

Two Sides of the Same Coin – Wildmeat Consumption and Illegal Wildlife Trade at the Crossroads of Asia

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Abstract

Domestic trade and consumption of wildmeat is intricately linked with the international trade of wildlife and together they are driving a biodiversity crisis across Southeast Asia. Forming a key juncture between countries and bioregions, Myanmar is an important piece of this puzzle and acts as a source and a conduit for illegal wildlife trade across Asia. While some information on key markets and border crossings exists, this is frequently limited to single taxa. An assessment of wildlife trade across Myanmar that quantifies international and domestic trade, and consumption is missing. We summarize results from a nationwide hunter survey, linking hunting practices at the local level to specific markets and to broader trends in illegal wildlife trade. Our survey results reveal widespread, intense hunting around Myanmar for local trade and wildmeat consumption. The majority of hunters surveyed can be classified as ‘subsistence harvesters’. Hunters report declines in populations across a range of species of conservation concern. Pangolin are hunted extensively, and Myanmar is a major contributor to the illegal pangolin trade. A better understanding of internal trade routes is needed to prevent wildlife products reaching markets that are largely outside government control. Legislative changes are encouraging, but enforcement at the local level must be combined with community-level action to provide alternatives for subsistence harvesters to halt the rapid declines reported in endangered animal populations.

1. Introduction

The illegal trade of wildlife constitutes a multi-billion dollar black market industry (United Nations Office on Drugs and Crime 2016), possibly surpassed only by the narcotics and arms trades (Rosen and Smith 2010). The wildlife trade ranges in scale and extent from local hunting and consumption of wildmeat (Nasi et al. 2011; Risdianto et al. 2016) to international trade in pets, medicinal and animal products, as well as trophies and ornaments by highly organized criminal networks (Bush et al. 2014; United Nations Office on Drugs and Crime 2010; Zimmerman 2003). Many species are in danger of being hunted to extinction to feed the seemingly insatiable global demand for wildlife products. Additionally, moving illegal wildlife products and live animals across countries may result in the spread of pathogens as well as the introduction of exotic species elsewhere, representing a significant threat to animal and human health globally (Karesh et al. 2005). Although routes and destinations can vary by species, reports from international NGOs point to China as the major consumer, followed by surrounding Southeast Asian countries, the USA, and Europe (C4ADS 2018; Heinrich et al. 2017).

The consumption of wildmeat and the illegal wildlife trade are often addressed separately. However, they are intertwined in a complex web of biological, economic, anthropological, and psychological factors that need to be addressed in a multidisciplinary approach to fully understand the dynamics of wildlife trade and consumption (Blair et al. 2017). Recent studies on illegal wildlife trade in Asia, and Myanmar in particular, have focused more on cross-border trade and large wildlife markets (Nijman et al. 2019; Nijman and Shepherd 2015; Shepherd and Nijman 2008b) rather than addressing

widespread consumption of wildlife products at the local scale. Phelps et al (2016) proposed a framework for categorizing harvesters, intermediaries, and consumers along the chain of illegal wildlife trade. They acknowledge that there are different drivers for people to engage with illegal wildlife trade at different stages including subsistence harvesting, opportunistic harvesting, deliberate criminal behaviour, and reactionary killing of animals. Detailed knowledge of hunting practices and the factors driving people to engage in the illegal wildlife trade is critical when formulating strategies that will be most effective in curbing illegal hunting. Hunting for domestic trade and local use has received much attention in Africa where wildmeat consumption is a major driver in creating 'empty forests' (Atuo et al. 2015; Beaune et al. 2013; Nasi et al. 2011; Nuno et al. 2013; Razafimanahaka et al. 2012; Redford 1992). Consumption of wildmeat in Southeast Asia has been documented at high rates in Sumatra and Malaysia (Bennett et al. 2000; Bennett 2002) but some authors believe it has declined as forests across the region have been progressively emptied of their wildlife (Bennett 2002). Although wildmeat consumption is known to be a major threatening process for biodiversity in Southeast Asia (Milner-Gulland and Bennett 2003), efforts to combat the illegal wildlife trade have focused more on transboundary trade at clearly defined points of entry rather than addressing the more nebulous and widespread practice of local consumption of wildmeat (Harrison et al. 2016).

Myanmar is a global biodiversity hotspot (Myers et al. 2000) that has retained more forest coverage than most countries in Southeast Asia. These forests are key to conserving many of the critical wildlife species and populations in Southeast Asia, including tiger, elephant,

tapir and many lesser known species. Environmental laws, logging bans, trade patterns, and resource demands in the neighbouring countries of India, China, and Thailand as well as internal political reform leading to an opening of markets and booming development likely have increased pressure on Myanmar's biodiversity and natural resources. These internal and external threats shape illegal and legal trade (e.g. timber, wildlife products) as well as development (e.g. hydroelectric dams, railroads and roads) in Myanmar. In addition to being a source for wildlife products, Myanmar likely serves as a destination and conduit for wildlife products originating elsewhere. For example, Myanmar's ivory carving industry has been suspected of sourcing African elephant ivory, which is then carved and sold into China (Nijman and Shepherd 2014). Similarly, wildlife products from India likely are being moved across Northern Myanmar into China (Grieser-Johns and Thomson 2005; United Nations Office on Drugs and Crime 2016).

