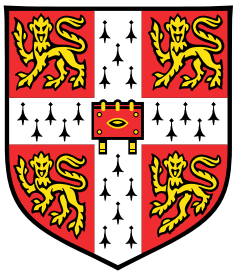
Characterising pangolin trade in China from a social science perspective



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Declaration

I hereby declare that except where specific reference is made to the work of others, the contents of this dissertation are original and have not been submitted in whole or in part for consideration for any other degree or qualification in this, or any other university. This dissertation is my own work and contains nothing which is the outcome of work done in collaboration with others, except as specified in the text and Acknowledgements. This dissertation contains fewer than 80,000 words excluding appendices, bibliography, footnotes, and tables.

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Abstract

The demand for wildlife products around the world is growing rapidly according to various researches. As a result, trade in, and consumption of, wildlife products has become a major threat to global biodiversity. Pangolins are currently recognised as one of the most trafficked mammalian taxa globally, due to the high international and local demand for their products. Many recognize China as one of the biggest markets for pangolin products. Thus, its role in tackling illegal pangolin trade is a crucial responsibility for China globally. However, pangolin trade and markets in China have been little investigated in any holistic and in-depth way. My study uses social science approaches and aims to provide insights on pangolin trade and markets in China to help suggesting more effective conservation interventions.

Literature, regulations, and seven online trade platforms related to pangolin trade and conservation were searched and relevant data were collected to provide background knowledge of current pangolin trade and markets in China. Fieldwork was conducted in the two Chinese provinces of Henan and Hainan from Sept 2016 to Apr 2017. Questionnaire surveys, semi-structured interviews, in-depth discussions with stakeholders along the pangolin trading chain were the main social science methods used in this research. Market Reduction Approaches (Schneider 2008) and Theory of Planned Behaviour (Ajzen 1991) were used as theoretical frameworks to design the research questions. One pangolin hunter, 131 individual villagers, four villager groups (four to ten people per group), 34 reserve workers, two pangolin meat dealers, four pangolin meat consumers, five restaurant owners, traditional Chinese medicine (TCM) practitioners in 41 hospitals, sellers in 134 pharmaceutical shops, two TCM wholesalers, and 2168 members of the general public were interviewed or surveyed in this study.

Results show that illegal pangolin trade is widespread in the two study provinces of mainland China, especially in TCM markets, which were active both online and offline. The wild pangolin populations on Hainan Island still face threats from poaching and local demand for wildmeat. The main contributors to the widespread illegal trade were the lack of adequate law enforcement; poor awareness of trade related regulations

among public and some key stakeholders; and the absence of certain key stakeholders in pangolin conservation process, such as the TCM community. Through this study, I suggest enforcement could be strengthened through increasing public participation in the process, in ways of reporting illicit trade and products. This requires enhancing public knowledge and awareness on pangolin trade and related regulations. On the other hand, to deal with the lack of representation of TCM community in pangolin conservation, their unique function and role in the overall conservation blueprint needs to be highlighted and targeted interventions are needed. In summary, achieving effective pangolin conservation in China needs close collaboration between all key stakeholders to correspondingly address the multiple types of demand on pangolin products. Methodology and insights from this study can also contribute to helping conservation in China or globally, and not only for pangolins, but for other threatened species as well.

摘要

多项研究表明，世界各地对野生动物产品迅速增长的需求刺激着野生动物产品的贸易和消费的不断扩张，从而对全球生物多样性构成重大威胁。对穿山甲制品的高需求使其成为目前全球公认的被非法贩运最多的濒危哺乳动物之一。许多学者认为中国对穿山甲制品因需求量高而形成巨大的市场。因此，中国在打击非法穿山甲贸易方面的担负着非常重要的责任。然而，对中国穿山甲贸易和市场的全面、深入调查却很不到位。为此，我在此项研究中利用社会科学的方法对中国穿山甲贸易和市场进行更深度的研究，以求对未来制定高效的保护、恢复措施有所助益。

通过查阅中国有关穿山甲贸易和保护的文献、法规，在 7 个网上交易平台搜索穿山甲制品，我汇总了背景数据来反映当前中国穿山甲贸易和市场的概貌。2016 年 9 月至 2017 年 4 月，我在中国河南和海南两省进行了实地调查研究。主要方法为：问卷调查、半结构化访谈、观察、与穿山甲贸易链攸关方的深入讨论等社会科学研究方法。市场减少方法(Schneider 2008)和计划行为理论(Ajzen 1991)是设计研究问题的主要理论框架。本研究共计访谈了 1 名穿山甲猎人，131 名村民个体，4 个村民小组(每组 4 至 10 人)，34 名保护区工作人员， 2 名穿山甲肉经销商，4 名穿山甲肉消费者，5 家餐馆老板，41 家医院的中医， 134 间药店销售人员，2 名中药材批发商，以及 2168 名市民。

结果显示，非法穿山甲贸易在中国大陆的两个研究省份普遍存在，特别是在中医药市场，不管是线上市场还是线下市场都较为活跃。而在海南岛，中国的野生穿山甲种群仍然面临着偷猎和作为野味需求的威胁。造成非法贸易广泛存在及偷猎和食用等违法行为屡禁不止的主要原因是：相关部门执法不足；公众以及主要贸易攸关方对穿山甲贸易相关法律的认识不足； 部分主要贸易攸关方，如中医群体，在穿山甲保护方面的整体缺席。因此，本研究建议：强化公众相关生态及法治教育，增加公众对执法过程的参与以增效执法。 比如，可以鼓励举报非法贸易和产品。另一方面，针对中医相关群体对穿山甲保护意识的缺乏及参与的缺席，应开展专项治理，凸显中医行业及人员在穿山甲保护蓝图中的地位和作用。总体而言，在中国实现有效的穿山甲保护需要所有主要贸易攸关方的密切合作来协调解决贸易链各环节对穿山甲产品的多种需求。这项研究的方法和见解也可为中国乃至全球其他濒危物种的保护提供借鉴。

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Table of Contents

Chapter 1 Introduction

1.1 General introduction

This thesis examines the trade in, and markets for, pangolins and pangolin products, in mainland China. The main aim was to provide useful insights to improve the conservation prospects of pangolins. China is often criticised for the demands it places on various wildlife products, including from pangolins. In turn, this partially drives the corresponding illegal international wildlife trade. However, few studies have investigated the consumption and trade patterns of pangolin products within China, yet such knowledge is crucial for designing effective conservation interventions. This thesis addresses this knowledge gap by investigating participants engaged in the pangolin trade, including hunters, traders along the domestic trading chain, and end consumers. Social science methods, including semi-structured interviews, in-depth discussions, and questionnaire surveys, were the main methods of study. These approaches can help understand the context of existing pangolin conservation efforts in mainland China and allow suggestions to be made for future efforts to conserve pangolins and other species of conservation concern. This is especially the case for species such as pangolins, where rigorous biological data are both lacking and hard to gather. The next section establishes up some of the broader considerations of the study.

