Pangolin seizures in Nepal indicate priority areas for conservation interventions

Tulshi Laxmi Suwal, Sabita Gurung and Kurtis Jai-Chyi Pei

Abstract Two species of pangolins occur in Nepal: the Chinese pangolin *Manis pentadactyla* and the Indian pangolin *Manis crassicaudata*. They are categorized as Critically Endangered and Endangered, respectively, on the IUCN Red List, and are protected under the National Parks and Wildlife Conservation Act 1973 in Nepal. Although both this national law and CITES prohibit pangolin hunting and trade, such trade still occurs. To better understand the patterns of pangolin hunting and trade in Nepal, we analysed data on pangolin seizures gathered from official records, grey literature and verified public media reports dating from 1 January 2010 to 31 December 2020. A total of 122 pangolin seizures were reported in 27 districts, mostly in the central mid-hills. Seizure cases included 23 live pangolins, 18 whole-body skins with scales and 1,046.7 kg of scales. We estimate a minimum of 1,500 individuals were hunted locally over the 11-year study period. Analysis of the trade network identified the capital city, Kathmandu, as the main pangolin trade hub, with scales being the most commonly seized item. The illegal trade occurred mostly in two regions: central and eastern Nepal, and areas bordering China. The pangolins were hunted mainly from core habitats within rural areas, then transported to the city for trade. These data support the future development of effective law enforcement and policy interventions for this region, to stop the illegal pangolin trade. Greater understanding of the patterns of the local pangolin trade and the identification of hotspot areas and peak hunting seasons will allow us to prioritize areas for future conservation interventions.

Keywords Illegal wildlife trade, Kathmandu, *Manis crassicaudata*, *Manis pentadactyla*, Nepal, pangolins, seizures

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Introduction

Wildlife trade involves the collection of live specimens or body parts of wild animals and their transport and distribution locally, nationally and internationally (Paudel et al., 2020a,b). This trade is a major cause of the rapid decline of many wild species (McMurray, 2009), threatening global conservation efforts (Kumar et al., 2020). The illegal wildlife trade is of particular significance in Nepal, a region known as a transit hub for illegal wildlife products such as rhinoceros *Rhinoceros unicornis* horns, tiger *Panthera tigris* and leopard *Panthera pardus* pelts, red panda *Ailurus fulgens* skins and the scales of pangolins of various species (Shrestha-Acharya & Heinen, 2009; PHG, 2017). Although Nepal has been a signatory of CITES since 1975, this trade has increased over time. Nepal has seen increased demand for wildlife products, supported by border connectivity to neighbouring countries that drive this demand (Awale, 2019), resulting in an increasingly organized and sophisticated transport network.

The hunting and trade of pangolins have occurred since the 19th century, with no controls or monitoring in Nepal (Shakya et al., 2000). Asian pangolins are hunted intensively in parts of their range (CITES, 1999) for their skins, scales and meat. Although open markets selling items such as coats made from leopard, tiger and snow leopard *Panthera uncia* skins, python *Python molurus* skin handbags, bangles made of carved Asian elephant *Elephas maximus* ivory and garlands of pangolin scales have been banned in Nepal, the illegal trade in such items persists. Live pangolins and their scales, skins and meat are sold for use in traditional medicine within and outside Nepal (Paudel et al., 2020b). Pangolins are the most heavily trafficked mammals in the world, and they are threatened with extinction (Challender et al., 2020). Of the eight extant pangolin species, two occur in Nepal: the Chinese pangolin *Manis pentadactyla* and the Indian pangolin *Manis crassicaudata*. The Chinese pangolin is categorized as Critically Endangered and the Indian pangolin as Endangered on the IUCN Red List of Threatened Species (Challender et al., 2019; Mahmood et al., 2019); both species are listed in CITES Appendix I (CITES, 2017) and are protected by the National Parks and Wildlife Conservation Act 1973 (DNPWC & DOF, 2018). They are distributed widely, mostly in the human-dominated landscapes in the central and eastern parts of the country, outside protected areas (Suwal et al., 2020), making their protection challenging.

