, such as combatting organized crime, protecting natural resource sovereignty, controlling migration, to name a few.

For better or worse, jaguars, as one of the few widely-known representatives of Latin America's charismatic megafauna, have entered the IWT spotlight and filled the space previously reserved for African and Asian megafauna such as elephants, rhinos and tigers. Felids have an overwhelming, almost unparalleled public appeal globally relative to other species, provoking a marked taxonomic inequality when it comes to engendering public support for conservation (Macdonald et al., 2015). Similar to how the killing of "Cecil", a satellited-tagged male lion shot by a trophy hunter in Zimbabwe in 2015, provoked unprecedented media reaction and public outrage, which led to global interest and investment in lion conservation (Macdonald et al., 2016), the illegal trade in jaguars may have opened a political window of opportunity for jaguar conservation and IWT in Latin America. Windows of opportunity are created when politics, policies and problems come together in critical times, such as in the aftermath of natural, social or economic crises, engaging new actors, renegotiating old

leaderships, channelling investments, fostering change and presenting an opportunity for the uptake of science (Birkmann et al., 2010; Rose et al., 2017). The prospect of the extinction of the jaguar, a symbol of Latin American identity, at the hands of foreign actors who had already caused the precipitous decline of tigers, may have delivered the crisis needed to spur action against IWT in the region.

While the construction of the illegal trade in jaguars as a political phenomenon has opened a window of opportunity that has and may continue to drive much-warranted attention and investment into IWT and wildlife conservation in Latin America, my DPhil has brought attention to some of the potential perils of dwelling on politics and dominant IWT narratives for decision-making, in the absence of sufficient evidence. Chapter 6 highlights the problematic treatment of evidence by conservation practitioners working to address jaguar trade and IWT more generally, and denotes some potential implications of implementing unevidenced conservation or enforcement actions. Local livelihoods and subsistence practices on the supply side of the trade chain may be unfairly criminalized, creating tensions in the communities on which conservation depends (Duffy, 2016, 2014). At the other end of the trade chain, consumer audiences may be wrongly targeted and accused as a result of prejudice (Margulies et al., 2019b). For the specific case of the illegal jaguar trade, there are also risks of unintentionally spreading information about demand to areas which the trade has not yet reached, of damaging diplomatic and business ties between China and Latin American countries, and of assigning limited conservation resources to places and species that are not the most threatened by illegal trade. Chapter 6 proposes an approach to promote reflection on the types of action warranted by the evidence, seeking to enhance transparency and evidence-based decision-making on IWT. IWT decision-makers in Latin America should rely on robust evidence, particularly now that more attention, funding and scientific information on these issues is becoming available. However, it would be impractical to wait for certainty, and in so doing to miss the unprecedented political opportunity

and momentum that the illegal trade has now opened for jaguar conservation and the fight against IWT in the region. A potential solution to managing uncertainty while at the same time adhering to the precautionary principle and responding to the political opportunity behind the jaguar trade, would be to employ carefully thought-through, legitimate, participatory and transparent active adaptive management systems (Possingham, 2008). In this way, scientists and decision-makers can work together to design policies and interventions based on the best available evidence, test those efforts through piloting and models, build in the tools and capacity for monitoring their impacts, and quickly adjust interventions based on results (Addison et al., 2013; Possingham, 2008).

7.3 Research scope and transferability

In my DPhil, I studied the illegal trade in jaguars in two regions with varying socioeconomic and political contexts, and with different drivers and degrees of risk from the illegal trade in jaguars, providing an overview of this threat at a regional level. However, my DPhil's findings may not necessarily apply to other countries or jaguar trade contexts. The illegal jaguar trade is an example of a complex human-carnivore socio-ecological system that depends on multiple interacting factors, such as jaguar population densities, habitat status and configuration, human population densities and migration, socioeconomic status and cultural practices, market dynamics, natural resource institutions and governance, macroeconomic policies dictating foreign investment, among many others (Carter et al., 2017; Lischka et al., 2018). These factors are constantly changing, and the scale at which they operate may also vary, leading to spatial, temporal and functional (e.g. process) mismatches between the scale of environmental variation and the scale of natural resource management and/or research efforts (Cumming et al., 2006). While I aimed to capture the dynamics of these systems in both of my study areas, and to consider both the natural and social sides of the equation, obtaining a complete understanding of such a system would have required considering the more than 50 variables

suggested by socio-ecological systems theory (McGinnis and Ostrom, 2014), which was beyond the scope of my research. Additionally, these variables would have needed monitoring across time, extending outside the temporal boundaries of my DPhil. This means that my findings should be understood as a snapshot in time and space, rather than a comprehensive picture of the illegal jaguar trade. Moreover, in choosing to study the topic in two different regions, I made a trade-off between gaining a more geographically broad understanding of the issue over achieving a more detailed grasp of each of the multiple interacting factors in the socio-ecological systems and trade chains behind the jaguar trade. I believe this was an appropriate decision, as this is one of the first studies to investigate current illegal trade in jaguars, and consequently, this whole DPhil was an exploratory effort that responded to an urgent need to build the evidence and characterise the threat, rather than a detailed monitoring exercise aimed at guiding the implementation and evaluation of any particular intervention.

