Patterns of illegal and legal tiger parts entering the United States over a decade (2003–2012)

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Abstract  
Poaching and illegal trade are primary threats to tigers (Panthera tigris). Trade in tiger parts has been well documented in Asia. However, little is known about tiger parts entering the United States (US). We analyzed seizures of tiger parts trafficked through US ports of entry from 2003 to 2012 along with shipments that had been issued legal Convention on International Trade in Endangered Species import permits. We found 292 seizure incidents and 283 permitted imports over that 10-year period. The amount of tiger parts trafficked into the US illegally was larger than what has been previously reported. Most tiger parts entered the US legally and illegally for personal purposes; 81.8% of seized items were medicinal products. San Francisco, Dallas, and Atlanta were entry hotspots for illegal tiger imports which mainly entered the United States from China and Vietnam. Of the 65.8% of seized parts with a known origin, 99.5% originated from wild tigers. Since country of origin and source of many legally and illegally traded tiger parts was unknown, we recommend the use of forensic DNA analysis to address these knowledge gaps to focus conservation and enforcement efforts. Research should continue in the United States to adequately capture the global supply, demand, and trade of tiger parts.

KEYWORDS  
CITES, LEMIS, seizures, Tiger (Panthera tigris), wildlife crime, wildlife trade

1 | INTRODUCTION

Wild animals and plants can be found for sale alive or in the form of skins, souvenirs, medicines, or food. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) regulates global trade in listed species which fall under Appendix I, II, or III, providing varying regulations. Tigers (Panthera tigris) are listed on Appendix I, which prohibits commercial international trade of species threatened with extinction while allowing trade for scientific, breeding, or educational purposes with import and export permits (CITES, 2021a). The treaty’s signatory nations are responsible for the implementation of CITES regulations in their respective countries. That occurs through domestic legislation and national enforcement; issuing permits for regulated legal trade in CITES listed species; and detecting, preventing, interdicting and prosecuting illegal trade (CITES, 2021b).

Global illegal wildlife trade is valued at up to $20 billion United States dollars (USD) annually (UNODC, 2016), although this value excludes ecological consequences of...
unregulated trade (Rosen & Smith, 2010). Wildlife trade can be lucrative for individuals and transnational criminal organizations involved in additional illicit activities including human, gun, and drug trafficking (Douglas & Alie, 2014; van Uhm et al., 2021). Illegal trade is a significant driver behind the current extinction crisis which threatens ecosystems worldwide (Dirzo et al., 2014; Symes et al., 2018) and is responsible for population declines of species ranging across plant and animal taxa (Ferreira et al., 2015; Ghoddousi et al., 2019; Phelps & Webb, 2015; Van Balen et al., 2000; Wittmeyer et al., 2014), including tigers (Goodrich et al., 2015; Kenney et al., 1995).

By 2020, there were an estimated 4981 tigers of five subspecies remaining in the wild across Asia (Jhala et al., 2020; Liu et al., 2018), though methods to estimate global or national populations may be unreliable (Gopalaswamy et al., 2019). Wild tiger populations have undergone massive declines for more than a century and occupy about 5% of their historic range (circa 1500) (Wolf & Ripple, 2017). Wild tigers are killed in retaliation for preying on livestock or endangering people in human settlements and for the trade of their high-value parts (Saif et al., 2018). Most tiger subspecies were listed as an Appendix I species under CITES in 1975; all are now listed (Goodrich et al., 2015). Despite prohibited international trade and domestic trade restrictions, poaching and continued illegal trade within and between countries continue to threaten tiger populations (Goodrich et al., 2015).

Between 2000 and 2018 there were 1142 seizures of tigers parts globally and almost half occurred in India (Wong & Krishnasamy, 2019), a country with more than half the world’s wild tiger population (Jhala et al., 2020). Seizures occur when illegally traded animals, including their parts and products, are detected; the true scale of trade is considered higher than seizure records reflect (Dobson et al., 2020; Stiles et al., 2013). Statistical methods to quantify the probability of detection and occurrence of tiger crime are under development (Sharma et al., 2014). Molecular forensics is emerging as a valuable method to prioritize anti-poaching efforts (Wasser et al., 2008; Wasser et al., 2015); DNA analysis was used to trace the geographic origin of 14 seized tiger parts in Nepal (Karmacharya et al., 2018). Forensic methods are not widespread because a global tiger DNA reference database does not exist and limited resources are dedicated to wildlife forensics (Smart et al., 2021).

