

RESEARCH ARTICLE

Using community-based crime scripting to elucidate pangolin scale trafficking

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Abstract Illegal wildlife trade is accelerating rates of biodiversity loss and undermining conservation. Crime scripting systematically details the crime commission process, informs prevention activities, and is usually based on experts' perspectives. We conducted community-based crime scripting of pangolin scale trade in Cameroon, July–December 2024 in 22 communities in Cameroon ($n = 152$ participants). Using NVivo 15.1.1 for analysis of perspectives, we identified six enabling conditions for trade and four categories of crime prevention activities. Identifying the crime commission process structure and mapping interventions onto specific stages of the process offers novel insight for crime prevention. Participants stressed that focusing interventions on early and late stages of the crime commission process would have a high impact on reducing harms to animals and people associated with illegal trade. This research demonstrates the value in engaging communities in pinpointing opportunities for conservation crime prevention.

Keywords Cameroon · Community-based conservation · Illegal wildlife trade · Protected areas · Situational crime prevention · Universal crime script

INTRODUCTION

Local and international trade in pangolin meat, skin, and scales is a primary threat to the conservation of the 8 pangolin species distributed across Africa and Asia (Waterman et al. 2014; Ingram et al. 2018; UNODC 2024). Pangolin scale trade is global. Between 2016 and 2020, authorities reported 955 seizures involving an estimated

250 000 pangolins or their derivatives across 33 countries (CITES 2022, 2025). Analysis of pangolin interception data linked to Africa from social media between 2016 and 2024 identified 130 seizure incidents accounting for more than 28 700 kg of African pangolin scales involving 15 African and 7 Asian countries (Nethavhani et al. 2025). International commercial trade for all 8 pangolin species has been illegal since 2017; domestic markets are governed by national laws (e.g., CITES 2025). The harms associated with pangolin scale trade—like other forms of illegal trade in wild fauna and flora—are diverse, dynamic, and interconnected. Harms to pangolins from illegal scale trade include population declines (Challender et al. 2020) and loss of genetic diversity increasing extinction risk (Din Dipita et al. 2024). Harms to people from illegal pangolin scale trade include links to criminality (Van Uhm and Wong 2021) and depletion of an important cultural, financial, and consumptive resource. Around the world, diverse approaches are used to help conserve pangolins and reduce harms from illegal trade. Community-based approaches are widely deployed with indigenous peoples and local communities (IPLCs) because people living in and around pangolin habitat(s) can be both actors and uniquely victimized by illegal trade and are on the front line of conservation. They hold traditional ecological knowledge about pangolin conservation, including illegal scale trade, and what makes conservation effective and ineffective (Cooney and Challender 2020; Suwal et al. 2023).

Illegal pangolin scale trade persists despite knowledge about multiple enabling structural, social, environmental, systemic, or psychological factors (e.g., Heighton and Gaubert 2021). The extant literature identifies multiple drivers for pangolin scale trade (e.g., Zanzo et al. 2021;

Emogor et al. 2025) including typologies of illegal market actors (Gore et al. 2021a, b), market trends (Challender et al. 2020), diversity of demand markets (Wang et al. 2023), and geographic context derived from case studies (Emogor et al. 2021). These insights have been produced via data from wildlife forensics (Priyambada et al. 2021), law enforcement seizures (Xi et al. 2025), and spatial monitoring and reporting tools (Sampson and Appiah-Opoku 2024), among other methods. Knowledge gaps about illegal pangolin scale trade—separate from pangolin meat trade—remain, creating a bottleneck in the science-to-action pipeline and for evidence-based decision making (Sabo et al. 2024). This is problematic because intelligence has historically proven essential for effective customs and border training, investigative tools for criminal justice professionals, as well such as community-based conservation, outreach, and adaptive management (Sabo et al. 2024; Moreto and Elligson 2025). Advanced insights about temporal patterns and trends in illegal trade functions are one such knowledge gap that, if filled, could provide valuable guidance for multiple conservation stakeholders. Granular temporal patterns and trends are also not widely published in the literature, based on our search. For conservation law enforcement authorities, such information could support their efforts to control crime via predictive policing interventions, informing optimal resource allocation along key points of trade routes, and directing targeted interventions at specific points in place and time. Conservation planners could use enhanced temporal insight for evaluating program impacts, designing enhanced monitoring, and adapting management strategies for protected areas. Corporate actors (e.g., shipping companies, commercial airlines) concerned about supply trade disruptions and sustainable logistics operations could leverage temporal insights for determining supply-chain vulnerabilities. For example, some business scholars have suggested that advanced temporal understanding could help answer economic questions about financial repercussions (or lack thereof) following the public disclosure of illicit supply chain activities (Hilend et al. 2023). There are also implications for general collaborative partnerships in conservation, resource sharing, stakeholder engagement, and technological innovation.

Theoretical framework: Crime scripting for conservation

Because international pangolin scale trade is against the rule of law, considering the criminogenic dimensions of the activity is reasonable in applied scientific research such as that described herein. A criminal event results from a series of decisions and actions; linked actions occur in sequence (Hübschle and Berg 2024). Some types of crimes are more

complex than others because they require different locations, longer perpetration periods, and/or multiple offenders, for example, in the case of organized crime (De Korte and Kleemans 2022). A crime script details, in order, all actions before, during, and after a crime event (De Korte and Kleemans 2022). The notion is based on the proof that sequential acts of crime have inherent causality and that the actions along the chain of events are contingent on the preceding stages (Skidmore 2021). Crime script analysis has been used to produce extremely detailed information about the various ways in which criminal activities are conducted, helping to unravel complexity, identify logistical bottlenecks, delineate conditions that precipitate the commission of crime, and determine opportunities for potential intervention or deterrent efforts (De Korte and Kleemans 2022).

Crime scripts have been produced for hundreds of crime types, including digital piracy, illegal waste dumping, child abuse, fire setting, kidnapping, credit card fraud, and burglary (Dehghanniri and Borrión 2021). Wildlife crime scripts are also now increasingly part of the extant literature (Moreto and Clarke 2013; Lavorgna 2014; Van Doormaal et al. 2018; Viollaz et al. 2018, 2021; Lemieux and Bruschi 2019; Riungu et al. 2025). Systematically detailing offender flexibility using crime scripting can provide novel insights for crime prevention in any context because scripts are learned by offenders, much like how actors learn and perform their roles in a play. Actors can improvise to ensure their success, which leads to innovation in how the offense is enacted (Hutchings and Holt 2015). This universality helps make crime scripting a popular and widely used method in criminology.

