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Research Article

Spatial analysis of wildlife trafficking and concealment methods: The case of Pangolins

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Abstract

A significant threat to the pangolin species worldwide is the illicit trafficking of the mammal for its scales, meat, and skin. The illicit trafficking of pangolins has a potential impact on public health as it enables the transmission of zoonotic diseases, threatens biodiversity by disrupting ecological dynamics, and compromises international security by empowering criminal networks. In-depth information about the concentration of illicit trafficking of pangolin scales and strategies for concealment around the world is provided by this paper's analysis. Using tools such as SPSS and QGIS, the paper reveals that ninety-four percent of pangolin scales were confiscated from only 6 countries—Nigeria, Vietnam, China, Singapore, Hong Kong, and the Democratic Republic of the Congo (DRC)—highlighting their crucial role in the pangolin trade worldwide. Pareto chart study highlights the necessity of focusing conservation efforts in these high-volume nations to stop this successfully. Africa (42%) and Asia (57%) account for significant shares of pangolin scale seizures, highlighting the need for focused conservation measures. The potential implications of pangolin trafficking around the world is also presented in this paper. The paper concludes that to combat the illicit pangolin trade, there should be more law enforcement, community engagement, education, economic measures, international cooperation, and information sharing.

Keywords: Wildlife, Public Health, Trafficking, Biodiversity, International Security

Introduction

Illicit wildlife poaching and smuggling networks have become increasingly sophisticated and the size of seized shipments indicates the involvement of highly advanced and organized criminal networks (Akella & Allan, 2011). Although some low-level poaching and trade persist, the vast majority of wildlife trafficking is carried out by highly skilled and specialized transnational crime

syndicates (Ayling, 2013). Professional hunters now feed into well-established wildlife trafficking rings that, in turn, supply extensive domestic and international networks of underground retailers, taxidermists, and galleries (Abotsi et al., 2016). Illicit trafficking of wildlife products also thrives online, where websites and dealers cannot be tracked easily (CITES, 2013). Wildlife traffickers advertise on online auctions, forums, and classified lists, claiming their items were legally obtained but not providing documentary proof or using acronyms and euphemisms to avoid detection (Fleming, 2012). Thus, operating under the cover of globalization, criminal networks are poaching and moving unprecedented quantities of illicit wildlife products across continents (Elliot, 2012).

Increasingly, illicit wildlife hunters and traffickers have shown both the capacity and propensity to use violence to protect themselves from arrest. Armed with sophisticated weaponry, poachers pose a grave threat to not only wildlife but also civilians and law enforcement officers, as well as domestic peace and security (Fleming, 2012). The sophisticated weaponry includes state-of-the-art heat-seeking telescopes, night-vision goggles, GPS satellite receivers, automatic and semi-automatic weapons, and even rocket-propelled grenades (Douglas & Alie, 2014). In 2013, the International Ranger Federation reported that at least 5000 rangers have lost their lives globally to poachers (Bottollier-Depois, 2013). Rangers often include women and men, members of indigenous communities, volunteer teams, and conservation veterans who brave many hardships to protect and conserve threatened wildlife worldwide. It is in this light that the International Union for Conservation of Nature, in collaboration with the World Commission on Protected Areas (IUCN WCPA), recently instituted International Ranger Awards to recognize rangers who have gone above and beyond the call of duty to protect wildlife and support local communities. Winners of the award receive a commemorative plaque, a custom uniform patch to signify their achievement, and US$10,000 to support their work (IUCN, 2021).

To sum up, illicit wildlife trade and trafficking is a complex undertaking that poses risks to the security of nations, global health, biodiversity, and sustainable social and economic development of nations. The security of nations is at risk in cases where illicit wildlife trafficking is found to be run by criminal groups with broad international reach and the profits used to finance civil conflicts and terrorist-related activities (WWF, 2012). Similarly, the corruption that is associated with illicit wildlife trade can reduce the effectiveness of governments, deter civic engagements, erode the rule of law, and negatively affect the development of local communities. It can quickly deplete

biodiversity, easily bring endangered species to extinction, and serve as a conduit for disease transmission that threatens global health (WWF, 2012). The pangolin has the dubious honor of being the most illicitly trafficked species in the world.

Pangolin Trafficking

The pangolin, the only animal with a full coat of scales, uses them to protect itself from predators in the wild. The pangolin uses its sharp-scaled tail to defend itself by curling into a tight ball when it feels threatened (Canton, 2021). Ironically, despite being highly protective in its natural habitat, this defensive stance has unintentionally made the animal more susceptible to being caught, traded, and trafficked because of how easily it can be lifted. According to Boakye's sobering 2020 report, the pangolin has acquired the dubious distinction of being the most trafficked mammal worldwide. Eight living species of pangolins have been identified worldwide (Gaubert & Antunes, 2015). These species are found on two continents, with four of them inhabiting African regions (Wilson & Reeder, 2005; Gaudin et al., 2009; Ingram et al., 2019b). The giant ground pangolin (*Smutsia gigantea*), white-bellied pangolin (*Phataginus tetradactyla*), black-bellied pangolin (Phataginus tricuspis), and Temminck's ground pangolin (*Smutsia temminckii*) are found in various regions of Africa, including sub-Sahara Africa, west and central Africa, as well as the east and south of Southern Africa. Additionally, there are four pangolin species in Asia: Chinese pangolin (*Manis pentadactyla*), Sunda pangolin (M. javanica), Philippine pangolin (*M. culionensis*), and Indian pangolin (*M. crassicaudata*). These distributions have been documented by Pietersen et al. (2019a, 2019b), Gaubert and Antunes (2005), Challender et al. (2014a, 2019a, 2019b), Mahmood et al. (2019), Nixon et al. (2019), and Schoppe et al. (2019). Their distribution spans from Pakistan to Southern China, southwards from the Himalayas in Nepal, and encompasses the whole Indian sub-continent, including Sri Lanka. They are also found in a significant portion of Mainland and Island Southeast Asia, including Palawan in the Philippines (Challender et al., 2014b).