China has been and remains the main destination and largest consumer of tiger parts (Sanderson et al., 2005; Stoner et al., 2016), which are sold worldwide (Dinerstein et al., 2007; Moyle, 2009; Nguyen & Roberts, 2020). Nearly every part of the tiger has been used in traditional Chinese medicine. Bones, used in tiger bone wine and traditional medicines, and skins, used as luxury décor, are the most commonly seized tiger parts (Wong & Krishnasamy, 2019). The purchase of tiger parts as luxury products has increased (CITES, 2014; UNODC, 2020) while medicinal use and demand continues (Davis et al., 2020; Nowell, 2010).

Although tigers are endangered in the wild, they live in high numbers in captivity. As of 2018, CITES estimated there were 12,574 captive tigers globally; 2589 captive tigers were held in accredited World Association of Zoos and Aquariums facilities or Species360 member institutions (CITES, 2016). In such managed and accredited zoos, tiger subspecies are bred to ensure support for wild populations. However, most captive tigers are bred for entertainment or commercially farmed for their parts. Hereafter, captive-bred refers to tigers outside of managed and accredited zoos. In many countries, including the United States (US), captive tigers are poorly regulated and the population size is unknown. In 2016, the United States Fish and Wildlife Service (USFWS) reported that the number of captive tigers in the United States was unknown and likely larger than the wild tiger population (USFWS, 2016). Others have estimated the US numbers at 5000 to 10,000 (Guynup, 2019).

Prior to 2007, captive breeding operations were permitted to commercially trade in tiger parts if they registered with the CITES Secretariat; but none did so (UNODC, 2020). In 2007, CITES adopted Decision 14.69 stating that tiger breeding operations must “restrict the captive population to a level supportive only to conserving wild tigers” and “tigers should not be bred in captivity for the purpose of trade in their parts and derivatives.” Nevertheless, only domestic policy and enforcement can uphold CITES regulations. As of 2020, tiger farms in China, Lao PDR (hereafter Laos), Thailand, and Vietnam held more than 8000 tigers, raised mainly for consumption (EIA, 2020). Tiger parts sourced from captive-bred tigers have been regularly seized in those and other countries since 2007 (Stoner et al., 2016).

Supply-side trade interventions alone, including enforcement, have been inadequate in addressing illegal trade in high-value species such as tigers (Challender & MacMillan, 2014; Crudge et al., 2018). Corruption in government and public and private sectors undermines enforcement and enables trade (Guynup et al., 2020; UNODC, 2020). Demand interventions are essential tiger conservation strategies (Holden et al., 2019; Moorhouse et al., 2020; Verissimo et al., 2020). Although, without unbiased evaluations, uncertainty exists about the impacts of behavior change campaigns (Verissimo & Wan, 2018).

In some instances, consumers prefer wild tiger products (Gratwicke et al., 2008); urban individuals in China and Vietnam recently stated an equal preference for wild versus farmed tiger bone wine (Coals et al., 2020).
However, actual consumption and consumer behavior is influenced by product availability, cost, and legality, and are more complex than stated consumer preferences (Hinsley & ‘t Sas-Rolfes, 2020; Rizzolo, 2020). Monitoring the trade in parts sourced from captive-bred tigers will improve our understanding of availability and provide insights into the implementation of CITES regulations.

Peer-reviewed studies on trade patterns primarily examine evidence from the 13 “tiger range countries” (TRCs): Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Russia, Thailand, and Vietnam (Gratwicke et al., 2008; Moyle, 2009; Nowell, 2010; Stoner et al., 2016; Verheij et al., 2010; Wong & Krishnasamy, 2019). There is limited research in the United States, beyond opportunistic documentation of tiger trafficking. The US ranks as the world’s second-largest consumer of illegal wildlife products and seizures of wildlife entering the country have increased since 2003 (Kurland & Pires, 2017; Petrossian et al., 2016).

Illegal trade in the United States has largely been described at the genus-level, including 941 imports seized of big cat (Panthera) species from 2003 to 2012 (Kurland & Pires, 2017). The USFWS issues permits for CITES-compliant trade and works alongside agencies such as the US Customs and Border Protection to inspect goods for illegally trafficked wildlife (CFR 14.52). Tigers are “Endangered” under the Endangered Species Act (ESA)—the US implementation of CITES—which prohibits importing, exporting, taking, possessing, selling, and transporting endangered species except for scientific purposes or activities that enhance the propagation or survival of the species.

1.1 Theoretical approach

We approach the tiger trade from a crime science perspective (i.e., Clarke et al., 2017; Moreto & Lemieux, 2015; Petrossian et al., 2016; Pires, 2015; Sosnowski et al., 2020; van Uhm et al., 2019). This includes rational choice theory, routine activities theory, and crime pattern theory (Wortley & Mazerolle, 2013), which suggests that crime is the result of opportunity structures within a built environment and is nonrandomly distributed (Clarke, 1999).