Myanmar has historically had loosely defined wildlife laws. Enforcement of those laws has been largely absent (United Nations Office on Drugs and Crime 2015), particularly in border regions where conflict with ethnic groups has limited the government's enforcement capabilities (Nijman and Shepherd 2015; Shepherd et al. 2018; United Nations Office on Drugs and Crime 2015). These conditions have allowed for a flourishing wildlife trade, particularly along Myanmar's Eastern border. To date there has been no countrywide assessment of hunting for domestic consumption and the illegal wildlife trade in Myanmar.

Given Myanmar's globally-significant biodiversity and its apparent role in international wildlife trade, the lack of detailed knowledge of illegal wildlife activity within the country represents a crucial missing piece of the puzzle

in understanding the illegal wildlife trade across Asia. Here, we present summary analysis from our nationwide survey of hunters with a focus on hunting intensity, hunting practices and links between initial harvesting and the broader wildlife trade across multiple taxa. We gathered first-hand information from hunters on their hunting practices, prices paid to hunters and destinations of hunted animals. Using these data, we aim to 1) Identify broad trends in hunting practices and wildlife trade across Myanmar; 2) Collect detailed information on hunting pressure and population declines for key species of conservation concern; 3) Identify previously unknown internal market locations that may have been overlooked by previous surveys targeting cross-border trade

By providing a detailed picture of the nature and extent of illegal wildlife consumption and trade across Myanmar, we can equip governments and NGOs with data on the drivers of illegal hunting, key species in decline and spatial patterns of hunting and trade beyond well-known border crossings. This knowledge is crucial in assessing the effectiveness of current and future interventions and building an effective response to combat widespread hunting and trade of endangered species across Myanmar.

2 Methods

2.1 Nationwide Hunter Survey

We conducted a nationwide survey of hunters across Myanmar between February and December 2018 to assess the degree of hunting pressure, the species hunted and potential wildlife trade routes (Fig 1). We limited our study to townships with at least 25% forest cover, determined using available forest cover maps (Bhagwat et al. 2017). We used stratified random sampling to select 3 townships from each of Myanmar's

15 states/regions. An additional 10 townships were chosen randomly across all states/regions. This combination of random and stratified-random sampling ensured that state/regional data summaries, even for small states/regions, were based on surveys from a minimum of 3 different townships. Townships with active conflict between government forces and ethnic groups were excluded from surveys for safety reasons.

Within each of the 55 selected townships, we visited three villages that were in close proximity to forest where local people would have access to forest resources. Many villages in Myanmar are not officially registered or mapped by government bodies, these village locations were identified through discussions with local township forestry officials. Within each village, our survey teams arranged first to speak with the locally elected village leader regarding overall socio-economic conditions in the village and to compile a list of individuals who regularly hunt. Interviews were conducted with two to three local hunters or knowledgeable individuals who were chosen at random from this list provided by the village leader. With this approach of speaking with resident hunters who were amenable to being interviewed we would expect a bias in the data toward medium sized and easily caught animals. Data on larger, higher value target species such as elephants or tigers is difficult to gather largely due to their low population density and rarity of encounters but also because transient professional hunters and poaching gangs moving through an area were unlikely to be interviewed in our survey.

Our interview survey focused on 16 key species that were selected based on their IUCN status, known presence in wildlife markets and/or widespread consumption for wildmeat (Table 1). The questionnaire included questions on the presence/absence of key species, the perceived abundance of these species over the last five years, the species hunted at each village as well as the location of and distance to the nearest wildlife markets (See Supplementary Material for questionnaire). Distance travelled to hunt was estimated by respondents. Distance to market was measured as the straight-line distance between the respondents' village and the stated market location for each species. The questionnaire was delivered by native Burmese speakers who had previously conducted similar surveys. To avoid any possible confusion with local names for species, the questionnaire included images of all key species. If a respondent selected one of our key species as being hunted in that area, this triggered a set of detailed questions concerning that species. We allowed for hunters to add additional species that were not in our key species list. Although our survey design used pictures of animals to avoid confusion, mistaken or uncertain identification of some species did occur. For example, respondents were shown a picture of an Arakan forest turtle (*Heosemys depressa*) but many reported hunting this turtle in areas where it is not likely to occur. In these cases, the animal identification could not reliably go beyond 'forest turtle'. Similarly, of the three species of