1.2 The sixth mass extinction

Research by many conservation biologists has established that biodiversity on Earth is experiencing a much higher rate of extinction than it should (Grooten & Almond 2018; Díaz *et al.* 2019). Terms such as the ‘Evil quartet’ and ‘Sixth mass extinction’ have been coined to describe this phenomenon (Diamond 1994; Barnosky *et al.* 2011; Ceballos *et al.* 2015). However, global losses of biodiversity had started to occur long

before these terms came into wide used. Anthropogenic extinction/extirpations had started long before the industrial revolution, the most commonly accused extinction trigger (Diamond 1994). As an example, researchers used historical records to demonstrate the extinction or shrinking distribution range of many faunal species due to human activity started in China thousands of years ago (Rookmaaker 2006; Elvin 2008; Turvey, Crees & Di Fonzo 2015). On the other hand, the emergence of conservation-related ideologies had also started long ago. For example, regulations to sustainably manage natural resources could be found in the early histories of many cultures including the Chinese. Regulations such as banning the fishery during breeding season have been traced back to 21st BC during the Xia Dynasty in Central China (Li, Jin & Tang 2012). While the importance of biodiversity as a whole may have been acknowledged, losses of biodiversity was not mainstreamed until more recently. In 1962, Rachel Carson published her landmark book "*Silent Spring*" which documented the concerning impacts of pesticide use on the surrounding natural environment (Carson 1962). Public social awareness of biodiversity loss and consequently biodiversity conservation has gained momentum since then (Mastroni 2008; Griswold 2012). However, biodiversity losses have continued unabated (Díaz *et al.* 2019).

There are many reasons why humans should care about biodiversity and conservation. In general, those reasons can be grouped into three broad categories:

- biodiversity is useful or essential for human survival and wellbeing. In other words, humans need biodiversity to survive (Costanza *et al.* 1997; Farber, Costanza & Wilson 2002; Bennett *et al.* 2015). Many studies have acknowledged the diverse and indispensable ecosystem services that nature has provided, such as water purification, pollination, flood regulation, climatic mitigation and so on (Salzman, Thompson Jr & Daily 2001; Kremen *et al.* 2007; Nedkov & Burkhard 2012); 2),

- in many cases, humans have developed close associations with biodiversity, both culturally, spiritually, and socially. The loss of biodiversity often means more than the extinction of some species (Posey & l'environnement 1999; Gorenflo *et al.* 2012; Clark *et al.* 2014);

- recognizing the intrinsic values or rights of natural environment/living beings, conserving biodiversity poses a moral obligation, since humans are responsible for most of the devastating impacts suffered by the natural environment (Markku 1997; O'Neill, Holland & Light 2008).

Given that there are well-grounded reasons for conserving biodiversity, the next logical step is to look at the causes of biodiversity loss and find corresponding solutions. Thus, the drivers behind biodiversity loss have been studied extensively (Lenzen *et al.* 2012; Mantyka-pringle, Martin & Rhodes 2012). The main drivers identified in various studies include habitat loss/degradation, exploitation, invasive species, pollution and so on. Among these drivers, exploitation of wildlife has been found to threaten up to 55% of fish populations and more than 35% of mammal populations in the survey (Corlett 2007; Schipper *et al.* 2008; Benítez-López *et al.* 2017; Grooten & Almond 2018).

1.3 Overexploitation of wildlife

The continuing growth of human populations has inevitably resulted in increasing demand for land and resources (Ehrlich & Holdren 1971). Many human populations depend directly or indirectly on natural resources for food, medicine, housing, fuel, and other subsistence or well-being needs (Badola 1998; Fa, Currie & Meeuwig 2003; da Nóbrega Alves, da Silva Vieira & Santana 2008). Moreover, advanced transportation and technology allowed a more convenient international market to exist in parallel with the local demand (Sodhi *et al.* 2004; Schneider 2008). As a result, pressure on nature in many areas has grown exponentially.

Many species are threatened with extinction due to unsustainable and mostly illegal exploitation, but some attract more public and conservation attention than others. Charismatic animals such as elephant and rhino have been under the research spotlight for decades (Beachey 1967; Hoogerwerf 1970; Johnson 1978; Hillman & Martin 1979). One focus of conservation action/research on these charismatic species has been reducing illegal trade, a major form of unsustainable exploitation of wildlife resources (Sas-Rolfes *et al.* 2019). A large number of animals have been hunted during the past

decades due to demands from illegal trade (Parker & Martin 1982; Milliken, Emslie & Talukdar 2009). Various means of mitigating that trade included reducing demand in end markets, increasing enforcement at transit countries, and preventing poaching in source countries (Stiles 2004; Wasser *et al.* 2008; Gao & Clark 2014; Gao *et al.* 2016; Truong, Dang & Hall 2016; Cooney *et al.* 2017).

1.4 Pangolins, a new entrant among charismatic species

Recently, another group of animal species, the pangolins, have gained increasing attention. Pangolins are a group of mammals in the order Pholidota, family Manidae (Gaubert *et al.* 2017). The bodies of pangolins are covered by keratinised scales except in their ventral belly regions. These scales differentiate pangolins from other mammal groups which are mostly covered by furs. Pangolins branched out as a unique evolutionary lineage around 31–45 million years ago (Gaubert *et al.* 2017). Eight species of pangolin currently exist worldwide (Figure 1.1). Four species are native to Asia and the other four to Africa. All species are heavily threatened by poaching and illegal trade (Heinrich *et al.* 2016). Seizures containing products involving more than thousands of animals were frequently seen in reports (Cheng, Xing & Bonebrake 2017; Heinrich *et al.* 2017). These frequent and large seizures during the past decades were believed to have contributed to significant population declines in all species. Consequently, in combination with other data, the conservation status of all pangolin species in the IUCN Red List of Threatened Species^{TM} has been revised and up-listed (IUCN 2020). More specifically, two African species, White-bellied pangolin (*Phataginus tricuspis*) and Giant ground pangolin (*Smutsia gigantea*), were up listed from "Near Threatened" to "Vulnerable" in 2013. At the same time, the other two African species, Black-bellied pangolin (*Phataginus tetradactyla*) and Temminck's ground pangolin (*Smutsia temminckii*), were moved from “Least Concern” to “Vulnerable”. Chinese pangolin (*Manis pentadactyla*) and Sunda pangolin (*Manis javanica*) were changed from “Endangered” to “Critically Endangered” while Indian pangolin (*Manis crassicaudata*) and Philippine pangolin (*Manis culionensis*) were up listed from "Near Threatened" to "Endangered" (Table 1.1).