Pangolins have a significant economic impact on a wide range of sectors globally. Notably, the skin of pangolins is prized for its unique leather, its scales are used in traditional medicine, and its meat is considered a delicacy in some areas (Boakye et al., 2015). The estimated $3000/kg black market value of pangolin scales highlights how profitable this illicit activity is (Ingram et al., 2020). The startling fact that nearly 220,509 kg of pangolin scales were seized worldwide in 2019 highlights how serious the situation is (WJC, 2020).

Due to their status as a threatened species, CITES grants pangolins the utmost protection and globally bans the commercial trade of wild-caught pangolins (CITES 2016). Nevertheless, pangolins continue to be subjected to extensive illicit trade. It is estimated that between 2000 and 2019, more than 2.7 million pangolins were captured from their natural habitats (Harrington et al., 2018; Canton, 2021). China and the United States of America (USA) were identified as the primary destinations for the illicit trade of pangolins, including their scales and body parts, according to studies conducted by Heinrich et al. (2017) and Shairp et al. (2016). Cyranoski (2020) highlights the pangolin's involvement in the spread of zoonotic diseases. One possible route for human transmission has been linked to the illicit pangolin trade (Bryner, 2020). These two issues—the pangolin's propensity for zoonotic illnesses and its endangered condition—have sparked international campaigns to stop pangolin poaching and trade. The Convention on International Trade in Endangered Species (IUCN, 2016), the US Congress through the END Wildlife Trafficking Act of 2016, and the United Nations Convention on Biodiversity are essential players in this effort. Against this background, this study analyzed pangolin scale trafficking and concealment methods across 27 countries. Specific objectives were to describe the nature of pangolin-scale seizures among the countries, discuss the implications on public health, biodiversity, and international security, and discuss policies and strategies to mitigate the illicit pangolin trade worldwide.

Material and Methods

This paper is based on content analysis of secondary data. Data was acquired from a compilation of pangolin seizure records between 2016 and 2019 on the countries identified as leading in pangolin trafficking (Wildlife Justice Commission, 2020). The study used quantitative research tools such as SPSS to run descriptive statistics to analyze the data. Results from the study are presented in figures, and charts, to give a detailed description of pangolin trafficking and concealment methods. In addition, quantitative GIS methods were applied in QGIS to aid in spatial analysis of pangolin scale seizure locations and other analyses the descriptive statistics could not provide. Mainly, a hotspot analysis was conducted to pinpoint countries with substantial levels of pangolin scale trafficking. This approach entails the examination of seizure data from several

countries to identify both country and regional patterns of both high and low levels of activity in pangolin scale trafficking.

Results and Discussion

Descriptive Statistics on Pangolin Scale Seizures

Descriptive data on pangolin scale seizures from 27 different countries offer essential information about the scope and geography of the illicit pangolin trade. A wide range of seizure counts are shown by the entire dataset, with a minimum of 500kg and a maximum of 113,130kg (Figure 1). There have been 454,998kg seizures in total among these 27 countries, with a mean of 16,851kg. This shows a significant range in the number of pangolin seizures, emphasizing how widespread this illicit activity has become. The global seriousness of the problem is highlighted by the mean value of 16,851kg, representing an average of more than 16,000kg seizures per nation. An urgent need for increased conservation and law enforcement measures is highlighted by the high maximum value of 113,130kg (Figure 1), which raises worries about the major pangolin trafficking operations that are taking place in some locations or countries.

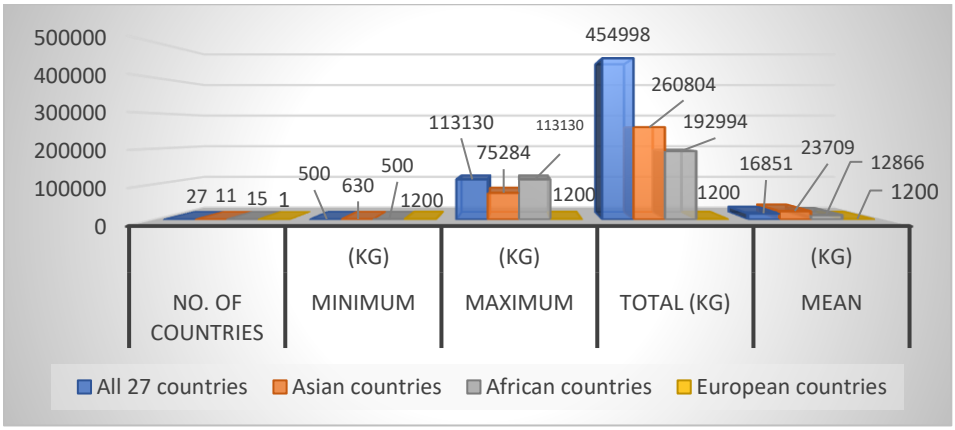


Figure 1. Descriptive statistics on seizures

The results become much clearer when the data is broken down by continent (Figure 1). The range of seizures is greater in Asian nations, with a minimum of 630kg and a maximum of 75,284kg. With a mean of 23,709kg, the total seizure for Asian countries is 260,804kg. This points to a more diverse and pervasive problem throughout Asian nations and possible hotspots or regions with heightened pangolin trafficking activity. The range is smaller in African nations, with a minimum of 500kg and a maximum of 113,130kg. With a mean of 12,866kg, the total seizure for African nations comes to 192,994kg. This points to a more concentrated yet ongoing issue in African