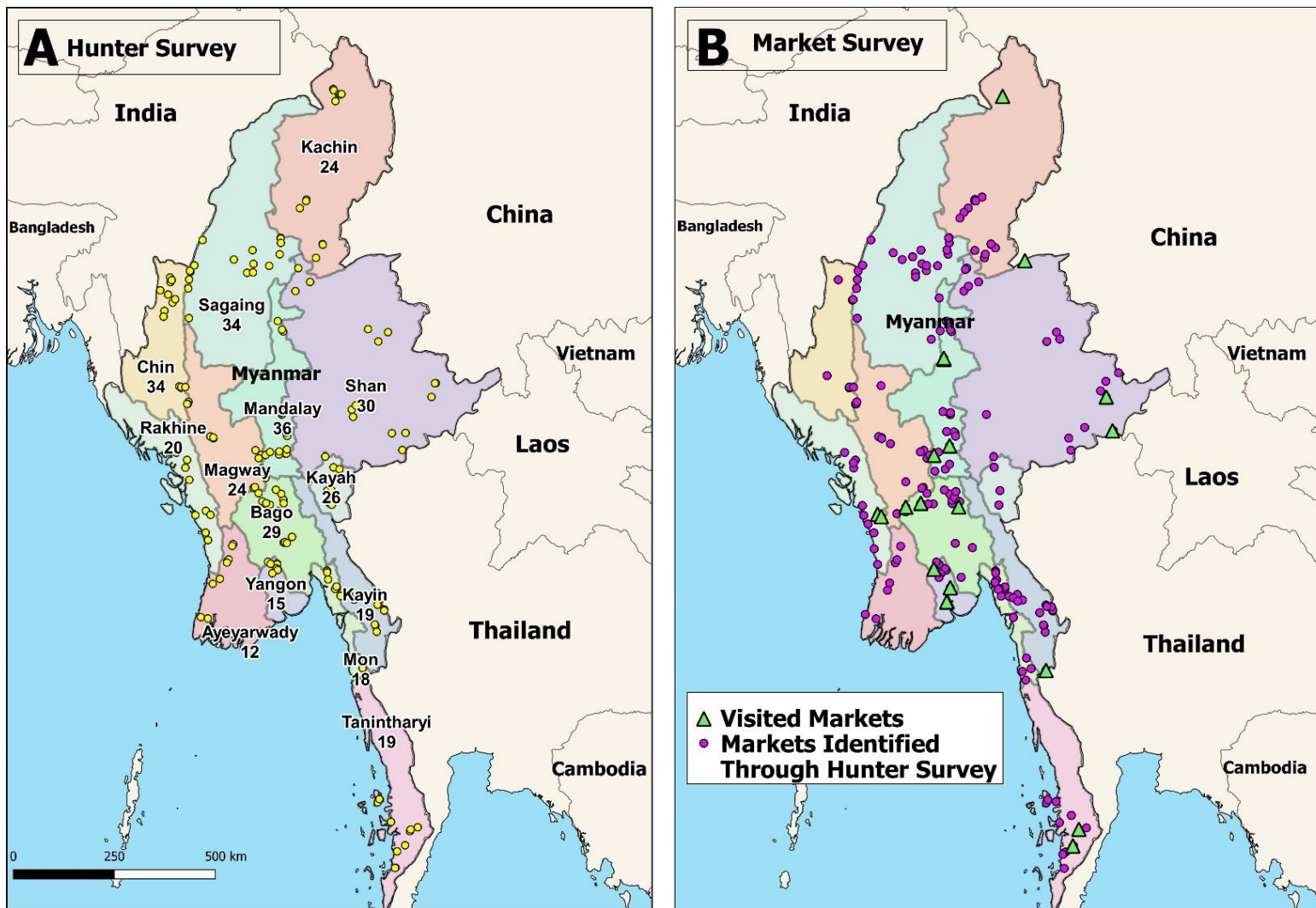


Figure 1: A) Survey locations from the nationwide hunter survey, including 55 townships visited and 342 total respondents. Numbers represent the number of respondents from each State/Region B) Market locations identified through surveying hunters and 20 direct visits to markets.

pangolin present in Myanmar, it is believed that Sunda pangolin (*M. javanica*) and Chinese (*Manis pentadactyla*) are probably most commonly hunted and traded (Challender et al. 2015; Nijman et al. 2016). However, most respondents were not able to distinguish between these pangolin species and we combined all pangolins into a generic pangolin group, reducing our key species list to 14. To better understand the drivers behind observed hunting practices, we asked questions regarding peoples' reasons for engaging in hunting (e.g., sport, trade) and the hunting techniques employed. Further questions covered frequency of hunting, prices for each species sold, and a set of socio-economic questions.

The study design and questionnaire were approved by the Smithsonian Institution Institutional Review Board (IRB Protocol #HS18011).

2.2 Market Surveys

Interviews with hunters provided valuable information on the existence of local wildlife markets, many of which have never been surveyed by researchers. Where possible our survey teams followed up on information from the interviewees and visited markets to directly observe what species were being sold. Many of the locations identified by hunters as places of trade were not permanent, open wildlife markets but more commonly single vendors within larger food markets or private residences with infrequent availability, making it difficult to visit and survey every location. Survey teams visited 20 markets and stores across 18 townships during the data collection period (Fig 1). A further 180 market locations were identified through responses to the hunter but were not visited or were not accessible to survey teams during the study period. Our market survey intentionally avoided visiting well studied markets

such as Mong La in Shan state in favour of gathering information from smaller markets and stores which may have been overlooked in previous surveys. The survey team recorded the type and size of the market, the species available, the animal parts used (e.g. elephant skin, bear gall bladder), the form in which products were sold (e.g. liquid infusion, powdered bone, worked jewellery), the units of sale, number of units available across the market, price range and, where possible, used hidden cameras to photograph products on display.

3. Results

3.1 Nationwide Hunter Survey

3.1.1 Hunting Practices

Under the framework proposed by Phelps et al. (2016), the majority of respondents to our survey can be categorized as 'subsistence' and/or 'opportunistic' harvesters. A large majority of respondents (80%) listed farming as their main occupation with hunting as an occasional activity (Table 2). Respondents often referred to this opportunistic harvesting of animals as 'collecting forest products' as distinct from 'hunting' which was perceived as a more organized activity. Respondents varied in their hunting frequency, but the most common response was hunting once every three months (30%) and more commonly for food (66%) rather than specifically for trade or sport. Those hunters that listed sport or trade as their main reason for hunting could be classified as 'recreational' harvesters but may also fall into the category of 'local guide' harvesters as defined by Phelps et al. (2016). It was not clear from the data if they were hunting alone for sport or acting as a guide to game hunters from elsewhere. Hunters who hunted for trade or sport tended to travel further from their home than those who hunted for subsistence or pest control (Fig 2). Forty-nine percent of respondents said that when they

sold wildlife products they were picked up by a middleman and, of those, 98% reported that the middleman arrived on demand rather than on a fixed schedule.