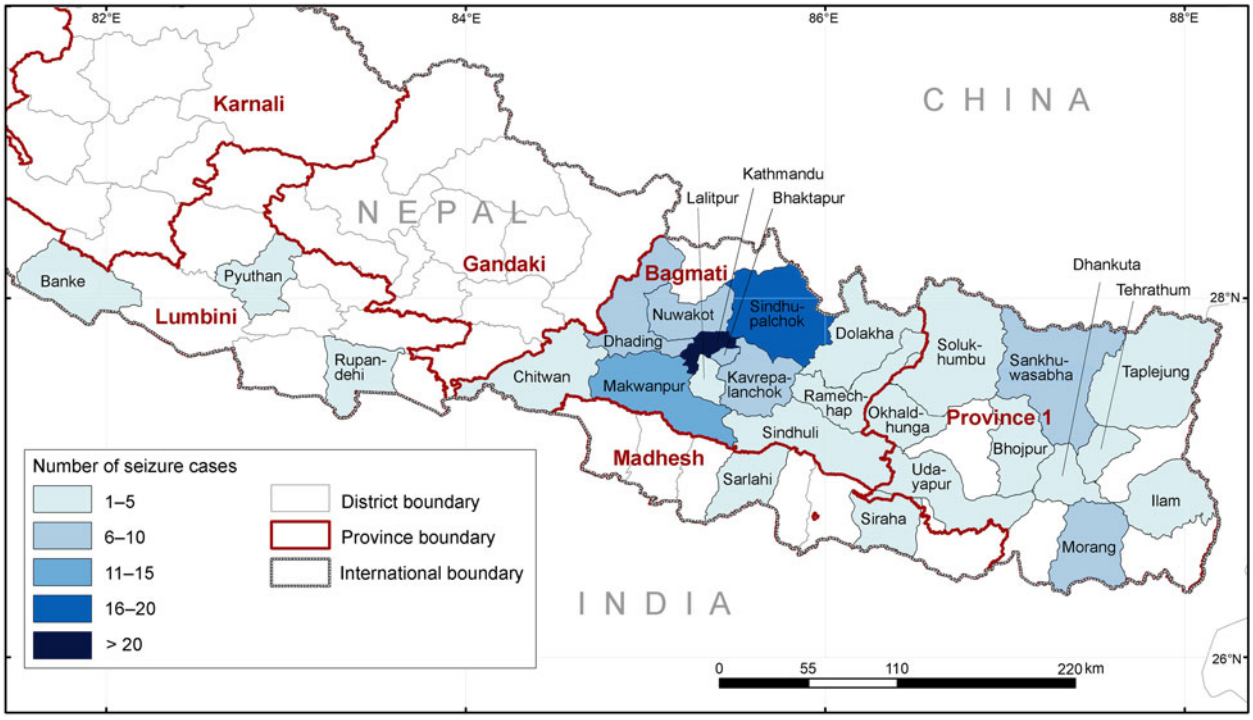

FIG. 1 The reported number of seizure cases of pangolin derivatives in the districts of Nepal during 2010–2020 (Table 1).

In the period August 2000–July 2019, 895,000 pangolins and their derivatives were trafficked internationally, with most of this trade taking place during 2016–2019 (Challender et al., 2020). Global databases containing information on wildlife trade mostly focus on trade on a national scale, and often provide only limited practical application for law enforcement (Challender et al., 2015). Previous studies in Nepal have not examined the patterns of illegal pangolin trade by considering specific source or destination information, which also hampers conservation efforts (Nijman et al., 2016). Because of the relatively lower trade volume (compared to other African and Asian countries) and the lack of reliable information on trade in transit countries such as Nepal, local trade is often neglected and understudied, limiting our understanding of such smaller-scale trade and its important links with global trade patterns. This information is needed to identify target areas for policy and enforcement efforts.

The Government of Nepal has developed a 5-year (2018–2022) National Pangolin Conservation Action Plan (DNPWC & DOF, 2018). However, the implementation of conservation interventions to reduce pangolin poaching and trade has been limited, partly because of the low priority assigned to this work. Thus, large numbers of pangolins may have been collected and traded, without these activities attracting the attention of the media and conservation stakeholders. To quantify the volume of pangolin trade in Nepal over the last decade, we collected data from pangolin seizures reported during 2010–2020. Based on our findings, we highlight hotspot areas and important periods of illegal pangolin trade in the country. This information could help us to identify patterns associated with this trade, prioritize conservation actions and develop an effective conservation strategy to curb illegal pangolin trade and related crime in Nepal.

Study area

Nepal lies between China to the north, bordered by the Himalayan Mountain ranges, and India to the south, east and west, with an open border (i.e. people can enter and leave the country easily without requiring permissions or visa). The country comprises seven federal provinces divided into 77 districts, with diverse topographies and human socio-demographic characteristics (Central Bureau of Statistics, 2021). Province 1 (not yet named) lies in the easternmost region, at altitudes of 70–8,848 m. This province borders China in the north and the flat plains of the Indian Terai in the south-east. The central Bagmati Province includes Kathmandu, the capital city, with a large, ethnically diverse population and many rural in-migrants. Madhesh Province is situated in the southern Terai. The remaining four provinces of Gandaki, Lumbini, Karnali and Sudurpashchim are in the west of the country (Fig. 1). Of the seven provinces, all but Karnali share a border with India. Human population density is lowest in the upper Himalayas.

Methods

Prior to 2010, there were only limited official records of the illegal trade of pangolins in Nepal, primarily because

TABLE 1 Pangolin seizure cases reported in Nepal during 2010–2020 (Fig. 1), with seizure district and the location of origin, type of derivative, total number of such cases and total quantity of pangolin scales.