My DPhil's findings should also be understood within the scope and limitations of the methods I used. The selection and implementation of key informant interviews, questionnaire surveys and sensitive questioning techniques, while successful and hugely beneficial to achieving my aims, also came with important biases and limitations. As described earlier, the results from the key informant interviews I conducted in Mesoamerica were based on the perspectives and subjective understandings of the people I interviewed. Although I tried to include the views of participants with diverse backgrounds, representing multiple organizations, and used snowball sampling and the advice from my local partnering organization to expand my initial purposive participant selection, the results could have been strengthened by including more interviewees, or by adopting other social science approaches in conjunction. In the case of my questionnaire surveys in Bolivia, even though I obtained higher than expected prevalence estimates for multiple jaguar killing and trading behaviours through the use of the Ballot Box Method, I regretted not being able to spend more time at each of the villages I visited

to build more trust with participants and observe their interactions with wildlife and markets. I anticipate the estimates of prevalence I encountered could have been even higher had my team and I become more acquainted with our participants, and particularly with those who clearly had a deeper knowledge about the trade. In this case, the structured approach of questionnaire surveys, while ideal for collecting information quickly and at large scales (Newing, 2011), was less suitable for investigating the nuances behind the motivations and decision-making processes of jaguar traders. Additionally, by focusing on jaguar body part suppliers in my questionnaire surveys, it was not within the scope and objectives of my research to fully understand the motivations, purposes, and modus operandi used by traders and consumers higher up in the trade chain. The lack of evidence of violent, sophisticated, and organized criminal strategies in my results may not hold for the intermediary and demand stages of the supply chain, as has been suggested by the media (Romo, 2021). Similarly, my focus on rural communities existing within jaguar habitats may have limited my understanding of international or transboundary trade. I have confidence that given my large sample size and wide geographical cover, it would have been rather difficult to altogether miss the signs of organized, criminal, transnational trade. Nevertheless, I recognize that this was a possibility, and that my contribution should be taken together with other sources of evidence about the illegal trade in jaguars to design and implement robust and comprehensive anti-trafficking policies and interventions.

7.4 Ways forward

My DPhil experiences and findings, along with my broader engagement with policies and conservation efforts on my research topic, allow me to provide recommendations for future studies aiming to understand the illegal trade in jaguar and addressing IWT and biodiversity conservation more broadly.

Future research of the illegal trade in jaguars would benefit from taking the following potential directions: First of all, the illegal killing, use and trade in jaguars has not been explicitly studied in most countries in the jaguar range. Aside from my DPhil, to the best of my knowledge, very few studies have directly approached people who coexist with jaguars to ask about their own behaviours related to the species (e.g. Jędrzejewski et al., 2017; Knox et al., 2019). Instead, the vast majority of the studies on human-jaguar interactions have focused on enquiring about people's knowledge, attitudes, conflict risk perceptions, intentions to kill, acceptability of killing, or other social norms regarding jaguars (Engel et al., 2017; Marchini and Macdonald, 2012), even though these do not necessarily translate into behaviours (Gore et al., 2008; Kahler and Gore, 2012). The belief that directly asking about jaguar killing would be challenging due to its illegality and sensitivity has probably prevented researchers from engaging with the issue at all, but this information is necessary to empirically assess the status and gravity of this threat and there is ample guidance in the literature on how to ethically and robustly delve into sensitive topics (e.g. Nuno and St. John, 2015). Therefore, more research is needed to both measure the extent of jaguar killing, for reasons as varied as human-jaguar conflict, subsistence, consumption or trade, and to uncover the values and cultural practices dictating jaguar use elsewhere in the range. Beyond sensitive questioning techniques, this would require in-depth sociological and anthropological research. Countries like Honduras, Nicaragua, French Guiana, Guyana, Ecuador, Paraguay and Argentina are particularly lacking in information on these issues.

Second, there continues to be an important knowledge gap with respect to the potential impacts of the illegal trade on jaguar populations, a question that needs an improved understanding of jaguar populations in source locations, as well as data on jaguar offtakes. Many of my field areas in Mesoamerica and Bolivia, which were outside of protected areas, lacked updated and methodologically sound assessments of jaguar densities, estimated population sizes and trends. The problem surrounding the lack of basic jaguar population ecology data extends beyond my study sites,

and is reflected in the wide variation in global jaguar population estimates, which range from 64,000 (lower estimate 62,156; upper estimate 66,030), to 173,000 individuals (lower estimate 138,000; upper estimate 208,000) (de la Torre et al., 2017; Jędrzejewski et al., 2018). Even though jaguars are a highly charismatic species that in theory should be mostly understood from an ecological point of view, this statistically significant difference in population estimates means that efforts are urgently needed to more accurately measure jaguar populations through time, particularly in areas where human offtake is a growing concern. Moreover, as jaguar populations respond to numerous other ecological factors, such as prey availability, and to multiple threats, such as deforestation, human-jaguar conflict and forest fires (Quigley et al., 2017), these factors must be explicitly measured and incorporated into population viability models or other assessments of the impacts of illegal trade. Beyond ecological factors, offtake levels and population impacts also respond to market dynamics, including how the demand and supply of jaguar body parts interact depending on the price and availability of products, constrained by factors like access to the resource, law awareness, enforcement or the existence of alternative products (Challender et al., 2015; McNamara et al., 2016). Along these lines, an interesting and important future research direction would be to more carefully explore domestic and foreign jaguar markets, including demand elasticity, consumer preferences, and whether there are any noticeable substitution effects between big cats, as has been proposed by the media (Villalva and Moracho, 2019). Such investigations have already taken place in the case of the substitutability between tigers and lions within Asian markets (e.g. Coals et al., 2020), and would contribute towards an improved understanding of foreign jaguar markets. The dynamics between the domestic and foreign jaguar markets and other ecological and economic variables, and their impacts on jaguar populations, can be explored through bioeconomic models, which integrate economic and biological considerations into mathematical relationships and then validate them in the real world (Milner-Gulland and Rowcliffe, 2007).

