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A global perspective on trade in jaguar parts from South America

Starting in 2010 and accelerating in 2014, reports of trade and seizures of jaguar *Panthera onca* parts surfaced from several countries in South America. In this paper we summarise knowledge to date including official reports, peer-reviewed publications, public articles, seizure records, online searches, and market surveys in source countries in South America and big cat consuming countries in Asia. We found widespread records of domestic use and commerce in jaguar parts, in many cases without effective enforcement of existing laws to provide a substantial deterrent. We found less abundant solid records of trade from South America to China, with the exception of Bolivia where 95.4% of the historic interceptions of jaguar canines were oriented towards China, and Suriname where seizures in airports testify to international trade. International trade is particularly onerous as it can drive domestic killing of jaguars at an increased level due to higher prices and diversified markets. More material may be shipped to Asian markets than we have detected and we recommend vigilance in all potential mediums for transport (passenger aircraft, air freight, postal services, courier services, and marine shipping). We present a summarised review of relevant legal structures. The depth and breadth of domestic commerce that we recorded from diverse sources suggest the need for increased enforcement of existing laws, coupled with behaviour change and livelihood alternatives. All jaguar killing starts at the local level, and when there is a local national market for jaguar parts there is less incentive to pursue the means and methods for coexistence already tested and proven in much of the species' range.

The jaguar, known for its golden rosetted coat and cultural symbolism, has been considered a valuable and sought-after species throughout the history of Latin American societies. Archaeological records show that jaguar body parts travelled long distances across the Caribbean Sea, potentially transported as prized items of exchange between Amerindian and Caribbean societies, as early as the Ceramic Age (500 BC to AD 1500; Laffoon et al. 2014). During the 18th century, there are records of approximately 2,000 jaguars being exported annually from Buenos Aires to Europe for the fur industry (Swank & Teer 1989). Jaguar trade reached unprecedented commercial levels during the first three-quarters of the 20th century, when the spotted cat fashion trend reached its peak. In Brazil, an estimated 180,000 jaguars were killed during this period (Antunes et al. 2016), causing a widespread population decline. In response to the imminent extinction risk posed to jaguars and other spotted cats by the fur trade, in 1975, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) listed these species under Appendix I, prohibiting their commercial trade across international boundaries (CITES 2017, Reuter et al. 2018).

Even though by the end of the 20th century, international jaguar trade was virtually over, low-scale but widespread jaguar trading continued to occur domestically, commonly as a by-product of killing caused by opportunistic encounters between people and jaguars or human-jaguar conflict, as well as for subsistence and cultural use (Arias & Lambert 2019, Arias et al. 2020, 2021a). However, starting in 2010, reports of trade and seizures of jaguar body parts surfaced from several countries across the jaguar range, suggesting a re-emergence of international jaguar trade (Kernam 2010, Nuñez & Aliaga-Rossel 2016). Between 2014 and November 2023, 825 jaguar canines have been seized in trafficking cases linked to Chinese individuals in Bolivia and in mainland China. Other similar cases were registered in the region, including the sale of jaguar body parts in physical and online markets, and the preparation of jaguar paste in Suriname for alleged export to China (Lemieux & Bruschi 2019, Verheij 2019, SERFOR & WCS 2020). These seizures and reports mobilised attention on the issue. Subsequent reports and publications have shed light on the drivers and dynamics of the trade (e.g. Morcatty et al. 2020). This team of international experts explored the state of the evidence on this threat in 2023, focusing on its geographical characteristics and nuances. The paper starts with preliminary results of a seven-language investigation of online trade in jaguar parts, transitions into specific country analyses and legal considerations, and closes with recommendations for future actions.

Online investigations of jaguar trade conducted 2019–2020

Between May 2019 and March 2020, a multinational team of researchers conducted systematic searches for online trade of jaguar parts in seven languages (Spanish, Portuguese, Vietnamese, Chinese, French, Dutch, English; Polisar et al. 2023). The team searched for offers of sale of jaguar parts and processed items, as advertised, through multiple platforms, accessible via search engines, online marketplaces, video-sharing, social media and weblogs (blogs). The results were collated in a standardised database including the platforms, assessed country locations of posts, jaguar part and product type, prices and other trade information where available, and corresponding images of jaguar parts and products were visually reviewed, where available. Platforms showing jaguar parts varied across countries and languages. Methods such as standardised collection and metrics of effort facilitated structured searches, subsequent analyses and interpretations, and revealed the most productive search terms, search engines, and platforms for potential future searches. Following data collection, experts from Noel Kempff Mercado Natural History Museum NKM Museum in Bolivia with expertise identifying and classifying jaguar parts resulting from a successful prosecution of a jaguar trafficking case in Santa Cruz visually verified images as jaguar (Figs 1–3). The analyses presented here incorporate the results of image review, yet should be still considered preliminary.