Year	Seizure district (location of origin)	Type of derivative (no. of cases)	Total seizure cases	Total quantity of scales (kg)
2010	Kathmandu (Ramechhap), Bhaktapur, Kathmandu (Nuwakot), Kathmandu (Hetauda-Makwanpur)	Scales (5)	5	12.0
2011	Kavrepalanchok, Kathmandu (Nuwakot), Makwanpur, Sankhuwasabha, Tehrathum, Sindhupalchok	Scales (4), skins with scales (2), alive & dead pangolins (4)	10	49.6
2012	Kathmandu (Makwanpur), Kathmandu (Sindhupalchok), Kavrepalanchok, Kathmandu (Nuwakot), Kathmandu (Sankhuwasabha), Ramechhap, Pyuthan	Scales (15), skins with scales (2), alive & dead pangolins (7)	24	275.1
2013	Kathmandu, Kathmandu (Makwanpur), Sarlahi, Sindhupalchok	Scales (7), skins with scales (2), alive & dead pangolins (1)	10	147.4
2014	Kathmandu, Sindhupalchok, Kavrepalanchok, Kathmandu (Nuwakot), Sindhuli, Dolakha, Kathmandu (Makwanpur), Bhojpur	Scales (8), skins with scales (3), alive & dead pangolins (2)	13	69.7
2015	Lalitpur, Kathmandu, Kathmandu (Sindhuli), Kathmandu (Okhaldhunga), Morang, Taplejung, Dhankuta	Scales (7), skins with scales (3), skins (1), alive & dead pangolins (3)	14	60.9
2016	Kathmandu, Kathmandu (Ramechhap), Dhading, Kathmandu (Sindhupalchok), Nuwakot, Kavrepalanchok, Banke	Scales (11), skins with scales (2), alive & dead pangolins (2)	15	106.3
2017	Kathmandu, Kathmandu (Nuwakot), Kathmandu (Rupandehi), Kathmandu (Dolakha), Morang	Scales (4), skins with scales (2), alive & dead pangolins (2)	8	60.6
2018	Kathmandu, Kathmandu (Dhading), Solukhumbu, Ilam (Bhutan–India–Nepal), Banke, Kathmandu	Scales (5), skins with scales (1), alive & dead pangolins (1)	7	74.4
2019	Kathmandu, Dolakha, Bhaktapur	Scales (3)	3	173.4
2020	Makwanpur, Bhaktapur, Udayapur, Kathmandu (Kavrepalanchok), Bhaktapur (Dhading), Kathmandu (Sindhupalchok), Bhojpur, Okhaldhunga, Kathmandu (Dhanding), Siraha, Chitwan	Scales (9), skins with scales (1), dry meat (1), alive & dead pangolins (2)	13	17.3
Total	27 districts	Scales (78), skins with scales (18), skins (1), dry meat (1), alive & dead pangolins (24)	122	1,046.7

pangolins were being considered as a lesser conservation priority compared to large mammals such as tigers and elephants. Thus, we considered data on the illegal trade of pangolins from 11 years, covering 1 January 2010–31 December 2020. We reviewed publicly available records such as national newspapers and media reports, official records at the Division/Sub-division Forest Offices and Central Investigation Bureau, and grey literature on seizures of pangolins and their body parts in Nepal. We communicated with forest officers, protected area staff, security personnel, journalists and local people to verify any doubtful reports. From this information we developed a database on these seizure records, which covered both arrest and confiscation cases. Arrest cases involved the arrest of people who were involved in the pangolin trade and the seizure of pangolin body parts. Confiscation cases represented those cases involving only the collection of pangolin body parts based on information provided by an informer. For each seizure incident we recorded the date of the seizure, the types of seized derivatives (scales, skins with scales, skins, meat, live or dead individuals) and the weight and quantity of the confiscated/seized items. Based on the quantities confiscated, we then estimated the number of individuals, assuming 0.5 kg of scales per individual (Cheng et al., 2017). We also documented the origins and sources (locations from which the derivatives were transported and where they were seized) of the seizure cases and the destinations (where the derivatives were transported), to avoid duplication of the same cases collected from different sources and to map the trade network.

We analysed seizure cases by year, month, district and seized derivatives. We defined March–May as spring, June–August as summer, September–November as monsoon and December–February as winter (Dahal et al., 2019), to determine seasonal patterns of illegal pangolin hunting and trade. We used *R 4.0.3* (R Development Core Team, 2020) for statistical analyses. We prepared a map of seizure cases based on the sources, destinations and numbers of seizure cases using *ArcGIS 10.6* (Esri, 2016).

We developed an adjacency matrix by district and number of seizure cases and performed network analyses using the *igraph* package in *R* (Csardi & Nepusz, 2006). The districts are represented as nodes and seizure events in different districts are represented as vertices. We calculated the

eigenvector centrality of each network using *igraph*. Centrality measures are amongst the most used indices in network analysis (Marsden, 2005). Eigenvector centrality is a measure of the influence a node has on a network, evaluating both the number of connections to a node and the connectedness of its neighbours. It measures the relative importance of an individual item in a group, which is crucial to identifying which components have a wide-ranging influence within a given network. Each node is given a score, with higher scores denoting a greater level of influence within the network. We also analysed the network with respect to pangolins and pangolin derivatives confiscated in different districts. We used the *igraph* and *circlize* (Gu et al., 2014) packages in *R* to construct plots of the trade networks.

