Wildlife conservation in Myanmar: trade in wild sheep and goats for meat, medicine, and trophies, with links to China, India, and Thailand

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Abstract
In Myanmar, the hunting and trade of wildlife are increasingly recognised as a major threat to the persistence of species. We here focus on the trade and conservation of wild sheep and goats (Caprinae; Antilopinae) as these species are indeed hunted and traded for a variety of reasons. Seizure reports from 2000 to 2020 and 20 visits to four wildlife markets between 1998 and 2017 resulted in records of ~2,000 body parts, the equivalent of ~1,200 wild sheep and goats. When combined with data from previous surveys conducted over the same period, the number of wild sheep and goats recorded in trade increase substantially, i.e. serow (the equivalent of 1,243 animals), goral (213 animals), takin (190 animals), blue sheep (37 animals), and Tibetan antelope (10 animals). With records from 10 out of 15 States, trade appears to be widespread and persistent over time. There was poor concordance between seizure data and trade observations, but data from various surveys are largely in agreement. The most prevalent body parts in trade were horns, followed by plates (the frontal portion of the skull with horns still attached) and heads of freshly killed animals. These parts are offered for sale both for decorations and for their purported medicinal properties. Meat, fat, and rendered oils were observed frequently but because of mixture with other wildlife, it was challenging to confirm species identity or to convert this to number of animal equivalents. Tongues and eyes were offered for sale as medicine. In order to better protect wild sheep and goats in Myanmar, it is imperative that the illegal trade in their parts is more effectively curbed than at present. This is the responsibility of both the Myanmar authorities and, given the high prevalence of trade in border towns, their international partners, including China and Thailand.

Keywords Conservation · CITES · Illegal wildlife trade · Southeast Asia · TCM · Wild meat

Introduction
Myanmar is the largest country in Southeast Asia with some of the highest potential for biodiversity conservation. While little primary forest remains in Myanmar as a whole, several States and Regions still have substantial forest cover, and, importantly, compared to other parts of Southeast Asia the percentage of forest that is under threat is relatively low (Rao et al. 2011; Anonymous 2014). Natural forest is found in two broad types in Myanmar, i.e., evergreen forest and deciduous forest (Whitmore 1975). Both broad types of forest are characterized by large mammal species such as the Asian elephant *Elephas maximus*, gaur *Bos gaurus*, Asiatic black bear *Ursus thibetanus*, and tigers *Panthera tigris*, and, until recently, both Javan rhinoceros *Rhinoceros sondaicus* and Sumatran rhinoceros *Dicerorhinus sumatrensis* (Shepherd and Shepherd 2012). While the species richness is high, partially because the country is situated on the borders of the Indo-Malayan, Indian, and Eastern Palearctic Regions and thus having representatives of all their faunas within its borders, levels of endemism (at the country level) are low. Many of the mammal species with globally small geographic ranges that are known to occur in Myanmar are found in neighbouring countries such as India to the west, China to the north and east and Thailand to the southeast. However, establishing the level of endemism is partially dependent on what taxonomic treatment one follows. Recent taxonomic revisions of, for instance, the ungulates

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(Groves and Grubb 2011) suggests that the number of species in Southeast Asia is higher than previously thought – some of these species may turn out to be Myanmar country endemics. Myanmar has committed to safeguard its wildlife through national legislation and international conventions, including the Convention on Biological Diversity (CBD, ratified in 1994) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, ratified in 1997). To fulfill its commitments to the CBD, Myanmar has vowed to maintain diverse, representative ecosystems and biodiversity. Sustainable use of wildlife and strict protection of imperiled species are two cornerstones of this commitment. The protection of wildlife in Myanmar is governed by the Biodiversity and Protected Areas Law which was recently amended in 2018. Under this law, species are afforded varying levels of protection within three main categories, i.e. completely protected, normally protected and seasonally protected.