Raw results included a total of 230 posts motivated by trade in jaguar parts; other posts referred to sharing news about jaguars, or posting images of parts but with an unclear motivation, or wearing items, and these were not included. From the 230 posts, 71 posts contained images that were identified as definitely jaguar. We sampled a ten-year period and found that the numbers of posts increased over time from 2009 to 2019, which may be an artifact of posts removed or becoming moribund with time, or an increase in trade. Excluding duplicate posts, posts were present on 31 distinct platforms, and the posts with images verified as jaguar were present on 12 platforms, comprised of 10 online marketplace sites (18 posts or 25.4% posts) and 2 social network sites (53 posts or 74.6% posts).

The most widely used language in posts was Spanish. In our searches 98.6% of all posts accompanied by verified jaguar images were in Spanish, Chinese, and Portuguese. Whilst Vietnamese language searches identified 31 posts without duplicates, none of the posts accompanied by an image were deemed to be jaguar.

The location was assessed by researchers for 193 of all posts, with records from at least 17 countries (plus one subset indicating posts derived from one of two countries, but unclear which), however, only 64 posts from at least 9 countries included images that were definitely jaguar, the most prolific being Brazil, Mexico and Bolivia. For the 437 parts that were counted in posts, 15 categories of body parts were recorded, with teeth being the most popular item traded (156 posts totalling 367 teeth), followed by skins (Fig. 4), entire or fragments (37 skins, 1 skin piece and 1 skin scrap spanning at least seven countries), claws (12 posts of 14 claws), heads (nine posts counting nine heads) and additional posts related to parts including bones, bodies and live animals. Where the probable country of the post could be assessed (through platform addresses, stated business geo-tag and other contextual information, but not physically verified by researchers), jaguar skin posts were confined to jaguar range countries, with highest prevalence in Brazil, Peru, Bolivia, and Mexico. Meanwhile, posts advertising teeth were most prevalent in countries including Brazil, Mexico, Bolivia, China and Vietnam. However, following image verification, those proportions changed with Mexican posts representing over one quarter of all teeth counted (26.8%), Chinese posts one quarter of teeth (25.4%), Bolivia around one-fifth (16.9%) and Brazil approximately one-tenth (12.7%). Vietnamese posts included tiger, leopard, and bear teeth in posts obtained from searches targeting jaguar, illustrating some of the challenges of search terms across geographies and languages, even with native speakers conducting the research. Whilst searching in Chinese, and less intensively in Dutch, we encountered very few records of medicinal oil/paste, a product reported from Suriname (Kerman 2010, Lemieux & Bruschi 2019, World Animal Protection 2018).

Fig. 1. Jaguar, puma, and ocelot canines seized from trafficking (Photo D. Rumiz, NKM Museum).

Bolivia National/International Trade - from reports/records 2014–2022

The recent international trade in jaguar parts, especially canine teeth, was first reported in Bolivia in July 2014, when Bolivian scientists who were camera trapping for jaguars in Madidi National Park heard local radio advertisements offering to buy jaguar teeth in the nearby Beni Department. This was immediately reported to the Ministry of the Environment and Water, which coordinated with multiple authorities, including the Bolivian postal system, resulting in the detection of several packages containing jaguar teeth, addressed to locations in China. Simultaneously, customs officials stopped two individuals in El Alto International Airport in La Paz travelling to China with jaguar teeth. Subsequently, three high profile legal cases of jaguar teeth trafficking involving individuals of Chinese descent recently naturalised in Bolivia, further increased national and international attention towards the threat of jaguar teeth trade (WCS, WWF & Panthera 2016, Bale 2018, Franco 2018, León 2018), and led to increased investigations on the matter, including academic and journalistic efforts, NGO investigations, and enforcement operations in Bolivia (Nuñez & Aliaga-Rossel 2016, Verheij 2019, Arias et al. 2021a,b, CITES 2021, Earth League International 2021).

Efforts by the Wildlife Conservation Society to systematise official data on illegal wildlife trade in Bolivia now include data provided by 62 institutions, including the Ministry of the Environment and Water, the Bolivian Forestry and Environment Police POFOMA and most of the Departmental governments and wildlife rescue centers in the country, and reveal that since mid-2014 there are a total of 83 verifiable jaguar trafficking cases in Bolivia, with two additional cases of jaguar parts seizures in China coming from Bolivia. Of these, 32 cases (37.6%) are of jaguar teeth, amounting to 825 jaguar canines, making teeth the most trafficked part. Additionally, 27 of the 83 cases so far, and 95,4% of Bolivian seized canines, are directly linked to China. Online analyses in Bolivia have revealed 24 additional posts mainly on social media, across the Bolivian lowlands. Although most recent cases of jaguar parts trafficking in Bolivia occurred between 2014 and 2019, two cases were reported in 2022 and 3 cases in

2023, all involving jaguar teeth. One of these involved 4 men of Chinese descent.