Results

Pangolin seizures

A total of 122 pangolin seizure cases were reported in Nepal during 2010–2020, averaging 11.1 cases per year. The highest number of cases was in 2012 (n = 24, 19.7% of the total number of reported seizures) and the lowest were in 2019 (n = 3, 2.5%) and 2010 (n = 5, 4.1%). Pangolin scales were the most frequently seized derivative (n = 78, 63.9% of seizure cases; Table 1). The quantity of scales seized per year fluctuated; the highest quantity was in 2012 (275.1 kg, 26.3% of the total quantity seized), followed by 2019 (173.4 kg, 16.6%), which also included 162 kg of pangolin scales of African origin that were seized in Nepal. The illegal hunting of pangolins occurred throughout the year, with the highest number of seizures recorded during winter (n = 40, 32.8%), followed by summer (n = 32, 26.2%) and the monsoon season (n = 29, 23.8%), and the fewest cases occurring in spring (n = 21, 17.2%). During the study period, pangolin seizures consisted of 23 live animals, one dead individual, 18 whole-body skins with scales, one skin, 300 g of dry meat and 1,046.7 kg of scales overall (range 375 g–162 kg per seizure), resulting in an estimate of $>$1,500 individuals having been illegally hunted locally in Nepal, excluding the scales of the African pangolins seized. During 2020 (the year of the Covid-19 pandemic outbreak; Table 1), the quantity of scales seized was lower, but the number of seizure cases increased compared to the previous 3 years.

Illegal pangolin trade network

Seizures of illegally traded pangolins were reported in four provinces (27 districts) within Nepal (Figs 1 & 2). Most of the seizure cases were reported in Bagmati Province in central Nepal (n = 93, 76.2%), followed by Province 1 in the east (n = 22, 18.0%). Fewer cases were reported in Lumbini Province (n = 4, 3.3%) and Madhesh Province (n = 3, 2.5%) in the western and central southern Terai regions,

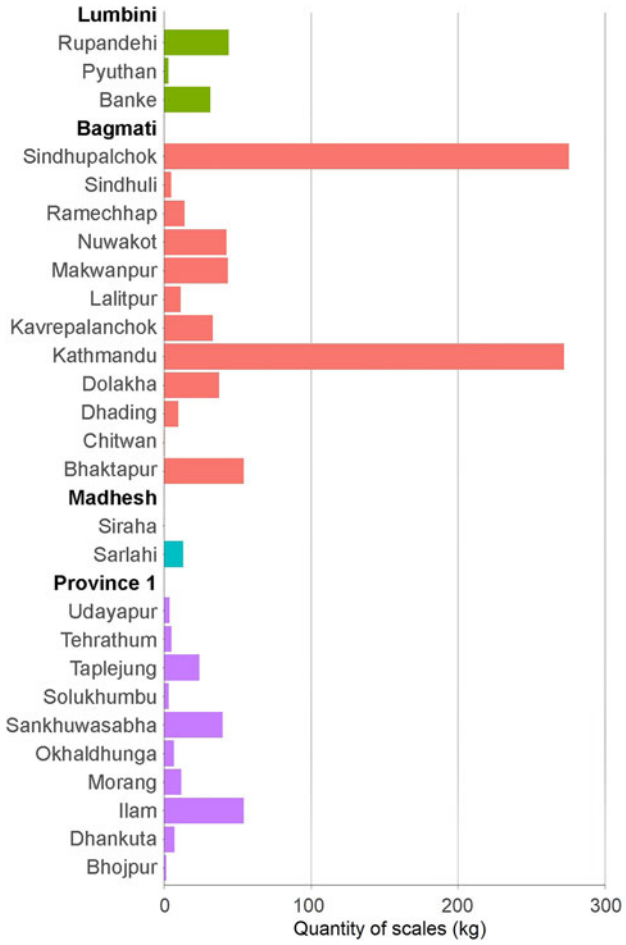

FIG. 2 Total quantity of pangolin scales seized in the districts of Nepal during 2010–2020 (Table 2).

respectively. These provinces represent two clusters connected extensively to the Chinese border in the north and, to a lesser extent, to the Indian border in the south (Fig. 1). We found the capital city, Kathmandu, to be the main destination for the illegal trade of pangolins, having the highest number of seizure cases (n = 26, 21.3%), followed by Sindhupalchok (n = 16, 13.1%) and Makwanpur (n = 11, 9.0%) situated in central Nepal. The largest quantities of scales were seized in Sindhupalchok (275.4 kg) and Kathmandu (272.0 kg; Fig. 2). Kathmandu showed high connectivity in terms of the pangolin trade with ten peripheral districts of the country: Dhading, Dolakha, Kavrepalanchok, Nuwakot, Ramechhap, Sindhupalchok, Makwanpur and Sindhuli in central Nepal, and Okhaldhunga and Sankhuwasabha in eastern Nepal (Fig. 3). The eigenvector centrality was highest for Kathmandu, with a value of 1, indicating that it is the major trade hub for pangolins; the city had the highest number of connections with other districts. The eigenvector centrality also showed that scales (value of 1) were the most traded pangolin derivative, followed by live pangolins (value of 0.45; Table 2).