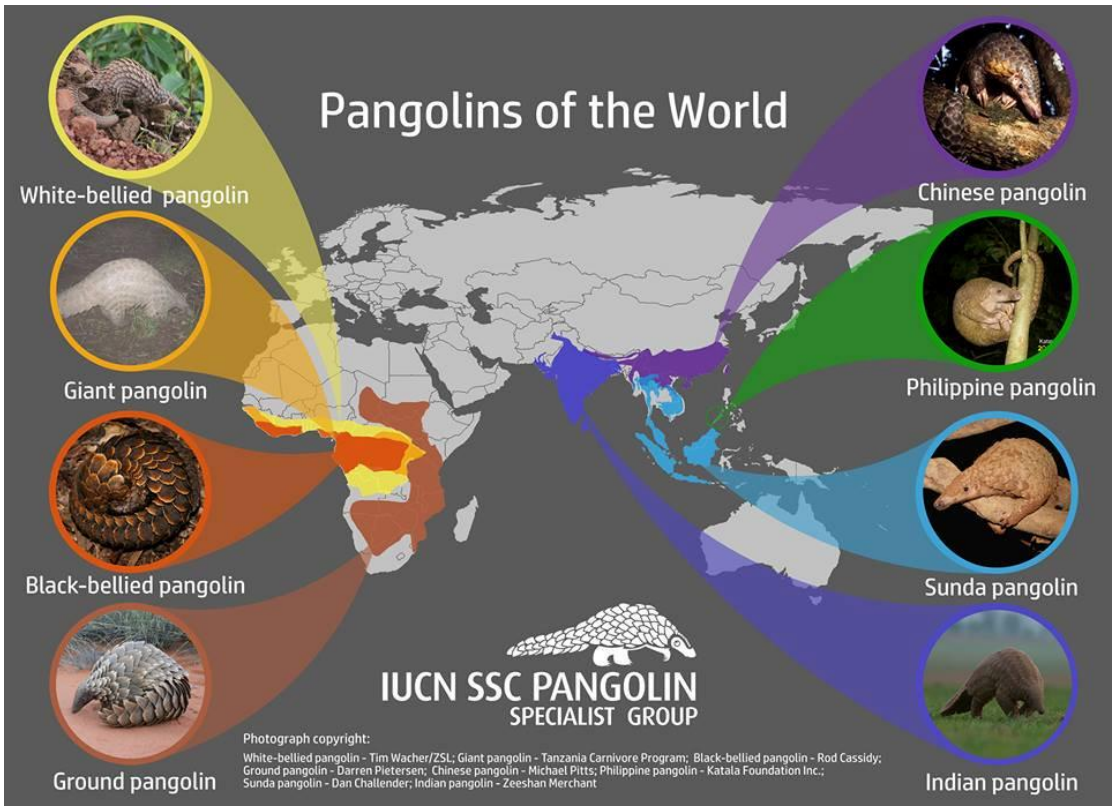

Figure 1.1 Distributions of eight extant pangolin species worldwide. Source: IUCN SSC Pangolin Specialist Group.

Table 1.1 Current pangolin species and their conservation status.

Common name	Scientific name	Distribution continent	IUCN Red List status
White-bellied pangolin	*Phataginus tricuspis*	Africa	Vulnerable
Giant ground pangolin	*Smutsia gigantea*	Africa	Vulnerable
Black-bellied pangolin	*Phataginus tetradactyla*	Africa	Vulnerable
Temminck's ground pangolin	*Smutsia temminckii*	Africa	Vulnerable
Chinese pangolin	*Manis pentadactyla*	Asia	Critically Endangered
Sunda pangolin	*Manis javanica*	Asia	Critically Endangered
Indian pangolin	*Manis crassicaudata*	Asia	Endangered

Philippine pangolin	*Manis culionensis*	Aisa	Endangered

All pangolin species have very specialized diets and they feed mainly on termites and ants. Different species also have unique preferences for their species of prey (Swart, Richardson & Ferguson 1999; Sun Nick *et al.* 2019). One pangolin can consume 100-200g of food per day on average. Thus, pangolins play an important role in the local ecosystem by regulating ant and termite populations (Ofusori & Caxton-Martins 2008; Cabana *et al.* 2017). Moreover, another ecological function provided by pangolins is to modify the physical landscape. Their usual species of prey often live underground or in tree trunks. Thus, pangolins have evolved strong claws for digging burrows to feed (Mahmood *et al.* 2013). Other animals can benefit from this behaviour through using the leftover burrows (Thapa 2014).

The importance of pangolin species to conservation not only concerns their ecological importance, but also reflects on their associated cultural, spiritual and economic values. Although most species are nocturnal, except the Black-bellied pangolin (*Phataginus tetradactyla*), all pangolin species were once abundant in their native habitats, which resulted in frequent interactions with local people (Wilson 1994). Thus, the cultural and traditional connections between people and pangolins were established long ago. Traditional use of pangolin products, stories and tales about the pangolin, and belief and religious practices involving pangolin parts were observed and reported throughout their distribution ranges either in Asia or Africa (Douglas 1957; Coggins 2003; Katuwal *et al.* 2015; Liu *et al.* 2016; Boakye 2018). Nowadays, pangolins play an increasingly visible role in various mainstream cultures including featuring in cartoons, movies, books, and other culture media across the world (Zhang, Lu & Tang 2016; Silk *et al.* 2018).

Despite the important reasons for conserving pangolins, very little is known about their ecological and biological characteristics. Pangolin species are relatively understudied compared to other charismatic species such as elephant and rhinos. Basic information such as population density, precise distribution range, home range size, and reproductive behaviour remains unknown for most pangolin species. Unfortunately, such data are hard to collect from cryptic, nocturnal and burrowing species like pangolins (Challender & Waterman 2017). However, pangolin populations are probably being exploited at unsustainable rates based on available trade data and what is known of their life histories. In general, pangolins have a low reproductive rate, producing around one youngster per year or once every two years (Challender 2009; Mohapatra & Panda 2014). They are also very vulnerable to human hunting since their only defence mechanism is rolling up into a ball. Yet, confiscation reports involving thousands of pangolins is frequently seen (Heinrich *et al.* 2016; Cheng, Xing & Bonebrake 2017).

1.5 The need to understand pangolin trade

Although baseline populations of pangolins might once have been abundant, long-term and unregulated intensive hunting could have easily pushed the population to the edge of extinction, as happened with Chinese pangolins in China (Wu *et al.* 2002; Wu *et al.* 2004). Therefore, reducing illegal pangolin trade and poaching of wild pangolins is a top priority for their conservation. However, to effectively reduce illegal trade and poaching, it is very important to understand the drivers behind the trade.

Studies have pointed out that pangolin meat, scales, and various body parts[1] (such as leather) are in high demand in both international and domestic markets, yet often for different purposes (Challender & Hywood 2012; Heinrich *et al.* 2017; Ingram *et al.* 2018). Different labels could be found associated with the same pangolin product under different scenarios. For example, pangolin meat is regarded as a luxury dish in some southeast Asian countries. In contrast, pangolin meat is often regarded as subsistence

[1] for a definition of "body part" see Heinrich 2017

bushmeat or cheap protein source in rural areas in African countries (Boakye *et al.* 2016; Nijman, Zhang & Shepherd 2016; Sandalj, Treydte & Ziegler 2016; Ingram *et al.* 2018).

Different types of demand on the same product can also occur at even more domestic levels. Pangolin scales were traded as Traditional Chinese Medicine (TCM) in China while an ornament market of pangolin scale carving also existed alongside (Zhejiang Online News 2014; Yin *et al.* 2015). Thus, understanding domestic trade is equally important to understanding the international trade.