Crime scripts can vary in their level of detail (Dehghanniri and Borrión 2021). They are known to differ depending on the perspective that is taken; traditionally, crime scripts focus on the offender perspective (Snaphaan 2025). The most general type of crime script, the universal crime script, depicts a sequence of “scenes” representing the entire criminal process and identifies the key actors, actions, locations, and objects involved in a crime. Crime script analysis via a universal crime script provides a common standard for investigating crimes in a systematic fashion, enables temporal comparison across crime types, and provides a foundation that can be added to or elaborated on as new information becomes available about evolving offender behavior. One advantage of the method is that it makes it easier to recognize potential similarities in actions and requirements within scenes. Another is that formerly unknown or unseen information can be identified (De Korte and Kleemans 2022). When scripts identify specific barriers and routes to a specific goal, they can assist law enforcement authorities and their partners in

intervening along specific stages of the crime commission process to more effectively impede the flexibility of offenders (De Korte and Kleemans 2022). Situational crime prevention measures (i.e., strategies for preventing crime) can be implemented by diverse actors to increase the risk of apprehension, reduce rewards associated with crime, reduce provocations to engage in criminal behavior, remove excuses, and increase the effort needed to complete criminal behaviors (e.g., Gore et al. 2020; Kahler et al. 2021).

Crime scripts are often constructed from police investigations, case files (De Korte and Kleemans 2022), court cases, semi-structured or structured interviews (Skidmore 2021), electronic text from online forums (e.g., Hutchings and Holt 2015), participant observations (Lavorgna 2014; Lemieux and Bruschi 2019; Viollaz et al. 2021), and focus group discussion with technical experts (Moreto and Clarke 2013; Lavorgna 2014; Lemieux and Bruschi 2019; Skidmore 2021; Viollaz et al. 2021). Community-based samples appear to be a less commonly used form of data collection for crime scripts, based on our review of literature (but see King-Parker et al. 2024). Crime analysis (e.g., mapping) is only as good as the data. Crime geographers have noted it is naïve to think about police crime data—and data from other criminal justice agencies, or data derived from crime surveys—as producing uniquely accurate, unproblematic representations of the reality of crime (Hall and Yarwood 2026). Some have advocated for giving greater attention to knowledge and concerns of people from the Global South in particular, including efforts to draw upon Indigenous perspectives and empowering people from neglected social groups to contribute. In practice, this means empowering and listening to communities (Hall and Yarwood 2026). Given the extensive community-based nature of conservation (Berkes 2007; Kothari et al. 2013; Galvin et al. 2018) and this gap in the knowledge base for crime scripting, we merged approaches for the context of pangolin scale trade. This is not to say that we viewed communities as offenders or perpetrators of crime, but rather a knowledgably source of information about harm for advancing learning. Thus, we sought to create a crime script for pangolin scale trade based on community perspectives and provide a detailed and structured understanding of how the trade operates in practice according to participants. Our research is structured to give primary voice to local participants. We were interested in participants' perceptions about intervention points for scale trade disruption and prevention that could possibly be evaluated by experts or implementing partners for practicality, financial feasibility, and community interest. Our objectives were to (1) create a community-based universal crime script of the pangolin scale trade, (2) characterize the facilitating factors or enabling conditions

of the trade, and (3) identify a range of possible crime prevention measures linked to discrete crime script stages.

Study site

The Republic of Cameroon is a nation with diverse natural landscapes. Approximately half of its surface area of 47 550 000 hectares is covered by dense humid forests, with the other portion covered by savanna and steppe vegetation (FAO 2007). Most of the forests form part of the Congo Basin Forest, which is the second-largest area of dense tropical forest in the world, after the Amazon Basin (Central African Regional Programme for the Environment 2006). Cameroon shares a border with six nations and is home to approximately 9000 species of plants, 297 mammals, 849 birds, 373 amphibians and reptiles, and 451 species of fish, including many endemic and endangered species (Ministry of the Environment and Nature Protection 2005). Three of the four African pangolin species are found in Cameroon. The white-bellied pangolin (*Phataginus tricuspis*) and giant pangolin (*Smutsia gigantea*) are listed as Endangered on the Red List of Threatened Species, and black-bellied pangolin (*Phataginus tetradactyla*) is listed as Vulnerable. All three species are included in Appendix I of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). All are also totally protected by Cameroonian law, making it illegal to kill, capture, keep, or trade them. Today, pangolins in Cameroon are exploited for their meat and scales and are traded in local, regional, and global markets. Previous traceability research has shown that the forested areas of Cameroon's southern border region are important harvest areas for pangolin products traded illegally and internationally (Tinsman et al. 2023). The country continues to feature prominently at the top of global lists for illegal trade in pangolins and their parts. Approximately 13 000 kg of scales were seized out of the illicit trade in Cameroon between 2013 and 2023 (LAGA 2023).

MATERIALS AND METHODS

Participant recruitment

We selected 22 communities in seven localities in Cameroon's geographic south for this research based on their relative proximity to a protected area known to have pangolins present, accessibility and permission from local authorities, receptivity of community leaders, recommendations of local conservation practitioners with a history of working with local communities in the region, and scoping trip outcomes (Fig. 1). We recruited participants using inclusion criteria of being at least 18 years of age and self-confirmed lived experience in the community. We