Previously, jaguar populations were recovering in protected areas in Bolivia (Mongabay 2018), with indigenous territories (Polisar 2021), forestry concessions (Polisar et al. 2017), and cattle ranches (Polisar 2021, Polisar et al. 2022), all demonstrating real potential for the conservation of jaguar populations. However, conflicts between jaguars and livestock owners are likely to be fueling part of the supply of jaguar teeth, responding to the high prices being paid for jaguar canines, teeth, heads, claws and skins. Similarly, local people's attitudes towards jaguars are mixed, with some indigenous groups publicly declaring to be against the illegal wildlife trade and in favor of jaguars (CIPTA 2019, CRTM 2019), whilst other local actors have admitted their fear of jaguars and willingness to kill them (Knox et al. 2019; Arias et al. 2021a). Aside from cattle ranching, other forest dependent livelihoods (e.g. wild meat hunting, farming, non-timber forest product collection) have been associated with jaguar killing (Arias et al. 2021a). Moreover, a high proportion of rural households in north Bolivia buy, sell and use jaguar body parts for a wide range of purposes, from decorative (jewelry, accessories, furnishings) to medicinal (Arias et al. 2021b). Although illegal, these traditional uses continue in the Beni Department, where it was shown recently that inmates of the Trinidad prison buy wildlife skins to make wallets, bags and belts (Elwin et al. 2023). These handicrafts are commonly sold to tourists in town markets, but are also bought in bulk by foreign middlemen for export. Four cases of wildlife parts seized in La Paz, Santa Cruz, and Riberalta, with support from the Noel Kempff Mercado Natural History Museum for forensic identification during 2022-2023, included jaguar teeth or skin pieces. Illegal trade in jaguar teeth, alongside habitat loss and recent increases in frequency and intensity of Amazonian fires, are currently the largest threats to jaguar populations in Bolivia (Romero-Muñoz et al. 2019).

Suriname National/International Trade - from reports/records 2005–2022

Nearly 93% of Suriname's territory is covered by contiguous rain forest (FAO 2015) that extends over the border with Brazil, French Guiana and Guyana. Suriname has numerous reports of jaguar trade, which suggest high rates of removal of jaguars and reports of hunters selling jaguar teeth in Paramaribo dating back to 2005 (Kernam 2010, World Animal Protection 2018, Lemieux & Bruschi 2019, Verheij 2019). Several incidents support the assertion that the trade in jaguar body parts in Suriname may be more pronounced than in neighboring countries. According to CITES (2021), at least 60 jaguar teeth and a smaller number of other body parts have been officially seized by the authorities from 2009 to 2020, 14 of which came from 3 seizures made at international airports, indicating international trafficking. According to news and published reports on seizures, at least 11 jaguars were killed in Suriname between 2012 and 2018; three of the reports involved jaguar body parts claimed to be destined to China, comprising two canines and four bodies or meat (Morcatty et al. 2020). Verheij (2019) estimated that at least 17 jaguars were killed between 2007 and January 2018 due to trafficking, and put an emphasis on the involvement of both the Chinese diaspora and Chinese visitors in this trade. Trafficking was apparent from the seizures of seven teeth in the Amsterdam airport in 2010 and 19 teeth in the Paramaribo airport in 2018 (Verheij 2019) and 5 teeth also at Paramaribo airport in 2019 (Anonymous 2019). However, the intensity of the trade may be even higher. One informant estimated over 80 jaguars killed in 2017 alone (Verheij 2019).

Following information from hunters and traders interviewed in 2009 that the main consumers of jaguar parts were Chinese (Kerman 2010), subsequent research on the trade and trafficking of jaguars in Suriname has focused largely on the Chinese communities living in Suriname, or on Chinese nationals that visit the country (Lemieux & Bruschi 2019, Verheij 2019). Jaguar body parts reportedly have diverse uses for Chinese people in Suriname, from medicinal application of the meat and bones, especially skulls, to jewelry made from teeth (Kerman 2010). Earth League International (2020) offered an online platform where wildlife trafficking information can be anonymously reported. With regards to the trade in jaguars in Suriname, reports were received of alleged killing and sale to Chinese buyers of jaguars from the North-west Nikerie and Wageningen region, as well as the area close to the international airport in the period 2017-2020. Two Chinese-owned shops in the capital were singled out as selling jaguar parts, meat and jaguar paste.

As early as 2010, records emerged of Chinese traffickers requesting suppliers for entire carcasses for producing medicinal powder or paste (Kerman, 2010, Verheij 2019, Lemieux & Bruschi 2019). According to Verheij (2019), local informants also stated that teeth and processed medicines were transported by passengers in flights to China as well as in timber containers transported by ships. Jaguar teeth are used in necklaces and gold jewelry and thus bought and sold in jewelry shops in Paramaribo (Kerman 2010). An indirect factor elevating this trade is that poorly patrolled new access roads to logging and gold mining sites have opened up previously inaccessible forested regions, facilitating the establishment of trafficking routes. Recent independent reports state that vendors actively approach villagers, loggers, gold miners and hunters soliciting jaguar body parts (Lemieux & Bruschi, 2019, Verheij 2019). In March 2021, a baby jaguar was offered for sale on social media in Suriname with an asking price of USD 2,500, and in October 2021 videos were posted on TikTok of a freshly killed jaguar; it was unclear if this animal entered the trade (Fig. 5).