nations. The smallest range is seen in European nations, where the mean and total number of seizures are both 1,200kg. The range is from 1kg to 1,200kg. Even if there are fewer seizures in Europe, the worldwide nature of the pangolin trade is highlighted by even one seizure in a European nation. In general, this analysis gives insights into the distribution and intensity of pangolin trafficking around the world. Similarly, data on pangolin scale seizures shows that there is a notable concentration of illicit activities in a small number of countries.

Spatial Analysis of Pangolin Scales Seizures.

The Pareto graphic indicates that six nations—Nigeria, Vietnam, China, Singapore, Hong Kong Special Administrative Region (SAR), and the Democratic Republic of the Congo (DRC)—combine to make up 22% of all the nations examined in the study (Figure 2). These same nations also make a significant contribution to the size of the pangolin trade as 94% of all pangolin scales seizures come from these countries. This clearly illustrates the Pareto principle, sometimes known as the 80/20 rule, since most pangolin scale seizures (94%) worldwide occur in a small number of countries (22%).

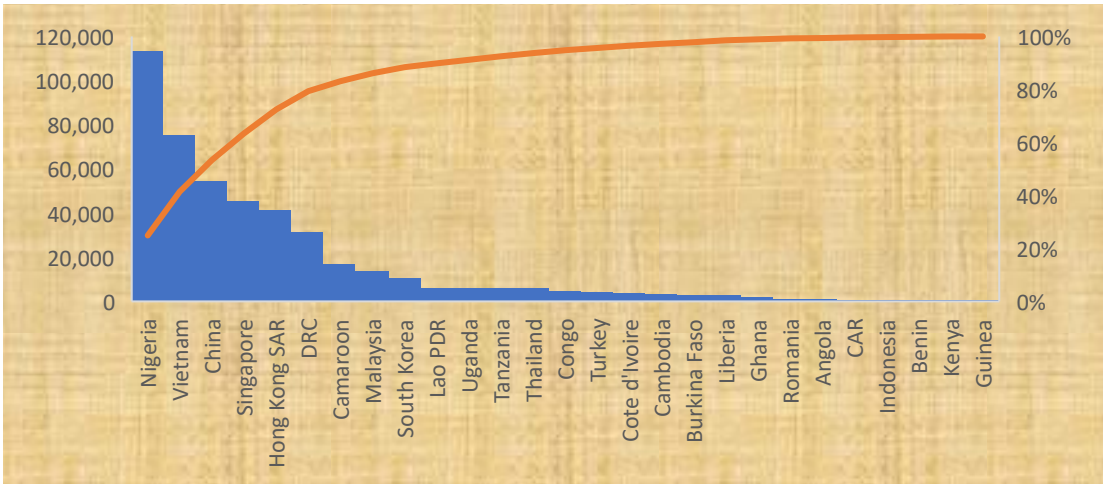


Figure 2. Seizures of pangolin scales (in kg.) based on countries.

The reasons for Nigeria's prominent position in the trade remain uncertain (Omifolaji et al., 2020). The Wildlife Justice Commission (2020) has identified corruption as a potential factor, noting that Nigeria has consistently received low scores on the Corruption Perceptions Index over the past decade. In 2020, Nigeria scored 25 out of 100 on the index, where 0 indicates high corruption and 100 indicates high transparency (Transparency International, 2020). The studies conducted by Cheng et al. (2017), Zhang et al. (2017), and Ingram et al. (2019a) have found that the concentration of pangolin scales in China has not decreased over time. Additionally, over the past

decade, there has been an increase in both the number and volume of pangolin seizures, particularly in China and Vietnam (Harrington et al., 2018; Omifolaji et al., 2020). Nearly all seizures made in Nigeria, over 99%, were intended for use in other countries, particularly Vietnam, China, and Hong Kong (Gomez and Leupen, 2016; Heinrich et al., 2017; Ingram et al., 2019). The Democratic Republic of Congo's presence in the countries with the highest trafficking of pangolin scales is not coincidental, since a substantial number of pangolins are harvested each year in the Congo basin alone (Ingram et al., 2018).