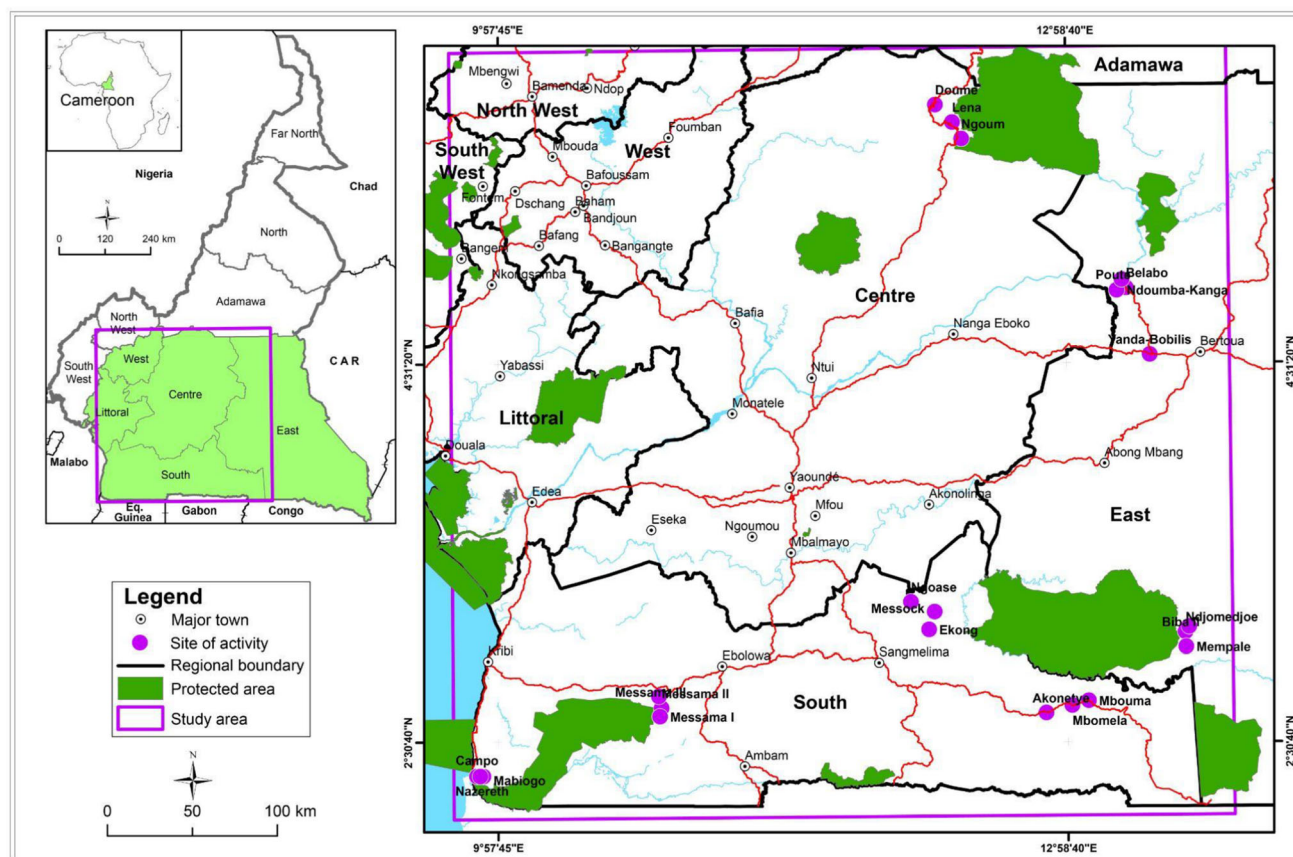


Fig. 1 Community-based crime scripting exercises were conducted in twenty-two communities throughout southern Cameroon July–December 2024

aimed to achieve gender parity and a target group size of ~ 20 people for each exercise. Participants also needed to be involved in an occupation with the potential to be associated with pangolin scale trade (e.g., farmer, hunter, trader). We relied on the community leader(s) or his/her representative, leaders of conservation organizations, and staff of the Cameroonian Ministry of Forestry and Wildlife (MINFOF) to help guide participants' selection under these criteria. The Subdivisional Officer facilitated access to communities, while chiefs facilitated access to individual respondents, which is the appropriate and expected sequence of permissions and approvals for work with communities in Cameroon. We conducted an advance in-person visit to the communities to confirm the activity, seek individual consent from respondents, and finalize logistics before commencing data collection. During this scoping trip, we affirmed that we were not approaching communities or participants as offenders or perpetrators of crime, but rather as unique sources of information about a topic of conservation concern: pangolin scale trade. All stages of participant recruitment occurred in French by native French speakers.

Data collection

We conducted participatory crime scripting exercises in French in July–August and November–December 2024. We generated crime scripts with participants from ~ 3 villages at a time, who we gathered in either the community hall or the community leader's residence. We reintroduced the exercise and obtained final informed consent from all participants and then proceeded to verbally pose questions to the group guided by the universal crime script stages (see Supplemental Information). We framed crime script questions according to principles of projective questioning; instead of asking participants directly how they individually felt or behaved, we asked them to project their answers onto their community map as an external object (e.g., Das 2018). We used projective questioning during all conversations about pangolin scale trade to help bypass social desirability bias via a third-person technique. This approach was intended to help participants feel safer in expressing opinions because they were technically describing someone else's behaviors and not their own. Projective questioning is useful for providing space for participants to explain their knowledge, in this case drivers

of pangolin scale trade, without admitting to the activity themselves. Projective questioning is known for producing ethically safe and rich data, which can provide more nuanced understanding than direct questioning (i.e., worded in first person) (Das 2018). The approach is relevant to the communities recruited to participate in this research. The field team encouraged verbal discussions among participants and asked probing or clarifying questions as appropriate but took care to not probe too much to avoid shifting from dialogue to interrogation. Over probing can push for levels of details that participants do not possess, and pressure participants to invent or guess at an answer rather than admit they don't know. Over probing can also create fatigue among participants, increase the length of activity time beyond what was planned and make the research team look unprepared or disrespectful, and make participants less likely to participate in future research. All team members (1 female, 2 males, all bilingual Cameroonians) recorded notes, but no names were associated with responses, nor was attribution of ideas assigned to an individual. After each exercise, team members shared written notes with the lead author for consolidation into a single electronic document for analysis (i.e., the dataset). This dataset was translated into English, back-translated into French, and reviewed by the field team before analysis in English.

Analysis

Qualitative data analysis of the dataset followed an emic-based universal crime scripting procedure using NVivo 15.1.1 (Lumivero 2025). We used an emic approach to help ensure the research captured authentic participant perspectives rather than forcing data into researcher-conceived frameworks in line with community-based conservation practices (e.g., Russell and Harshbarger 2003). Thus, inductive coding was used, and results are intentionally not over-generalized beyond the study context (Chapman and Kinloch 2011). Our case-oriented analysis also employed searches for disconfirming evidence to prevent premature closure and ensure diverse perspectives were included. This approach is common in qualitative research contexts and also justifiable in the context of under-researched topics (Galperin et al. 2022). NVivo software was used to facilitate data-driven coding, classification, and thematic organization of responses (Hutchings and Holt 2015). First, the lead author reviewed the entire dataset for temporal sequencing, organized and integrated data into the four universal crime script stages. Second, he coded the data according to the following themes: the driving forces behind pangolin scale trade, a “totally protected” species in Cameroon, and measures proposed by local stakeholders to reduce illegal trade in pangolin and their products. Subcodes were assigned for facilitating factors or

enabling conditions (e.g., easy access to pangolins, interpersonal communication, need for fast money) and for intervention measures (e.g., alternative means of income earning, reinforce checkpoints, sensitization and education) making sure all participant feedback was captured. We produced six codes representing the enabling conditions for trade in pangolin scales and four codes for possible crime prevention measures. Because the research design was community-based and qualitative, we intentionally worked to not impose researcher-centric terminology during analysis, make assumptions about causation or correlation between concepts discussed by participants, or extrapolate comments beyond the scope of community scale. In some instances, results are unable to be elaborated on because participants did not elaborate, and the team did not probe. All data collection methods were reviewed and approved by the Florida International University Institutional Review Board (IRB #23-0500) (in English) and the research authorized by the Cameroonian Ministry of Scientific Research and Innovation (in French).