Despite these international agreements and national protection, Myanmar is rapidly losing its wildlife due to illegal hunting to supply demand for local subsistence and the commercial wildlife trade at both national and international levels (BirdLife International 2005; Shepherd and Nijman 2007a; Oswell 2010; McEvoy et al. 2019). Illegal wildlife trade in Myanmar is widespread and often carried out openly due to weak enforcement efforts, political instability, and high levels of corruption (Shepherd 2001; Shepherd and Nijman 2007a; Oswell 2010; Nijman and Shepherd 2014). Myanmar has some of the last large open wildlife markets in Southeast Asia, with many of these being situated immediately on international borders (Shepherd and Nijman 2007b; Nijman and Shepherd 2014). Ilicitly obtained wildlife flow virtually unchecked through Myanmar’s porous borders at numerous locations in violation of national legislation and international conventions (Davidson 1999; Shepherd and Nijman 2007b; Oswell 2010; Nijman and Shepherd 2014; Nijman et al. 2016).

Among the myriad of species threatened by trade in Myanmar, but which have received little conservation attention, are the wild sheep and goats (Family Bovidae, sub-families Caprinae and Antilopinae), poached for local subsistence and commercial trade. Meat used and traded for consumption and body parts are traded for use in traditional medicines and as trophies (Shepherd and Nijman 2016; Nijman and Shepherd 2017). The taxonomy of wild sheep and goats has been subject to much debate and change over the years and has yet to be fully resolved but it is evident that Myanmar hold large populations of several imperiled species. As such, the country bears a large responsibility for global wild sheep and goat conservation.

Here we aim report on the parts and species of wild sheep and goats, and animal equivalents, that (1) have been confiscated by the Myanmar authorities, (2) we observed in wildlife markets and shops and (3) that others have reported. We then specifically test if seizures are reflective of what is observed in markets, if there are differences between markets located in different States and Regions, and we test if the species composition of wild sheep and goats in trade differs between studies that have been conducted over the last two decades.

Methods

Study species and taxonomy

Wild sheep and goats are included the family Caprinae and the closely related monotypic Pantholopinae (Gatesy et al. 1997), although some include Pantholopinae within the Caprinae. The taxonomy of this group of species has been confusing, to say the least, and has been revised multiple times over time, especially the serow and gorals. For serow and gorals, we follow here the latest revision by Mori et al. (2019), which reduces the number of species of serow and goral in Myanmar to two each. Takin too are problematic, and while the IUCN Red List of Threatened Species (hereafter the Red List), recognises one species (with four subspecies (Song et al. 2008)), Groves and Grub (2011) and Castelló (2016) recognise four species. In any case, the Mishmi takin Budorcas taxicolor is the only species occurring in Myanmar and we assume here that it is the only species of takin observed in trade in Myanmar. We here include the Tibetan antelope Pantholops hodgsonii (Pantholopinae) as well, and this is the only species observed in this study that is not native to Myanmar.

Blue sheep Pseudois nayur (considered by some authors as greater blue sheep, split with the dwarf blue sheep Pseudois schaeferi; Groves and Grub 2011) have a wide range covering Bhutan, China, India, Myanmar, Nepal, and Pakistan (Harris 2014). They were first identified as being present in Myanmar in 1996 and are only known to occur in the extreme far north of the country in Kachin State (Rabinowitz and Khaing 1998). There is very little data on the species in Myanmar. They are known to be poached for local subsistence needs and their horns have been observed for sale in wildlife markets, in Putao in 1996 (Rabinowitz and Khaing 1998) and Putao and Myitkyina in 2010 (Sapai 2012). Nevertheless, poaching for trade is considered rare and not a significant threat to the species due to the remoteness and difficult accessibility of blue sheep habitat (Harris 2014). Blue sheep are assessed as Least Concern (Harris 2014).

Myanmar is home to two goral species, the Himalayan goral Naemorhedus goral (which now includes Chinese goral N. griseus (Mori et al. 2019)) found in the eastern and western regions of the country, and the red goral N. baileyi found in the northern most part of the country. There are
no populations estimates for either species, but populations are in decline because of hunting to meet demand for their fur, meat, and parts used in traditional medicine (Duckworth and MacKinnon 2008; Nijhawan 2020). The red goral in particular is considered rare in Myanmar primarily due to its restricted range, compounded by trade-driven hunting (Nijhawan 2020). The Himalayan goral is assessed as Near Threatened (Duckworth and MacKinnon 2008), and the red goral as Vulnerable by the Red List (Nijhawan 2020).