We did not locate much evidence of online trade in Suriname in our study conducted May 2019-March 2020, and found no posts advertising medicinal jaguar paste or powder. Verheij (2019) reported several advertisements selling jaguar canines found on a Facebook group in Suriname between 2016 and 2018, and 13 canines that resemble jaguar teeth posted on WeChat, an online platform used by the Chinese community. Only 57.8% of Suriname's population has access to the internet. It is the country with the third lowest internet penetration in South America (Miniwatts 2019), and thus online advertisements may not be a primary medium for the trade of jaguar body parts, especially close to source areas.

Peru National/International Trade - from reports/records 2014–2019

The upper Amazon of Peru probably holds the second-largest jaguar population after Brazil (Carrillo-Percastegui & Maffei 2016). In recent years, deforestation and gold mining in the Amazon have aggravated the perils faced by jaguars (Swenson et al. 2011) as more people penetrate previously inaccessible areas. Jaguars are sometimes killed due to livestock loss, a pattern that is likely exacerbated as cattle ranching and small-scale agriculture expand (Tobler et al. 2013). Both killing and trade seem to take place despite laws prohibiting killing of jaguars and trade in their parts. Teeth, claws, and skin (whole or

in parts) continue to be traded openly in local markets across Peru, a situation that strongly indicates that more active, committed, and courageous enforcement of existing laws is needed to change the situation.

Research on jaguar trade in the Peruvian Amazon carried out between October 2018 and January 2019 found 102 jaguar parts sold in 12 of the 19 localities studied, including Iquitos (Loreto), Pucallpa (Ucayali), Puerto Maldonado (Madre de Dios) and Puno (Puno; SERFOR & WCS 2020). Sales were most prevalent in the Amazon towns of Iquitos and Pucallpa, with a few teeth found in Lima. A journalist, Berton (2018), researched jaguar trade in three markets in Iquitos for seven days and found 44 canines, four skulls, five skins, and 70 claws. According to Berton (2018), between 2000-2015 Peru's National Forestry Service (also known by its Spanish acronym 'SERFOR') seized 11 live jaguars and parts and products as 9 skulls, 14 skins, and 38 canines – the last product encountered in one confiscation event in March 2015. The implication is that approximately the same amount of material was encountered by journalists in one week in one city as the national authorities had confiscated in more than 30 incidents. If true, more effective enforcement is needed. Based on official international seizures found in the UNODC World Wise Database, Peru stands out as the most frequent source of jaguar body parts (CITES 2021). Braczkowski et al. (2019) identified links between 'ayahuasca' tourism and jaguar related trade, and that in tourism hubs jaguar body parts are openly sold on markets, with vendors offering to help with export.

Fig. 2. Jaguar fangs (canines; Photo D. Rumiz, NKM Museum).

Brazil National/International Trade in Jaguar Parts – from reports/records 2010–2019

Brazil contains around 60% of the Amazonian rainforest and 66% of current jaguar range (de la Torre et al. 2018). Although Brazil has been suggested as a potential source of wildlife for international traffic (Phelps et al. 2010), little is known about the intensity of trade and the impact of illegal wildlife trade on wild populations.

During online investigations, we recorded a total of 42 unique online advertisements of jaguar parts in Brazil in the last decade, involving 84 counted parts (72 teeth, 10 skins and two bodies; Polisar et al. 2023). Advertisements focused on handcrafts containing canines, such as sculptures and necklaces, and skins, such as coats, carpets or wall decorations, potentially aimed at a domestic market. Most of the online advertisements were encountered on online marketplaces located through commonly used search engines or social media. However, seizure reports and news indicate that there may be an existence of an international market for jaguar body parts from Brazil (6.5% of the seizure reports; Morcatty et al. 2020). This suggests that stakeholders supplying international markets may use alternative methods to trade jaguar body parts, other than advertising online or risking exposure in open fairs. Further research on that matter is merited.

In an examination of reported seizures and news available online, the majority seemed to be domestic trade in comparison to the international trade, accounting for near to 80% of the individuals (46/57) and body parts seized (65/82; Morcatty et al. 2020). Skulls represented 33% of the seizures (27), followed by leather items 46.3% (38) and bodies 8% (6; Morcatty et al. 2020). However, 56% of the skulls seized in recent years were directed to international markets. Apart from skulls, all the remaining body parts seemed to supply the domestic market (Morcatty et al. 2020). In 2016, 16 killed jaguars were seized in the countryside in Pará state by authorities who raised strong concerns about links to wildlife trafficking. The official, though unpublished, database of the Brazilian government reports ca. 50 infraction notices involving jaguars in Brazil, however, most of those do not provide any details on the type of infraction (whether trade or killing due to conflict with livestock; Brazilian government, unpubl. data). Only four records explicitly stated that pieces of skin and handcrafts were seized. The fine in one case was USD 2,400 (10,000 Brazilian Real). In an investigation of open-air markets throughout the Brazilian Amazon and in South-eastern Brazil conducted by members of our team in 2019, only a few pieces containing jaguar skin or teeth in handcrafts were found. The sellers expressed fear of fines and prosecution due to the illegality of the trade, confirming their awareness of the laws, but the persistence of material offered in those venues suggest enforcement is ineffective.