Rather than focus on individual criminals, this approach examines crime characteristics. Patterns in crimes have demonstrated the Pareto Principle, also known as the 80/20 rule, which states that approximately 80% of outcomes are produced or caused by 20% of inputs (Tanabe, 2018). Kurland and Pires (2017) found that roughly 80% of seized wildlife entering the United States were exported from 20% of the world’s countries into 20% of US ports of entry; Sosnowski and Petrossian (2020) found that approximately 80% of luxury fashion items seized in the United States came from 20% of wildlife genera. According to crime science theories, concentrations reflect structures that facilitate the opportunity for crime.

In this study, we investigate the extent and attributes of tiger parts entering the United States from 2003 to 2012. We use seizure data to identify product types in the illegal trade, countries of origin and export, ports of entry, methods of transportation, purposes of import, and shipment sizes. Based on global tiger trade characteristics, we expected to find skins, bones, and medicines exported from China and Southeast Asia, and parts that originated from countries with large wild or captive tiger populations such as India, China, Thailand, Laos, and Vietnam. The patterns we identify can inform focused prevention and detection strategies, although further research guided by our preliminary overview will be needed to understand contemporary trade. We also examine CITES trade data to identify the types, amounts, purposes, export countries, and origins of legally imported tigers and parts. Based on CITES and USFWS regulations, we expected to find that a majority of legal imports were for scientific, breeding, or educational purposes.

2 METHODS

2.1 Data

Seizure data of tiger parts entering the United States from 2003 through 2012 was obtained from the USFWS Law Enforcement Management Information Systems (LEMIS) database via a Freedom of Information Act (FOIA) request made in September 2013. Our analysis was constrained to 2013 because changes in the regulations regarding subsequent USFWS FOIA requests limited data to summarized yearly information.

The LEMIS database contains all records of US wildlife seizures confiscated upon import or export, making it the most comprehensive and reliable source of US wildlife trafficking data (Eskew et al., 2019; Petrossian et al., 2016; Sosnowski et al., 2020; Sosnowski & Petrossian, 2020; van Uhm et al., 2019). A single seized shipment may be recorded in one or more seizure incidents. Therefore, we treated each line of this database as a seizure incident and examined cases as shipments, using control numbers associated with each line in the database.

For every seizure incident, the LEMIS database records genus, species, subspecies, wildlife product type (e.g., bone, medicine, meat), quantity, unit of measurement, country of export, country of origin (i.e., source country), source (i.e., wild caught, captive bred, unknown), purpose, import or export, CITES appendix
number, transportation mode, disposition (e.g., seized), violation of specific US legislation, and the shipment date. We examine “seizures” of *P. tigris* parts, removing legal imports/exports and those that were “cleared,” “abandoned,” or “reeported.” “Abandoned” items were voluntarily surrendered. A “reeported” item means an item, that originally entered the country as an import, was cleared for export. This, along with any “cleared” item, would be legal. No exports of tiger parts were seized from 2003 to 2012.

To complement seizure records, we obtained data on tigers and parts legally entering the United States from 2003 to 2012 from the CITES Trade Database (found at https://trade.cites.org/). We included information on wildlife product type, country of export, source, purpose, and year. We also examined CITES data on import permits from 2013 to 2017 to track more recent trends.

### 2.2 Seizure and permitting procedures

The LEMIS database includes observations made and recorded by USFWS wildlife inspectors and special agents. The USFWS requires that wildlife imports and exports include a Declaration for Importation or Exportation of Fish or Wildlife (Form 3-177) (CFR 14.61); seizure incidents often include information from this document. The source and origin of seized tigers and parts is not assessed or assumed without obvious indications or accompanying verbal or written documentation or declaration (US Fish and Wildlife Service personal communication, May 13, 2021). Seized items are generally identified as medicinal when they are unidentifiable as a body part and they are declared as medical, written or verbally, by the importer/exporter (US Fish and Wildlife Service personal communication, May 13, 2021). Commercial trade is the presumed purpose of trade if there are eight or more similar items, although USFWS or the importer/exporter may declare other purposes based on facts and circumstances (CFR 14.4 and 23.62). Personal use is noncommercial, for a person’s own consumption or enjoyment (CFR 23.5).

The CITES trade database contains import and export records of CITES-listed species that have been submitted by signatories and is maintained by the United Nations Environment World Conservation Monitoring Centre. We do not report on country of origin because this field is sometimes left blank if the exporting nation is the same or if the origin is not reported (Musing, 2020). Commercial trade is activity with the purpose to obtain economic benefit (in cash or otherwise), such as resale, exchange, or provision of a service whereas personal trade is a transaction involving movement of legally-acquired personal property, not to be traded commercially after the import/export (CITES, 2021c).