1.6 International pangolin trade

The quantities of pangolin products involved in international trade is enormous and supports the argument that illegal trade is one of the main causes for their overall population decline (Zhou *et al.* 2014; Heinrich *et al.* 2016). Illegal pangolin trade and management of international pangolin trade have had a long history. Back in 2000, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) agreed on a zero-quota for exports of wild Asian pangolin products for commercial use, in order to protect the declining populations (see Chapter 3 for details). However, illegal trade involving wild Asian pangolins continued after the launch of this ban in commercial trade (CITES 2019). International seizures most frequently involved a single type of product, for example, scales or body parts or whole bodies (with or without scales, dead or alive). This suggests the various products are trafficked along distinct international trade routes. Geographical trade data also confirms this observation. Large seizures of the whole bodies of pangolins most commonly originated from Asian countries, while seizures of scales are more often from African countries (Heinrich *et al.* 2016; Mwale *et al.* 2016; Xu *et al.* 2016).

Trade of pangolin products often do not differentiate between the various pangolin species, during either national or international trade. Most products are traded under the

generic name of "pangolin". However, the species involved in the trade were found to have differed over time by researchers. Taking China as an example, this country exported large volumes of pangolin products before the 1990s and Chinese pangolins were the primary species sourced (Wu *et al.* 2002). However, as Chinese pangolin populations have become gradually depleted, China later became a net importer of pangolin products with a small number of exports (Yue 2009). At the same time, seizures involving Chinese pangolins decreased while seizures of other Asian pangolin species increased (Wu *et al.* 2004; CITES 2019). Later, African pangolins started to appear in intercontinental seizures more since 2008: their number and the number of products seized has increased each subsequent year (Challender & Hywood 2012; Heinrich *et al.* 2016)

China has been identified as an important player in this extensive global network of illegal pangolin trade (Figure 1.2). Many such seizures are destined for China which sometimes is also found to be a source country providing large numbers of pangolin body parts, for example, leather products or medicine containing pangolin-origin materials, to the USA and other countries (Figure 1.2) (Heinrich *et al.* 2017). Consequently, China is also important for tackling the illegal trade (Zhou *et al.* 2014). Yet again, knowledge regarding patterns, levels, and drivers of pangolin trade in China is little-studied (Zhang & Yin 2014; Yin *et al.* 2015). The following sections will provide a general overview of existing knowledge of pangolin trade and conservation in China.

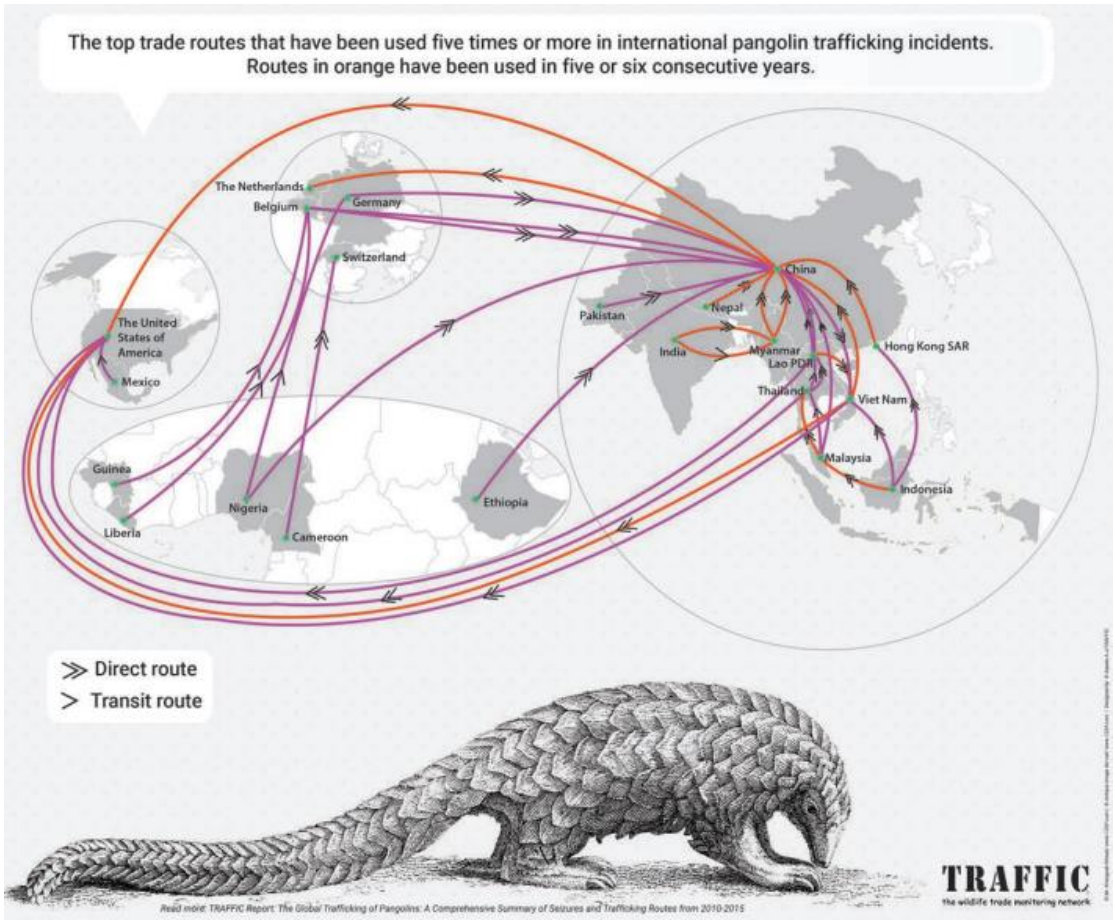

Figure 1.2 Summary of international pangolin trafficking routes from 2010 to 2015 (Heinrich *et al.* 2017).

1.7 Pangolins and their trade in China

Among the eight extant species of pangolin living today, three have been observed in the wild in China. Indian pangolin (*Manis crassicaudata*) and Sunda pangolin (*M. javanica*) have occasionally been recorded within the southwest border in Yunnan Province. The historic distribution of Chinese pangolin (*M. pentadactyla*) once laid across the forested areas south of the Yellow River. Meanwhile, currently depleted populations of Chinese pangolin are thought to occur south of the Yangtze River yet the detailed distribution is unclear (Figure 1.3) (Wu, Wang & Feng 2005; Smith *et al.* 2010; IUCN 2014). Since the main pangolin species native to China is Chinese pangolin, this is the species of focus for the next section.