In Brazil, selling an unauthorised piece of a native and protected species is a crime independent of source, and the buyer may also receive the same penalties as the trader in case of proven purchase. Simply liking or sharing a post advertising the trade of jaguar body parts, or complimenting the piece that is for sale, is also breaking the law. The article 287 in the Penal Code (Law nº 2.848/1940) states that public communication (apology or incitation) of a criminal act is liable to punishment. Enforcement of all regulations across all scales, local, national, and international is important. As a response, a Federal Task Force was formed in 2019 aiming towards an integrated approach for counter-wildlife trafficking in Brazil.

Current knowledge of status and trends in illegal trade in the remainder of South America

Although detected in a much lesser degree, trade in jaguar parts exists in other South

American countries. During online investigations, we recorded posts offering visually confirmed jaguar parts linked to other countries, such as three posts in Venezuela and one in Uruguay (Polisar et al. 2023). Additionally, seizure reports of illegally owned jaguar body parts included three cases in Colombia, four in Paraguay, and one each in Ecuador and Venezuela in the last six years (Morcatty et al. 2020).

Source South American countries with relatively high levels of corruption and Chinese private investment and low income per capita had 10–50 times more jaguar seizures than the other countries (Morcatty et al. 2020). Likewise, the links between jaguar trafficking, human-jaguar conflict, and other criminal activities such as drug or weapons trafficking have been raised in countries like Brazil and Guatemala (Arias et al. 2020, CITES 2021). Regarding online trade, internet penetration has proven to be a critical factor influencing online wildlife trade listings (Nijman et al. 2023). the lower internet penetration combined with extent of jaguar range within a country may be a factor leading to a low detection of online jaguar trade and seizure records. The three countries adjacent to Brazil of Colombia, Venezuela, and Guyana have low internet penetration (63.2%, 53% and 50.5%, respectively) yet individually and as a block contain a considerable proportion of current jaguar range. Paraguay and Argentina have high internet penetration (89.6% and 93.1%, respectively) but contain a relatively small proportion of total jaguar range (Miniwatts 2019, de la Torre et al. 2018). The few online trade records we detected for Suriname, compared to other reports emphasising interviews and market searches (Kernam 2010, World Animal Protection 2018, Lemieux & Bruschi 2019, Verheij 2019) suggest a high degree of variability in the role of online platforms in jaguar part commerce. This seems potentially significant in the largely porous, remote, and unpatrolled common international boundaries of Brazil, Guyana, Venezuela, Colombia, Ecuador, Peru, and Bolivia, which have likely low internet penetration. Increased physical vigilance by national and local authorities in border areas is merited to prevent possible illegal trade threats from emerging in future.

In French Guiana records are maintained by the police division of a governmental agency titled "Office Français de la Biodiversity" (French Biodiversity Office), that works mainly by checking online social networks. The jaguar is not protected by a governmental decree (i.e. at the National – French – level), but by a local decree, meaning that killing a jaguar is not a criminal offence, but punished by a fine. Between 2018-2022 the division recorded one intentional killing), and traffic of jaguar parts that involved one skin, 72 teeth (in seven different judiciary cases), and eight claws.

China and Vietnam

In parts of Asia, Asian big cat parts and products are consumed for multiple purposes, including skins for décor, taxidermy and non-financial bribes, teeth and claws for jewelry, and bones for steeping in tonics, carving, and traditional medicine including 'glue' or 'paste' (EIA 2018). Previous research has indicated China and Vietnam to be significant markets for tiger trade (Gratwicke et al. 2008, Wildlife Justice Commission 2016, Wong 2016, Indenbaum 2018).

Verheij (2019) noted in Suriname, "there are indications that Chinese individuals were buying jaguar parts as early as 2003", and transnational trafficking has been generally viewed as an emerging trend. Kerman (2010) noted for Suriname that jaguars were sold to Chinese nationals as early as 2005. Aside from the seizures made in Bolivia and Suriname, which included Chinese cities as destinations for jaguar body parts seized at post offices or airports, there are few examples of confirmed seizures of jaguar body parts within Chinese territory. According to the recent study on jaguar trade conducted by CITES (2021), China was identified as the destination country in just three out of 76 (4%) jaguar seizures reported by UNODC's World Wise Database in the past two decades, involving less than 10 jaguar specimens (body parts or live animals; CITES 2021). In that same study, internet searches yielded information on another three seizures involving a total of 137 teeth (CITES 2021). Detections commonly feature teeth, and are generally related to Chinese nationals either within Latin America or shipping into China (Franco 2018, Kerman 2010, Leon 2018, Nuñez & Aliaga-Rossel 2016, Verheij 2019).