### 3 | RESULTS

#### 3.1 Illegal imports

Between 2003 and 2012, there were a total of 292 seizures of illegally-traded tiger parts at US ports of entry in violation of the ESA from 288 shipments; three shipments were recorded in more than one seizure incident. The number of seizures varied widely year to year (Figure S1), ranging from a maximum of 40 in 2010 to a minimum of 12 in 2004. The average number of seizures per year was 29.2 (standard deviation [SD]: 9.6, median = 29.5).

Most (65.8%, *N* = 192) seized products were recorded as sourced from wild tigers, while 33.9% (*N* = 99) of items were of unknown origin and one item was sourced from a commercially bred tiger (Table 1). Of 24 export countries (Table S1), the majority of seized products were imported from China (34.2%, *N* = 100), followed by Vietnam (29.5%, *N* = 86); Canada (5.5%, *N* = 16); and Thailand (4.5%, *N* = 13) (Figure 1).

**Table 1** Source of illegal and legal tigers and tiger parts entering the United States from 2003 to 2012

| Source                | Illegal (LEMIS) | Legal (CITES) |
|-----------------------|-----------------|---------------|
| Wild                  | 192             | 36            |
| Unknown               | 99              | 10            |
| Commercially bred     | 1               | 0             |
| Bred/born in captivity| 0               | 51            |
| Confiscated or seized | –               | 169           |
| Preconvention         | –               | 17            |

Abbreviation: CITES, Convention on International Trade in Endangered Species.

*Confiscated or seized* CITES source designations indicate that a tiger or tiger product had been originally confiscated or seized by authorities prior to its legal import/export. For instance, if a live tiger had been seized by authorities and sent to a rehabilitation center for care, a CITES permit subsequently issued to legally re-import/export the specimen to a zoo in another country would indicate a “confiscated or seized” source designation. “If a specimen was obtained prior to the CITES listing date of that species—collected from the wild or held in captivity—it may be granted a pre-Convention certificate that will allow for the specimen to be exported. For Appendix I specimens, no CITES import permit is required.” (https://www.fws.gov/international/pdf/Factsheet-cites-permits-and-certificates-2013.pdf).
Francisco, followed by 18.8% in Dallas, and 10.3% in Atlanta (Figure 2). Less than 10% occurred at other ports of entry (Table S3).

Tiger parts were illegally transported in various ways, with 52.1% \((N = 152)\) carried in personal baggage, 25.0% \((N = 73)\) shipped via air cargo, and 15.1% \((N = 44)\) mailed. Of seized items, 85.6% \((N = 250)\) were recorded as imported for personal use and 13.0% \((N = 38)\) were for commercial purposes (Table 2). Most seizures involved medicinal products \((81.8%, N = 239)\), followed by teeth \((N = 16)\) and claws \((N = 16)\) (Table 3). Of the 281 seizures that listed multiple items, the average number of items per seizure was 67.2 (SD: 260.2, median: 6.0); the largest included 3600 items (Figure 3). Almost half \((48.4%, N = 136)\) of seizures contained eight or more items and 22.8% \((N = 64)\) contained a single item.

**FIGURE 1** Countries that illegally (blue circles) (a) and legally (orange triangles) (b) exported tigers or tiger parts to the United States from 2003 to 2012.
3.2  |  Legal imports

There were 283 CITES import permits issued for tigers and tiger parts brought into the United States from 2003 and 2012, with 145 permits issued from 2013 to 2017; numbers fluctuated yearly (Figure S1). From 2003 to 2012, more than half (59.7%, \(N = 169\)) of permits were issued for tigers and parts or products that were categorized as “confiscated or seized” by authorities in another country prior to legal entry into the United States (Table 1). Another 18.0% (\(N = 51\)) of permits included parts, products, and live tigers that were sourced from captive bred tigers; 12.7% (\(N = 36\)) came from the wild.

Of the 36 permits for tigers or parts from wild tigers, more than half (52.8%, \(N = 19\)) were issued for personal use of various products (Table S4).

Most legal imports entered from Vietnam (\(N = 65\)) (Figure 1). We found that 61.1% (\(N = 173\)) of permits were issued for personal use; 14.1% (\(N = 40\)) were authorized for circus/traveling exhibition; and 13.4% (\(N = 38\)) were issued for commercial purposes (Table 2).

| Purpose                          | Illegal (LEMIS) | Legal (CITES) |
|----------------------------------|-----------------|---------------|
| Personal\[^a^\]                  | 250             | 173           |
| Commercial                       | 38              | 38            |
| Scientific                       | 2               | 18            |
| Biomed/medicinal                 | 1               | 2             |
| Hunting trophy                   | 1               | 1             |
| Circus/traveling exhibition      | 0               | 40            |
| Zoo                              | 0               | 7             |
| Educational                      | 0               | 4             |

Abbreviation: CITES, Convention on International Trade in Endangered Species.