Third, it would be important for future research efforts to more comprehensively consider the suite of variables encompassed within the socio-ecological systems framework (McGinnis and Ostrom, 2014) in the context of human-jaguar interactions and the illegal jaguar trade. Previous efforts to build conceptual socio-ecological models to explain negative interactions between humans and carnivores (e.g. Carter et al., 2017; Lischka et al., 2018) and to map out the range of factors involved in the trade chains of illegal wildlife products (e.g. Oyanedel et al., 2021) can provide a reference for some of the variables that should be considered. On the environmental side, beyond jaguar population sizes and trends, researchers may wish to consider individual jaguar traits and behaviours that increase their risk of being poached (e.g. habituation to humans, sex, age), as well as landscape factors, such as their distribution in space and time or the characteristics of the terrain (Carter et al., 2017).

On the social side, it would be valuable to gain a more detailed understanding of the motivations and decision-making processes of jaguar poachers, traders and consumers. A wide range of economic, behavioural and psychological theories applied within the field of criminology, such as the Instrumental Model (Becker, 1968), the Compliance framework (Ramcilovic-Suominen and Epstein, 2012), and the Theory of Planned Behaviour (Ajzen, 1985) can provide a framework for exploring how actors evaluate the costs and benefits of violating the law, while also considering social norms, attitudes, and the legitimacy of the behaviour (Oyanedel et al., 2020). Other criminological theories, such as the Routine Activity Model (Cohen and Felson, 1979) or the Crime Pattern Model (Brantingham and Brantingham, 1984) can support the exploration of how contextual factors, such as the presence and distribution of guardianship factors (e.g. fences, patrols), suitable targets and capable offenders interact to facilitate crimes. The importance of normative (e.g. social norms) vs. regulatory (e.g. laws and penalties) models in motivating compliance with wildlife laws and jaguar protections should continue to be investigated, along with a wider exploration of poaching motivations beyond the "cooking pot and pocket book", including for entertainment, curiosity, firearms testing, or as a coping

mechanism or form of protest (Kahler and Gore, 2012; Muth and Bowe, 1998). Studies focusing on the enforcement capacity and limitations of environmental institutions in Latin America could help to identify key areas of potential intervention that can drastically reduce crime opportunities. At the macro scale, researchers might also want to explore how legal, political and economic changes at the regional or national level, such as political crises, electoral cycles, presidential and party views, migration (e.g. the Chinese diaspora) or economic relationships with China and other nations can affect local economies and increase the likelihood of poaching or illegal trade (Carter et al., 2017). These factors began to be explored by Morcatty et al (2020), who identified a relationship between Chinese corporate investments, countries' GDP, national corruption indices and the illegal jaguar trade, but more work is needed to trace the influence of such macroeconomic factors down to local jaguar markets and transactions. Additionally, a much needed contribution would be to explore the legal loopholes and vacuums surrounding the illegal jaguar trade and wildlife trade more broadly within Latin America. Pursuing these and other lines of research will become crucially important in the years to come, as policies and interventions to address the illegal trade in jaguars continue to unfold. These investigations would not only provide guidance for the design of such actions, but also strengthen baseline understanding of the illegal jaguar trade, which is necessary to evaluate the outcomes and effectiveness of conservation interventions.

The lessons from my DPhil can also be applied to the study of other illegally traded taxa, in Latin America and elsewhere, and to biodiversity conservation more generally. A large focus of my DPhil has been to explore the use of evidence within conservation, particularly in contexts where there is scarce scientific information, such as IWT. I have shown that in those circumstances, even highly trained and experienced conservationists and decision-makers may have a tendency to rely exclusively on seizure data or anecdotal accounts, or to be swayed by dominant narratives, which may fail to represent IWT and lead to sub-optimal conservation outcomes. Future research should continue to

explore the implicit and explicit biases that conservationists and decision-makers have towards evidence of different types and qualities, which may challenge their uptake of scientific information on IWT. The use of choice experiments (e.g. Hinsley et al., 2015), along with social-psychological theories behind message framing (e.g. Bertolotti and Catellani, 2014) could quantitatively highlight some of the attributes that make some IWT evidence more appealing to decision-makers and the media alike, and inform how future scientific messages should be communicated. Tools like horizon scanning and scenario planning (e.g. Cook et al., 2014; Peterson et al., 2003), which encourage engagement between multiple actors with different perspectives to ponder upon plausible futures around conservation decisions, can also be implemented to promote a more rigorous consideration of uncertainty in IWT and conservation decision-making. Beyond just researching these topics, scientists and decision-makers should continue to make efforts to communicate and work together to co-design research questions that are policy-relevant and which can be applied in practice (Gore et al., 2020; Rose et al., 2019). This would be perhaps the best way to encourage a more evidence-based conservation policy and practice, particularly now that Latin American governments and organizations are increasingly interested in the fight against IWT and environmental issues. Additionally, the validity and legitimacy of dominant narratives, such as those on the role of organized crime, terrorism, super-consumers and criminalized communities on IWT, should continue to be questioned and explored at different scales and in different contexts (Milner-Gulland et al., 2018). Systematic reviews, accompanied with clear definitions and typologies of IWT types and actors (e.g. Gore et al., 2021; Phelps et al., 2016) could support with 'myth busting' such narratives, and help to increase the nuance and ethical sensitivity behind approaches to address IWT. In the cases where these discourses do not apply (which may be most of them), scientist should actively engage with the media and conservation practitioners and decision-makers to oppose and counterbalance the potential negative effects of misleading discourses. These recommendations could help to fill key knowledge gaps to improve

evidence-based IWT and conservation science, to the benefit of wildlife and the communities that coexist with, and depend on, nature.