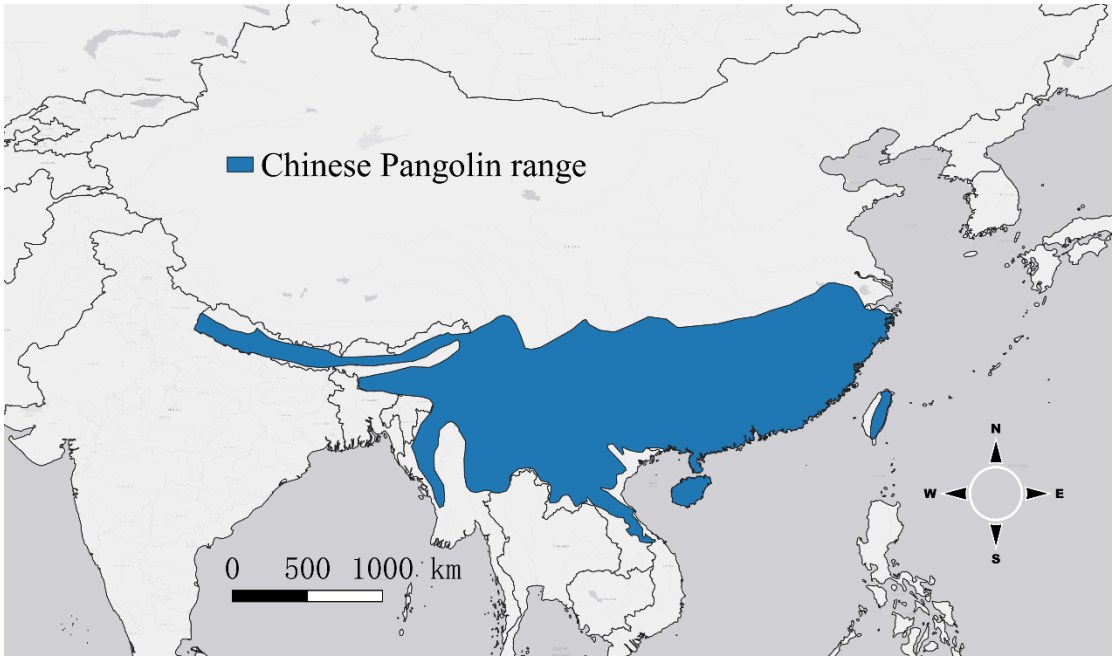

Figure 1.3 Current global distribution range of Chinese pangolin (*Manis pentadactyla*). Source: shapefile data obtained from the IUCN Red List of Threatened Species™ (IUCN 2014).

1.7.1 Ecology of Chinese pangolins

Very little is known about the current status of Chinese pangolin populations or their precise distribution across mainland China (Figure 1.3). Using harvest data from the 1960s to the 1990s, Wu *et al.* (2002) estimated that the size of Chinese pangolin populations within China was around 50,000 to 100,000 animals, which represented an 88.9–94.1% decline since the 1960s (Wu *et al.* 2002). This estimation was also cross-referenced with the 1998 National Wildlife Census conducted by the State Forestry Administration (SFA), now the State Forestry and Grassland Administration (SFGA), estimating the Chinese pangolin population to be around 63,000 (Wu *et al.* 2004). Although national wildlife censuses are supposedly conducted once every 10 years, there has been no publicly available census data on Chinese pangolin since 1998. The population of the Chinese pangolin subspecies on Hainan Island (*M. p. pusllia*) is also reported to have declined rapidly in recent decades (Nash, Wong & Turvey 2016). However, despite the national population collapse, the Chinese pangolin remained a Class II Protected Species in China until 2020. In June 2020, the State Forestry and

Grassland Administration released an amendment of the List of Protected Animal and raised Chinese pangolins to Class I Protected Species (SFGA of China 2020).

Although the national distribution of Chinese pangolins in China is commonly described as "south of the Yangtze River (Figure 1.3), the species is thought to have been extirpated from many areas of its former range (Yang *et al.* 2018). A study modelled the species' potential distribution in three provinces in eastern China and revealed that its habitat has been reduced by more than 52% compared to the 1970s (Yang *et al.* 2018). More data are needed to produce a comprehensive understanding of the current distribution of the Chinese pangolin at a national scale. Until these data are available, this lack of understanding may undermine the effectiveness of targeted pangolin conservation interventions, such as anti-poaching, conservation education and designation of protected areas.

The reasons behind pangolin population declines and local extirpations in China probably include over-exploitation, habitat loss, and habitat fragmentation and so on. Meanwhile, large-scale and unregulated hunting from the 1960s to the 1980s is thought to have been one of the major causes of the current low pangolin population densities across China (Wu *et al.* 2002). The national harvest rate during the 1960s was estimated to be between 150,000 to 160,000 individuals per year (Yue 2009). This rate dropped substantially in the 1980s to around 30% of that in the 1960s (Wu *et al.* 2004). Ongoing illegal hunting has continued and suppressed population recovery (Nash, Wong & Turvey 2016). Persistent hunting is mainly driven by high economic returns, high market demand, and little risk of being caught or serious punishment (Wu *et al.* 2004; Challender, Waterman & Baillie 2014). Biologically, the reproductive rate of the Chinese pangolin is very low, usually one offspring per year (Smith *et al.* 2010). The low-density and fragmented population, combined with the low reproduction rate, further slowdown the potential recovery of already-depleted populations.

1.7.2 Pangolin trade and conservation in China

Although Chinese pangolins are the predominant pangolin species found in China, the trade in pangolins within China is not limited to this one species. Reports of international seizures by Chinese customs and domestic market studies confirmed that most of pangolin products in trade were not differentiated according to species and species other than Chinese pangolin were found to dominate the current trade under the generic name of pangolin products (Yin *et al.* 2015; Xu *et al.* 2016; Cheng, Xing & Bonebrake 2017). Moreover, cross-border pangolin trade between China and its neighbouring countries, such as Myanmar and Lao PDR, was found to be common (Yongping 2009; Nijman, Zhang & Shepherd 2016). The depletion of Chinese pangolin populations was the main reason why international trade has become the main source of supply for domestic pangolin market in China (see Section 1.6).

China's trade in pangolins and their products has resulted in varied trade chains (Cheng, Xing & Bonebrake 2017), involving distinct and differentiated demand markets. Demand on pangolins for medicines and food lead to two major markets, as identified by recent studies (Yin *et al.* 2015; Xu *et al.* 2016). The medicinal demand here specifically refers to the demand from TCM in which the use of pangolin scale could be traced back to AD 480 (Li 1578; Liu *et al.* 2016). News articles and sightings of pangolin-made ornaments also suggested the existence of an ornament market yet available data is very limited and the market size might be small (Zhejiang Online News 2014; Ruan 2019).

Quantitative data on overall market demand are generally lacking. One study published in 2010 estimated that the demand from markets in China, combining legal and illegal, was around 200,000 pangolins per year (Zhang *et al.* 2010). However, this study derived its quantitative data under two key assumptions that: (i) trade volumes in the 1990s could represent contemporary market demand; and (ii) current market demand has increased compared to that of 1990s. However, those assumptions might not hold true and, even if they do, demand from legal and illegal market needs to be differentiated for policy design and implementation. Further quantitative research is

required to better understand the current levels of demand for different pangolin products.

Studies on consumers of pangolin in China are also few (Xu *et al.* 2016) and often limited to data from large cities. Only two openly available survey results were found. USAID Wildlife Asia survey covered 1,800 citizens from 6 cities and HSI included 1,892 participants from 10 cites. From these two surveys, pangolin consumption is not considered as a rare behaviour (HSI & Aita Foundation 2016; USAID Wildlife Aisa 2018). A total of 7% interviewees had consumed pangolin products during the previous 12 months according to USAID (8.7% as recent meat consumers and 14.1% as recent medicine consumers from the Aita and HIS report). A total of 13% of interviewees stated they would probably consume pangolin products again from the USAID report. Meanwhile, 12.1% would consume meat and 18.1% would consume the medicine, according to the HSI and Aita report. The USAID report found 61% of recent consumers were males who primarily fell in the 31–40-year age group. Although medicinal use is often proposed as the main motivation for consumption, this not reflected in USAID Wildlife Asia's 2018 survey. When asked about reasons for purchasing pangolin products, "no specific reason" and "for different reasons" were the two most frequently chosen answers with "celebrating new-born" as the third most popular choice.