While many news articles have suggested that a wide variety of jaguar body parts (including bones, meat, and organs) are being used in the context of Traditional Chinese Medicine (TCM) in China, official seizure evidence is mostly limited to teeth, and there is scant official evidence of the use of jaguar parts in TCM, making 'Wenwan' (subculture of collecting sophisticated items) a more likely driver of the trade (Li et al. 2022). In China, news reports suggest two pieces of alleged jaguar bones seized in 2014; 1,490 grams of jaguar bones and paws in 2014 (Anonymous 2014). The only official seizure made in China, referenced above, involved 119 jaguar teeth and 13 jaguar claws seized in 2015, the latter resulting in a custodial sentence of 4.5 years and a fine equivalent to USD 7,200 (He 2016). In 2019, nine 'American lion' teeth from Peru were seized, later identified as puma (Verheij 2019). It is unclear if suspects arrested at airports were in possession of jaguar parts for personal use, or intended to supply consolida-

Fig. 3. Hat with jaguar skin (Photo D. Rumiz, NKM Museum).

tors in other jurisdictions. This has occurred against the backdrop of increasing trade in big cat teeth in recent years, including on Asian online platforms (Indenbaum 2018). Despite the Suriname-China links suggested by some reports, there is scant information from seizures within China reflecting known links to Suriname.

Online research may be challenging as Chinese language does not clearly distinguish among leopard, cheetah, clouded leopard, and jaguar, for example using the same character "豹" across species. Chinese media also may confuse common names when reporting trade in big cats. The Vietnamese language presents similar challenges for online research: online traders of big cats in Vietnam refer to tigers and lions and products from these two species and all others big cats as "báo".

Jaguar parts featured in Chinese-language online posts cited "the Americas" as the source to indicate jaguar parts, and both Chinese and Vietnamese platforms featured discussions about how to differentiate the teeth of different big cats. Notably, genuine jaguar teeth were less likely to occur in Vietnamese than Chinese posts; visual review of Vietnamese posts verified no images of jaguar parts, however Chinese posts did contain jaguar teeth. We encourage and recommend online research that includes additional countries in Asia.

Legal considerations to control and eradicate jaguar trade in and from South America

The killing of jaguars that eventually enter international trade are preventable at the local level, within each country. National legal frameworks and their local implementation play an important role in deterring opportunistic killings and accidental takes; they can also reduce the human-carnivore conflict that may lead to killing jaguars, or to opportunistic trade of parts and products in the underground market (Fukushima et al. 2021).

All jaguar range countries have entered the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Jaguars are listed in Appendix I of CITES, which prohibits commercial international trade of live animals, parts or products. According to this, jaguar trade across South American borders is forbidden in the terms of the Convention, though there is no similar homogenous framework for in-country legal provisions.

Other international instruments, such as the Convention on Biological Diversity CBD and the Convention on the Conservation of the Migratory Species of Wild Animals CMS, also contribute to setting international standards for the maintenance of robust wildlife populations. Implementation of international instruments relies solely on each country's development and enforcement of their national and subnational – where applicable – legal frameworks.

Hunting and in-country trade laws, though not specifically covered in CITES, are oftentimes contained in the same legal instruments approved to comply with said Convention. Such instruments can contribute to curbing in-country trade, provided they include clauses to address capacity-building and robust implementation among the local authorities. Importantly, comparability of the legal frameworks in adjacent countries is needed as these instruments may be applicable to jaguars (potentially, the same individuals) across borders. Legal measures can be heightened when acknowledging that consequences extend beyond conservation issues, impacting economic, health, and security ramifications associated with illegal activities (Cardoso et al. 2021). A range-wide review of national legal frameworks within countries in the jaguar range by Kretser et al. (2022) offers insights on the legal trends informing national laws and suggests legal best practices and ways to strengthen existing laws related to trade of jaguar parts. Recently, the enactment of Law N° 1525 for the Protection and Conservation of the Andean Condor, Kuntur Mallku *Vultur gryphus* in Bolivia, included an additional provision that categorises illegal wildlife trafficking as a criminal offense within the Penal Code of Bolivia.

How countries design and enforce administrative and criminal penalties has far-reaching implications for jaguar conservation, especially in areas where subsistence hunting takes place, and where human-wildlife conflict is escalating. Administrative penalties are applied to infractions of regulations and may be enforceable by countries' wildlife authorities; criminal penalties are enacted by criminal courts. Penalties (and the probability of them being enforced) need to be high enough to deter opportunistic killings, not only among the local population but most importantly to middlemen that have access to international underground markets. All South American countries include both administrative and criminal penalties for illegal killing of endangered species, such as jaguars. However, many of the penalties are calculated based on each country's minimum wage (Ecuador, Peru, Colombia) and might be insufficient to deter hunters that supply trade for the international market.

All countries require hunting licenses for sport hunting of wildlife, but not all require licenses for subsistence hunting, and many allow for killings under the umbrella of self-defense (Kretser et al. 2022). Hunting licenses are granted by local or national officers in the executive branch – often times a regional manager, or a national-level directorate – and while it is unlikely that a public official would grant a permit to hunt jaguars, some of the existing frameworks have not made it entirely illegal.