There are two species of serow found in Myanmar, the red serow Capricornis rubidus and the mainland serow C. sumatraensis (the latter now including the Chinese serow C. milneedwardsii (Mori et al. 2019)). In Myanmar, the mainland serow (formerly referred to as the Sumatran serow) is found across much of Myanmar (Groves and Grubb 2011) with its distribution appearing to follow the forested mountain ranges surrounding the central plains. There is little information on the status of the red serow (Shepherd 2021), but it is thought to be in decline due to habitat loss from logging and due to poaching (Castelló 2016; Shepherd 2021). Its precise range in Myanmar is poorly known but it has been found in the north and possibly west of the country (Castelló 2016; Shepherd 2021). In general, serow are widely hunted for their meat which is eaten and for their body parts which are used as ingredients in traditional medicines, throughout their range in mainland Asia (Shackleton 1997; Shepherd and Krishnasamy 2014; Leupen et al. 2017; Phan et al. 2020). In Myanmar, serow are heavily hunted and traded for their meat which is usually consumed by the hunter and the hunter’s family, and perhaps close neighbours and extended family, and parts are sold for use in local traditional medicines and as trophies or talismans. Serow are frequently observed in wildlife markets in Myanmar, especially those close to international borders, indicating further demand from neighbouring countries. Both serow species are assessed as Vulnerable by the Red List with populations believed to be in significant decline due to over-hunting for food and medicine (Phan et al. 2020; Shepherd 2021).

Takin have a wide range occurring in Bhutan, China, India, and Myanmar (Song et al. 2008), with the species native to Myanmar considered to be the Mishmi takin (Groves and Grubb 2011; Castello 2016). This species is restricted to the northern regions of Myanmar and were once considered common near Mt Hkakabo-Razi Protected Area (Rabinowitz and Khaing 1998). Populations are now considered rare as over-hunting for meat has resulted in significant population declines (Song et al. 2008) and is assessed as being Vulnerable in the Red List. In addition to information from hunters, takin parts have also been observed for sale in Myanmar’s wildlife markets (Shepherd and Nijman 2016). The Tibetan antelope does not occur in Myanmar. The populations closest to Myanmar are found in China and India. The species is assessed as Vulnerable on the IUCN Red List (Song et al. 2008).

Four of the species we focus on are listed as completely protected under Myanmar’s legislation; goral, serow, takin, and Tibetan antelope involving Myanmar for the period 2000 to 2020. We obtained data from the Government of Myanmar, WCS Myanmar as well as from publications, open source media, the CITES trade database, and grey literature. We included records involving Myanmar as an origin, transit point, or end destination.

We conducted market surveys of trade in wild goats and sheep intermittently in Myanmar over two decades. Four main locations known to be wildlife trade hotspots were visited repeatedly i.e., Kyaiktiyo, which is also known as Golden Rock (April 2000, February 2006, June 2015, January 2017), Mong La (February 2006, February 2009, December 2013, January 2014, March 2015, February 2016), Tachilek (July 1999, January 2000, February 2006, February 2009, June 2011, December 2013, June 2017), and Three Pagoda Pass (April 2006, June 2017, September 2017). Surveys were mostly conducted in open wildlife markets and traditional medicine retail outlets and lasted between a morning or an afternoon and four days (e.g. Shepherd and Nijman 2007a, b; Nijman and Indenbaum 2017). In addition, we made several visits to wildlife shops in Yangon (February 2006, June 2015, July 2015, January 2017), Mandalay (February 2006), and Taunggyi (February 2006). We recorded all wildlife products that were openly displayed.

Finally, to obtain a more comprehensive overview of the trade in wild sheep and goats, and to a lesser degree the pressures that hunting asserts on these species, we reviewed the literature. A number of other research teams have reported on the conservation and use of wild sheep and goats in Myanmar in a quantitative manner, i.e. Rao et al. (2005, 2010, 2011), Sapai (2012), and Nijman (2015) all report on Kachin State in the north of Myanmar, Sapai (2016, 2017) report on Shan State, and McEvoy et al. (2019) report on a country wide assessment. Methods of data collection differed, and included hunter and traders’ interviews, trade records, seizure data, and direct observations in shops and wildlife markets, but all report on the number of individuals involved.
or number of body parts. We converted this to a minimum estimate expressed as individual animals. Given the complexity in taxonomy, and different taxonomies used by these authors, for goral and serow, we analyse these data at the generic level.