\[^a^\] CITES defines “personal” effects as specimens as:
1. Personally owned or possessed for noncommercial purposes.
2. Legally acquired.
3. At the time of import, export, or reexport either:
   a. Worn or carried or included in personal baggage
   b. Part of a household move (CITES, 2020).
**TABLE 3** Wildlife descriptions and breakdowns of illegal and legal tigers and tiger parts entering the United States from 2003 to 2012

| Product type | Illegal (LEMIS) | Legal (CITES) |
|--------------|----------------|--------------|
|              | No. incidents | No. specimens | Grams | Pounds | Liters | No. permits |
| Medicinal    | 239           | 18,731        | 3683  | 4       | –      | 14           |
| Teeth        | 16            | 46            | –     | –       | –      | 16           |
| Claw         | 16            | 26            | –     | –       | –      | 17           |
| Skin pieces  | 2             | 2             | –     | –       | –      | 4            |
| Unspecified  | 3             | 4             | –     | –       | 1      | 2            |
| Specimen     | 2             | 58            | –     | –       | –      | 16           |
| Trophy       | 1             | 1             | –     | –       | –      | 5            |
| Bone piece   | 2             | 3             | –     | –       | –      | 2            |
| Skin         | 1             | 1             | –     | –       | –      | 6            |
| Hair         | 1             | 2             | –     | –       | –      | 3            |
| Skull        | 1             | 1             | –     | –       | –      | 3            |
| Dead animal  | 1             | 1             | –     | –       | –      | 2            |
| Bones        | 1             | 1             | –     | –       | –      | 2            |
| Genitalia    | 1             | 1             | –     | –       | –      | 2            |
| Meat         | 1             | –             | 100   | –       | –      | 1            |
| Oil          | 1             | 1             | –     | –       | –      | 1            |
| Jewelry      | 1             | 1             | –     | –       | –      | 0            |
| Rugs         | 1             | 1             | –     | –       | –      | 0            |
| Trim         | 1             | 1             | –     | –       | –      | 0            |
| Derivatives  | 0             | –             | –     | –       | –      | 128          |
| Live         | 0             | –             | –     | –       | –      | 49           |
| Carvings     | 0             | –             | –     | –       | –      | 5            |
| Plates       | 0             | –             | –     | –       | –      | 2            |
| Extract      | 0             | –             | –     | –       | –      | 1            |
| Garments     | 0             | –             | –     | –       | –      | 1            |
| Leather products | 0     | –             | –     | –       | –      | 1            |

Abbreviation: CITES, Convention on International Trade in Endangered Species.

**FIGURE 3** Number of items (units) versus number of seizures for 281 seizure incidents that reported the number of specimens.
Circuses/traveling exhibitions accounted for most (81.6%, \( N = 40 \)) permits for live tigers, followed by zoo and commercial purposes, listed on seven (14.3%) and two permits, respectively. Almost half (45.2%, \( N = 128 \)) of legal permits were allotted for derivatives, defined as “any processed part of an animal or plant (e.g., medicine, perfume, watch strap)” (CITES, 2020). Other common legally imported products included claws (\( N = 17 \)), teeth (\( N = 16 \)), and specimens (\( N = 16 \)) (Table 3).

4 | DISCUSSION

4.1 | Concentrations in crime characteristics

Many trends we identified mirror results from previous wildlife crime studies (Kurland & Pires, 2017; Sosnowski et al., 2020; Sosnowski & Petrossian, 2020) and the Pareto Principle. Notably, 20.8% (\( N = 5 \)) of known export countries accounted for 80.6% of seizure incidents; 79.9% of seizure incidents originated from 20.0% (\( N = 3 \)) of countries; and 69.5% of seizure incidents occurred at 20.0% (\( N = 5 \)) of US ports of entry. These results can guide situational crime prevention methods, which focus on increasing risk, reducing rewards, reducing provocations, and removing excuses (Clarke, 1980; Clarke et al., 2017) and are increasingly being applied to conservation issues (Wilson & Boratto, 2020).

Illegal wildlife trade is often low risk and high reward (Petrossian et al., 2016). Tiger trafficking in the US was substantial (see Sections 4.2 and 4.4). Managing medicinal demand for tiger parts can reduce drivers of trade (see Section 4.3). The USFWS may consider prioritizing detection efforts at entry hotspots (see Section 4.5) and automatically checking shipments by those with a history of wildlife trafficking. Countries involved in trafficking routes (see Section 4.6) should cooperate to increase the crime risk for tiger traffickers through increased surveillance of wildlife parts and products exiting and entering the countries. We encourage the use of forensic methods to monitor the tiger trade (see Section 4.7).