Due to China's important role in tackling illegal pangolin trade, many interventions have been proposed to target a Chinese audience. In general, these interventions could be grouped into two categories: (i) education/awareness programmes; and (ii) enforcement actions. Examples of the first group include two campaigns launched by WildAid advocating to refuse illegal pangolin products (WildAid 2016). Enforcement interventions include examples such as training provided by TRAFFIC and an online reporting platform supported by Tencent. These interventions strengthened law enforcement either through capacity building for law enforcers or enabling more public participation through active reporting (Tencent 2015; TRAFFIC 2018). However, no evaluations of these interventions could be located, so their overall effectiveness could

not be defined. Lack of theoretical base and systematic evaluation has been found as a common drawback for many such conservation interventions (Salazar, Mills & Veríssimo 2019; Olmedo *et al.* 2020).

1.8 Thesis questions and structure

Despite the lack of evaluation of existing interventions, continuous and frequent seizures of pangolin products have been made, suggesting that current conservation efforts need to be strengthened. Therefore, there is a need to understand how current pangolin conservation efforts might be made more effective. The answers to this broad question will require a better understanding of what is happening on the ground. Thus, the preceding over-arching question has been broken down to include the following questions that my study aims to provide sights on:

Review related regulations:

- What is the current policy framework for regulating pangolin trade in mainland China, and how has this changed over time?

Identify trade participants and trade characteristics:

- Who are the pangolin hunters, the sellers and the consumers of pangolin products?
- How does pangolin trade and hunting occur in terms of factors such as location, transportation, hunting methods, and seasonality?

Model trade-related behaviours:

- How do participants in the trade such as hunters, sellers, and consumers, view and understand the trade, about pangolins, and pangolin related regulations?
- Which factors influence trade-related behaviours?

Overarching question:

- Based on the regulation framework and pangolin trading chain, what conservation interventions are recommended to consider for reducing illegal trade and regulating the legal trade?

This thesis has the following chapter structure:

Chapter 1: General introduction to the background, main foci including the importance of biodiversity, the main threats faced by biodiversity, pangolins as the 'new' charismatic mammal, their general ecology and the conservation of Chinese pangolins. This chapter feeds directly into my thesis questions.

Chapter 2: Research design and methodology. This chapter will describe the theoretical framework used together with a general overview of the methods employed. I will also provide an introduction to the study sites and a description of simplified pangolin trading chain.

Chapter 3: Review pangolin-related policies and preliminary scans of online markets in mainland China. Current and historical pangolin-related policies in mainland China will be covered. The main foci include wildlife conservation law and its revision, pangolin scale trade regulations, pangolin farms regulations, and law enforcement. Results from online medicine and ornament market scans will be described in this chapter to provide a preliminary comparison between regulation blueprint and real-life trade.

Chapter 4: Public surveys on the consumption of wild animal products. This chapter will provide a preliminary answer on who are the consumers and how they understand and see pangolin trade. Factors influencing their behaviour and understanding will be analysed.

Chapter 5: The qualitative side of pangolin trade as traditional Chinese medicine. This chapter will focus on the qualitative aspects related to TCM trade, including public attitude and knowledge about the trade, sellers and practitioners' perspective and potential conservation implication.

Chapter 6: Quantitative aspects of pangolin trade as traditional Chinese medicine. This chapter will focus on the qualitative aspects related to TCM trade, including price and sale quantity, the fluctuation across years, estimating sale in a wider geographical range, and connecting to the system of legal trade system introduced in Chapter 3.

Chapter 7: Local hunting practices and wild meat trade. This chapter will answer questions related to pangolin hunting in Hainan and compare with another endangered local species, Hainan peacock pheasant.

Chapter 8: Current problems and future directions for pangolin conservation in China. This concluding chapter will also discuss insights from this study to a wider context of conservation related to Traditional Chinese Medicine trade and in China.

Chapter 2 Research design and methodology

2.1 Introduction

As one of the most trafficked mammal groups in international wildlife trade, pangolins need effective conservation interventions to save them from the edge of extinction. However, poaching and trafficking continue unabated, and in large volumes (Heinrich *et al.* 2017). One key obstacle to efficient conservation of pangolins is lack of knowledge of their ecology and lack of understanding of the trade itself. This study aims to present social science data on the second gap through looking at pangolin trade within China, one of the largest pangolin products demand markets, to help improve conservation efficiency. To maximize the potential contribution of the results to conservation applications, the study has been designed based on a combined theoretical framework incorporating Market Reduction Approaches (MRA), Theory of Planned Behaviour (TPB), and Demarketing. This chapter will provide a description of general methodology and discuss the ethics and limitations of the study. More detailed methods will be presented in each data chapter corresponding to different datasets.

2.2 Theoretical framework

Market Reduction Approaches (MRA) originated from observations of the interconnections between stolen goods and market demand in the field of criminology. Researchers observed that criminals mainly steal goods that they can easily sell or otherwise dispose (Sutton 1995). To help reduce the incidents of crimes such as stealing, it is important to understand how the stolen goods are re-sold along the trading chains. Based on such understandings, weak linkages along the trading chain can be targeted to disrupt the trade and ultimately reduce stealing (Sutton, Johnston & Lockwood 1998; Hale *et al.* 2004). Crime reduction programmes have demonstrated that MRA can have a positive impact in reducing crime in real life through disrupting markets based on known data (Hale *et al.* 2004; Schneider 2005; Bullock & Tilley 2012).

Schneider (2008) was the first to propose the use of MRA to combat illegal wildlife trade, and adapted MRA to the conservation sector. Poachers, like thieves, will continue poaching only if they can easily profit from their harvests or need wildlife products for their own use as consumers. Stolen goods in these cases are wildlife or wildlife products that are obtained illegally and/or unsustainably in cases such as unregulated harvesting. To control poaching, it is critical to understand the trade flow from suppliers to consumers and identify weak points within. Based on such information, conservation strategies could be better formulated to target and disrupt the market and then reduce poaching in the long-term (Sutton 1995; Graham-Rowe 2011). As all pangolin populations are mostly threatened by poaching and illegal trade, MRA could be a very useful framework in helping design effective pangolin conservation strategies.

Information from MRA can be used to advise the targets for enforcement and behaviour change interventions (Challender & MacMillan 2014; Holden *et al.* 2019). However, changing the behaviour of people who are involved in the trade chains requires understanding on the behaviour which is beyond the scope of MRA. Instead, I adopted the Theory of Planned Behaviour (TPB), which are widely used behavioural models to understand and predict intended human behaviours (Chen & Tung 2014). Many researchers have used TPB to successfully understand conservation behaviours with a high explanatory power (Kaiser & Gutscher 2003; Kaiser & Scheuthle 2003; Kaiser, Hübner & Bogner 2005; Chen & Tung 2009; Han & Kim 2010). According to the TPB, volitional behaviour is the consequence of behavioural intention which is influenced by attitudes towards the behaviour, perceptions of social norms involved in the action, and perceived behavioural control, as illustrated in Figure 2.1 (Ajzen 1991; Hrubes, Ajzen & Daigle 2001; Trumbo & O'Keefe 2001; Ajzen 2006).