RESULTS

We held seven participatory crime scripting exercises involving 22 communities and 152 participants, with 57 female and 95 male respondents (Table 1). We first created a community-based universal crime script of pangolin scale trade in Cameroon to achieve our first objective. Following input from participants, we described the four stages for “successful” crime, in this case, trade in pangolin scales: preparation, pre-activity, activity, and post-activity (Table 2, Description of Stages).

Enabling conditions for trade in pangolin scales

Participants identified six enabling conditions across all stages of the pangolin scale trade process (Table 2, Enabling Conditions), which we used to satisfy our second objective and discuss below. During focus group discussions, participants identified and defined different stakeholder groups which transcended stages (Table 3).

Easy access to pangolins and their scales

Participants repeatedly indicated that for pangolin scales to be obtained and traded, the animals first had to be captured and killed. This geographical enabling condition was relevant to the preparation stage. Cameroon's three species of pangolins are generally forest dwellers, and when people live adjacent to forested areas (e.g., protected areas, community forests, logging concessions), the perceived access to pangolins was relatively easy, even to the point that

Table 1 Community-based crime scripting activities about pangolin scale trade were conducted in multiple locations throughout Cameroon July–December 2024. At each location, people from multiple nearby communities were invited to participate

Crime scripting activity location (<i>n</i> = 7)	Participating communities (<i>n</i> = 22)	Number of participants (<i>n</i> = 152, 57 female, 95 male)
Bélabo	Bélabo, Ndoumbe-Kanga, Poute, Yanda-Bobilis	20 (10/10)
Ndjomedjoe (Djomédjo)	Biba II, Ndjomedjoe, Mempale	24 (11/13)
Campo	Campo, Mabiogo, Nazareth	20 (9/11)
Ekong	Ekong, Messock, Ngoasé	17 (2/15)
Mbouma	Akonétyé Mbomela, Mbouma	23 (11/12)
Doumé	Doumé, Léna, Ngoum	23 (7/16)
Messama II	Messama I, II, III	25 (7/18)

participants noted pangolins cross roads, feed in plantations, and traverse villages regularly. According to our study participants, capturing and killing pangolins does not require extensive skill or specialized supplies. Removing scales is possible with readily available household materials, most commonly, boiling water. Some participants perceived pangolin encounters were decreasing over time because populations have decreased in size and habitats have fragmented. One participant noted, “Pangolins have significantly reduced; they used to come close to the house, and some decades back, I used to pick pangolins on the road, about four per day, but today only hunters find them in the forest” (Crime scripting exercise #7).

Interpersonal communication

Interpersonal communication was mentioned as key for enhancing coordination among offenders and supporting evasion for pangolin scale trade. The enabling condition was particularly important for the pre-activity stage. Participants identified two main forms of interpersonal communication: a) cell phones in locations with cellular signals and b) word of mouth when cellular service was unavailable. Both forms of communication were identified as foundational to the organization of what participants called dealers and intermediaries (Table 4). In some cases, dealers operated independently, purchasing scales on their own and later selling them to dealers in urban centers. Some participants stated that interpersonal communication enabled any actor to easily and quickly change routes to avoid being caught and still allow the trade to flourish. One participant stated, “the itinerary depends on the buyer and also they usually call to find out if there is an obstacle, and they change their itinerary” (Crime scripting exercise #3). Cell phones were identified as being essential for enhanced evasion coordination. Participants also shared that without communication via cellphone, pangolin scale trade would not thrive as it currently does because offenders would unknowingly use roads where law enforcement authorities were present.

Corrupt authorities and officials

Participants reported multiple ways authorities (e.g., agencies) and officials (i.e., individuals) exploited their power within the pangolin scale trade for personal gain, particularly during times when authorities interacted with dealers. Corruption was an important enabling condition for the preparation and post-activity stages. Participants shared hunters exchanged pangolin meat (or other wild meat) for guns and ammunition in a *quid pro quo*. They equally reported buyers exchanged direct cash bribes (~ 15 000 XAF or \$30USD) with law enforcement officials in exchange for safe passage along trade routes. According to participants, bribe pricing varied depending on the officials’ mood and the pangolin species involved. Further, dealers used cash bribes with road crews working to maintain roads. Bribes were exchanged for up-to-date information about the location of impromptu law enforcement checkpoints. One participant noted that “generally, they know if there is control on the roads and so they change their itinerary” (Crime scripting exercise #1). Participants explained that sometimes, bribes were not exchanged at the time of trade; but rather personal or professional relationships between law enforcement authorities, dealers, and road crews were exploited to exchange information for safe passage in return for a reciprocal favor later. Importantly, participants noted that not all officials and authorities engaged in corrupt behavior. They observed that some officials regularly carried out their duties with integrity. Participants opined that if the example of honest officials was followed by others, illicit pangolin scale trade would decline significantly.

Local dialect and French language capacity

Local dialects (e.g., Bati, Bulu, Ewondo, Fang, Koonzime) and French language were identified by participants as enabling conditions for pangolin scale trade, as both are understood by community members involved in the trade,

Table 2 Four stages of a community-based universal crime script of successful pangolin scale trade in Cameroon.

Universal crime script stage	Description of stage	Observations about enabling conditions
Preparation	• <i>Money</i> for the activity, pangolin scale trade, sought through diverse means • Preexisting <i>relationships</i> between buyers, sellers, and professional hunters are activated, and new ones are created which determines where they go to get scales • <i>Communications</i> via phone calls, SMS, and word of mouth in places with limited or no phone network • <i>Actors</i> (e.g., dealers, intermediaries, buyers) meet up in hotel lobbies to discuss procedures, especially in cities like Bertoua, Douala, Ebolowa, Kribi, and Yaoundé. Intermediaries and buyers can recruit hunters in local areas • Hunting <i>equipment</i> is given to hunters (e.g., cables, guns, cutlasses) and packaging material to transport scales (e.g., bags) are purchased in larger cities like Bertoua, Douala, Ebolowa, Kribi, Yaoundé. Obfuscation products (e.g., bush mangoes, peppers, cocoa, corn flour, fish) purchased in satellite towns	• <i>Language</i>: local dialect(s), French and Pidgin English are used for communication • <i>Geography</i>: dealers of scales hail from Bafoussam, Douala, Kribi, and Yaoundé • <i>Geography</i>: intermediaries in the scale trade hail from neighboring satellite towns and sometimes are residents
Pre-activity	• An intermediary from satellite town, or indigene, known to local residents is <i>recruited</i> to move materials from dealers to hunters • Advance <i>payment</i> for scales to be collected in a later date • Hunter <i>organizes</i> materials for activity, individually or with partners, depending on the size of the demand • Professional hunters (i.e., those considered in the area as having hunting as their only livelihood activity) <i>enter</i> the forest for hunting pangolins, both within and outside protected areas • Information on the nature of the road like presence of law enforcement or not, is <i>collected</i>	• <i>Communication</i>: in villages without a phone network, discussion is usually mouth-to-ear, and phone calls and SMS are used in other cases
Activity	• Pangolins are <i>captured</i> by hunters, most typically with snares though also guns, sticks, cutlasses, dogs and bare hands are also employed depending on opportunity and terrain. Occasionally, non-hunters capture pangolins when they encounter them on the road or within village compounds • Pangolins are <i>killed</i> and immersed in boiling water for 3–5 min, with no special need for securing new pots and fuel. Pangolins are removed from water, scales scraped off using knives or sticks, and then arranged on mats or sawn bags to dry in the sun (usually far from the public) • Dried scales (at times from many animals) are <i>stored</i> in bags, within a house or other private area, such as in the forest • Dealers <i>visit</i> multiple villages by car and motorcycles, and collect scales (from those who had received advance payment) or request scales to buy • While the scales are generally <i>bought</i> from hunters, instances exist where individuals in the village buy and stock scales to sell eventually • The species of pangolin and the size of scales determine the <i>price</i> per kilogram, with measurement done with the use of hand-held scales brought by buyers or bags generally known as “<i>sacs a moto</i>” • Scales can be <i>sold</i> everywhere (depending on the arrangement) • Cash <i>payments</i> are made exclusively in local currency (XAF), since both parties want to avoid any evidence if payment is done through online mobile transfers • Sellers generally <i>sell</i> scales to buyers they known through relationships established earlier in the preparation stage	• <i>Rapid response</i>: Scales are sold by sellers to buyers very fast (a matter of hours when the buyer shows up), meaning that law enforcement officers must be alert and proactive if interception is the goal • <i>Social network</i>: pangolin scale sellers want to know their buyers because they fear being tricked or arrested similar to what happens with cannabis trade