The legality of jaguar killings is delicate, as only Paraguay and Argentina have national level laws that place the species in a special category, and it would require Congress to pass a new law in order to lift the protections. In contrast, the majority of South American countries (except Bolivia, French Guiana and Suriname), place jaguars in a special management category by listing them alongside all the endangered species in the country. While such lists are potentially efficient management strategies, they present certain weaknesses: they often rely on the global conservation status of the species, rather than the national status, and they are typically infra-legal level regulations; that is, vulnerable to being modified by a low-level executive order.

Most countries allow for subsistence hunting, particularly for Indigenous Peoples and/or local communities. Each country's enforcement determines whether wildlife parts and by-products can be traded after allegedly hunting for subsistence reasons. Local non-monetary trade of meat and animal by-products within rural communities is quite common. However, subsistence hunting of game species for food should not enter commercial trade. Market hunting to satisfy urban demands for cash returns is usually detrimental to game populations (Robinson & Bennett 2000, Greenberg 2014) and presumably, also to the jaguars that depend on those prey species (Polisar et al. 2003, Novack 2005, Foster et al. 2014, McNab et al. 2019). For jaguar conservation, the case is clear; no commercial trade of jaguar parts should be legal. Allowing any trade in jaguar parts leaves a door open for abuse, fraudulent interpretation of the law and the potential rapid decline of jaguar populations.

Fig. 4. Jaguar skin (hide; Photo O. Torrico, WCS Bolivia).

For human-wildlife conflict where some flexibility to address chronic losses exists, few laws ensure such flexibility is not abused, since it potentially provides a window to legitimise killing for trade. To stop wildlife parts and by-products originating from legal self-defense or depredation control killings from entering the market – and therefore creating an incentive to cover up illegal hunting for trade – countries could adopt provisions similar to Peru: where the forest authority is in charge of disposing of the remains of legally-killed jaguars (with prior governmental authorisation). While enforcement is not yet ideal in Peru, such a legal mandate would simplify authorities' efforts to confiscate dead jaguars, thereby preventing parts from entering illegal trade.

Given the complexity of these issues only a combination of policies, deterrence mechanisms and reinforced implementation efforts have a chance at stopping illegal trade (Fukushima et al. 2021). Since legislation in each country already regulates against trafficking in the parts of threatened and endangered species, including jaguar, the primary need is to enforce existing laws more actively and effectively in both rural areas where the killing happens and urban areas where demand for parts may exist. At the same time, given that a considerable proportion of jaguar killings are associated with opportunistic encounters between humans and jaguars, human-jaguar conflict, and subsistence/cultural practices, it is essential to include behaviour change, awareness building, and alternative livelihoods efforts into the mix of interventions to deter jaguar trafficking (Arias et al. 2021a). Finally, tech companies must bear responsibility for illicit transactions on their platforms, as they play a role in facilitating illegal wildlife trade (Morcatty et al. 2022), including transactions involving jaguars.

Discussion and Conclusions

Recent questions regarding trade in jaguar parts have included: 1) is the extent of Asia driven trade in jaguar parts, especially teeth, echoed in additional countries but thus far poorly detected? 2) what are the relative proportions of domestic and international commerce? 3) what needs to be done to halt the trade? In this review we found: 1) widespread evidence of domestic commerce in several countries, mostly unimpeded by law enforcement; 2) a narrower band of evidence of international transport of jaguar parts (which by definition are collected on local and national levels before export), including to Asia. Teeth were the most common part traded. All South American countries in the jaguar range have some evidence of jaguar trade, but international trade is particularly concerning in Bolivia, Peru, Suriname and Brazil due to potentially higher volumes; 3) ambiguity as to how much domestic trade enters international trade.

The number of interceptions of jaguar parts in China has been low but concerning nevertheless due to the amount of body parts traded, and seizures in South America with direct links to China, which indicate that jaguar body parts may have entered that country without being seized. Online searches revealed jaguar parts on Chinese platforms and advertised in Chinese, yet in low numbers. Thus far, online and interception records of material coming from Suriname and other potential source countries in South America to China do not match the volume implied in some published reports focused on source countries. Two conclusions may be drawn: 1) trade in jaguar parts may be coming into China from several sources in South America, but has been difficult to detect, record and disrupt; 2) while not diminishing the gravity of existing and potential South America to Asia trade in jaguar parts, currently domestic commerce in jaguar parts in source countries may exceed international commerce. Conclusion 2 emphasises the dramatic need for improved national level education and enforcement within South America to curb all commerce in jaguar parts. Both conclusions (1 & 2) represent grave threats. More investigative efforts are needed to examine jaguar trafficking from South America to Asia, and wherever encountered, disrupt it. Given international travel between the two regions, and the frequency of legitimate commercial shipments that provide opportunities to smuggle wildlife parts, increased vigilance and additional investigations are recommended.

While it remains necessary to investigate the illegal trade in jaguars in China, the growing evidence of international trade in jaguar body parts points towards a wider geographical scope. In particular, some North American and European countries, including the United States, Mexico, Germany and France have been found to have some of the

highest numbers of official jaguar seizures (CITES 2021). These markets have received less attention than China, and they are not well understood in terms of their drivers or scale. Several jaguar seizure events in range countries have taken place in touristic areas frequented by foreign and national tourists, suggesting that tourism may be an underestimated driver of jaguar trade (Braczkowski et al. 2019, Arias et al. 2020, CITES 2021).