Of the species reported as being hunted, selling a single gaur (*Bos gaurus*) appeared the most lucrative, with a mean price of \$317 USD. However, gaur take considerable effort and access to a gun to hunt, whereas pangolin are predominantly caught by hand and fetch a mean price of \$89 USD, making them a profitable target for part-time hunters.

Table 1: Key focal species chosen for our hunter survey based on IUCN red list status and known widespread consumption for wildmeat. The status of each species under recently updated wildlife laws in Myanmar is also shown. It should be noted that even for non-protected species, a hunting permit is required, and these permits are no longer being issued. Therefore, all hunting is effectively illegal in Myanmar. Pangolin species were combined into a single category of ‘pangolin’.

Common Name	Scientific Name	IUCN status	Status Under Myanmar Law
Sunda Pangolin	<i>Manis javanica</i>	CR	Completely protected (no hunting allowed, severe penalties)
Chinese Pangolin	<i>Manis pentadactyla</i>	CR	Completely protected (no hunting, severe penalties)
Arakan Forest Turtle	<i>Heosemys depressa</i>	CR	No specific mention. All emydid species are normally protected, thus can be assumed normally protected (no hunting allowed, less severe penalties)
Malayan Tapir	<i>Tapirus indicus</i>	EN	Completely protected (no hunting, severe penalties)
Tiger	<i>Panthera tigris</i>	EN	Completely protected (no hunting, severe penalties)
Asian Elephant	<i>Elephas maximus</i>	EN	Completely protected (no hunting, severe penalties)
Indian Pangolin	<i>Manis crassicaudata</i>	EN	Not mentioned in protected list
White Handed Gibbon	<i>Hylobates lar</i>	EN	Completely protected (no hunting, severe penalties)
Burmese Roofed Turtle	<i>Batagur trivittata</i>	EN	No specific mention. All emydid species are normally protected, thus can be assumed normally protected (no hunting allowed, less severe penalties)
Burmese Peacock Softshell Turtle	<i>Nilssonina formosa</i>	EN	No specific mention. All trionychid species are normally protected, thus can be assumed normally protected (no hunting allowed, less severe penalties)
Bamboo Rat	<i>Rhizomys pruinosus</i>	LC	Not mentioned in protected list
Malayan Porcupine	<i>Hystrix brachyura</i>	LC	Not mentioned in protected list
Gaur	<i>Bos gaurus</i>	VU	Completely protected (no hunting allowed, severe penalties)
Asiatic Black Bear	<i>Ursus thibetanus</i>	VU	Normally protected (no hunting allowed, less severe penalties)
Clouded Leopard	<i>Neofelis nebulosa</i>	VU	Normally protected (no hunting allowed, less severe penalties)
Leopard	<i>Panthera pardus delacouri</i>	VU	Completely protected (no hunting allowed, severe penalties)

3.1.2 Animals hunted

The 342 respondents in our interview survey reported 38 unique species as being hunted across 55 townships (Fig 3). The most commonly hunted species included muntjac deer (*Muntiacus sp.*), Malayan porcupine (*Hystrix brachyura*), wild boar (*Sus scrofa*), pangolin (three species: Sunda (*Manis javanica*), Chinese (*M. pentadactyla*) and Indian (*M. crassicaudata*)) and bamboo rat (*Cannomys badius*). Pangolin and bamboo rat (*Rhizomys pruinosus*) were extensively hunted in every area of the country where they were reportedly present. The latter was hunted almost entirely for local consumption. Common palm civet (*Paradoxurus hermaphroditus*), Asiatic black bear (*Ursus thibetanus*), gaur, and small cats such as jungle cat (*Felis chaus*) were also hunted, but reported less frequently than pangolin even though some of these species are likely abundant. Less commonly hunted species such as clouded leopard, sun bear, and spotted linsang appeared in fewer responses. None of the respondents in our survey reported hunting tapir, tiger, or elephant.

The majority of key species were reported to have declined over the last five years (Table 3). Bamboo rat was the only species not reported to be declining. Elephants were reported present in 29/55 townships, with the most common sighting frequency being every 6 months and a mean group size of 8.25 individuals. More than half (53%) of respondents reported declines in elephant numbers over the last 5 years.

3.1.3 Hunting and Market Locations

Distances to markets from source locations varied across species (Fig 4). Small animals such as bamboo rat and porcupine generally did not move far between source and market and were most commonly sold in the same or neighbouring villages (bamboo rat mean distance= 1.2

km +/- 5.9 km SD). Similarly, the three species of turtle included in our survey were sold close to the point of hunting (maximum distance for Burmese roofed turtle was 58 km). Pangolin showed the greatest variation in the distance travelled for sale with a mean distance 32.7 km (+/- 31.45 km SD). Gaur and bear were transported slightly longer distances than smaller animals (mean: 18.6 km +/-25.46 km SD & 26.8 km +/- 32.4km SD, respectively). Felids such as leopard and clouded leopard were reported to be transported longer distances, up to 91 km, but there were few reports of these species in the data. The mean distance to market for any species did not exceed 100 km from where it was hunted. These distances reflect the distance to where the hunter would sell goods or where they believed a middleman would bring them. They do not necessarily reflect the end point of sale or consumption of a particular animal.