Table 2 continued

Universal crime script stage	Description of stage	Observations about enabling conditions
Post-activity	- Quantities of scales are <i>transported</i> away from seller locations (villages where scales are collected) using a variety of transportation methods, depending on village accessibility (e.g., bikes, bicycles, boats, canoes, cars, trains) - Dealers use roads to <i>transport</i> scales, and those with less control are preferred - Dealers prefer to <i>use</i> roads where/when their enforcement officers, friends, or relatives are on duty - Dealers will <i>move</i> on foot if needed to avoid controls and/or alter their routes if they receive information about an unexpected check on the intended route - Scales are <i>concealed</i> (either directly from where they are bought or at the assemblage point and change of hands) during transportation by being comingled with other non-durable goods (e.g., cocoa, corn flour, bush mangoes, peppers, fish, charcoal)	<i>Countermeasures</i>: Buyers employ a range of different concealment methods to hide scales and other wildlife products during transport <i>Controls</i>: Road conditions (practicability and presence of law enforcement on the routes) significantly impact the collection routes and itineraries of buyers out of the forested regions <i>Sanctions</i>: Principal dealers are Cameroonians, Chinese, and Nigerians

Table 3 Communities participating in crime scripting exercises proposed a range of measures to help reduce trade in pangolin scales, which we list alphabetically. Each measure linked to different types of situational crime prevention strategies

Measure proposed by participants	Description of the measure	Situational crime prevention strategy type
Alternative sources of income	Provide alternative livelihood options and sources of income to Indigenous People and Local Communities to help reduce dependence on forest resources and illegal wildlife trade	Reduce rewards
Education	Increase awareness about conservation within communities and especially in schools	Remove excuses
Employment opportunities	Support sustained local employment for all age people to help reduce economic reliance on wildlife exploitation	Increase effort Reduce rewards
Fight against corrupt officials	Reducing corruption among enforcement and administrative officials across supply chain to reduce benefits from rule breaking	Increase risk Remove excuses Reduce rewards
Punishments	Apply stricter penalties to offenders involved in illegal wildlife trade, increase severity and consistency of punishment for rule breaking	Increase risk
Reinforce checkpoints	Strengthen checkpoints along roads and other supply chain nodes and paths to improve detection and complicate rule breaking	Increase effort Increase risk
Sensitization	Conduct awareness building campaigns about conservation laws and punishments related to wildlife crime	Remove excuses

rendering interpersonal communication easy regardless of the medium (e.g., cellphone, word of mouth). Local dialects were key, even though other major languages like Arabic and English are spoken in the region. Linguistic familiarity fosters trust between actors, which participants shared is used to evade detection by authorities and ensured discretion across all stages of the trade. Participants indicated “the principal language of communication was the French language and the local dialect” (Crime scripting exercise #4). Sometimes, buyers from Douala, Yaoundé, Kribi, Bafoussam, or even Nigeria use the local dialect to request “Bibas Bi Okekeh” (i.e., local name for pangolin scales in one community).

Trust in local community members

Participants described familiarity and trust among community members and traders as essential for facilitating the pangolin scale trade, particularly during the post-activity stage. They explained that transactions typically occurred only between people who know one another personally. One participant noted that “the sale of scales can be compared to that of drugs (for example, cannabis), and so we only sell to those we know” (Crime scripting exercise #1). The fear of being exposed and then arrested by law enforcement officials was cited as the reason. Participants

Table 4 Communities participating in crime scripting exercises proposed a range of measures to help reduce trade in pangolin scales. Each measure can be linked to a different type of situational crime prevention strategy

Measure proposed by participants	Description of the measure	Communities proposing the measure (<i>n</i>)	Communities proposing the measure (%)	Situational crime prevention strategy type
Alternative sources of income	Provide alternative livelihood options and sources of income to Indigenous People and Local Communities to help reduce dependence on forest resources and illegal wildlife trade	5	29	Reduce rewards
Sensitization	Conduct awareness building campaigns about conservation laws and punishments related to wildlife crime	4	23	Remove excuses
Education	Increase awareness about conservation within communities and especially in schools	2	12	Remove excuses
Employment opportunities	Support sustained local employment for all age people to help reduce economic reliance on wildlife exploitation	2	12	Increase effort Reduce rewards
Reinforce checkpoints	Strengthen checkpoints along roads and other supply chain nodes and paths to improve detection and complicate rule breaking	2	12	Increase effort Increase risk
Fight against corrupt officials	Reduce corruption among enforcement and administrative officials across supply chain to reduce benefits from rule breaking	1	6	Increase risk Remove excuses Reduce rewards
Punishments	Apply stricter penalties to offenders involved in illegal wildlife trade, increase severity and consistency of punishment for rule breaking	1	6	Increase risk

reported that sellers rarely transported scales directly to markets but instead waited in their villages for buyers to come to them.