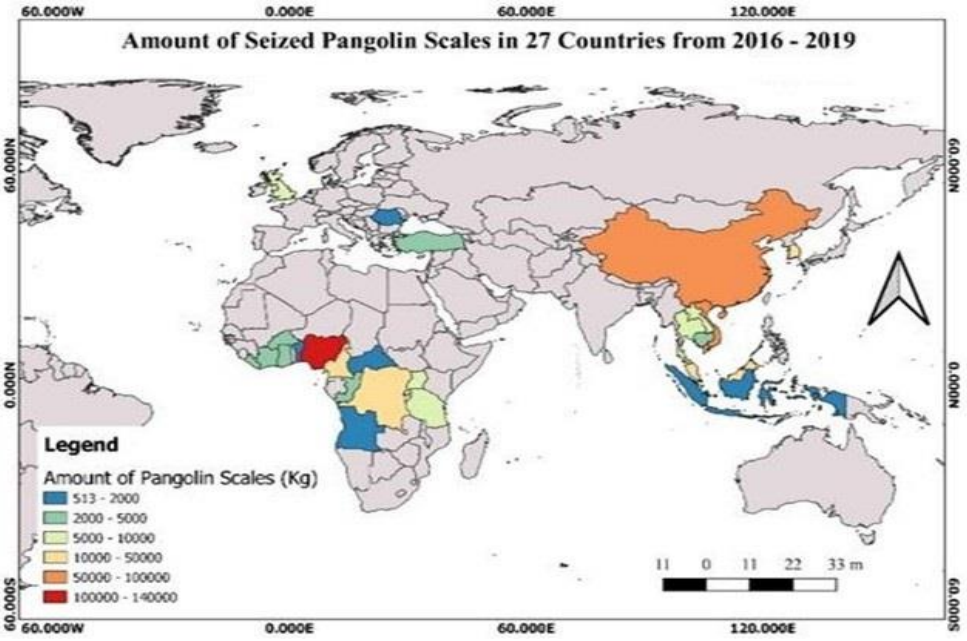


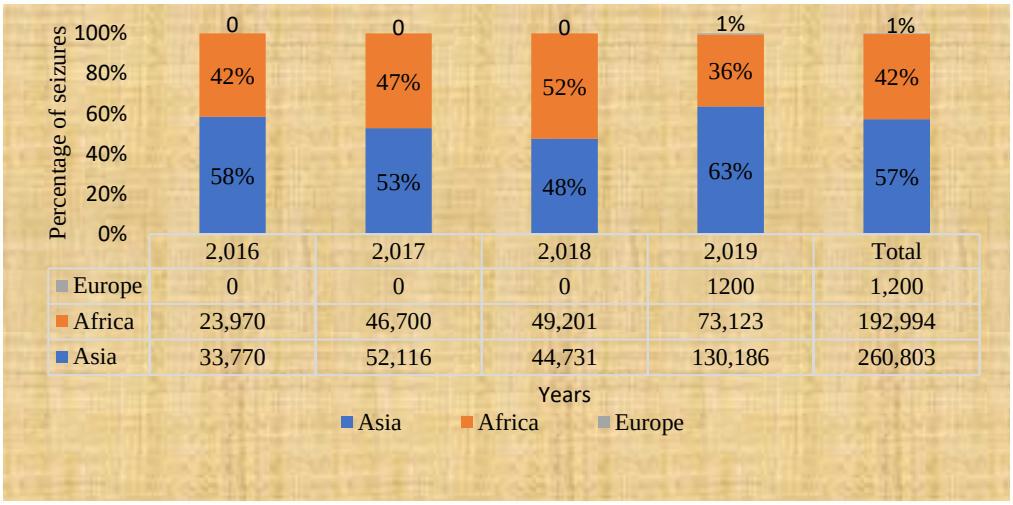
Figure 3. A map showing countries associated with pangolin scale seizures

These findings have important ramifications for devising effective conservation initiatives. By concentrating efforts on six important nations—Nigeria, Vietnam, China, Singapore, Hong Kong, and the Democratic Republic of the Congo (Figure 3)—it may be possible to reduce the illicit pangolin trade significantly. Effectively combating this business requires identifying and addressing the underlying reasons for pangolin-scale trafficking in these countries. The information also emphasizes how critical it is for countries to work together and launch focused initiatives to solve the problem and prevent pangolin exploitation in the future.

Proportion of Pangolin Scale Seizures Based on Continents.

Information about the percentage of pangolin scale seizures by continent from 2016 to 2019 sheds light on the regional dynamics of this illicit trade (Figure 4). Pangolin scale seizures were

noticeably zero in Europe in 2016, 2017, and 2018, except for 2019 (1,200kg) which forms only 1% of the global seizures. This implies that during the early years, European countries were relatively lowly involved in pangolin-scale trafficking, with a minor increase in 2019. The percentages were significant in Africa, accounting for 42% of all seizures in the years 2016 through 2019. Throughout the monitored time, pangolin scale trafficking was consistently present in Africa, as indicated by the stable proportion, which highlights the necessity for focused conservation efforts on the continent. With percentages ranging from 53% to 63%, Asia had the greatest rates, suggesting a major contribution to pangolin scale seizures. The growing percentages over time highlight how urgent it is for Asian nations to address this problem.



	2,016	2,017	2,018	2,019	Total
Europe	0	0	0	1200	1,200
Africa	23,970	46,700	49,201	73,123	192,994
Asia	33,770	52,116	44,731	130,186	260,803

Figure 4. Proportion of pangolin scale seizures based on continents.