3.2 Market Survey

Direct market surveys at 20 locations across 18 townships identified through hunter survey responses yielded observations of 22 different species for sale (Supplementary Material, Tables S1 & S2). Among the items available, elephant products and pangolin featured

prominently. Elephant products, predominantly in the form of small carved ivory trinkets or bracelets, were found in six markets across the central, south-central, eastern and southern regions of the country, including tourist markets in Yangon and the capitol Nay Pyi Taw. The mean price for a small ivory bracelet was 19,656 Kyatt (~ \$14 USD); blocks of skin were sold for 20,000 Kyatt (~\$14 USD). Pangolin, both live and their scales, were found in six markets located in the north-west (Shan State) and the south-central region (Bago and Yangon Divisions). The mean sale price for a whole live pangolin was 300,000 Kyat (~\$214 USD) while individual scales could be purchased from 10,000 Kyat each (~\$7 USD). Clouded leopard pelts were found for sale at two locations at Tarlott near Tachilek in Shan State and Pyay in Bago Region. Deer species, such as muntjac and sambar, as well as red goral (*Naemorhedus baileyi*) and Southern serow (*Capricornis sumatraensis*) were widely sold for meat and antlers across all areas surveyed. Other species of note were otter and peafowl at two locations in Shan State and the bills and casques of oriental pied hornbill (*Anthracoceros albirostris*) and great hornbill (*Buceros bicornis*).

Table 2: Summary of hunting practices across all respondents (n=342) including occupation, hunting frequency and distance travelled to hunt and to market. Distance travelled to hunt was estimated by respondents. Distance to market was measured as the straight-line distance between the respondents' village and the stated market location.

Mean Households per Village	Most Common Occupation	Most Common Frequency	Hunt Purpose	Mean Distance to Hunt (km)	Mean Distance to Market (km)
194.29 (+/- 210.77 (SD))	Farming (273/342)	Every Three Months (102/342)	Food (225/342)	10.96 (+/- 10.18 (SD))	12.48 (+/- 34.87 (SD))

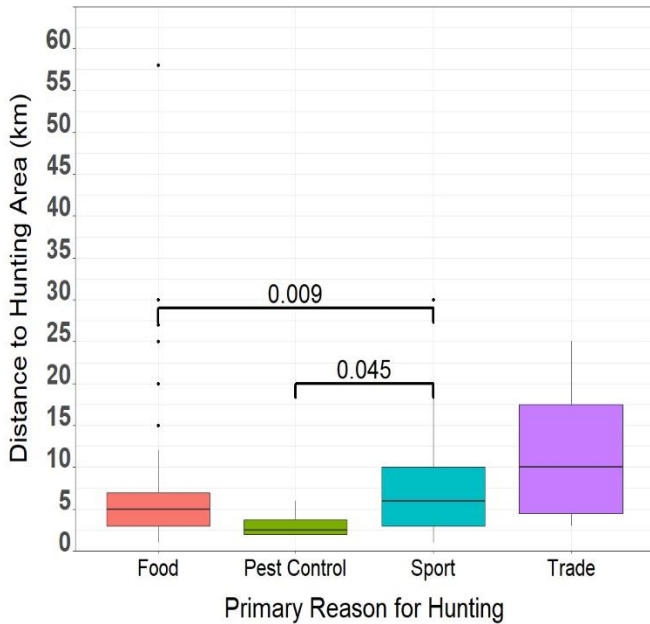


Figure 2: Distance to hunting area grouped by primary reason for hunting. Significant differences were found between distances travelled by those hunting primarily for food and for sport, and between those hunting for pest control and sport (pairwise Wilcoxon tests, p-value: 0.009 and 0.045 respectively).

4. Discussion

Myanmar has long been recognized as a source for wildlife products (Nijman 2010; Nijman and Shepherd 2014; Shepherd and Nijman 2016; Zhang et al. 2017a). However, the country's importance for the regional and global wildlife trade has largely been inferred from scant data provided by general trends in official seizure records (C4ADS 2018; United Nations Office on Drugs and Crime 2016) or from species-specific studies at a small number of key border crossings (Martin 1997; Min 2012; Nijman et al. 2017; Nijman and Shepherd 2015). By carrying out the first national-level survey of hunters, we developed an improved picture of the state of wildlife trade both within Myanmar and across its borders.

4.1 Key Findings

The key findings from our study are: 1) Hunting and local consumption of endangered species is widespread, frequent and largely unregulated, and represents a

major threat to biodiversity in Myanmar and across Southeast Asia; 2) Many of the most targeted species are reportedly decreasing in abundance, with 11 of the 14 key species perceived as declining by a majority of hunters. These species include endangered and critically endangered species such as pangolin, Asian elephant, gibbon, tiger and clouded leopard; 3) Local markets and sole traders combine to form an extensive national network for internal trade and consumption of wildlife products.