Need for (fast) money

Participants frequently linked engagement in pangolin scale trade with financial need. They explained that limited employment opportunities, particularly for young people, restricted subsistence farming and harvest of non-timber forest products to being the main livelihood options. Participants indicated that fast turnover rates of pangolin scales for cash incentivized engagement in the trade despite risk of arrest, imprisonment, or fines. They noted that pangolin hunting was not historically a means of income generation. One participant explained, “originally, pangolin hunting was only for meat consumption, and scales were thrown away, but later, we had this additional gain of selling scales” (Crime scripting exercise #7). Participants from crime scripting exercise #7 reported the shift occurred in 2013–2014, noting that increased demand from scale buyers led to more targeted hunting by local people; until such time, locals viewed their subsistence hunting as being sustainable. Another participant said, “when I receive a request for 5000 XAF worth of scales, I make every effort to fulfil the order” (Crime scripting exercise #4). Reported

scale prices ranged from 45 000 to 60 000 XAF per kilogram, reaching up to 100 000 XAF for all the scales from a giant pangolin. Participants noted buyers often paid in advance and later returned to collect scales.

Perceptions of crime prevention measures

For our third objective, we identified patterns in participant feedback about interventions, or crime prevention measures, and linked them to specific stages where they could be implemented based on participant perceptions. Interventions were not exclusively assigned to a single stage because participants did not explicitly state to do so. In the end, participants relayed certain interventions would be more obvious to implement to achieve situational crime prevention such as increasing effort, increasing risk, and reducing excuses and rewards (Table 4). Participants proposed measures during crime scripting exercises. They mentioned a range of measures including alternative sources of income, sensitization on punitive actions in local dialects, education about conservation, employment opportunities, checkpoint reinforcements, combating corruption, and imposing severe penalties. These measures were based on their lived experience and expertise; results do not include researcher-imposed considerations of measures so as not to dilute the voices of participants.

Reduce rewards through alternative income-earning and employment opportunities

Participants noted that increased access to alternative income-generating activities would reduce reliance on forest resources, including pangolins. One participant explained, “alternative activities will occupy us and so we will no longer go to hunt pangolins” (Crime scripting exercise #4). With alternative forms of employment, hunting pangolins and trading their scales would not be needed for income generation. Suggested alternatives included fish and snail farming, livestock and poultry rearing, and sustainable harvesting of non-timber forest products. Participants considered these options for both income sources and employment opportunities that could divert community members, especially youths, from engaging in illegal trade. Some participants noted a plow-back effect, where employed youths could financially support relatives and reduce household dependence on wildlife resources.

Remove excuses through sensitization and education

Participants emphasized a need for implementing more generalized sensitization about punitive actions in villages and strengthening environmental education. These measures were presented as key for removing excuses associated with pangolin scale trade. Participants acknowledged the sensitivity of scale trade, and many people in their communities already had awareness of the legal restrictions on trading protected species such as pangolins (classified as “class A” and fully protected in Cameroon). Still, participants stressed a need for intensifying awareness-building campaigns highlighting the ecological and social importance of pangolins within their communities. According to one participant, “it is not enough to plant signposts and assume that the conservation will work. Conservation must be taken to the communities through regular sensitization” (Crime scripting exercise #5). Another participant said, “Conservation should come to the villages and not through workshops in offices in town” (Crime scripting exercise #2). Participants expressed clear theory of change-based logic where consistent exposure to pro conservation messages, information about the consequences of destructive behaviors, and awareness of the legal penalties for violations would encourage community members to internalize these messages, be more likely to reconsider their actions, and ultimately collaborate for conservation. One participant emphasized, “sensitization in the media about people arrested for trafficking elephant tusks has helped in reducing this trade and other wildlife species too, with pangolin scales inclusive in our locality” (Crime scripting exercise #7).

Increase effort and risk through reinforced checkpoints

Many participants recommended increasing both the number and effectiveness of checkpoints, emphasizing that to them, effectiveness meant ensuring law enforcement authorities performed their duties diligently. They indicated that authorities often fail to enforce the laws consistently and thus illegal trade continues. Participants shared that reinforced checkpoints would increase the effort to trade scales and increase the chances of getting caught. This measure was particularly relevant for post-activity stages of the crime commission process. Participants opined more effective checkpoints would make it harder for scale buyers to use bribes. They suggested that diversifying the presence of law enforcement authorities (e.g., to include forest guards, police, gendarmes, and customs officers, not just one of them) and regularly changing team composition to avoid familiarity between authorities and offenders at checkpoints could further strengthen efforts to prevent illegal trade. They shared that the cost of bribing multiple different law enforcement authorities would be prohibitive and mutual oversight among these enforcement officials would foster accountability. One participant concluded “if transporting scales is made complex to buyers, then the activity will be challenging to continue” (Crime scripting exercise #2).

Increase risk, remove excuses, and reduce rewards via attention to corruption and severity of punishment

Participants emphasized reducing the trade in pangolin scales and other wildlife species depended largely on addressing corruption and enforcing stricter punishments. They stressed law enforcement officials involved in corruption should face harsher penalties. They believed if law enforcement officials denied bribes and/or received severe punishment (as stated by the law), dealers in pangolin scales would be discouraged from engaging in the activity, particularly during the post-activity stage. Beyond law enforcement authorities, corruption within the judiciary system could also be addressed, as judges and magistrates often undermine the work of law enforcement officials by releasing offenders, many of whom have allegedly bribed them or have personal ties to those involved in the illegal wildlife trade. A community member succinctly summarized this sentiment in a few words and referring to law enforcement officials: “defaulters should be punished” (Crime scripting exercise #2).

DISCUSSION

Pangolin conservation continues to be hampered by over-exploitation, even as the range of international and local

interventions to reduce and prevent harms associated with the pangolin scale trade expands. Some interventions focus on improved governance and strengthened legislative protections, awareness raising among key actor groups, or intensified monitoring of ship and airplane cargo and baggage (e.g., Xi et al. 2025). Others focus on local communities, including engagement through alternative livelihood programs, education campaigns, and anti-poaching patrols (Emogor et al. 2025). Tools such as forensic analysis and machine learning models can be leveraged to help inform or evaluate such interventions (e.g., Moorat et al. 2020; Xi et al. 2025). Ideally, all interventions are implemented based on empirical evidence and on-the-ground insights about trade characteristics, particularly those that separate trade in pangolin meat from scales (Xi et al. 2025) and a specific time or stage in the crime commission process. This research helps advance the evidence base about pangolin conservation, and crimes that affect the environment, by leveraging community-based insights to inform a crime script analysis of pangolin scale trade and identify patterns in perceptions of measures to reduce harms associated with the trade. Below, we discuss noteworthy findings from this research relative to the extant literature; we discuss both methodological and conservation implications. Although our discussion is focused on pangolin scales and Cameroon, we engage with the illegal wildlife trade (IWT), geography of crime, and community-based conservation literatures to help broaden implications without overgeneralizing results.