7.5 Conclusion

For thousands of years, jaguars have been embedded within the religious and cultural cosmovision of Latin America's societies, and their existence continues to marvel and inspire new generations up until this day. The "indomitable beast" that once roamed nearly the entire continent as a supernatural spirit, imposing fear and respect from humans and animals alike, has been reduced to half of its historic range and is now perceived by many as a nuisance or a commodity, worthwhile only for its teeth, skin and bones. Time has changed the relationship between humans and jaguars, leaving them globally 'Near Threatened' and locally 'Endangered' in most of their range, making their future existence uncertain. In addition to struggling to survive in the rapidly shrinking habitat they now share with cattle, soy and human infrastructure, jaguars are increasingly threatened by poaching due to human intolerance, fear, amusement, in retaliation over livestock depredation, and for the cultural and economic value of their body parts. Their golden rosetted skins make for beautiful tapestries, their teeth can be worn to symbolize bravery, their meat can feed a family for several days, and even their fat can be used to allegedly treat multiple illnesses and to keep crop raiding pests away. Regardless of the reasons behind jaguar killing, jaguars are a valuable resource to the communities that coexist with them, giving rise to thriving domestic markets for jaguar body parts across their range, from Mesoamerica to Bolivia. Owing to the increasing interconnectedness of the world and the movement of people from all corners of the world to and from Latin America, for reasons as varied as tourism, business, and refuge from political and economic instability, in recent years demand for jaguar body parts has diversified and increased. Domestic wildlife markets are now bustling with traders and consumers from different nationalities and ethnicities, and jaguar body parts are crossing vast

distances to become novelty items in other continents, from Europe to Asia. As jaguar markets expand and the value of dead jaguars grows along with relentless habitat loss, their impacts on the already fragile jaguar populations will do so as well. Many countries may witness the extinction of jaguars within our lifetimes and with it will come the loss of ecosystem function, our cultural heritage, and the wonder of Latin America's deep grasslands and forests. I am optimistic that this looming scenario will not unfold, thanks to the passion of hundreds of conservationists, community leaders, researchers, journalists, authorities, and concerned citizens who are working tirelessly to remind us of the importance and value of keeping jaguars alive for generations to come.

Through this DPhil, I have aimed to contribute towards that goal by providing scientific evidence on the prevalence, characteristics and drivers of the illegal trade in jaguars in two extremes of its range. My research, which was only possible thanks to the support of multiple individuals and organizations, has improved knowledge about this threat, and highlighted some of the risks of relying on partial and biased information for decision-making on IWT. It has also added depth to the general discourse on the illegal jaguar trade, underscoring the complexity of its actors and drivers, and the need for multifaceted conservation approaches that move away from morally relative, colonialist and discriminatory accusations, to inclusive, evidence-based strategies that address the root causes behind the illegal jaguar trade. My findings encourage a change in perspective regarding the illegal jaguar trade, from a problem originating in a distant land at the hands of a foreign consumer with exotic practices, to a local, longstanding and ubiquitous reality of the coexistence between humans and jaguars in Latin America. This shift in the narrative transfers the responsibility for addressing this threat back to Latin American governments and relevant stakeholders working in the region to step up their actions, and their national and international commitments to conserve jaguars. It also introduces domestic actors as key target audiences of future jaguar conservation campaigns, and as the custodians of the future of the species. Through my DPhil, I have been fortunate to personally

embark on the process of linking science with conservation policy and practice, having the opportunity to share these important findings and lessons directly with those who are in the position to enact policies and actions to stop the illegal trade. I have also described the limitations of my findings, and provided guidance on future research directions that will continue to expand our understanding and ability to address the illegal trade in jaguars, including a more comprehensive consideration of the population impacts and of the multiple socio-ecological interacting factors behind this threat. I have also emphasized key issues surrounding the use and treatment of evidence and uncertainty in IWT, and provided suggestions to build a more evidence-based research and practice to address this issue. While the focus of this thesis has been on jaguars, it contributes to the knowledge-base on IWT and human-wildlife coexistence in Latin America, a region that is greatly lacking in research attention on these matters. Moreover, its focus on the effective use of evidence in conservation has implications for a vast array of taxa threatened by IWT in other regions, and for biodiversity conservation at large.

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Appendices

List of Appendices

Appendix 1: Survey Guide in English and Spanish languages (Chapters 3 and 4)

Survey #:	**Date:**
Study Area:	**Start time:**
Village #:	**End time:**

Socioeconomic Questions (Part 1)

1.Gender: 🗀 Male 🗀 Female

2. What is your age? ……

3. What is your occupation? ……..

4. Where you born in this village? 🗀YES 🗀 NO
Where are you from? …….. For how long have you lived here? …….

5. How many people live in this household currently? **Total ……. Children ……. Adults ……**

Questions about jaguars:

6. What words come to mind when you think about jaguars? ……

7. Are there jaguars in this village? 🗀YES 🗀 NO **How many?** ……..

8. Have you noticed any changes in the number of jaguars in the past 5 years?

a. Reduced a lot Why?	b. Reduced a little Why?	c. Stayed the same Why?
d. Increased a little Why?	e. Increased a lot Why?	f. Don't know

9. Would you prefer it if jaguars…

a. Disappeared Why?	b. Reduced a lot Why?	g. Reduce a little Why?
c. Stayed the same Why?	d. Increased a lot Why?	h. Increased a little Why?