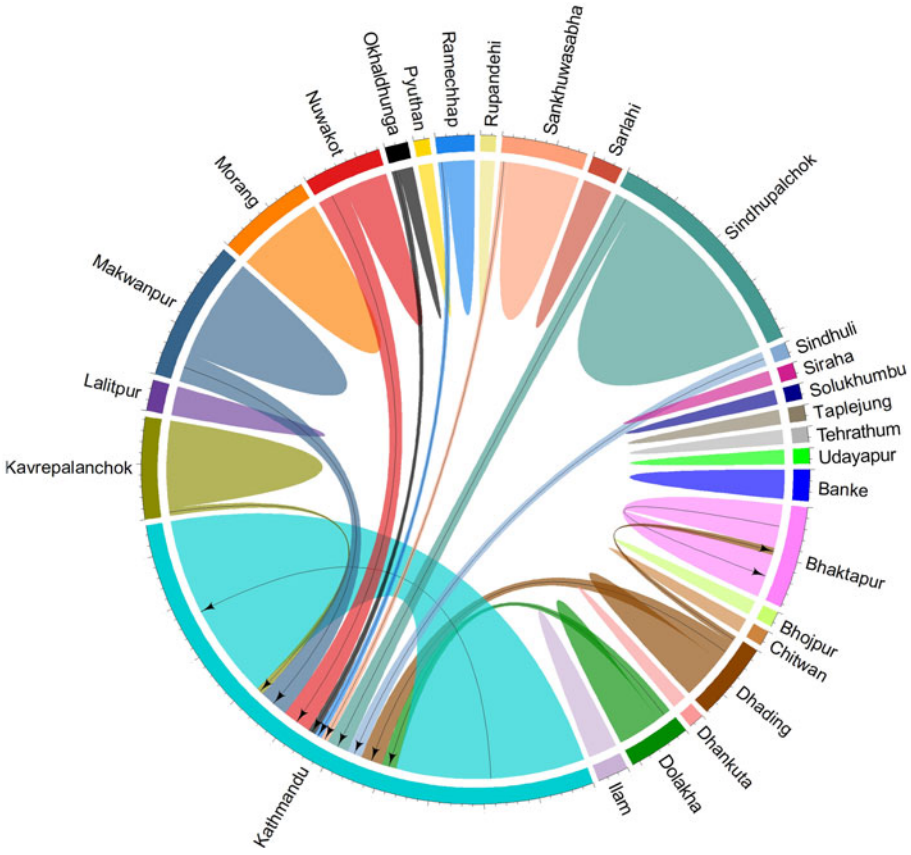

FIG. 3 Circular plot showing directional movement patterns of pangolins and their derivatives amongst various districts in Nepal during 2010–2020. The width of each band represents the number of seizure cases in that district. The arrows indicate the direction of trade flow amongst various districts, with the head of each arrow showing the destination district where the seizure occurred. The part of each band that does not include any arrows indicates illegal trade that originated and was seized within the same district.

Discussion

This is the first analysis of data on illegal pangolin seizures in Nepal during 2010–2020. Although seizure data have an inherent bias in that not all traded products are seized and not all seizures are reported (Cheng et al., 2017), we gained important insights regarding trends in the illegal pangolin trade over time, and identified key areas and routes of this trade. There has been progress in the mitigation of the illegal rhinoceros and tiger trade in Nepal, but our findings highlight that this is not yet the case for the illegal pangolin trade. Seizures of live pangolins or pangolin body parts appear as of yet ineffective in reducing the illegal pangolin trade. The data gathered during this study could help with the development of strategies to control this trade through the identification of hotspot districts and important trade routes.

It was not clear whether the fluctuation in the annual number of seizure cases over the study period reflects variation in the intensity of the illegal trade or varying law enforcement efforts. Nevertheless, the number of pangolin seizure cases in Nepal decreased during 2016–2020 (total 46 cases) in comparison to 2011–2015 (total 71 cases; Table 1). In contrast, pangolin trafficking increased globally during 2016–2019 (Challender et al., 2020). The decrease in the number of seizure cases reported in Nepal could be because of ongoing, collaborative pangolin conservation actions and increased research activity by local and international NGOs, university students and researchers, along with conservation initiatives and support provided by the Government of Nepal from 2016 onwards, and the participation of local communities (SMCRF, 2021).

The numbers of recorded pangolin seizures were highest in the winter and summer seasons. This could reflect seasonal activity patterns of pangolins: young pangolins disperse from their mothers to establish their own home ranges during the summer, and adult males search for mates in winter (Sun et al., 2019). Identification of peak seasons of animal movements and illegal activities is key to informing law enforcement agencies and local wildlife conservation stakeholders, so that they can increase their surveillance during these higher-risk months/seasons to reduce illegal activities in and around core pangolin habitats. We estimate that $>$1,500 pangolins were poached locally for local use and trade during 2010–2020. Most of the seized derivatives were considered to be of Chinese pangolins based on the location of the seizures and the colour and size of the scales. In 2011, the estimated population of the Chinese pangolin in Nepal was c. 5,000 individuals (Jnawali et al., 2011). If illegal pangolin hunting and trade continue at the present rate, this species will probably become extinct in Nepal within the next few decades. Therefore, local, national, regional and international collaboration, support and campaigns are

TABLE 2 Seizure cases of pangolin derivatives reported in various locations within Nepal (provinces and districts), with number of seizure cases and per cent and type of derivatives (Fig. 2).