A greater percentage of seizures in Asia originate from Africa, and the reason is that the population of Asian pangolins has declined since the late 20th century (Legakul & McNeely, 1988; Irshad et al., 2015; Newton et al., 2008; Schoppe et al., 2020). The primary cause of the decline in Asian pangolins can be attributed to the extensive utilization of pangolin scales in traditional medicine and the cultural significance of consuming pangolin meat in Asia (Ingram et al., 2019). This decline is further exacerbated by the increasing economic connections between Asia and Africa, which may facilitate the trade of pangolins from Africa to Asia. In 2017, Nigeria emerged as a major source of pangolins for Asia, coinciding with the implementation of the pangolin's CITES Appendix I listing (Emogor et al., 2021). During this time, enhanced law enforcement measures were simultaneous, as evidenced by the rise in training programs, heightened awareness of

concerns related to illicit wildlife trade inside the Nigeria Customs Service (NCS), and intensified international partnerships (Emogor et al., 2021).

Items Used in Trafficking Pangolin Scales

Pangolin scales are frequently concealed through a variety of methods to avoid detection by law enforcement during trafficking. Traffickers have devised advanced techniques to disguise these illegal items, often embedding them within legitimate shipments to minimize suspicion. A prevalent strategy includes hiding pangolin scales with lawful cargo, such as frozen food, timber, furniture, tar, beans/nuts, and ginger, thereby enabling their transport under the pretense of regular trade (Heinrich et al., 2019). Research indicates that frozen food containers are commonly used because the cold storage environment can mask the scent of the scales, reducing the likelihood of detection by sniffer dogs (Kehinde et al. 2022). Timber and furniture shipments, due to their bulk and opacity, offer ideal concealment for smuggling large quantities of pangolin scales, with scales often hidden within hollowed-out logs or disguised as wood shavings (Heinrich et al., 2019). Similarly, items like tar, beans, and ginger, which are shipped in large, dense quantities, serve to physically mask the scales when they are mixed up and packed in sacks (Challender & MacMillan, 2014). This method has significantly complicated efforts by authorities to detect and intercept these illicit consignments (Challender & MacMillan, 2014).

From Figure 5, with a noteworthy 33% of the total, frozen items are the most popular, suggesting a strong correlation between the frozen food trade and pangolin-scale smuggling. With 23% of the total, timber comes in second, indicating a strong correlation between the trafficking of pangolin scales and timber activity. Kehinde et al. (2022) have uncovered that the extensive interception of pangolins during cargo screening has effectively raised the rate of identifying illicit shipments of pangolins disguised as wood logs, masquerading as lawful merchandise. In addition, the category labeled as "Unknown" comprises 17% of the total, suggesting a significant proportion of trafficking when the specific item is hidden or undisclosed. There is a likelihood that future traffickers are likely to employ smuggling methods that law enforcement agents are not currently familiar with (Challender and MacMillan 2014; Heinrich et al. 2019).

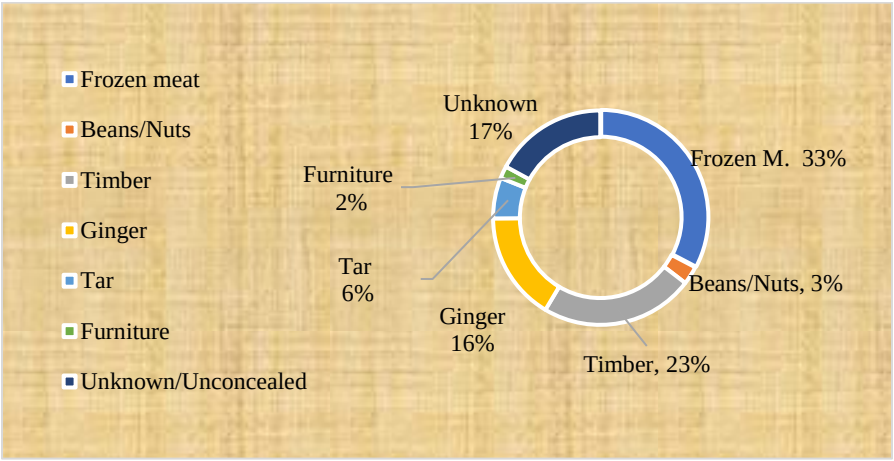


Figure 5. Items used in trafficking pangolin scales.

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Ginger's 16% of the total suggests that it might be used as a disguise in the pangolin scale smuggling trade since its color resembles that of the pangolin scale (Kehinde et al. 2022). Tar, furniture, and beans/nuts have significantly lower percentages (6%, 2%, and 3%, respectively), indicating a more minor but significant involvement in pangolin-scale trafficking. This analysis highlights the various ways of concealing the illicit pangolin scale trade and provides insightful information for focused conservation and law enforcement initiatives. Next, we present the potential implications of pangolin trafficking around the world if nothing is done to stem the tide.

Potential Impact of Pangolin Trafficking

Public Health

The trade of pangolins, which is motivated by the high demand for their scales and flesh in the luxury cuisine and traditional medicine industries, has substantial ramifications for the field of public health (Challender et al., 2019). Pangolins are potential vectors of zoonotic diseases, such as coronaviruses, that may infect humans via infected pangolin products, direct contact, or ingestion (Zhang et al., 2020). Zoonotic transmission pathways present a significant hazard to public health, as exemplified by the emergence of zoonotic diseases such as COVID-19, which are thought to have originated from the trade of wildlife, including pangolins, in China's damp markets (Andersen et al., 2020). Moreover, the potential for infectious pathogens to proliferate is heightened due to the unhygienic conditions frequently associated with the trafficking and handling of pangolins (Liu et al., 2020).