Methodological implications

The first noteworthy finding from this research is methodological. Even though crime is known to be experienced locally, community-based samples remain uncommonly used in data collection for crime scripts. Because of this, and also because pangolin conservation has so many linkages with communities (e.g., Khatiwada et al. 2020), we sought to explore if using universal crime scripting informed by diverse local community members could enhance the knowledge base about the sequence of pangolin scale trade. We successfully focused our crime scripting exercises on community members who could be both impacted by and impact the pangolin scale trade, approaching participants as informants and not offenders. Community perspectives on crime affirmed the truism that crime is distributed unevenly across space and distribution is not random; using a community-level scale of analysis for our crime script helped reflect that reality. Future research could help further elucidate whether this methodological approach is useful in communities across the 38 pangolin range States.

Our community-based approach created a universal crime script with four stages. We found the four temporally

discrete stages of the crime process were easily informed by participants' perceptions, lived experience, and expertise of local community members. We know the structural aspects of the crime commission process can differ from, for example, those of licit supply chains, which organize their structure according to the market characteristics of source, transit, and destination geographies (e.g., Magliocca et al. 2021; Gore et al. 2023; Keskin et al. 2023). We also know crime is highly spatial in nature; understanding the relationship between crime, people, and place, as well as how crime and policing perpetuate social and spatial inequalities in conservation, are important questions for science and conservation practice. Our crime script advances knowledge by offering a temporal architecture for the pangolin scale trade in Cameroon. This structural information could help inform future research on evaluation of changes over time in *modus operandi*, offender learning, and interventions. The crime script also offers insights from the community-level, one of the most important scales of analysis for conservation science writ large.

A final methodological contribution of this research relates to the ability to map participant perceptions about measures to reduce harms associated with pangolin scale trade onto different crime script stages. Conservationists already know IWT interventions can be targeted on different places along the supply chain (e.g., Gore et al. 2021a, b). Our methods enabled capturing ground-level insight about where in the process interventions could be implemented according to participants' perceptions. This insight may have been missed if expert-only crime scripting processes were used, with implications for conservation interventions. One meta-analysis on the impact of local cultural context on efficacy of conservation interventions verified this point, concluding that interventions engaging the local context were most likely to succeed (Waylen et al. 2010). Cooney et al. (2017) further emphasized the importance of local context, stating that alternative livelihood programs around the world are most successful when they increase the benefits from wildlife conservation using, for example, payments for ecosystem services or securing jobs in nature-based tourism, where available. This research affirmed engaging communities in a crime scripting process is methodologically possible; engagement alone may contribute benefits by shifting communities from passive to active voices in reducing harms from the pangolin scale trade. Future research could explore and prove this idea.

Practical implications

A second noteworthy point of this research relates to the practical aspects of crime scripting and subsequent linking of measures to help reduce harms with specific stages of

the crime commission process. For example, study participants noted the preparation stage, which in this research involved recruiting collaborators and acquiring tools or knowledge, could be addressed via increased awareness raising. This links to what is already known about community-engagement-based interventions that raise awareness to reduce recruitment or provide alternative livelihoods, ultimately preventing the crime from commencing (Gore et al. 2016). We know raising awareness for prevention may be achieved via cultural and ethnolinguistic approaches. In our study, participants emphasized the importance of local dialects being used for effective communication on trade and broadening the geographic reach of communities engaged, specifically people from communities near protected areas or forests where pangolins live. In Cameroon, there are many ethnic groups known to live in and around pangolin habitat. Around the Mbam et Djerem National Park alone, for example, people identify as being members of ethnic groups that are often broadly grouped ethnolinguistically into Bantoid and Bantu, Atlantic, Adamawi-Ubangi, and Afro-Asiatic (Mouafo et al. 2021). Raising awareness about pangolin scale trade in local languages and using culturally reflexive and traditional knowledge-based terminology is very possible using established and robust conservation social science methods (e.g., Mouafo et al. 2021). In general, using local languages is essential for reducing disinformation or misinformation about conservation rules; language barriers reduce understanding and trust. This measure portends success for crime prevention, based on the literature, but it is not widely deployed in Cameroon compared to non-local languages. Local language is just one manifestation of culture, along with taboos, traditions, and codes of conduct; place-based dialogics can be intensive in conservation practice but are overwhelmingly associated with more positive outcomes (Sowards et al. 2017). In general conservation practice, and for pangolins in Cameroon specifically, understanding traditional use by local people may help prevent crime simply through awareness raising; ethnolinguistic research in southern Cameroon has found evidence of local use of pangolins for meat, but few respondents reported use of pangolin scales. If implemented using best practices, including codesign methods, awareness raising efforts that build local people's willingness to prevent crime could generate positive conservation impacts (e.g., Kahler et al. 2023).

According to participants, the pre-activity stage of illegal pangolin scale trade involved securing materials and equipment and moving toward the to-be-traded scales is well-suited for interventions that include checkpoints, border controls that increase inspections, or risk-based screenings. Other studies have suggested that IPLCs may be uniquely capable of serving as informal checkpoint

guardians and handlers capable of managing potential offenders through reporting suspicious activity to authorities or engaging in conversations to support compliance (Rizzolo et al. 2021; Viollaz et al. 2022; Kahler et al. 2023). We know guardianship (i.e., people whose presence or proximity discourages a crime from taking place; they must be capable and often their mere presence is sufficient) has been repeatedly identified as a key disruptive mechanism in IWT, and IPLCs may be available and willing to serve as local or informal guardians, particularly during the early stages of the crime commission process (Kahler et al. 2021). *Who* assumes responsibility for guardianship may be less important than *what* the guardians do when they are guarding (Costa et al. 2023; Kahler et al. 2023); thus, there may be under-tapped opportunities to engage religious authorities, village elders, athletes, or other noteworthy people who are trusted and networked. Future research could further explore pre-activity stage interventions engaging IPLCs.

The activity stage is well suited for interventions involving community-informant networks that enable timely alerts from local actors serving as guardians (Kahler et al. 2023). In our study, participants noted not only how rapidly this stage commences but also how social networks are integral for supporting rapid behavior. According to participants, road maintenance crews could be integral to interventions at this stage's success because they are part of the network; hyper-targeted outreach and education for heavy machinery operators, mechanics, traffic controllers, and scheduling supervisors to report crimes in timely fashion could be included given their centrality in the social network. Roads and rivers are well-known enablers of conservation crime in general, including in other parts of Africa (e.g., Merem et al. 2018; Hariohay et al. 2019).

The post-activity stage involved the movement of scales toward final consumers. In our study, participants reported diverse countermeasures were integral for stopping success at this stage because pangolin scale buyers employ a range of different concealment methods to hide scales during transport. We question if durable traceability sensors could be integral for this stage of the crime commission process. Although study participants did not elaborate on this intervention, this stage could be well-suited for forensic tracking that uses DNA to trace source and supply chains (Kumar et al. 2014) or consumer demand reduction via social marketing (Greenfield and Verissimo 2019).