10. Have you ever heard of a jaguar attacking humans? 🗀 YES 🗀 NO
How did it happen? How long ago did it happen? ……

11. Is there a risk of a jaguar attacking people surrounding your village? 🗀 YES 🗀 NO

a. No risk	a. Very low	b. Low
c. Medium	d. High	e. Very high
f. Don't know		

12. Have you ever heard of jaguars attacking livestock? 🗀YES 🗀 NO 🗀 Happened to me
🗀 Happened to others

Where*? How long ago? Which and how many animals? How did it happen? How was it solved? How did you recognize the predator? What happened to the jaguar?*

13.Have you had any other interactions with jaguars, either dead or alive?
🗀 YES 🗀 NO 🗀 Happened to me 🗀 Happened to others

Where*? How long ago? How did it happen? What happened to the jaguar?*

14.In this village, do people use jaguar body parts or keep live jaguars? 🗀SI 🗀NO

Which parts?	**Use**	**Year**	**Price**
a. Skin			
b. Teeth			
c. Claws/paws			
d. Skull			
e. Fat			
f. Bone			
g. Tail			
h. Other			

15. How are jaguars killed?

a. Shooting	b. Dogs	c. At night with flashlight
d. Baiting	e. Poison	f. While crossing the river
g. Trapping	h. Sound lure	i. After depredation
j. Lasso	k. Gun traps	l. Other:

16. For you, killing a jaguar is:

a. Very bad Why?	b. Bad Why?	c. Not good or bad Why?
d. Good Why?	e. Very good Why?	

17. If you were to find a jaguar, what would you do:

a. Kill it	b. Sell it	c. Keep its body parts
d. Ask for help	e. Nothing	

Law Enforcement

18. Is it allowed to kill jaguars: 🗀 YES 🗀 NO
When is it allowed to kill jaguars?

a. Never Why?	b. Always Why?	c. Sometimes When?

19. Are there any authorities responsible for protecting jaguars?: 🗀 YES 🗀 NO Which ones?

20. In the past 5 years, did authorities do something if jaguars were killed? 🗀 YES 🗀 NO
What happened?

Interactions with foreigners

21. Have foreigners asked to purchase jaguars or other wildlife in this area? 🗀 YES 🗀 NO

What nationality?
How long ago?
Where?
Jaguars?
Other animals?
What body parts?
What do they use it for?
How much did they pay?

Direct Questions (same questions as ballot, note do repeat these questions if the person already provided the information above)

	YES	**NO**
22. In the past 5 years, have you owned a live jaguar?		
23. In the past 5 years, have you owned jaguar body parts?		
24. In the past 5 years, have you bought jaguar body parts?		
25. In the past 5 years, have you been asked to kill a jaguar?		
26. In the past 5 years, have you killed a jaguar?		
27. In the past 5 years, have you killed more than 5 jaguars?		
28. In the past 5 years, have you sold jaguar body parts?		
29. In the past 5 years, have you asked someone else to kill a jaguar?		

Socioeconomic Questions (Part 2)

30. Do you hunt or fish? 🗀YES 🗀 NO How frequently?

31.What is your education level?

a. None	b. Primary	c. Secondary	d. Bachelor
e. University	f. Technical	g. I prefer not to respond	Other

32. What is your weekly income?

a. Less than 500 bol	b. Between 500 and 1000 bol	c. Between 1000 and 2000 bol
d. More than 2000 bol	e. I prefer not to respond	

Move on to ballot box…

GUIA DE ENCUESTA (ESPANOL)

Encuesta #:	**Fecha:**
Área:	**Hora de inicio:**
Comunidad #:	**Hora de fin:**

Preguntas socioeconómicas (Parte 1)

1. Género: 🗀 Masculino 🗀 Femenino

2. ¿Edad? ……

3. ¿Ocupación? ……..

4. ¿Nació en esta comunidad? 🗀 SI 🗀 NO
¿De dónde es? …….. ¿Cuánto tiempo ha vivido aquí? …….

5. ¿Cuántas personas viven en esta casa actualmente? **Total ……. Niños ……. Adultos ……**

Preguntas sobre jaguares:

6. ¿Qué palabras le vienen a la mente cuando piensa en el jaguar?……

7. ¿Existen jaguares en esta comunidad? 🗀SI 🗀 NO **Cuantos?** ……

8. ¿Ha notado cambios en el número de jaguares en los últimos 5 años?

a. Disminuyó mucho ¿Por qué?	b. Disminuyó un poco ¿Por qué?	c. Igual ¿Por qué?
d. Aumentó un poco ¿Por qué?	e. Aumentó mucho ¿Por qué?	f. No se

9. Usted preferiría si los jaguares…

a. Desaparecen ¿Por qué?	b. Disminuyen mucho ¿Por qué?	g. Disminuyen un poco ¿Por qué?
c. Igual ¿Por qué?	d. Aumentan un poco ¿Por qué?	h. Aumentan mucho ¿Por qué?

10. ¿Ha escuchado de ataques del jaguar hacia humanos? 🗀 SI 🗀 NO
¿Cómo sucedió? ¿Hace cuánto tiempo? ……

11. ¿Existe un riesgo de que el jaguar ataque a personas alrededor de su comunidad? 🗀 SI 🗀 NO

a. No hay riesgo	b. Muy bajo	c. Bajo
d. Medio	e. Alto	f. Muy alto
g. No se		

12. ¿Ha escuchado de ataques del jaguar hacia animales domésticos? 🗀SI 🗀 NO 🗀 Propio 🗀 Ajeno

¿Donde? ***¿Hace cuánto? ¿Cuáles y cuantos animales? ¿Cómo sucedió? ¿Se resolvió? ¿Cómo se reconoció al predador? ¿Qué pasó con el jaguar?***

13. ¿Ha tenido otras interacciones con el jaguar, ya sea muerto o vivo?
🗀 SI 🗀 NO 🗀 Propio 🗀 Ajeno

¿Donde? ***¿Hace cuánto? ¿Cómo sucedió? ¿Se resolvió? ¿Qué pasó con el jaguar?***

14. ¿En esta comunidad, las personas usan las partes del jaguar o crían jaguares vivos? 🗀SI 🗀NO

Que partes?	**Uso**	**Año**	**Precio**
a. Piel			
b. Dientes			
c. Patas/garras			
d. Cráneo			
e. Grasa			
f. Huesos			
g. Cola			
h. Otros			

15. ¿Cómo se mata a los jaguares?

a. Disparo	b. Perros	c. Mecheo con linterna
d. Carnada	e. Veneno	f. En el rio
g. Trampas	h. Rondador	i. Carnada domestica
j. Lasso	k. Armadilla	l. Otros:

16. ¿Para usted, matar un jaguar es?:

a. Muy malo ¿Por qué?	b. Malo ¿Por qué?	c. Ni bueno ni malo ¿Por qué?
d. Bueno ¿Por qué?	e. Muy bueno ¿Por qué?	