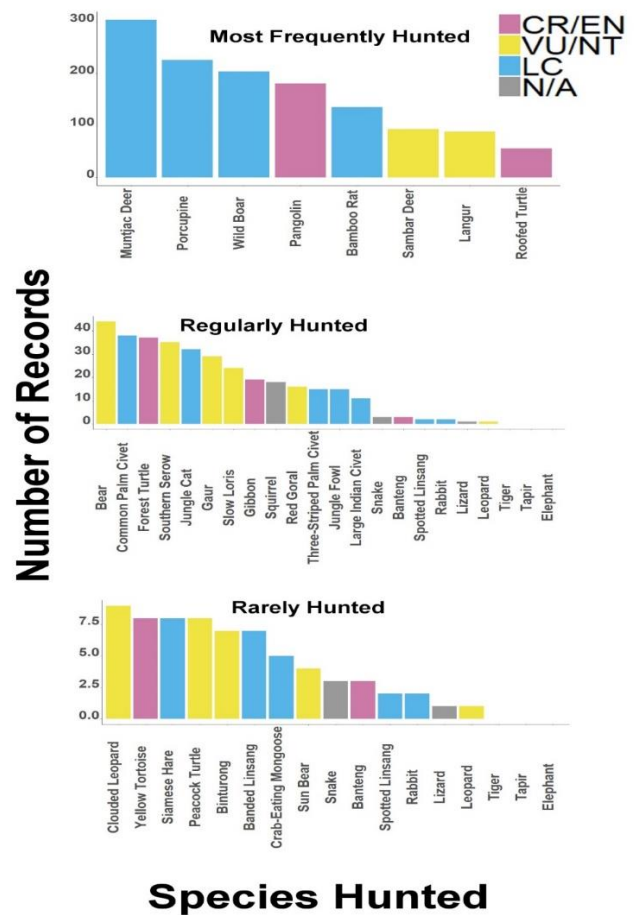


Figure 3: Species reported as hunted (n=342 respondents) in order of number of records split into three categories. Top Panel: most frequently hunted (50-300 records), middle panel: regularly hunted (10-50 records), bottom panel: rarely hunted (0-10 records). Colours indicate IUCN Red List category. CR= Critically Endangered, EN=Endangered, NT= Near Threatened, VU = Vulnerable, LC = Least Concern. N/A is used where a species either has not been assessed or the information was not sufficient to make an identification to species level.

4.2 Species Decline and Hunting Practices

The results of our nationwide survey indicate that hunting of animal species, some of which are endangered or critically endangered, is widespread across Myanmar despite their protected status. A majority of hunters reported population declines for 11 key species in our survey over the past five years (Table 3). Regardless of their perceptions that populations of their preferred species are declining, hunters are continuing to exploit species such as pangolin and gaur, contributing to further declines. Even species which are not currently endangered, such as muntjac deer, are hunted so extensively that their populations may crash if hunting pressure continues unabated. The reported declines in elephant populations are particularly worrying given the recent increase in poaching for the skin trade (Gosling 2018; Sampson et al. 2018) and the continuing trade in ivory (Shepherd and Nijman 2008a). Data from our market survey and those carried out in previous studies (Gosling 2018; Shepherd and Nijman 2008a) show elephant ivory is still available for sale even in major cities such as Yangon and Nay Pyi Taw whereas skin products appear in more rural markets, in border regions and are sold extensively online (Gosling 2018, Supplementary Material, Table S1).

Of the 16 key species originally chosen for this study, 11 are specifically protected by law. Of the remaining three species, Indian pangolin (*Manis crassicaudata*) is not listed but is considered only “possibly extant” in Myanmar by the IUCN and, as mentioned above is easily confused with other, protected species of pangolin. Bamboo rat (*Rhizomys pruinosus*) and Malayan porcupine (*Hystrix brachyura*) are not listed as protected under Myanmar law. However, regardless of their protected status, legal hunting of any species in

Myanmar requires a permit issued by the forest department and the department have ceased issuing these permits some years prior to this study. Therefore, whether species are protected or not, all hunting reported by interviewees and discussed here is illegal. The openness with which hunters and market traders across our study discuss hunting and selling pangolin, clouded leopard, gibbon and other species suggests that there is a lack of public understanding of the law and/or a tacit understanding that the law is not enforced.

Hunting methods varied across species and individual hunters. No hunter relied entirely on one method for every species. A single hunter may use a snare for porcupine but a dog to find pangolin and a shovel to dig out bamboo rat. Guns are strictly controlled in Myanmar, but many hunters still have access to them or make home-made firearms. See Fig S1 in Supplementary Material for a breakdown of hunting methods used for key species.

Critically endangered pangolin are openly hunted and sold across the country and were the 4th most commonly hunted species overall (51% of respondents, Fig 3). This high rate of hunting likely reflects a combination of the ease of capture (normally by hand) and the comparatively high price when sold. The combination of a favourable effort/reward ratio and a lack of enforcement means that even subsistence harvesters, who may not target pangolin specifically, will feel compelled to take them opportunistically whenever they can. While there are no reliable estimates of pangolin populations across Myanmar, this level of hunting pressure is sure to contribute to further declines and implicates Myanmar as a major player in the illegal trade of pangolin.

Table 3: Interview responses on species presence, perceived population trends, hunting frequency, hunting method, and mean price paid to hunters for key species. A total of 342 respondents were surveyed across 154 villages in 55 townships around Myanmar.