Analysis

For each survey and each study, we estimate the minimum number of animals that had to have been killed in order to obtain the observed parts. In this, we used a conservative approach, assuming that parts were perfectly distributed among all vendors. Thus, within one market, the observation of two legs of a serow in one shop and a set of horns in another are considered to have come from one animal. We refer to this as ‘equivalents’. Wildlife parts of wild sheep and goat species observed in trade were tallied and an estimate of the numbers of animal equivalents entering the markets were made. Where survey methods were the same, they were carried out spread out over long periods of time, and therefore, these figures are likely underestimated but they do provide a sense of the scale of the illegal and open trade in these species. Considering significant time passed between surveys, it is assumed here that no parts were counted twice as it is unlikely wildlife traders would retain stock for this long. Based on observations of these species in trade, a map was developed to highlight places of high concern, especially those on international borders.

We expect that the seizures reflect what is offered for sale in the markets, i.e., we expect the species composition not to differ significantly between these two datasets. We expect that the species composition and main body parts on offer not to differ between markets. Different body parts are sold for different purposes, including medicinal, ornamental or trophies, and charms. We hypothesise that trade in sheep and goat parts is demand-driven, and that if the markets cater for a similar clientele, the relative proportion of body parts do not differ between markets or between years. We tested for a deviation from a homogeneous distribution of body parts with $x^2$ chi tests, applying Yates’ correction where appropriate, and accepting significance when $P < 0.05$ in a two-tailed test.

Results

Seizures of wild sheep and goats

A total of nine seizure incidents were obtained over the last two decades (Fig. 1); seven of these occurred within Myanmar and one each in the Thai and Indian border regions involving Myanmar nationals. Serow was identified as being confiscated in seven seizures, takin in two incidents and red goral in one incident. Based on these nine records, seized commodities was estimated to amount to a minimum of 128 animals. For red goral four horns were seized, for takin two horns and 50 kg of meat, and for serow 1 live animal was seized, in addition to four hooves, ten legs, two pieces of meat and 241 horns and 12.4 kg of horns. There was a significant difference in species composition and numbers of what was seized and what we observed in markets ($x^2$ chi $= 182.12$, $df = 4$, $P < 0.0001$). This was partially driven by the differences between the number of takin we observed in the markets and the number that was seized ($x^2$ chi $= 150.73$, $df = 1$, $P < 0.001$).

Wild sheep and goats observed in wildlife markets and wildlife shops

In total, an estimated 1,041 wild sheep and goat equivalents (i.e., 35 blue sheep, 93 goral, 810 serow, 90 takin, and 13 Tibetan antelope) were observed in the four wildlife markets. In addition, we observed the equivalents of two serow in Mandalay and one serow in Taunggy. Meat that purportedly was from wild sheep or goats was observed in wild meat restaurants in Yangon, Kyaiktiyo, Mong La and Three Pagoda Pass. Tongues and eyes were offered for sale as delicacies and as medicine. Serow was the most common species found in trade in every location surveyed. In comparison, takin was only observed on four occasions in Tachilek with the highest numbers recorded in 1999 and 2000, and goral observed once in Mong La and Tachilek respectively, with the highest numbers in 2017. The three species were not observed in equal numbers in the four wildlife markets ($x^2$ chi $= 152.24$, $df = 12$, $P = 0.000$). This was largely driven by the trade in takin in Mong La (many more than expected) and trade in goral in Kyaiktiyo (far fewer than expected) (Table 1)

A total of 1,759 identifiable animal parts were observed in trade (Table 2). Individual horns were the most abundant animal part in trade, followed by plates (the frontal portion of the skull with horns still attached), followed by heads (freshly killed) with horns attached and skulls with horns attached. Serow parts in particular were the most common and most varied of all the species observed predominantly for use in traditional medicine. This included relatively fresh parts (i.e. heads with or without horns attached, legs, tail, and tongue), more durable parts (i.e. skulls and plates) and processed parts (i.e. bottled ointment containing oil made derived from serow fat and glands). Meat of various wild sheep and goats were observed on various occasions and in different markets, as were buckets of serow oil, often recognisable by the presence of serow heads soaking in the oil, but it was not possible to equate the oil to animal equivalents. The distribution of different body parts (heads, skulls and plates, horns, and meat) was not equal for the four species.
(χ² chi = 292.59, df = 9, P < 0.001); for instance, there were relatively more takin skulls that expected and fewer serow skulls and plates and fewer takin meat than expected.