A cycle of human-animal interaction is perpetuated by the illicit trade of pangolins, which increases the likelihood of outbreaks of emergent infectious diseases (EIDs) (Challender et al., 2020). Opportunities for the transmission of novel pathogens from animals to humans are created by the close contact between humans and wildlife made possible by the intensive exploitation and trafficking of pangolins (Lee et al., 2021). These types of interactions elevate the probability of spillover events, in which pathogens modify to infect novel hosts and may instigate pandemics that have catastrophic effects on the general public's health (Wan et al., 2020). In light of the increasing prevalence of zoonotic disease outbreaks in recent times, which can be traced back to the exploitation of wildlife species such as pangolins, comprehensive strategies to combat the illicit wildlife trade and mitigate the associated public health hazards are urgently required (Shi et al., 2020).

Biodiversity

The detrimental consequences of the illicit trade of pangolins extend to ecosystems and species diversity, causing a chain reaction (Challender et al., 2019). Pangolins serve as natural pest controllers within their respective ecosystems, controlling insect populations and preserving ecological equilibrium by consuming enormous volumes of ants and termites (Ingram et al., 2020). The environmental dynamics are disrupted by the widespread poaching and trade of pangolins, which may result in insect population imbalances and the potential destabilization of entire ecosystems. The decline of pangolin populations due to trafficking can significantly impact biodiversity, influencing interactions between plants and pollinators, predator-prey dynamics, and the overall functioning of ecosystems (Cunningham et al., 2021).

Furthermore, ecosystem resilience and adaptive capacity are compromised due to the disruption of ecosystem dynamics and reduction in overall biodiversity caused by the depletion of pangolin populations via poaching and trafficking (Loh et al., 2020). Moreover, pangolins function as keystone species that provide ecological health indicators; their extinction is a cautionary signal of more extensive environmental degradation and habitat loss (Cunningham et al., 2021). Hence, it is critical to prevent the trade of pangolins to safeguard not only the existence of this exceptional species but also the ecological balance and biodiversity of their habitats.

International Security

International security is gravely threatened by the illicit trade of pangolins, which bolsters transnational criminal organizations and undermines law enforcement operations across the globe (Challender et al., 2019). Sophisticated criminal syndicates frequently engage in pangolin trafficking, operating beyond national boundaries and capitalizing on regulatory loopholes and corruption to enable unlawful trade (Wyler & Sheikh, 2008). Criminal networks such as the one described above partake in a variety of illegal undertakings, such as poaching, smuggling, and money laundering, to amass considerable financial gains while endangering human life and wildlife (Nijman, et al., 2022). Furthermore, the exacerbation of conflicts in areas bountiful in pangolins is attributed to the participation of armed groups and militias in pangolin trafficking. This undermines endeavors to promote peace and security and destabilizes fragile communities (Canton, 2021). Illustratively, armed factions in Africa partake in wildlife trafficking as a means to fund their operations, thereby contributing to the continuation of cycles of instability and violence (Wyler & Sheikh, 2013).

In addition, the illicit trade of pangolins contributes to more extensive security concerns (Challender et al., 2019). zoonotic pathogens, such as coronaviruses, within pangolin, presents substantial risks to both worldwide security and public health (Zhang et al., 2020). As a result, epidemics occur, which have extensive implications for the stability of society and the economy (UNEP & INTERPOL, 2016). Moreover, environmental degradation ensues because of the illicit trade-induced depletion of pangolin populations, exacerbating susceptibilities and undermining endeavors towards sustainable development (Challender et al., 2019). Consequently, in addition to being crucial for conservation, combating pangolin trafficking is also vital for advancing global security and ensuring the welfare of communities across the globe.

Policy Implications

These discussions are intended to serve as a guide to mitigate the illicit pangolin trade, safeguard pangolins and their ecosystems, and address the wider effects of this unlawful activity on biodiversity, public health, and international security.

Regional Conservation Strategies

Effective conservation measures must consider the diverse geographical patterns of pangolin scale seizures. The distinct difficulties each continent faces must be acknowledged by policymakers, and solutions must be tailored appropriately. According to the data, trafficking in Africa is a

persistent problem, with 42% of all seizures occurring across the continent between 2016 and 2019. This emphasizes how critical it is for African policymakers to focus conservation efforts to combat the ongoing threat that the illicit pangolin trade poses. Comprehensive and expanded conservation initiatives are desperately needed to stop the rising trend of trafficking operations in Asia, where pangolin scale seizures account for between 57% of total seizures. While Europe, despite its small representation in previous years, made a slight comeback in 2019, highlighting the need for proactive steps and attention even in regions with comparatively lower involvement (WJC, 2020).

Information sharing and regional cooperation are essential to the success of these customized conservation programs. Working together, the countries on each continent can improve the effectiveness of intelligence sharing, law enforcement, and the execution of coordinated conservation activities. The Pareto chart study, which shows that a small number of nations contribute disproportionately to pangolin scale seizures globally, supports the collaborative strategy. Policymakers can better combat the illicit pangolin trade and pool resources to prevent pangolin exploitation by promoting regional partnerships (IUCN, 2016). This strategy not only acknowledges the various difficulties that other continents confront, but it also emphasizes how interrelated the actions that are required to stop the illicit pangolin trade globally must be (Heinrich et al. 2019).