17. ¿Qué haría usted si encuentra un jaguar?:

a. Lo mato	b. Lo vendo	c. Me quedo con sus partes
d. Pido ayuda	e. Nada	

Aplicación de la ley

18. Es permitido matar jaguares?: 🗀 SI 🗀 NO
¿Cuándo es permitido matar jaguares?

a. Nunca ¿Por qué?	b. Siempre ¿Por qué?	c. A veces ¿Por qué?

19. Hay autoridades responsables por la protección del jaguar?: 🗀 SI 🗀 NO Cuáles?

20. ¿En los últimos 5 años, las autoridades respondieron a altercados con jaguares? 🗀 SI 🗀 NO
Que pasó?

Interacciones con extranjeros

21. ¿Existen extranjeros que han pedido comprar jaguares u otros animales en esta comunidad?

🗀 SI 🗀 NO

Que nacionalidad?
Hace cuánto tiempo?
Donde?
¿Jaguares?
Otros animales?
Que partes?
Para que lo usan?
Cuánto pagan?

Preguntas Directas (las mismas que con la urna, no repetir si la persona ya ha dado las respuestas en cualquiera de las preguntas arriba, marcar aquí después de la encuesta).

	SI	**NO**
22. En los últimos 5 años, ¿ha criado un jaguar vivo?		
23. En los últimos 5 años, ¿ha tenido partes del jaguar?		
24. En los últimos 5 años, ¿ha comprado partes del jaguar?		
25. En los últimos 5 años, ¿le han pedido que mate un jaguar?		
26. En los últimos 5 años, ¿ha matado un jaguar?		
27. En los últimos 5 años, ¿ha matado más de 5 jaguares?		
28. En los últimos 5 años, ¿ha vendido partes del jaguar?		
29. En los últimos 5 años, ¿ha pedido a alguien más que mate un jaguar?		

Preguntas socioeconómicas (Parte 2)

30. ¿Usted caza o pesca? 🗀 SI 🗀 NO Que tan frecuente?

31. ¿Cuál es su nivel de educación?

a. Ninguna	b. Primaria	c. Secundaria	d. Bachiller
e. Universidad	f. Técnico	g. Prefiero no decir	Otro

32. ¿Cuál es su ingreso semanal?

a. Menos de 500 bol	b. Entre 500 y 1000 bol	c. Entre 1000 y 2000 bol
d. Más de 2000 bol	e. Prefiero no decir	

Seguir a la urna…

Appendix 2: Model results for all behaviours and intentions (Chapter 4)

Table AP2: Odds ratios of the association between jaguar trading-related behaviours and predictors. Values above one indicate whether predictors are associated with higher or lower odds of jaguar trading actions, respectively. Confidence intervals (95%) in parenthesis. Red values represent statistical significance (p<0.05).