Figure 2 are photos of market survey locations in Myanmar along with serow and takin body parts observed for sale.

**Overview of trade in wild sheep and goats**

Combining the data from various surveys conducted over the last two decades shows that the equivalent of a minimum of 1,517 animals was observed (Table 3). The numbers that were reported differed greatly, with relatively large numbers reported by Rao et al. (2005, 2010, 2011), Nijman (2015), and the present study and conversely low numbers reported by Sapai (2012, 2016, 2017) and McEvoy et al. (2019). The relative contribution of the different species (highest for serow, followed by takin or goral, and lowest numbers for blue sheep and Tibetan antelope) was consistent between studies. Given that the different studies covered the last two decades more or less equally, it is also clear that there is a persistent trade in wild sheep and goats. The studies found different proportions of the species of wild sheep and goat in trade (χ² chi = 285.10, df = 20, P = 0.000). Rao and colleagues observed more goral and fewer serow than the other studies; Sapai (2012) found fewer serow. McEvoy et al. (2019) recorded substantially more goral relative to the others, and we recorded fewer goral than what we could expect on the basis of the observations made by others. We mapped the records of wild sheep and goats (Fig. 2) and while it is clear that the trade has been observed in a large number of States...
and Regions these records are not equally distributed over the country. Areas that stand out because of their large number of records include Kachin (including parts that border China), Shan (including border areas with China and Thailand), and Mon and Kayin (including areas bordering Thailand).

**Discussion**

We documented a small number of seizures in wild sheep and/or wild goat species from 10 States and regions. We recorded wild sheep and goat species for sale in each and every survey we conducted in the four wildlife markets. Combined seizures and market observations totalled almost 600 individuals. Other than the reports we included in our review, there is limited information available on the trade in wild sheep and goats in Myanmar, but it is expected to be even more widespread that our analysis suggests. Davis et al. (2020), for instance, reported on the widespread knowledge, and use, of traditional medicine made from serow, in Myanmar’s Rakhine State, without quantifying this in terms of the number of animals involved. Evans et al. (2020) reported on the trade in serow (horns, meat, and oil), but not other wild goats and sheep, in Nyaung Lay Pin. Sapai (2020) also reported on the use of serow as an ingredient for traditional medicine, with relatively high number of interviewees indicated them being aware of its usage (51/210 interviewees in Yangon, Mandalay, and Tachilek). Importantly, however, her research did not indicate the use of wild sheep or goat species were important as a source of wild meat, with only 1/210 interviewees mentioning serow (but no other sheep or goats) being used for meat. Nye Mow Shwe (pers. comm. 2015) recorded serow horn sets for sale in Traditional Asian Medicine shops in Yangon’s Shwedagon Pagoda. Tun (2001) noted that serow were heavily hunted in all seasons in Hkakaborazi National Park and takin were hunted as well with their horns fetching high prices. Zhang et al. (2017) surveyed markets in Putao, near Hkakaborazi National Park, on 15 occasions in 2015 – 2016 and found serow meat for sale. Our data, combined with that of others, suggest that throughout Myanmar takin, serow, goral and, to a lesser degree, Tibetan antelope and blue sheep are important both as sources of wild meat, as decorations and as medicine.

Nijman (2015) reported on the observations of parts of takin (whole animals, carcasses, skulls, skins, and horns), mainland serow (carcass, skulls, skins, feet, and horns), and other wild sheep and goats in the Imawbum Mountains, Kachin State in the period 2010 – 2014. He reported that most were hunted using iron traps or, less commonly, guns. Information provided by the hunters and villagers suggested that parts were sold on to Chinese-owned timber companies operating in the area, or directly to Chinese traders across