Diversification of Concealment Tactics Awareness

Law enforcement organizations are essential in combating the illicit pangolin scale trade, but their ability to do so depends on their ability to fully comprehend the variety of deception strategies used by traffickers (Challender and MacMillan 2014). The study's data emphasizes how concealing techniques—like using frozen commodities, wood, and unknown items—are in pangolin scale trafficking. The category labeled "Unknown," which accounts for 17% of cases, indicates a significant proportion of trafficking in which the particular item is concealed, highlighting the necessity for law enforcement officers to have greater understanding and competence in this area (WJC, 2020). Training courses should be created to help law enforcement organizations identify and successfully combat various deception strategies to address this.

Considering these findings, law enforcement organizations engaged in the fight against wildlife trafficking must immediately put in place focused training and awareness initiatives. Officers

should be able to recognize pangolin scale concealing techniques, thanks to these programs, especially when it comes to frozen commodities, wood, and other known objects. These initiatives can only be successful if law enforcement trainers, wildlife conservation specialists, and pertinent government agencies work together. Effective training programs aim to strengthen law enforcement's capacity and raise the proportion of successful interventions in cases involving wildlife trafficking (Rosen, Smith, & Diaz, 2017). Law enforcement organizations can significantly increase their ability to disrupt trafficking networks and safeguard this endangered species by funding training programs to address the unique concealment strategies used in the pangolin scale trade (Challender and MacMillan 2014).

Global Collaboration and Information Sharing

Countries, law enforcement agencies, and conservation organizations must work closely together, share information, and coordinate their activities due to the intricate and international nature of the pangolin trade. The body of research continually emphasizes how critical it is for nations to work together to combat wildlife trafficking, especially when it comes to species like pangolins that cross borders at different points in the illicit trade chain (Wyatt, 2013). The results of this study, which show a notable concentration of the illegal activity in particular nations, emphasize the necessity of cooperation. Most pangolin scale seizures worldwide are attributed to these hotspot countries, which include Nigeria, Vietnam, China, Singapore, the Hong Kong Special Administrative Region, and the Democratic Republic of the Congo (WJC, 2020). Seeing this, specialists stress that exchanging information and implementing best practices are essential elements of efficient cooperation, guaranteeing a coordinated reaction to the issues raised by the trade in pangolins (Wyatt, 2013).

Working together can create a shared intelligence database that law enforcement organizations can use to stay ahead of changing trafficking routes and patterns globally (Bennett, Eckert, & Roe, 2017). Organizations dedicated to conservation are essential in fostering these kinds of partnerships and providing knowledge to improve enforcement tactics. The Convention on International Trade in Endangered Species (CITES) provides a foundation for international cooperation, which highlights the value of information exchange in the fight against the illicit wildlife trade (CITES, 2021). By highlighting these already-existing structures and encouraging

communication among stakeholders, more focused and efficient interventions may be made, eventually protecting pangolins from the dangers associated with the illicit trade.

Strengthened Law Enforcement and Penalties

It is important that nations with high pangolin scale seizures increase their law enforcement programs. According to research, breaking up trafficking networks requires a multipronged strategy that includes information collecting, collaboration between law enforcement agencies, and calculated interventions (Wyatt, 2013). Law enforcement personnel in nations that play a significant role in the pangolin trade, as those found to have high rates of seizures in the current study, need to get specialized training. According to Rosen, Smith, and Diaz (2017), training programs can improve their capacity to investigate and take down trafficking networks, resulting in more successful convictions and uprooting the illicit pangolin trade. Collaboration among countries and agencies is essential for sharing best practices in enforcement strategies, as the interconnected nature of wildlife trafficking demands a coordinated response (Bennett, Eckert, & Roe, 2017).

Furthermore, toughening the penalties for trafficking in wildlife, such as the smuggling of pangolin scales, is a vital way to discourage potential traffickers. The body of research on wildlife crime continually maintains that one of the most critical factors in deterring people from committing crimes is the harshness of the consequences (Tournier & Williams, 2019). Nations with elevated rates of seizures ought to contemplate examining and, if required, modifying their legal structures to guarantee that the sanctions correspond with the gravity of the offense. Proposed strategies to prevent wildlife trafficking include higher fines, lengthier prison terms, and asset forfeitures. These policies send a clear message that engaging in illicit activities would result in serious consequences (Tournier & Williams, 2019; EIA, 2020). Countries may create a deterrent that penalizes wrongdoers and upsets the financial incentives behind the illicit pangolin trade by implementing these findings into their legislative frameworks (EIA, 2020).

Community Engagement and Education

The importance of community engagement and education in regions where pangolin trafficking is prevalent is a recurring theme in conservation literature (Bennett, 2015). Local communities can

be crucial to protecting pangolins because they are frequently found in their natural habitats. Research indicates that community engagement initiatives can effectively raise knowledge, establish confidence, and cultivate a sense of responsibility toward wildlife (Veríssimo et al., 2019). A collaborative and inclusive strategy can be formed by integrating local communities in the conservation process, especially in locations identified as having high rates of pangolin trafficking (Veríssimo et al., 2019). This entails not just educating the public about the negative effects of the pangolin trade but also encouraging community members to report illicit activity and assist law enforcement in their efforts (Bennett, 2015). Programs that involve the community must be successful if techniques are adapted to local conditions and the socioeconomic issues that may encourage people to engage in the illicit wildlife trade are addressed (Inskip & Zimmermann, 2009).