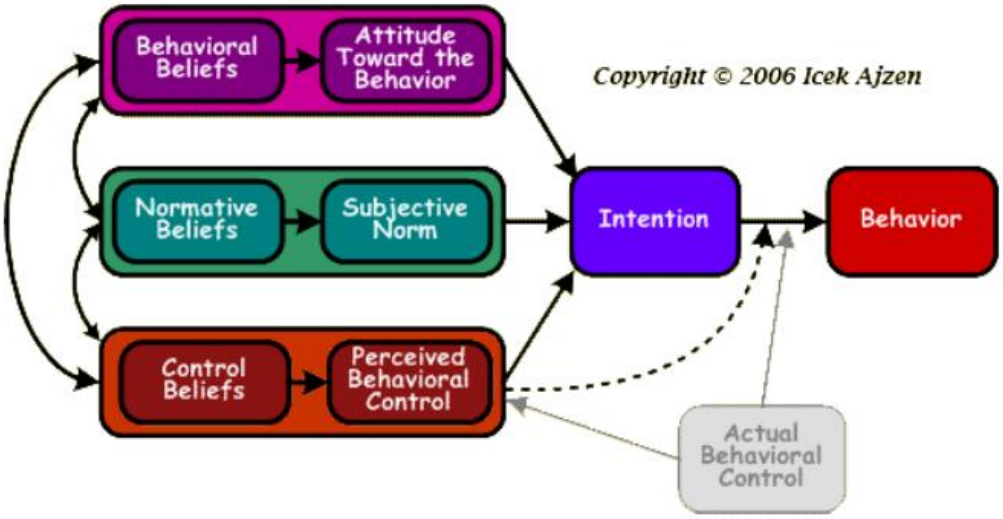

Figure 2.1 Theory of Planned Behaviour suggests behaviours are mainly influenced by four inter-correlated variables: attitudes toward behaviour, subjective norms (or self-perceived social norms), perceived behaviour controls, and actual behavioural controls (Ajzen 2006).

In other words, changes in behaviour are achievable either through changing people's attitudes towards actions, or their perceptions of social norms, or their perceived behaviour controls, or actual controls of behaviour such as law enforcement. Therefore, gaining an understanding of behavioural intentions, attitudes, and perceptions of the social norm of people involved in key components of the pangolin trading chains is essential to reduce trade behaviour and eventually reduce pangolin poaching. However, human behaviour is very complex, and no theory can fully explain all the causes of this complexity. TPB is one of the best models in explaining human behaviour as shown by many studies (King & Dennis 2006; Sentosa & Mat 2012; Chen & Tung 2014). Nevertheless, the possibility remained that this model would not perform well in this study. Therefore, questions about general environmental values were added to the questionnaire in hope that it would improve the explanatory power of the model as has been shown in some studies (e.g., Trumbo & O'Keefe 2001).

Evidence has suggested that poaching of pangolins is mostly driven and sustained by large and long-lasting market demand (Wu *et al.* 2004; Challender & Hywood 2012; Soewu & Sodeinde 2015; Heinrich *et al.* 2016; Ingram *et al.* 2018; Ingram *et al.* 2019).

Thus, it is important to understand the demand from end-users or consumers, in order to disrupt pangolin trading chains. Social marketing campaigns or programmes that aim to reduce demand from end-consumers are also called demarketing (Kotler 2011; Blythe 2013). Demarketing has been applied successfully in multiple disciplines including healthcare services and anti-smoking, as well as in ecotourism (Beeton & Benfield 2002; Armstrong & Kern 2011). Researchers have also suggested and successfully demonstrated that social marketing should be used by conservationists to reduce the demand on resources including products deriving from endangered species (Drury 2009a; Andriamalala *et al.* 2013; Veríssimo *et al.* 2018).

It is common among conservation practitioners to combine social marketing with behaviour theory to change targeted behaviours. This incorporates commercial marketing knowledge to design campaigns that advertise an idea/attitude/behaviour to a target population (Andreasen 1994; Foxall *et al.* 2006; Kotler 2011). With the knowledge of demand, conservation campaigns can target the specific cause of demand and change consumers' behaviours more effectively. For example, researchers have analysed the consumer demand on wild meat in Vietnam and found that awareness of protected status does not affect consumer behaviour and that farmed products may not be a good substitute given people's conscious preference for wild products (Drury 2009b). Similar research to examine what kind of information can, and cannot, influence consumer behaviour is also needed for pangolin conservation in China.

The wider theoretical framework for this study has been summarized in Figure 2.2. The MRA serves as the fundamental framework that provides insights for advising on law enforcement and behaviour change. It also helps to identify key behaviours in the trading chain that need to be changed. Identified behaviours, such as consumer behaviour based on existing evidence, will be investigated using the TPB. Then, appropriate demarketing strategies based on research results will be suggested to change behaviour. The goal of this research is to provide the information necessary to disrupt the trading chain which, in theory, can help reduce poaching and conserve the remaining wild pangolin populations.

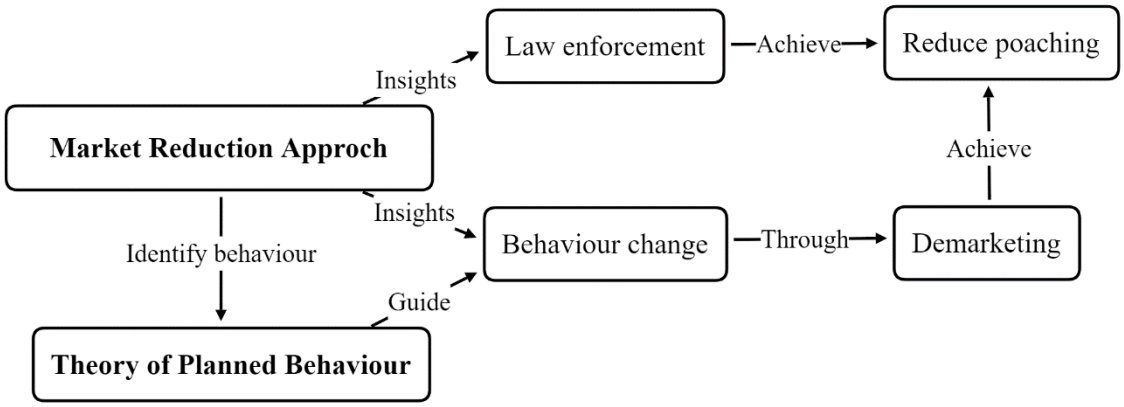

Figure 2.2 Summary of the theoretical framework of this study.