| Year | Species          | Kyaiktiyo La | Mong La | Tachilek Three Pagoda Pass |
|------|------------------|--------------|---------|---------------------------|
| 1999 | Takin            | 43           |         |                           |
| 2000 | Goral            | 82           |         |                           |
|      | Serow            | 46           | 466     |                           |
|      | Takin            | 39           |         |                           |
|      | Blue sheep       | 35           |         |                           |
|      | Tibetan antelope | 3            |         |                           |
| 2006 | Goral            | 1            |         |                           |
|      | Serow            | 18           | 7       | 37                        |
|      | Takin            | 7            |         |                           |
| 2009 | Serow            | 12           |         |                           |
|      | Tibetan antelope | 5            |         |                           |
| 2013 | Serow            | 46           |         |                           |
| 2014 | Serow            | 46           |         |                           |
|      | Tibetan antelope | 4            |         |                           |
| 2015 | Serow            | 9            |         |                           |
| 2016 | Serow            | 6            |         |                           |
|      | Tibetan antelope | 1            |         |                           |
| 2017 | Goral            | 10           |         |                           |
|      | Serow            | 43           | 76      | 5                         |
|      | Takin            | 1            |         |                           |
| Total|                 | 107          | 91      | 801                       | 42 |

Table 1 Observations of wild sheep and goat species in four wildlife markets in Myanmar and estimated number of animals that were recorded

| Commodity                  | Blue sheep | Goral | Serow | Takin | Tibetan antelope | Total |
|----------------------------|------------|-------|-------|-------|------------------|-------|
| Head (horns attached)      | 89         |       |       |       | 92               | 1,312 |
| Skull (horns attached)     | 40         | 1     | 41    |       | 246              |       |
| Plate or horn set          | 35         | 4     | 110   | 89    | 8                | 246   |
| Horn                       | 181        | 1,128 | 1     | 2     | 1,312            |       |
| Tail                       | 6          |       | 6     |       | 6                |       |
| Tongue                     | 3          |       | 3     |       | 3                |       |
| Leg                        | 54         |       | 54    |       | 54               |       |
| Skin                       | 5          |       | 5     |       | 5                |       |
the border in Yunnan. These observations are in line with that what was reported by Sapai (2012) based on data collected a few years prior in the same province. Sapai (2012) over the course of three years (2007 to 2010) made eight visits to the market towns of Putao, Tanai, Myitkyina, and Lazai in Kachin State, where she recorded a large number of wild sheep and goat parts.

Our observations are in sharp contrast to that what was reported by McEvoy et al. (2019) and Sapai (2016, 2017, 2020) in that we find the trade in wild sheep and goats to be more significant than they do. McEvoy et al. (2019) surveyed six wildlife markets and wildlife shops in 15 townships or cities. An unknown number of red goral was recorded in five townships (Muse, Lewe, Terchileik, Taungup, Tatkon) and serow was observed in one (Putao). Based on interviews with 342 hunters in 165 villages in 55 townships in 14 States, McEvoy et al. (2019) furthermore found that none of the wild sheep or goat species was reported as present or hunted in a large enough frequency to be picked up as being of significance. Their results suggested that the trade in wild sheep and goats was of minor importance. Sapai (2016) reported making six visits to Mong La in 2014–2015 surveying the market for several days each visit, and recorded a total of 15 pairs of Chinese serow horns and 20 serow heads with horns, but no other wild sheep or goat species. During two visits in the same period, we recorded 54 serow and 4 Tibetan antelopes.

Sapai (2017) made six visits to Tachilek in 2016 and 2017 and observed one or more red serow heads and one or more Chinese (mainland) serow skins and horns. During a single visit to the same market in 2017, we observed the equivalent of 10 goral, 76 serow, and one takin, suggesting that

Table 3 Minimum numbers of wild sheep and goat equivalents observed or reported in various studies conducted in Myanmar over the last two decades

| Species         | Rao et al. (2005, 2010, 2011) | Sapai (2012) | Nijman (2015) | Sapai (2016, 2017) | McEvoy et al. (2019) | This study (2021) | Combined |
|-----------------|-------------------------------|--------------|---------------|--------------------|---------------------|------------------|----------|
| **State/regions** |                               | Kachin       | Kachin        | Shan               | Countrywide         | Countrywide      |          |
| **Period**       |                               | 2002–2006    | 2007–2010     | 2010–2014          | 2014–2017           | 2018             | 1999–2020 |
| Blue sheep      | 0                             | 2            | 0             | 0                  | 0                   | 35               | 37       |
| Goral           | 95                            | 9            | 7             | 0                  | 5                   | 93               | 209      |
| Serow           | 138                           | 25           | 62            | 37                 | 1                   | 810              | 1,073    |
| Takin           | 51                            | 33           | 14            | 0                  | 0                   | 90               | 188      |
| Tibetan antelope| 0                             | 0            | 0             | 0                  | 0                   | 10               | 10       |
Tachilek is a more significant trade hub for wild sheep and goats than Sapai (2017) found it to be. Sapai (2020) reported that based on interviews with 210 people in Yangon, Mandalay, and Tachilek, only one interviewee in Mandalay indicated that serow was a species from which wild meat was eaten. Our findings suggest that meat is indeed largely eaten outside cities, with most of it being consumed by the hunters and their families.