	Seizures cases		Number of seizure cases by type of derivative					
District (by Province)	n	% of total	Scales	Whole-body skins with scales	Live pangolins	Skins	Dead pangolins	Dry meat
Province 1								
Morang	6	4.9	0	6	0	0	0	0
Ilam	2	1.6	2	0	0	0	0	0
Dhankuta	1	0.8	0	1	0	0	0	0
Tehrathum	1	0.8	0	1	0	0	0	0
Okhaldhunga	2	1.6	2	0	0	0	0	0
Solukhumbu	1	0.8	1	0	0	0	0	0
Sankhuwasabha	6	4.9	6	0	0	0	0	0
Taplejung	1	0.8	1	0	0	0	0	0
Udayapur	1	0.8	1	0	0	0	0	0
Bhojpur	1	0.8	0	1	0	0	0	0
Province 1 total	22	18.0	13	9	0	0	0	0
Madhesh Province								
Sarlahi	2	1.6	0	3	0	0	0	0
Siraha	1	0.8	0	0	1	0	0	0
Madhesh Province total	3	2.5	0	3	1	0	0	0
Bagmati Province								
Sindhuli	2	1.6	2	0	0	0	0	0
Chitwan	1	0.8	0	0	0	0	0	1
Makwanpur	11	9.0	7	0	3	0	0	0
Lalitpur	2	1.6	2	0	0	0	0	0
Kathmandu	26	21.3	18	1	6	1	0	0
Bhaktapur	6	4.9	4	1	1	0	0	0
Dhading	7	5.7	2	1	4	0	0	0
Nuwakot	7	5.7	2	1	4	0	0	0
Kavrepalanchok	7	5.7	5	0	2	0	0	0
Ramechhap	3	2.5	2	0	1	0	0	0
Dolakha	5	4.1	3	1	0	0	1	0
Sindhupalchok	16	13.1	15	0	1	0	0	0
Bagmati Province total	93	76.2	62	5	22	1	1	1
Lumbini Province								
Pyuthan	1	0.8	0	1	0	0	0	0
Rupandehi	1	0.8	1	0	0	0	0	0
Banke	2	1.6	2	0	0	0	0	0
Lumbini Province total	4	3.3	3	1	0	0	0	0
Overall total (27 districts)	122	100.0	78	18	23	1	1	1

needed to save the Chinese pangolin from extinction in Nepal.

Pangolin seizures were reported mostly in eastern and central Nepal (Suwal et al., 2020), which is the distribution range of the Chinese pangolin and also a major hotspot for illegal pangolin hunting and trade (Paudel et al., 2020a,b). Conservation programmes aiming to curb this illegal trade need to increase the participation of local communities for habitat management, and provide support for sustainable livelihoods, to help with the long-term protection of pangolins and their habitat. We recorded most of the seizure cases from Bagmati Province, central Nepal, corroborating the findings of previous studies (Dangol, 2015; Awale, 2019). This area contains the capital city, Kathmandu, which is the central hub for the illegal pangolin trade. Kathmandu contains the only international airport in Nepal (Tribhuvan International Airport), which provides opportunities for the international trade and transit of pangolins. Although there is better and quicker access to law enforcement in and around Kathmandu compared to other parts of the country, law enforcement for pangolin-related crimes has been weak because of the low priority assigned to the conservation of these species. Another reason for the role of Kathmandu as a trade hub is that many people from the surrounding villages have migrated to the capital city to access better education, employment, healthcare and business opportunities. Some of these rural in-migrants have become involved in illegal wildlife hunting and trade to supplement their income and meet basic household needs, and because of a lack of education and awareness of the ecological role and conservation status

of pangolins (Paudel et al., 2020a,b). Hence, future education and awareness campaigns, as well as capacity-building training for local communities and law enforcement agencies, should be focused particularly on central Nepal.

We reported seizures of pangolin scales trafficked internationally from Nigeria to Nepal, destined for China (Awale, 2019). People from Nepal were also arrested in India, in connection with pangolin scales that had been imported from Bhutan and were destined for sale in Nepal (Big News Network, 2018). These cases highlight that Nepal is used as a transit hub for pangolin derivatives originating from Africa and destined for Asia, as well as within Asia, for international trade and local consumption, creating a complex network of illegal pangolin trade (Challender & Hywood, 2012). Kathmandu has previously been identified as a major hub in the international networks of illicit trade in tigers, red pandas and leopards from Nepal to China (Paudel et al., 2020a).

We identified several other districts (Makwanpur, Sindhupalchok, Bhaktapur, Dhading, Dolakha, Kavrepalanchok and Nuwakot in Bagmati Province, central Nepal, and Morang and Sankhuwasabha in Province 1, eastern Nepal) as major hotspots for illegal pangolin hunting and trade, corroborating findings from previous studies (Ghimire et al., 2020). Illegal pangolin hunting and trade have also been reported in other districts such as Morang, Lalitpur, Ilam, Taplejung and Dhankuta in central and eastern Nepal (Katuwal et al., 2015). These districts and trade routes appeared to serve the illegal wildlife trade for locally harvested pangolins from Nepal to India and China, through the Terai region and the upper mountain region (Himalayas) as well as the mid-hill region. This is facilitated by the open border that provides a direct connection with neighbouring countries and easy access for wildlife transportation (Shakya et al., 2000).