Using online searches, we identified records that law enforcement could review for actionable information, and recommend additional online research in future to locate illegal trade to curb the threats to wild jaguar populations. Comparing the preliminary results of our online searches to other sources (Kerman 2010, Lemieux & Bruschi 2019, Verheij 2019, SERFOR & WCS 2020, World Animal Protection 2018) and team member experiences in the upper and lower Amazon, we note that even when sampling bias is avoided in online searches, variation in consistent electricity/internet across regions and trading contexts preferred among vendors means that online searches should be complemented by on-the-ground market reconnaissance and searches by mandated agencies. The greater Amazon includes nine of eighteen jaguar range states; the scale of the forest and porous international boundaries suggest that more research is advisable and greater vigilance and enforcement even in the more remote areas will be very important.

Recognising the international nature of the trade in jaguars, since November 2021 Suriname has deployed two specifically-trained jaguar detecting dogs at the international airport and other border posts. Increased enforcement in domestic commerce in Peru seems a priority. However, seizures without prosecution may elevate killing to replace stock lost. Tackling markets at all levels will require improvements in enforcement, surveillance efforts tracking different transportation routes, as well as improvement of capabilities and commitments to investigate and effectively prosecute wildlife poaching and trafficking cases.

The prevalence of jaguar parts in trade that we encountered, some of which may have originated in lethal responses to human-jaguar conflict, illustrates the importance of more effectively regulating local and national trade, so there are no disincentives to finesse coexistence due to a market that motivates killing jaguars for profit (Reuter et al. 2018). We also recommend greater efforts at effective outreach and investment that elevate the uptake of non-lethal conflict mitigation, as well as economic alternatives integrated with conservation that generate incentives to maintain live wild jaguars and intact natural wildlife communities.

A key issue that we identified, and which has also been raised by other attempts to collate and systematise information on jaguar trade (e.g. CITES 2021), was the lack of a centralised and reliable information on the matter. Reports of jaguar trade come from diverse sources varying in their quality and verification status, while data on official seizures made by enforcement authorities may be missing or unpublished. This has challenged the separation of facts from anecdotal information, and has presented challenges in evaluating the actual scale and trends of jaguar trade. The recommendations generated during the meeting of the jaguar range states in Cuiaba, Brazil, 18–22 September 2023 offer cause for optimism. Greater international collaboration to combat illegal cross-border trade is one of seven themes to be considered in a continental jaguar action plan. In addition, the CITES Standing Committee has requested that the Secretariat prepare terms of reference for the creation of modular system for monitoring illegal killing of jaguars and illegal trade in their parts and derivatives, which provides an opportunity to improve our capacity to evaluate the trade, and disrupt it (CITES 2023a, 2023b).

Almost all sampling includes some form of bias. Seizure data may be biased towards countries with greater enforcement capacity and reporting practices. Online searches may be biased towards areas with better electricity and internet accessibility. In this regard, there is a great value to proactive and carefully designed investigations that intentionally reduce bias (Arias 2020, Arias 2021a, Arias 2021b, Morcatty et al. 2020, Earth League International 2021) to support conservation. Cooperation between independent and academic researchers and national authorities, that include collaborative "methods and information transfers" can elevate knowledge and enable the interceptions that are important to disrupt the trade. Our recommendations are strengthened monitoring of physical and online markets to identify threats, supported by mandated law enforcement using existing mechanisms to disrupt trade in jaguar parts at all levels, local, national and international, whilst exploring multi-faceted approaches that do not criminalise vulnerable communities. Law enforcement should be complemented by social awareness, behaviour change and alternative livelihood programs that reduce the incentives to poach and trade jaguars.

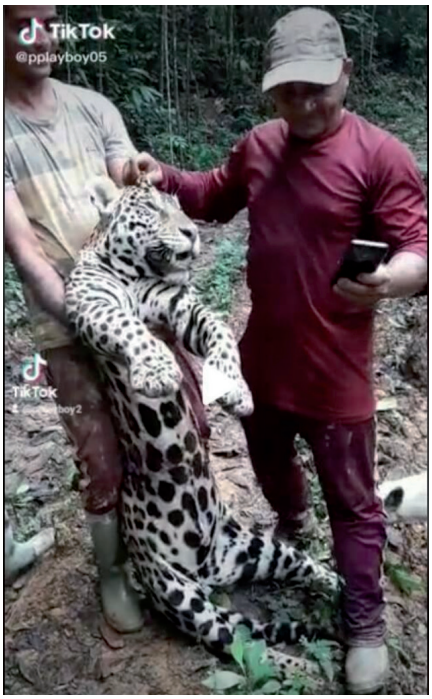

Fig. 5. Screenshot of a TikTok video posted in October 2021 of a freshly killed jaguar in Suriname's interior; the video remained online for several months after posting but has now been taken down (credit: pplayboy05/TikTok)

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