4.2 | Scale of crime

Our results found 292 seizures of tiger parts illegally entering the United States from 2003 to 2012, indicating that the scale of trade has been underestimated and is larger than previously reported. For the same time period (2003–2012), Wong and Krishnasamy (2019) reported six seizures of tigers and tiger parts and products in the US, based on news media outlet reports (K. Krishnasamy, personal communication, June 26, 2020). Globally, they document 624 seizures using a combination of data from news media outlets, governments, and nongovernmental organizations; US import seizures represent almost half (46.8%) of global seizures.

Tiger parts have entered the illegal trade from the United States but no export seizures were recorded in the LEMIS database. For national security reasons, customs agents and wildlife inspectors pay more attention to imports than exports (US Fish and Wildlife Service personal communication, June 20, 2019). Understanding the true scale of tiger trafficking into the United States and current trends in global trade will require additional research explained in the following sections.

4.3 | Demand for medicinal products

Medicinal products emerged as the most commonly seized product type (Table 3). We contribute to evidence that trade in tiger parts in destination countries outside the tiger’s range, such as the European Union (Musing, 2020), predominantly involves medicinal products. Within TRCs, tiger skins, bones, claws, and teeth have been the most commonly seized products (Wong & Krishnasamy, 2019) although the demand for and use of medicinal tiger products continues to drive trade. The seizures of processed products entering the United States from TRCs reveal gaps in enforcement of both trade and production of medicinal tiger products that subsequently entered global markets. Examining the labels of seized medicinal products may provide insight into the manufacturing and marketing of medicines.

Numerous campaigns that target consumers in the United States, including Stop Wildlife Trafficking (www.stopwildlifetrafficking.org), have been implemented to raise awareness about the illegal wildlife trade and purchasing endangered species products, which include tigers. New and existing interventions could focus on demand management among consumers of medicinal tiger products. It is important to inform the design of targeted demand management interventions through audience segmentation by characterizing the US consumer market for tiger parts. A nuanced social and cultural understanding of consumers may also help interventions avoid perpetuating racist stereotypes and misrepresenting consumers (Margulies et al., 2019). We suggest further research on buyers and consumers of tiger parts with a particular focus on users of medicinal products, including their sociodemographics, product preferences, motivations, willingness to purchase a plant-based or pharmaceutical substitute, and the availability of supplemental products (Coals et al., 2020; Davis et al., 2019, 2020; Thomas-Walters et al., 2020; Verissimo et al., 2020).
4.4 | Commercial trade

While a small percentage (13.0%) of confiscations were listed as commercial imports, almost half (48.4%) of those included eight or more items (Figure 3). Based on the quantity of items in each seizure incident, there may be more commercial imports than recorded. Offenders were not identified on seizure records, which hindered our ability to identify repeat traffickers. We recommend further research into persons trading commercial quantities of items and who may be illegally selling parts to US consumers or using the United States as a transit nation.

4.5 | Entry hotspots and modes of entry

Seizures were concentrated in San Francisco, Dallas, and Atlanta, which were entry hotspots for illegal imports of tiger parts into the United States. Geographic trends are influenced by law enforcement efforts including the number of inspectors at ports. As of 2008, Dallas and San Francisco both had 4 USFWS wildlife inspectors, while Miami had 9 and New York had 12 (Wyler & Sheikh, 2008). Yearly data on deployment of inspectors could be used in future studies to determine how this impacted detection and crime rates. While entry hotspots do not necessarily reflect the location of suppliers or consumers, authorities can use these findings to enhance enforcement and potentially deter tiger trafficking. Entry hotspots also provide geographic areas of interest for future research on domestic and international trafficking routes.

Over half (52.1%) of seized tiger parts were smuggled in personal baggage; a quarter arrived via air cargo. These patterns may indicate greater detection or effort by inspectors on these modes of transport or reflect the logistical ease of these methods. Our species-specific analysis reflects similar patterns for the concentration in mode of transportation for all seized wildlife entering the United States (Petrossian et al., 2016).

4.6 | Trafficking routes

Verifying the export country, origin, and source of tiger parts is essential to understanding global trade dynamics and demand, the influence of tiger farming, and poaching of wild tigers. Almost every (99.5%) seizure with a known source came from the wild. However, a country’s wild tiger population is not indicative of illegal trade routes (Figure 1). India was home to almost 40% of the world’s wild tiger population in 2010 (Jhala et al., 2020) but only 1 (0.3%) item was imported directly from India (Table S1) between 2003 and 2012 and a total of 6 (2.1%) parts were recorded as originating there (Table S2). Trade routes included transit nations, where tiger parts are imported then exported along the supply chain. Canada was the third-largest exporter, which reflects its geographic proximity and prominence as exporter of wildlife products entering the United States (Petrossian et al., 2016; Symes et al., 2018).