In neighbouring countries, there are also numerous records of these species in trade. Nooren and Claridge (2001) gave a comprehensive overview of wildlife trade in Lao PDR and included information on the trade in serow for meat, bones, bile, and other purposes. Johnson et al. (2003) noted that during household surveys in northern Lao PDR, nine out of ten respondents stated that serow was the most frequently used animal in traditional medicine production. Focussing solely on serow, Leuppen et al. (2017) observed the equivalent of at least 150 serow for sale throughout Lao PDR. Serow have been reported in trade for their meat and for their body parts used in traditional medicines in Malaysia as well (Shepherd and Krishnasamy 2014). Krishnasamy et al. (2019) reported that 18 seizures of serow parts had been made by the authorities from 2003–2019, which involved at least 27 individual serow. More recently, Davis and Glikman (2020) reported on the use of mainland serow, but not of other wild sheep or goats, in Lao PDR. Li and Wang (1999) reported on the trade in blue sheep, goral, and serow in Kunming, Jinpin, and Dulang in China’s Yunnan province, and Yi-Ming et al. (2000) reported on the seizure of 1000 s of kg of goral meat and two live gorals in China’s Sanxi province. It is unclear how many of these observations and seizures have links to Myanmar.

Wildlife trade in Myanmar is a major threat to a growing list of species in Myanmar, and clearly the wild sheep and goat species are no exception. Demand for their parts, largely sold as traditional medicines or for trophies, continues to drive poaching and trade, and ultimately the from the decline in all of these species in the wild. Serow appears to be the species most frequently poached and traded being the most frequent and abundant animal found in both seizures and market surveys. Despite legal protection, trade continues blatantly across Myanmar. Considering the numerous market observations of these species openly for sale and the corresponding lack of seizures indicates a serious lack of enforcement. There was also evidence of cross-border trafficking of species in violation of international regulations. Myanmar and all neighbouring countries are Party to CITES and therefore all cross-border trade in those species listed in Appendix I of the Convention is illegal. Having said this, Tibetan antelope parts were observed for sale, illustrating a clear violation of the Convention as this species is not native to Myanmar. Myanmar nationals were also caught for illegally hunting serow and takin in neighbouring India and Thailand further illustrating the threat to wild populations not just in Myanmar but across the region.

On the basis of our study, we suggest that there is a clear need for more effective monitoring, enforcement, and prosecution in order to deter the illicit trade in wildlife, as to ultimately reduce the pressure on these imperilled species. Further emphasising the need for stronger enforcement of the CITES Convention is the fact that three of the markets examined here are situated in Myanmar immediately on international borders with China and Thailand, as the main customer base comes from those countries. Relevant enforcement agencies within the Myanmar Government should increase vigilance and enforcement efforts in the markets outlined here, and all illegal trade in wild sheep and goats should be acted upon with offenders being prosecuted to the full extent of the law. Effective enforcement and suitable prosecutions are essential to ensure law is respected and the decline in these threatened species is stopped and reversed.

Monitoring of wildlife trade is essential to remain informed of the trade in illegal and threatened species. Random and opportunistic surveys provide only a snapshot of the true scenario, but are important nonetheless as they provide information to not only inform conservation interventions, but also to support enforcement actions. Such surveys should continue in the markets of Myanmar to support future actions and to measure the success of deterrents.

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Author contribution Study conception and design were done by Chris Shepherd and Vincent Nijman. Data collection and analysis were performed by Chris Shepherd, Vincent Nijman, Penthai Siriwat, and Lalita Gomez. The first draft of the manuscript was written by Chris Shepherd, Lalita Gomez, and Vincent Nijman. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.
Declarations

Competing interests The authors declare no competing interests.

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