Our findings suggest that rapid implementation of conservation interventions in the identified hotspot districts and regions could have a significant impact on the illegal pangolin trade network in Nepal. It is necessary to strengthen the capacity of law enforcement agencies at both local and national levels to curb illegal hunting and trade, with a particular focus on the identified hotspot areas and major illegal trade routes. Studies on the links between local and intercontinental illegal trade activities could identify the major factors driving the global illegal wildlife trade (Cheng et al., 2017), which would facilitate the development of effective strategies to address these conservation challenges on a larger scale. In conclusion, we suggest that to stop the illegal pangolin trade worldwide, national-level workshops and awareness-raising programmes are required, involving trans-border customs, airports and security forces, in collaboration with neighbouring countries. Extensive, long-term campaigns are required to raise public awareness of and support for pangolin conservation. In addition, community-based conservation programmes need to be implemented to minimize hunting and illegal trade, and to develop local stewardship programmes for pangolin conservation. Similar conservation programmes have been successfully implemented for other flagship species in Nepal, leading, for example, to zero poaching of rhinoceroses and the doubling of the tiger population in and around protected areas (WWF, 2017; NTNC, 2018; Acharya et al., 2020).

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Author contributions Study conceptualization: TLS, KJ-CP; data collection and management: TLS; data analysis: TLS, SG; writing: TLS; revision: SG, KJ-CP.

Conflicts of interest None.

Ethics standards This study abided by the *Oryx* guidelines on ethical standards. The information was collected mostly from reports of wildlife crimes from Division Forest Offices, Central Bureau of Investigation, and local and international NGOs, as well as from newspaper and online sources. Verbal consent was obtained during data collection and verification from the respective authorities.

Data availability Data are available from the corresponding author upon reasonable request.

References

Acharya, K.P., Thapa, R.K., Kuwar, K.J., Thapalia, B.P. & Paudel, P.K. (2020) Policy and management actions that resulted in curbing rhinoceros poaching. *Journal of Applied Ecology*, 57, 1452–1458.

Awale, S. (2019) Nepal–China Connectivity Aid Wildlife Smuggling. *The Pangolin Reports*, 6 September 2019. pangolinreports.com/nepal-china-connectivity [accessed 19 July 2022].

Big News Network (2018) Pangolin scales seized, 4 held. *Big News Network*, 10 February 2018. bignewsnetwork.com/news/256431232/pangolin-scales-seized-4-held [accessed 19 July 2022].

Central Bureau of Statistics (2021) *National Population and Housing Census*. Government of Nepal, National Planning Commission Secretariat, Kathmandu, Nepal.

Challender, D.W.S., Harrop, S.R. & MacMillan, D.C. (2015) Understanding markets to conserve trade-threatened species in CITES. *Biological Conservation*, 187, 249–259.

Challender, D.W.S., Heinrich, S., Shepherd, C.R. & Katsis, L.K.D. (2020) International trade and trafficking in pangolins, 1900–2019. *Pangolins*, 2020, 259–276.

Challender, D.W.S. & Hywood, L. (2012) African pangolins under increased pressure from poaching and intercontinental trade. *TRAFFIC Bulletin*, 24, 53–55.

Challender, D., Wu, S., Kaspal, P., Khatiwada, A., Ghose, A., Ching-Min Sun, N., Mohapatra, R.K. & Suwal, T.L. (2019) *Manis pentadactyla* (errata version published in 2020). In *The IUCN Red List of Threatened Species* 2019. dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T12764A168392151.en.

Cheng, W., Xing, S. & Bonebrake, T.C. (2017) Recent pangolin seizures in China reveal priority areas for intervention. *Conservation Letters*, 10, 757–764.

CITES (1999) *Manis crassicaudata*, *M. pentadactyla*, *M. javanica*. *Consideration Proposals for Amendment of Appendices I and II*. CITES, Geneva, Switzerland. cites.org/sites/default/files/eng/cop/11/prop/13.pdf [accessed December 2022].

CITES (2017) *Convention on International Trade in Endangered Species of Wild Fauna and Flora. Appendices I, II and III*. CITES, Geneva, Switzerland. cites.org/sites/default/files/eng/app/2017/E-Appendices-2017-10-04.pdf [accessed December 2022].

Csardi, G. & Nepusz, T. (2006) The *igraph* software package for complex network research. *InterJournal, Complex Systems*, 1695, 1–9.

Dahal, N., Shrestha, U.B., Tuitui, A. & Ojha, H.R. (2019) Temporal changes in precipitation and temperature and their implications on the streamflow of Rosi River, central Nepal. *Climate*, 7, 1–15.

Dangol, R.B. (2015) *Illegal wildlife trade in Nepal: a case study from Kathmandu Valley*. MSc thesis. Norwegian University of Life Sciences, Oslo, Norway.