Overall, China, Vietnam, and Thailand exported the most tiger parts to the United States; Laos was also an export country (Table S1). These four countries engage in tiger farming; illegal trade is highest in these countries (Krishnasamy et al., 2018; Wong & Krishnasamy, 2019) though wild tigers in Laos and Vietnam are functionally extinct and populations in China and Thailand are relatively low compared to India. It is possible that any wild sourced tiger part exported from China, Vietnam, Thailand, or Laos originated from a different TRC.

Levels of trade in tiger parts sourced from captive tigers are significant in China, Vietnam, and Thailand (Davis et al., 2020; Nowell, 2010; Wong & Krishnasamy, 2019). In these countries, corruption has facilitated licensed tiger farms to operate along international trafficking routes (EIA, 2013). While the trade in the parts and derivatives of captive-bred tigers is a violation of CITES Decision 14.69, the number of captive sourced parts entering the United States from China, Vietnam, Thailand, or Laos remains unknown because the source of one-third of products was not recorded in the LEMIS database.

4.7 | Forensic DNA analysis

Trafficking routes are complex and identifying the export country provides only a limited snapshot because tigers can come from a number of sources and origins and move through transit nations. It was difficult to determine whether tiger parts exported from a TRC were poached from the wild and where, or whether they came from captive-bred tigers. Seizure records lack information on the source (Table 1) or origin (Table S2) of tiger parts. Seven seizures were identified only as “big cats.”

Forensic methods can overcome such limitations in seizure records and address the source and origin of legally traded products that were recorded as previously confiscated or seized in the CITES database. Tiger DNA and forensic evidence can be collected from fur, claws, meat, and bones (Morgan et al., 2021) and a real-time DNA identification method has been developed for tiger bones (Dalton et al., 2020). It is not always possible to collect DNA sequences from heavily processed products though snow leopard (Panthera uncia) has been detected and identified in traditional medicines using DNA.
Wild-sourced tiger parts and those with unknown origin should be forensically evaluated with existing geospatial genetic profiles of wild tigers to identify the geographic origin. Conservation and enforcement in places where wild tigers live and breed are critical to saving them. Coupling this work with forensic methods to identify where tigers were poached would prioritize site-level strategies.

Similar forensic approaches can be used to monitor the quantity and origin of parts and products sourced from captive-bred tigers. However, genetic reference databases for captive tigers only exist in the Czech Republic and Thailand. This undermines our efforts to monitor compliance with CITES Decision 14.69 or examine trade patterns and opportunity structures that facilitate such trade. All countries with captive tigers should obtain and contribute genetic samples to an international database in collaboration with Czech Republic CITES authorities (Project Tigris ID - Development of Diagnostic Tools for DNA Analysis in Processed Products, 2019).

Further research is needed to assess the feasibility of using forensic methods for wildlife trade insights. It will require the development of robust methods for tiger DNA extraction from medicines and other highly processed items, and collaborative, coordinated law enforcement and research efforts both across tigers’ Asia range and across the globe. Finally, we need to establish mechanisms that transfer responsibility for reporting the source and origin of traded tiger parts from regulatory agencies to the exporters and importers of wildlife.

4.8 Captive tigers in the United States

Countries engaged in tiger farming—breeding tigers in cub petting attractions unaccredited zoos as commodity items for their parts and products—were predominantly involved in tiger trafficking routes into the United States (see Section 4.6). The United States also breeds large quantities of tigers, housing one of the world’s largest captive tiger populations (CITES, 2016), and is one of seven countries, along with China, Vietnam, Laos, Thailand, South Africa and the Czech Republic, identified by CITES that contains captive tiger facilities of concern; facilities that are involved in tiger trafficking or possess more than 49 tigers (CITES, 2018).

Tiger breeding in the United States increased after 1998, when the USFWS relaxed restrictions on interstate domestic trade in “generic” tigers, individuals that were crossbred between two or more subspecies. Thousands of tigers were then mass-bred for pets, for unaccredited zoos and for cub-petting tourist attractions that legally allowed hands-on contact with cubs under the age of 12 weeks (Nyhus et al., 2003; Nyhus et al., 2010). This loophole exempted crossbred tigers from permitting requirements until 2016, when the ruling was reversed.

Currently, the US Department of Agriculture (USDA) grants and oversees licenses to entities that exhibit tigers to the public. However, there are no comprehensive US federal laws counting or tracking captive-bred tigers, regulating private, noncommercial ownership, or regulating the disposal of high-value tiger parts (Williamson & Henry, 2008). Three states have no statewide laws restricting big cat ownership and nationwide, regulations and enforcement vary. Tiger ownership is unregulated in some states; others ban tiger breeding tigers without a USFWS permit.

Due to the poor regulations of captive tigers in the United States, there is no assurance of compliance with CITES Decisions aimed at managing commercial trade of Asian big cats in captivity. We recommend that USDA license renewal require the contribution of genetic materials and stripe pattern images of all captive tigers; allowing conclusive visual and forensic identification of individual tigers.