Species	Present in Last Year	Declining (% of 'present' responses)	Most Common Hunting Frequency	Most Common Hunting Method	Mean Price (USD)
Pangolin	225	84	Six Monthly	By Hand	89.42 (+/- 63.38 SD)
Porcupine	220	60	Three Monthly	Gun	10.51 (+/- 8.99 SD)
Bamboo Rat	135	24	Monthly	Digging	1.59 (+/- 2.98 SD)
Elephant	58	53	NA	NA	NA
Roofed Turtle	55	60	Monthly	By Hand	5.68 (+/- 10.15 SD)
Forest Turtle	37	51	Six Monthly	By Hand	3.08 (+/- 2.19 SD)
Bear	41	76	Six Monthly	Gun	127.31 (+/- 96.53 SD)
Gaur	29	72	Yearly	Gun	317.75 (+/- 145.85 SD)
Gibbon	19	53	Monthly	Gun	11.36 (+/- 8.22 SD)
Clouded Leopard	9	89	Six Monthly	Snare	59.85 (+/- 50.47 SD)
Peacock Turtle	7	86	Six Monthly	By Hand	8.88 (+/- 15.74 SD)
Tiger	6	83	NA	NA	NA
Leopard	1	100	Yearly	Snare	94.17 (1 Record)
Tapir	0	NA	NA	NA	NA

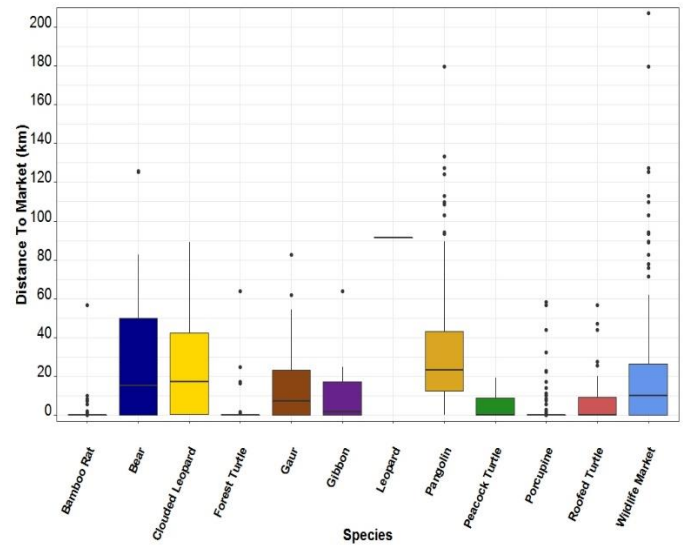


Figure 4: Mean straight-line distance (km) from village survey locations to nearest wildlife markets reported by interviewees to sell each species. The general category (Wildlife Market) summarizes responses to the question “how far is the nearest market that would sell wildlife products?”

None of the interviewees reported hunting elephants or tigers. In the case of elephants, recent publicity campaigns have raised the overall awareness that hunting elephants carries a potentially lengthy jail sentence and hence could make respondents less likely to talk about this subject for fear of implicating themselves. Further, evidence from elephant poaching sites and reports from forestry staff point to a high level of professionalism in terms of killing, skinning, butchering and transporting elephant parts. It is unlikely that those directly involved with professional poaching groups would meet with our survey teams to discuss the practice. In the case of tigers, the estimated population of tigers is so small and fragmented within Myanmar that the likelihood of a hunter encountering a tiger is very low (Lynam et al. 2006). Deliberately hunting a tiger would require a dedicated hunter to invest heavily in time and resources and is probably out of the scope of most of the hunters interviewed. While subsistence harvesters such as those interviewed in this study clearly contribute greatly to hunting pressure across a range of taxa, a limitation of this study is that we did not interview dedicated game hunters and/or organized criminal groups knowingly engaged in illegal hunting as an occupation and as such our data on high-value, low-density species are limited. Gathering detailed information on the hunting of high value targets that are well known to carry stiff penalties will

require additional, highly-focused, potentially covert, operations in collaboration with law enforcement.

The major border crossings for international wildlife trade and markets trading to international visitors in Myanmar have been the focus of the majority of the available literature (e.g. Nijman 2010; Nijman et al. 2019; Oswell 2010; Shepherd and Nijman 2016; Shepherd and Nijman 2008b). Previous studies have revealed free flow of illegal wildlife goods as well as live animals and plants into and out of the country, particularly along Myanmar's eastern border (e.g. Clements et al. 2014; Nijman 2014; Nijman et al. 2019; Nijman and Shepherd 2014; Nijman et al. 2016; Shepherd et al. 2018; Zhang et al. 2017a). However, quantifying levels of cross-border traffic in illegal wildlife products requires timely and accurate reporting by competent authorities in countries across the trade network. Assessments that rely solely on official records of seizures at border crossings, particularly from countries that lack strong governance and are poorly equipped to intercept smuggled wildlife products, likely vastly underestimate the trade volumes crossing borders (Nijman 2010). Such assessments also omit all products sold and consumed domestically.

4.3 Trade Routes

Logistical challenges coupled with either limited or inaccessible records on wildlife crime have left large gaps in our knowledge of the illegal wildlife trade within Myanmar and the role it plays in international trafficking of endangered species. Although Myanmar often features in maps of the international wildlife trade (C4ADS 2018) there are few seizure records and these maps only offer a generalized route for wildlife products from Myanmar to China and Thailand (D'Cruze and Macdonald 2015; Foley et al. 2011; Xu et al. 2016). Several studies have highlighted the importance of a

small number of towns on the Myanmar-Chinese border as major hubs for trade in a wide variety of species. In particular the towns of Mong La and Tachilek in eastern Shan State have been identified both in published literature and in news media as being key junctions for the flow of wildlife goods into China and Thailand (Nijman 2010; Nijman and Shepherd 2015; Nijman et al. 2016; Shepherd and Nijman 2008a). Mong La is known as a destination for Chinese tourists wishing to purchase wildlife products. Other studies have focused on the north-eastern Kachin State as a key source of pangolin flowing into China (Zhang et al. 2017b).