DNPWC & DOF (2018) *Pangolin Conservation Action Plan for Nepal (2018–2022)*. Department of National Parks and Wildlife Conservation and Department of Forests, Kathmandu, Nepal.

Esri (2016) *ArcGIS Desktop 10.6.x System Requirements*. ArcMap Documentation. desktop.arcgis.com/en/arcmap/10.6/get-started/setup/arcgis-desktop-system-requirements.htm [accessed 5 November 2021].

Ghimire, P., Raut, N., Khanal, P., Acharya, S. & Upadhaya, S. (2020) Species in peril: assessing the status of the trade in pangolins in Nepal. *Journal of Threatened Taxa*, 12, 15776–15783.

Gu, Z., Gu, L., Eils, R., Schlesner, M. & Brors, B. (2014) *Circlize* implements and enhances circular visualization in *R*. *Bioinformatics*, 30, 2811–2812.

Jnawali, S., Baral, H., Lee, S., Acharya, K., Upadhyay, G., Pandey, M. et al. (2011) *The Status of Nepal's Mammals: The National Red List Series*. Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

Katuwal, H.B., Neupane, K.R., Adhikari, D., Sharma, M. & Thapa, S. (2015) Pangolins in eastern Nepal: trade and ethno-medicinal importance. *Journal of Threatened Taxa*, 7, 7563–7567.

Kumar, V.P., Rajpoot, A. & Rasaily, S.S. (2020) Peril for pangolins: an evaluation of the status of the last decade in India. *Forensic Science International: Reports*, 2, 100058.

Mahmood, T., Challender, D., Khatiwada, A., Andleeb, S., Perera, P., Trageser, S., et al. (2019) *Manis crassicaudata*. In *The IUCN Red List of Threatened Species* 2019. dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T12761A123583998.en.

Marsden, P.V. (2005) *Network Analysis. Encyclopedia of Social Measurement*. Harvard University, Cambridge, USA.

McMurray, C. (2009) *Illegal Trade in Wildlife and World Environment Day*. U.S. Department of State, Archive. New York, USA. 2001-2009.state.gov/g/oes/rls/rm/106259.htm [accessed December 2022].

Nijman, V., Zhang, M.X. & Shepherd, C.R. (2016) Pangolin trade in the Mong La wildlife market and the role of Myanmar in the smuggling of pangolins into China. *Global Ecology and Conservation*, 5, 118–126.

NTNC (The National Trust for Nature Conservation) (2018) *Nepal Set to Become the First Country to Double Its Tigers*. ntnc.org.np/news/nepal-set-become-first-country-double-its-tigers [accessed 5 November 2021].

Paudel, P.K., Acharya, K.P., Baral, H.S., Heinen, J.T. & Jnawali, S.R. (2020a) Trends, patterns, and networks of illicit wildlife trade in Nepal: a national synthesis. *Conservation Science and Practice*, 2, e247.

Paudel, K., Potter, G.R. & Phelps, J. (2020b) Conservation enforcement: insights from people incarcerated for wildlife crimes in Nepal. *Conservation Science and Practice*, 2, e137.

People's Help Group. (2017) *Assessment of Poaching and Illegal Wildlife Trafficking in Banke-Kamdi Complex*. Report submitted to Hariyo Ban Program, WWF, Kathmandu, Nepal.

R Development Core Team (2020) *R: A Language and Environment for Statistical Computing*. gbif.org/tool/81287/r-a-language-and-environment-for-statistical-computing [accessed 5 November 2021].

Shrestha-Acharya, R. & Heinen, J.T. (2009) Emerging policy issues on non-timber forest products in Nepal, Himalaya. *Journal of the Association for Nepal and Himalayan Studies*, 30, 2005–2007.

Shakya, M.M., Pringle, C. & Murgatroyd, C. (2000) *The Illegal Trade of Wildlife Product in Nepal*. Report submitted to British Embassy in Kathmandu, Nepal.

SMCRF (Small Mammals Conservation and Research Foundation) (2021) *Celebration of World Pangolin Day 2021 'Against Wildlife Trade'*. smcrf.org/celebration-of-world-pangolin-day-2021-against-wildlife-trade [accessed 4 November 2021].

Sun, N.C.M., Arora, B., Lin, J.S., Lin, W.C., Chi, M.J., Chen, C.C. & Pei, C.J.C. (2019) Mortality and morbidity in wild Taiwanese pangolin (*Manis pentadactyla pentadactyla*). *PLOS ONE*, 14, e0212960.

Suwal, T.L., Thapa, A., Gurung, S., Aryal, P.C., Basnet, H., Basnet, K. et al. (2020) Predicting the potential distribution and habitat variables associated with pangolins in Nepal. *Global Ecology and Conservation*, 23, e01049.

WWF (2017) *Assessment of Poaching and Illegal Wildlife Trafficking in Banke–Kamdi Complex*. WWF Nepal, Kathmandu, Nepal. wwfasia.awsassets.panda.org/downloads/assessment_of_poaching_and_illegal_wildlife_trafficking_in_banke__kamdi_complex.pdf [accessed 19 July 2022].