Participants in our crime scripting activities shared insights relevant to multiple crime script stages. Criminologists have long known that crime prevention can be challenging to implement in communities (Bennett and Lavrakas 1989). Social cohesion has been identified as a critical factor in contexts where crime prevention efforts

fail in communities; lower levels of social cohesion result in less cooperative relationships with authorities such as police. In instances of low social cohesion, community participation in crime prevention is not always associated with reductions in crime rates or crime-associated harms (Bennett and Lavrakas 1989). Our study participants discussed the idea of social cohesion without the use of academic jargon; they identified the pre-activity and activity stages as the strongest points of social cohesion during the crime commission process. We know social cohesion can be reinforced through trusted institutions like traditional councils, churches and schools, as well as through benefit-sharing mechanisms and traditional dispute resolution processes (Redpath et al. 2013). Practitioners could consider social cohesion during implementation of interventions, particularly those focused on pre-activity and activity stages of the scale trade process. Future research could help elaborate on characteristics, dynamics, and drivers of social cohesion in the region and elsewhere, but in general, participants noted its existence.

Although in practice many interventions in Cameroon have focused on the later stages of the crime commission process (e.g., seizures of large shipments), focusing interventions on both early and late stages of the crime commission process could be impactful for conservation. The preparation stage is uniquely important for conservation crime prevention; many ideas proposed by participants were temporally focused on these early stages (e.g., alternative livelihoods, sensitization, education) and were very well justified within the local context. The post-activity stage was deemed uniquely important for successful completion of the crime commission process by participants, which echoes the literature (e.g., Petrossian and Pezzella 2018) in that it is the stage where profits are realized, where high-value actors become involved, and where evidence crucial for securing convictions is typically documented. During this stage, multiple criminal behaviors may be stacked by co-offenders. Some criminologists note crime scripts can be interrelated vertically and horizontally (Snaphaan 2025); our research overwhelmingly focused on the horizontal track, but our results signal one way that pangolin scale trade crime scripts can be vertically integrated. Our study participants noted stacking at this stage, when they gave examples of offenders using diverse concealment methods, such as in shipments of cocoa, fish, mangos, and clothes, among others. Concealing pangolin scales with licit products is common (Sampson and Appaiah-Opoku 2024) and may involve additional offenses, such as fraud, money laundering, forgery, or collusion. Participants mentioned motorcycles being used to transport scales along paths around roads with checkpoints, signaling violations of the law, such as evasion, obstruction of justice, or failure to comply. Participants mentioned

transporting scales during periods when friends or relatives were working, indicating corruption, collusion, or dereliction of duty. According to participants, criminal behaviors were not stacked during all stages. For example, during the preparation and pre-activity stages, many of the key behaviors are not criminal per se (e.g., meetings held in urban hotel lobbies, information about road conditions collected).

None of our participants mentioned the national “Green Line,” a natural resource-focused “tip line” that anyone can call to report environmentally related harms like wildlife poaching or corruption. Tips are directed to Cameroon’s Ministry of Forestry and Fauna (MINFOF). It is possible that the Green Line has not been extensively socialized with participants in our study area, or there are other reasons underlying the apparent lack of awareness or mentioning of the tool during data collection. Green (2016) noted the efficacy of anti-poaching or corruption hotlines in the United States depended heavily on a caller’s knowledge about wildlife laws. Sjöstedt et al. (2021) reported that in South Africa and Mozambique, survey participants were afraid of authorities and therefore less willing to report.

Our community-based universal crime script expands the suite of case studies focused on wildlife crime-related topics, to include pangolins in Cameroon, with prior work focused on species ranging from European eels (Pons-Hernandez and Petrossian 2025), ivory trafficking in East Africa (Riungu et al. 2025), to spiny-tailed lizards (Gondhali et al. 2024), live corals trade in Indonesia and Fiji, (Sosnowski et al. 2020), leopards in western Zambia (Whittington-Jones et al. 2020), general bushmeat (Hill 2020), redwood burl in the USA (Pires et al. 2020), and totoaba in Mexico (Earth League International 2024). Like these studies, our study participants acknowledged the role of corruption as an exogenous factor operating across multiple stages of the crime commission process, and the existing knowledge base notes that lawbreaking can be permissive (Pons-Hernandez and Petrossian 2025). Also, like other crime script studies, our results can inform multimodal datasets and innovative techniques, including network analysis, natural language processing, or audio-mining (Snaphaan 2025). Even when caught during the activity phase, wildlife crime offenders are rarely sanctioned, especially if they are corrupt law enforcement officials, and illegal products may be given as gifts to authorities to evade sanctions during the post-activity phase. Our participants identified a range of related interventions to address corruption, including reinforcing checkpoints and imposing more severe punishment on guilty corruption offenders. Participants also identified a range of enabling conditions for illegal trade in scales, but did not assign them to stages of the crime commission process. Future research could help elucidate these

relationships; it could also explore disrupted trade events, or “unsuccessful” crime events.

CONCLUSION

The value added by our community-based crime script for illegal pangolin scale trade is that real-world observations from IPLCs have been made and this can help verify other sources of data (e.g., remote sensing, secondary data) (Huntington 2000) or be combined in multimodal datasets (Snaphaan 2025). Communities helped reveal how the scale trade process operates differently across settings, as well as contributed unrecorded knowledge, thereby making scientific insights more culturally accurate. Although this research focused on pangolin scale trade, methods may be replicable for other illegal wildlife trade contexts (e.g., jaguars in Amazonia, succulents in South Africa, sea cucumbers in Mexico). How to operationalize community-based insights derived from a crime script is beyond the scope of this methodology. However, the methodology does produce insights that can serve as a foundation for conservation experts to consider translation of results to policy implications or programmatic practice. Instead, results from our community-based universal crime scripts may help inform pangolin-specific crime prevention by identifying where, when, and how interventions can be most effective by pinpointing specific opportunities for disruption, clarifying roles and responsibilities for inter-agency efforts across jurisdictions impacted by illegal trade, and distinguishing routine from other events. Conservation practitioners collaborating with local communities can consider how methods and results can best be adapted to other conservation contexts.

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Data availability Anonymous focus group discussion notes which provided the foundation for the crime script are available by request to the corresponding author.

Declarations

Conflict of interest None.

Ethical approval In Cameroon, research permits were obtained from the Ministry of Scientific Research and Innovation (permit #000121/MINRESI/B00/C00/C10/C13). The data collection methods were reviewed and approved by the Florida International University Institutional Review Board (IRB #23-0500). Before each data collection session, the participants were informed about the objectives of the project and all participants gave free, prior, and informed consent.

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