The Big Cat Public Safety Act (BCPSA) (H.R. 263 of the 117th Congress) is a bill that if adopted into law, would ban the private ownership of tigers. Current owners would keep their pets which would be registered with the USFWS. In the event that BCPSA is signed into law, we recommend that private owners who register their tigers with the USFWS submit genetic material and stripe pattern images. Genetic profiles and stripe images, compiled into a centralized database, should be made available to federal and CITES authorities and researchers.

Additional regulations are needed for the secure disposal of dead captive tigers and their high-value parts; adopting such policies would be meaningful steps toward the management of captive tigers in the United States. Illegal interstate transport of tigers has been widely documented and we encourage future research to investigate tiger trade within the United States (Guynup, 2019).

4.9 Trade regulations

More than half of permits included derivatives, teeth, skins, claws and genitalia sourced from the wild which were provided exemptions and given legal entry into the United States for personal purposes. Permits for a wild-sourced Appendix I species including tigers should face more stringent requirements. For example, permits should be issued solely for verified scientific purposes, as
illegal trade has occurred under the pretense of science. A more conservative regulatory approach may be to ban the imports of wild-sourced tiger parts for any purpose. CITES was enacted in 1975, and though pre-Convention items may be legally traded internationally for personal or commercial purposes, corruption can facilitate fraudulent paperwork for contemporary wildlife products (Outhwaite, 2020; UNODC, 2013). We recommend future research combine a nuanced review of domestic policies and implementation of CITES regulations alongside CITES trade data to adequately understand legal tiger trade.

4.10 | Observational bias and limitations

Patterns in seizure incidents from 2003 to 2012 may not reflect current trends in the illegal trade. The use of digital platforms to trade and pay for illegal wildlife products has increased, economic prosperity has expanded demand (Esmail et al., 2020), and lions and parts of other big cat species now supplement for tiger parts (Coals et al., 2020; EIA, 2020; Lemieux & Bruschi, 2019; UNODC, 2020). It is unknown how such changes have influenced tiger trade in the United States in recent years because illegal trade is dynamic.

The patterns and scale of trade that we report rely on the completeness and accuracy of CITES Trade Database and LEMIS data. We do not report the quantity of parts legally traded because there are discrepancies between quantity and source on import and export permits in the CITES database (Musing, 2020) and we only use data from import permits. Between 2001 and 2006, there were cases where a tiger left the United States legally for one purpose, such as circus/traveling exhibition, and was legally reimported for another purpose (Williamson & Henry, 2008). Future studies should cross-check import and export records for tiger parts entering the United States with export records (Berec et al., 2018).

The origin of more than half of legally traded tigers and parts entering the United States were listed as “confiscated or seized,” without information on whether they came from the wild or captivity. We found no apparent temporal trend in permits issued between 2003 and 2017 (Figure S1). Finally, derivatives were the most common legally imported tiger part and we were unable to categorically identify these items.

Unstructured observational data, such as seizure incidents, are biased (Dobson et al., 2020). The LEMIS database is a reflection of factors such as law enforcement efficiency and enforcement capabilities. As of 2014, USFWS had 130 wildlife inspectors and 212 special agents. Inspectors were posted at 64 of the 328 US ports of entry that are designated for wildlife imports/exports (Goyenechea & Indenbaum, 2015). Smuggled wildlife may enter or exit the United States at any port and our results reveal detection patterns that may not necessarily reflect true trade volumes and patterns. Additionally, it was not possible to approximate how many tigers were seized without an ingredient list or production information for medicinal products (Wong & Krishnasamy, 2019).

5 | CONCLUSION

We describe the previously underestimated scale of tiger parts illegally entering the US over the course of a decade for personal and commercial use. Most tiger parts entered the United States from China or Vietnam (Figure 1). Forensic methods could be employed to reveal the source and origin of tigers and their parts smuggled into the United States, identify locations where wild tigers were poached, and prioritize enforcement where captive tigers supply parts to the trade. We suggest future research on consumer demand and the availability, marketing, and distribution of parts in the United States with a particular focus on users and suppliers of medicinal products.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Sarika Khanwilkar and Monique Sosnowski conceptualized the study. Monique Sosnowski managed and led the data analysis. Sarika Khanwilkar led the writing with major input and revisions from Monique Sosnowski and Sharon Guynup.

DATA AVAILABILITY STATEMENT

Restrictions apply to the availability of data from USFWS, which were obtained via a FOIA request. Authors are unable to share this data. Data from CITES are available at www.trade.cites.org.

ETHICS STATEMENT

Our work involved data from CITES and USFWS. To further understand USFWS procedures, informal interviews were conducted with personnel following consent.
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