We are aware of only one study that attempted to map actual trade routes within Myanmar and utilized major roads to link large, well-known markets across Myanmar (Clements et al. 2014). While these major markets form important hubs of trade and cater to the international market (Nijman and Shepherd 2014), results from our nationwide survey reveal a widespread, if fragmented, network of smaller markets across the entire country. As can be seen from the recorded distance between source and market in our survey (Fig 4), hunting areas are often close to consumption areas that may also represent the first point of sale for illegal wildlife products entering the trade network. While there has been much focus on China and Chinese tourists as the major market for wildlife products produced in Myanmar, we show that many species, even critically endangered pangolin, are being sold and consumed locally, rarely travelling across more than one township from hunter to first point of sale. We acknowledge that this survey does not capture re-sale of items and is built on the responses of harvesters at the point of origin only. Our data suggest that increased enforcement of wildlife laws in centrally controlled areas away from the borders is important in

stemming the flow of wildlife products to domestic and international markets and could potentially throttle the supply to markets such as Mong La and Tachilek. Further interviews with traders, and crucially, with middlemen, could fill gaps in the fragmented information on trade networks documented here and shed further light on the links between domestic wildmeat consumption and international trade.

4.4 Legislative Changes

The new national law on wildlife crime (Conservation of Biodiversity and Protected Areas Law, enacted in May 2018) has made several major improvements over previous legislation (The Protection of Wildlife and Protected Areas Law enacted June 1994). The most significant changes are: 1) penalties have increased with minimum sentences specified, 2) use of protected species parts in traditional medicine is no longer exempted and, 3) species prohibited under CITES are now incorporated into the law.

Previous legislation required the Ministry of Natural Resources and Environmental Conservation to issue an official sanction for any case before it could proceed to court. This effectively placed the sole authority for enforcement on the Ministry. This unnecessary bottleneck for enforcement has now been removed. However, the law lacks detail on enforcement-related matters, including which government agency should be the enforcement authority for illegal wildlife trade cases, and who has authority for wildlife that falls under management of a different ministry (e.g. marine species). Even with these recent changes public understanding of and compliance with these laws is still severely lacking. Across all the species recorded in our survey, none of them can be legally hunted yet subsistence hunters routinely hunt and sell such species

as pangolin and forest turtles and talk openly about doing so. Indeed, our survey teams reported a perception amongst respondents that subsistence hunting is distinct from hunting which is done by professional hunters who spend weeks at a time in the forest. The true nature, number and extent of activities of these supposed professional gangs of transient hunters remains to be confirmed and may in some cases be a convenient 'bogy-man' on which to hang the blame for species declines due to excessive local hunting.

Conclusions

Our results paint a stark picture of wildlife harvesting and trade in Myanmar. Critically endangered, endangered, vulnerable, and near threatened species across taxa including birds, turtles, cats, pangolin, and elephant are widely hunted, consumed, and sold around the country and across borders. Urgent intervention is needed to save many of these species from extirpation and to forestall declines in more common species that are heavily hunted. Our hunter survey has produced a detailed overview of the wildlife trade on the ground in Myanmar, but many gaps in our knowledge remain. None of the data cited or collected in this study relate to the trade in illegally hunted marine species, many of which are of conservation concern. There remains little published literature concerning the online wildlife trade in Myanmar and beyond. Our surveys did not capture this trade as it was beyond the scope of the current study, but online trade, particularly for the pet trade, potentially represents a major black market for wildlife in Myanmar as in neighbouring countries (Gomez and Bouhuys 2018). Our survey allowed us to map out the first step in the pathway of illegal wildlife products as they come directly from the forest. Further studies should target the aggregation and re-sale of products

through middlemen and depots to explore connections between the many fragmented sub-networks, such as those identified in our study.

Our data suggest that shifting focus from high profile market locations that are essentially out of government control, in favour of enhanced policing of markets and trade routes with road checks along key internal routes could have significant impact on the flow of wildlife products within and through Myanmar. Domestic consumption and trade of wildlife species is a major factor in the declines of threatened species across the tropics and needs to be addressed in tandem with a focus on demand reduction in the international market. Our survey of hunters clearly shows that the majority of hunting reported is driven by subsistence harvesters taking whatever species are available. While strong enforcement of new wildlife laws is needed, taking punitive measures against subsistence harvesters would punish those who may have no viable alternative to support their families and is unlikely to effectively reduce harvesting. However, increasing income alone has been linked by one study to increases in consumption of wildmeat (Rentsch and Damon 2013). In cases where domestic consumption and local trade are driven by economic disadvantage, governments and NGOs need to work together to provide low-cost alternative sources of protein to divert these subsistence harvesters away from hunting (Fargeot et al. 2017; Rentsch and Damon 2013).

The complex interplay between domestic consumption of wildmeat and the illegal wildlife trade requires a multi-level approach that focuses not just on criminality and law enforcement, but also on the social and economic context within which harvesters are living. A combination of improved enforcement of newly strengthened laws, community outreach, and providing

alternative sources of protein will be required if the forests of this keystone country for Asian biodiversity are to be saved from falling silent forever.

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