Type	Predictors	Lethal Behaviours				Commercial Behaviours		Consumer Behaviours			Tolerant Behaviours	
		Killing	Being Asked	Asking Others	Would Kill	Selling	Would Sell	Buying	Owning	Would Possess	Passive reaction	Do nothing
Socioeconomic	Gender Male (ref: Female)	2.36 (1.50-3.70)	1.76 (1.19-2.61)	0.72 (0.46-1.13)	2.66 (1.72-4.14)	1.83 (1.12-2.97)	2.11 (1.38-3.21)	1.02 (0.62-1.68)	1.14 (0.81-1.60)	2.74 (1.55-4.85)	1.09 (0.76-1.56)	0.23 (0.16-0.32)
	Hunting/Fishing (ref: No)	2.11 (1.43-3.12)	1.66 (1.18-2.34)	1.44 (0.96-2.14)	1.07 (0.73-1.56)	1.89 (1.22-2.92)	1.19 (0.82-1.73)	0.58 (0.37-0.92)	1.15 (0.85-1.55)	1.58 (0.96-2.59)	0.87 (0.64-1.20)	0.73 (0.53-1.00)
	Agriculture/ NTFP (ref: No)	1.61 (1.03-2.51)	1.10 (0.74-1.65)	1.41 (0.90-2.22)	1.09 (0.70-1.70)	1.02 (0.62-1.67)	1.42 (0.94-2.17)	1.16 (0.69-1.95)	1.16 (0.81-1.65)	1.38 (0.79-2.41)	1.02 (0.71-1.48)	0.61 (0.42-0.88)
	Other jobs (ref: No)	1.00 (0.64-1.57)	0.89 (0.60-1.31)	1.24 (0.81-1.91)	0.86 (0.55-1.32)	1.37 (0.85-2.19)	1.10 (0.73-1.67)	1.47 (0.92-2.34)	1.09 (0.78-1.52)	1.06 (0.60-1.87)	1.16 (0.83-1.64)	1.05 (0.74-1.50)
	Ranching (ref: No)	2.28 (1.17-4.45)	1.23 (0.65-2.36)	0.90 (0.37-2.19)	1.46 (0.76-2.72)	1.61 (0.75-3.44)	0.95 (0.47-1.93)	0.70 (0.24-2.00)	1.36 (0.76-2.47)	2.24 (1.06-4.70)	1.27 (0.69-2.34)	0.47 (0.24-0.91)
	Income Low (ref: No say)	0.91 (0.56-1.48)	1.29 (0.85-1.95)	0.94 (0.61-1.46)	0.94 (0.60-1.50)	0.89 (0.53-1.51)	1.58 (1.02-2.46)	0.54 (0.32-0.90)	0.89 (0.63-1.26)	1.78 (0.92-3.47)	0.90 (0.63-1.29)	0.66 (0.45-0.95)
	Income Med (ref: No say)	1.35 (0.80-2.26)	1.46 (0.92-2.32)	0.70 (0.42-1.18)	1.26 (0.78-2.07)	1.37 (0.79-2.39)	1.39 (0.84-2.30)	0.91 (0.53-1.56)	1.26 (0.85-1.86)	2.77 (1.39-5.54)	0.85 (0.57-1.28)	0.48 (0.32-0.73)
	Income High (ref: No say)	1.55 (0.79-3.03)	1.88 (1.05-3.38)	0.71 (0.35-1.44)	0.95 (0.49-1.81)	0.77 (0.36-1.67)	1.24 (0.62-2.47)	0.76 (0.37-1.56)	0.99 (0.59-1.66)	0.69 (0.23-2.09)	1.06 (0.62-1.80)	1.10 (0.63-1.91)
	Age (Years)	1.00 (0.98-1.01)	0.75 (0.63-0.89)	0.76 (0.62-0.94)	1.12 (0.93-1.35)	0.74 (0.60-0.92)	1.12 (0.94-1.34)	1.16 (0.93-1.43)	0.93 (0.81-1.08)	0.92 (0.73-1.17)	1.12 (0.96-1.30)	0.88 (0.75-1.03)
	Education (Years)	0.98 (0.93-1.04)	0.87 (0.73-1.04)	1.01 (0.83-1.23)	1.16 (0.95-1.42)	0.87 (0.71-1.08)	0.78 (0.65-0.94)	1.10 (0.89-1.37)	1.03 (0.89-1.19)	0.99 (0.77-1.27)	0.81 (0.69-0.95)	1.08 (0.92-1.27)
Attitudes and Perceptions	Abundance_Dec (ref: Same)	1.29 (0.73-2.28)	1.06 (0.66-1.72)	0.81 (0.46-1.43)	1.11 (0.67-1.90)	1.15 (0.63-2.11)	1.31 (0.77-2.24)	1.18 (0.63-2.22)	1.08 (0.71-1.66)	1.44 (0.69-2.99)	1.17 (0.75-1.83)	0.68 (0.43-1.07)
	Abundance_Incr (ref: Same)	1.28 (0.72-2.27)	1.01 (0.62-1.65)	1.10 (0.63-1.92)	0.82 (0.48-1.44)	1.00 (0.54-1.85)	1.12 (0.66-1.93)	1.17 (0.62-2.18)	0.80 (0.52-1.24)	1.21 (0.57-2.55)	1.04 (0.66-1.64)	0.97 (0.61-1.55)
	Risk Low (ref: Don't know)	1.51 (0.90-2.55)	1.35 (0.87-2.09)	0.76 (0.46-1.25)	0.81 (0.52-1.27)	1.36 (0.77-2.39)	1.05 (0.67-1.65)	1.21 (0.68-2.16)	1.33 (0.92-1.92)	1.88 (0.99-3.57)	0.67 (0.46-0.96)	0.91 (0.62-1.34)
	Risk Med (ref: Don't know)	1.15 (0.62-2.14)	1.09 (0.65-1.85)	1.16 (0.66-2.03)	1.07 (0.64-1.80)	1.39 (0.72-2.68)	0.59 (0.33-1.05)	1.25 (0.65-2.41)	1.27 (0.82-1.97)	1.30 (0.60-2.82)	0.92 (0.59-1.41)	1.23 (0.77-1.96)
	Risk High (ref: Don't know)	1.82 (0.99-3.35)	1.54 (0.90-2.63)	1.32 (0.75-2.34)	0.74 (0.40-1.35)	1.82 (0.94-3.53)	1.19 (0.69-2.06)	2.01 (1.04-3.92)	2.13 (1.34-3.38)	1.23 (0.54-2.79)	0.98 (0.61-1.57)	0.99 (0.61-1.62)
	Op. Killing Bad (ref: Neut.)	0.51 (0.29-0.93)	1.02 (0.64-1.64)	0.73 (0.39-1.37)	1.14 (0.72-1.79)	0.30 (0.14-0.62)	0.26 (0.14-0.49)	0.64 (0.35-1.17)	0.80 (0.54-1.20)	0.85 (0.42-1.73)	1.66 (1.11-2.47)	2.11 (1.37-3.23)
	Op. Killing Good (ref: Neut.)	1.19 (0.79-1.78)	1.44 (1.00-2.09)	2.00 (1.30-3.08)	0.67 (0.45-1.00)	1.14 (0.74-1.77)	0.96 (0.66-1.40)	0.80 (0.51-1.25)	1.06 (0.78-1.46)	1.44 (0.85-2.43)	0.87 (0.63-1.22)	1.17 (0.83-1.64)
Experience	Attacked Family/Self (ref: No)	1.61 (0.98-2.64)	1.47 (0.94-2.31)	1.12 (0.67-1.88)	1.13 (0.65-1.89)	2.06 (1.23-3.45)	1.51 (0.94-2.42)	1.05 (0.59-1.89)	1.63 (1.06-2.49)	1.05 (0.54-2.05)	1.11 (0.72-1.74)	0.65 (0.41-1.02)
	Depredation (ref: No)	1.76 (1.22-2.55)	1.30 (0.93-1.82)	1.32 (0.90-1.93)	1.10 (0.74-1.61)	0.90 (0.59-1.38)	1.16 (0.80-1.67)	0.95 (0.61-1.48)	1.51 (1.12-2.05)	1.33 (0.83-2.12)	0.71 (0.51-0.99)	0.76 (0.55-1.06)
Costs/opp	Legal status illegal (ref: legal)	1.41 (0.88-2.27)	1.25 (0.81-1.92)	1.16 (0.71-1.91)	1.05 (0.64-1.67)	0.94 (0.54-1.63)	1.14 (0.70-1.86)	1.57 (0.94-2.60)	1.65 (1.13-2.42)	0.89 (0.47-1.71)	0.43 (0.27-0.68)	0.96 (0.63-1.44)
	Traders (ref: No)	1.08 (0.71-1.66)	1.99 (1.36-2.92)	1.71 (1.12-2.63)	0.62 (0.44-0.88)	1.42 (0.91-2.22)	1.11 (0.75-1.64)	1.86 (1.15-3.01)	1.83 (1.37-2.44)	1.01 (0.55-1.87)	0.97 (0.72-1.32)	1.21 (0.85-1.70)
	Price Awareness (ref: No)	2.33 (1.61-3.36)	1.84 (1.33-2.54)	1.65 (1.13-2.39)	0.81 (0.54-1.19)	4.31 (2.92-6.36)	1.84 (1.29-2.63)	4.87 (3.25-7.30)	2.78 (2.06-3.75)	0.89 (0.55-1.45)	0.72 (0.52-1.00)	0.72 (0.52-1.00)