Long-term conservation also depends on education initiatives aimed at the general public, which extend beyond the immediate communities affected by pangolin trafficking. Research indicates that public awareness programs can change people's attitudes and behaviors regarding wildlife protection (Veríssimo et al., 2019). Raising public awareness of pangolins' ecological significance and the negative effects of their trade can help conservation efforts gain more traction. Campaigns to raise public awareness have the power to mobilize support, which could persuade decision-makers to enact tougher laws and provide funding for pangolin conservation (Bennett, 2015). When such educational initiatives are maintained over time, they help to cultivate a worldwide coalition for the protection of biodiversity and pangolins, extending beyond local boundaries and regions.

Economic Approaches

Promoting alternate sources of income for communities involved in the illicit pangolin trade is necessary. Offering workable and sustainable substitutes can help those involved in trafficking shift to morally and legally acceptable endeavors, therefore lessening their dependency on the exploitation of pangolins (Karesh et al., 2005). According to Wyler and Sheikh (2008), sustainable economic ventures like agroforestry and eco-tourism have been suggested as valuable community development instruments that promote financial success and environmental preservation. These methods emphasize the integration of conservation objectives with economic growth, which aligns with the larger notion of Conservation Enterprises (McShane et al., 2011). Such programs target

the socioeconomic issues that encourage people to engage in the illicit wildlife trade in addition to protecting pangolins.

To reduce demand, it is essential to educate customers about the ecological consequences of pangolin trafficking and encourage alternative livelihoods. Research indicates that consumer awareness initiatives can impact preferences and purchase behavior, which could decrease the market for animal items (Veríssimo et al., 2017). Such ads can instill a sense of customer responsibility by drawing attention to the ecological repercussions of pangolin trafficking. This can encourage ethical choices and discourage the purchase of pangolin scales and related products (Veríssimo et al., 2017). When combined with consumer education, economic strategies can have a synergistic effect that changes demand patterns over time and aids in pangolin conservation.

International Cooperation on Zoonotic Disease Prevention

Given that pangolins are thought to be potential carriers of zoonotic diseases, there is an urgent need for international collaboration to track and stop the spread of illnesses linked to these unusual mammals. A growing body of research indicates that the wildlife trade, especially pangolins, is linked to outbreaks of zoonotic diseases, highlighting the need for preventative steps to reduce the dangers to public health (Karesh et al., 2005; World Health Organization, 2020). Because of their vulnerability to coronaviruses, pangolins have been linked to zoonotic disease outbreaks, making them a prominent topic of study in the field of global health (Cyranoski, 2020). To address the wider ramifications of the wildlife trade on public health, we must advocate for international collaboration in the monitoring and prevention of zoonotic diseases associated with pangolins. Kock et al. (2020) stated that governments, environmental agencies, and pertinent health organizations should collaborate to devise and implement solutions to limit the danger of disease transmission from pangolins to humans.

The public health impact of the pangolin trade must be addressed in concert with health groups. Researching and comprehending the zoonotic potential of wildlife, especially pangolins, is crucial, and health-focused organizations can offer essential insights into practical preventive and control strategies. Interaction with the World Health Organization (WHO) and other pertinent organizations becomes essential in this cooperative endeavor. The WHO can help develop guidelines and protocols to reduce the danger of zoonotic diseases linked to pangolins because of its experience in global health governance. Furthermore, collaboration with health organizations

makes it possible to incorporate public health viewpoints into trade and animal conservation laws, guaranteeing a comprehensive strategy to protect biodiversity and human health.

Conclusions

To sum up, the examination of pangolin scale seizures across 27 nations provides insightful information on the complex aspects of this illicit industry. The concentration of the illegal activity in a few countries highlights the crucial role these countries play in the global pangolin trade, especially Nigeria, Vietnam, China, Singapore, Hong Kong Special Administrative Region (SAR), and the Democratic Republic of the Congo (DRC). According to the Pareto chart study, concentrating efforts on these high-volume nations can significantly reduce the illicit pangolin trade globally. Furthermore, the necessity for customized conservation methods is highlighted by the geographical dynamics of pangolin scale seizures, emphasizing Africa and Asia due to the considerable proportions. The examination of deception strategies reveals the variety of techniques traffickers use; lumber and frozen commodities stand out among other products. To effectively combat the illicit pangolin trade, law enforcement, fines, community engagement, education, and economic measures should be strengthened. Addressing the larger effects of the wildlife trade on public health and biodiversity, in particular about zoonotic disease prevention, requires international cooperation and information exchange.

Acknowledging the gravity of the situation and the requirement for prompt, concerted action to advance these conclusions is crucial. The results of the study not only clarify the scope and geography of pangolin trafficking but also lay the groundwork for focused actions. The policy implications and recommendations that have been found underscore the significance of adopting a comprehensive approach that encompasses not only conservation measures and law enforcement but also economic incentives, community engagement, and international collaboration. Realizing how regional and global activities are interrelated is essential to producing significant and long-lasting outcomes. Adopting these suggestions can help create a holistic strategy that tackles the origins and effects of the illegal pangolin trade, which is a concern to public health and biodiversity. Governments, conservation groups, local communities, and the international community must work together to mitigate pangolin-scale trafficking successfully.

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