Appendix 3: Key informant Interview Guide (Chapters 5 and 6)

Background and Knowledge on Jaguar Trade

1. Could you please state your name and nationality?
2. What is your profession and your current institutional affiliation?
3. What is your educational background?
4. Please take me back to the history of your experience working with jaguars and/or wildlife trafficking and describe what you currently do.

Jaguar Population Status and Threats:

5. What are the main threats that jaguars are facing in the geographical areas that you work in? What do you base your answer on?
6. How would you rank those threats, from most important to least important? Please explain why.

Supply:

Jaguar killing:

7. In the areas about which you are able to provide information, do you know of any examples of jaguar killings? How long ago did those take place? How certain or uncertain are you about those events? Do you recall any other events?
8. In what locations did the jaguar killings take place and why?

Motivations for killing jaguars

9. In the areas about which you are able to provide information, what are currently the most common reasons behind jaguar killing? What do you base your answer on?
10. What do people who kill jaguars do with the carcasses in these areas?

People who kill jaguars

11. How would you describe the people who kill jaguars in present times these areas in terms of their nationality, ethnicity, age, gender, education level and occupation? Please describe the rationale for your description.

Methods to kill jaguars

12. What can you say about the methods used to kill jaguars in present times in these areas? Do you have any examples?

Rewards and costs for killing jaguars

13. Is there currently a legal or economic penalty for killing jaguars in these areas?
14. Are people in these areas aware of the penalty? What do you base your answer on?
15. Can you recall any examples of past penalties, prosecutions or law enforcement operations focused on jaguars in the areas you are able to tell me about? When did those happen?

Situational factors leading to jaguar killings

16. Are there any political or economic factors that may incentivize jaguar killings in present times in these areas? What do you base your answer on?
17. Is there any advantage to killing jaguars compared to other species? Why do you think that?

Distribution

Middlemen

18. How would you describe the jaguar trade middlemen in present times in terms of their nationality, ethnicity, age, gender, education level, occupation? Please describe the rationale for your description.

Recruitment and communication

19. How do jaguar traders find each other or recruit others? How certain or uncertain are you about your answer?
20. How do jaguar traders communicate with each other, and with suppliers and consumers?

Smuggling

21. How are the smuggled items concealed in present times? What do you base your answer on?
22. What are common packaging mechanisms?
23. What means of transportation and transport routes are used? How certain or uncertain are you of your answer?

Organized crime

24. Is there any evidence connecting jaguar traders with other kinds of criminal activity in present times in these areas? How certain or uncertain are you about your answer?
25. What do you think is the level of organization of jaguar trade? Why do you think that?

Detection

26. What kind of enforcement or detection strategy is currently in place in the areas about which you are able to provide information? What do you base your answer on?

Market

Countries

27. What regions or countries are the main markets of jaguar trade products in present times and why? What makes you think that?
28. Are you aware of any differences among the domestic and international markets of jaguar parts in terms of their scale, product types and uses, prices, etc.? How certain or uncertain are you about your answer?

Physical and online markets

29. Are you aware of any physical markets where jaguar body parts are being sold in present times in your areas?
30. In addition to physical markets, is there any evidence of online jaguar trade?
31. If so, what platforms are being used? Do you have any examples?

Prices

32. What are the current prices associated with jaguar body parts?
33. Are there any trends in the prices through the years? What makes you think that?

Demand

Consumers

34. How would you describe jaguar consumers in terms of their nationality, ethnicity, age, gender, education level, occupation? Please describe the rationale for your description.

Drivers

35. What are the drivers or motivations that each of those consumer groups might have for buying or using jaguar products? Why do you think that is?
36. How are the products used? Can you give any examples?

Countries

If China (or other countries) was mentioned earlier:

37. Please describe how the international trade of jaguar body parts began in your area. What makes you think that?
38. What do you think that Chinese consumers (or other nationalities) use jaguar body parts for? What do you base your answer on?

Strengths and Weaknesses

39. What are some of the challenges to addressing jaguar trade in your area?
40. What are some of the strengths and weaknesses of your organization in particular when it comes to dealing with those challenges?