To achieve the goal specified in Section 2.1, knowledge was required from key components in the trading chain (through MRA) and factors influencing behaviours involved in trade (through TPB). Gaining such knowledge will help establishing evidence-based conservation incorporating social, economic, and cultural factors that influence pangolin trade in China. Figure 2.3 summarizes a simplified pangolin trading chain in China, based on existing knowledge of poaching and pangolin trade and information obtained from my pilot visits to research sites (Zhang & Yin 2014; Zhou *et al.* 2014; Hu 2016; Nash, Wong & Turvey 2016; Phelps, Biggs & Webb 2016; Xu *et al.* 2016). This diagram identified target groups in this study. Local professional hunters refer to people who hunt for their livelihoods and are aware of middlemen to sell their catch. Local opportunistic hunters are people who opportunistically hunt a pangolin and may or may not have a route to sell it. Self-consumption, represented by the round arrow in the diagram, is more likely for opportunistic hunters compared to professional hunters. Various types of invigilation may apply along the trading chain, represented by the red arrow and bracket in Figure 2.3, that aims to stop or regulate the trade. The concept of "allele" in genetics was adapted in this study to describe different participant groups at similar levels in their own trading chain, e.g., medicine consumers versus food consumers or professional hunters versus opportunistic hunters.

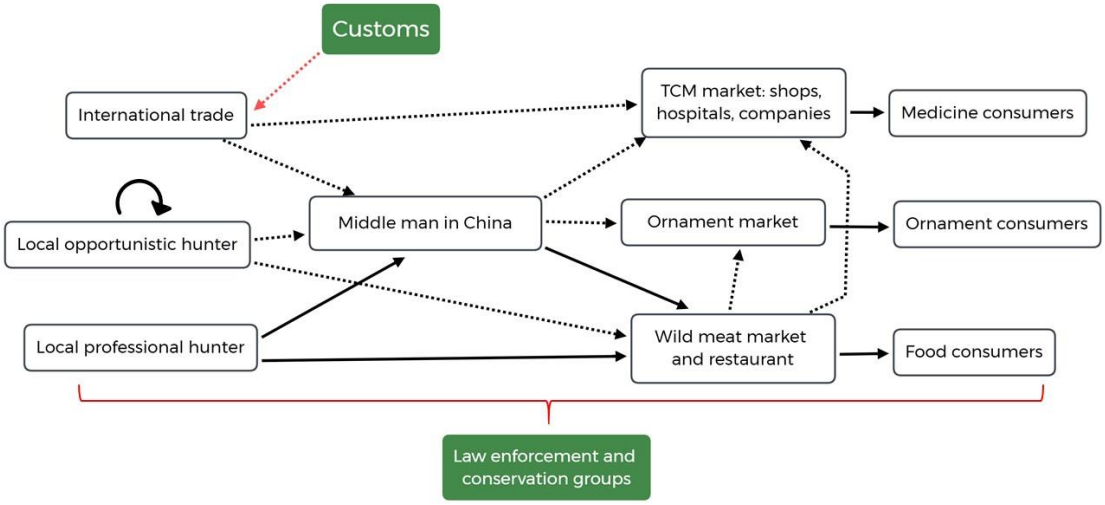

Figure 2.3 A simplified pangolin trading chain in China and different groups of people involved in it. Black arrows direct the trade flow with dash line arrow indicating trade flows that were not investigated in detail in this study. Red arrow/bracket show potential prohibiting behaviours towards the market.

2.3 General methodology

Social surveys or interviews are useful tools to obtain large-scale social, economic, and cultural data. Qualitative interviews provide data in the form of words instead of numbers and are very powerful in collecting information on people's views, perspectives and motivations (Newing 2010). Thus, conservation researchers are increasingly using qualitative interviews to better understand wildlife trade (Zhang, Hua & Sun 2008; Starr *et al.* 2010). In this study, both quantitative and qualitative questions were applied to understand the trade from different perspectives, such as quantities of sales involved, and peoples' knowledge of the trade.

Interviews can also be applied in different fora such as one-to-one or group discussions. My research required some sensitive questions on illegal behaviours. Therefore, one-to-one interviews were preferred over group discussion, to obtain more honest answers (Rasinski *et al.* 1999; Kaplowitz 2000). Techniques on asking sensitive questions were considered at the design stage but failed to work out during pilot tests (see Section 2.6). Thus, direct and indirect questioning techniques were used to enquire about sensitive behaviours, such as behavioural prevalence among neighbours. Ethical considerations related to asking sensitive questions were carefully reflected. The anonymous nature of the survey was explained to interviewees at the outset. Locations of key informants such as wildlife traders and professional hunters were not recorded to secure the

confidentiality and to gain trust from these interviewees.

Surveying people involved in pangolin trade was not straightforward since many of the stakeholder groups were hard to locate before interviews started, for example pangolin hunters and meat consumers. To facilitate the research, I assumed that all the public were potential consumers of pangolin products, whether as food or medicine or ornaments. Meanwhile, people living around reserve forests have a higher probability of encountering and hunting pangolins. Thus, they were considered as potential hunters. This assumption is based on previous studies which demonstrated distance to wildlife resources (measured by distance to access points) as a strong predictor for hunting pressure (Peres & Lake 2003; Yackulic *et al.* 2011). Another important component of the trading chain is middlemen who are even harder to identify. I decided to obtain their information indirectly through asking connections above and below hunters and sellers, respectively. This would result in less detailed and less accurate data on the group of middlemen. However, the time constraints placed on this study prohibited further detailed investigation of middleman group. At the same time, I looked opportunistically for consumers, hunters, and middlemen during fieldwork and have indeed successfully reached some through active social connections.

The ornament market requires strong social connections to obtain valid information through interviews, but such connections are often hard to secure beforehand. On the other hand, the quantity of ornaments demanded from pangolin products is unknown since no study has investigated this topic previously. Furthermore, it is also hard to identity whether the pangolin-made ornament is real or fake. Based on known information, derived through consulting people who sell ornaments, the quantity of pangolin products involved in the ornament market is likely to be of little popularity and low volume. Thus, this market is not strongly prioritized in this study. Instead, I conducted online market surveys to confirm the presence or absence of such demand and types of pangolin products sold on these platforms as preliminary and baseline information for potential future studies (see Chapter 3 for details). Therefore, interviewees targeted in this study are as follows: potential hunters (people living around reserves); potential consumers (public); sellers (wildmeat markets and restaurants, medical shops and hospitals, and online ornament shops); and potential

trade inhibitors (nature reserve workers and local forestry bureaus). The information required to answer the proposed research questions (see Section 2.2) were formulated into different questions targeting each group. Methods used to interview different study populations varied due to the characteristics of each targeted group. The following sections explain in detail about the study sites and how interviews were conducted among different interviewee groups.

2.3.1 Study sites

This research was conducted in two Chinese provinces, Hainan and Henan (Figure 2.4). Hainan Island is the second-largest island in China. It supports rich biodiversity with more than 55% forest cover rate and 49 nature reserves (National Bureau of Statistics 2019). Hainan used to host a large population of Chinese pangolin (*Manis pentadactyla*) and acted as an important supplier of pangolin products to traditional Chinese medicine (TCM) markets and wild meat markets (Wu *et al.* 2002). Research carried out in 2007 indicated that restaurants and TCM retailers were still selling pangolin products in Hainan (Xu 2009), and recent data from community surveys showed that remnant populations of pangolins still persisted on Hainan Island and that pangolin hunting was still ongoing in some regions (Nash, Wong & Turvey 2016).

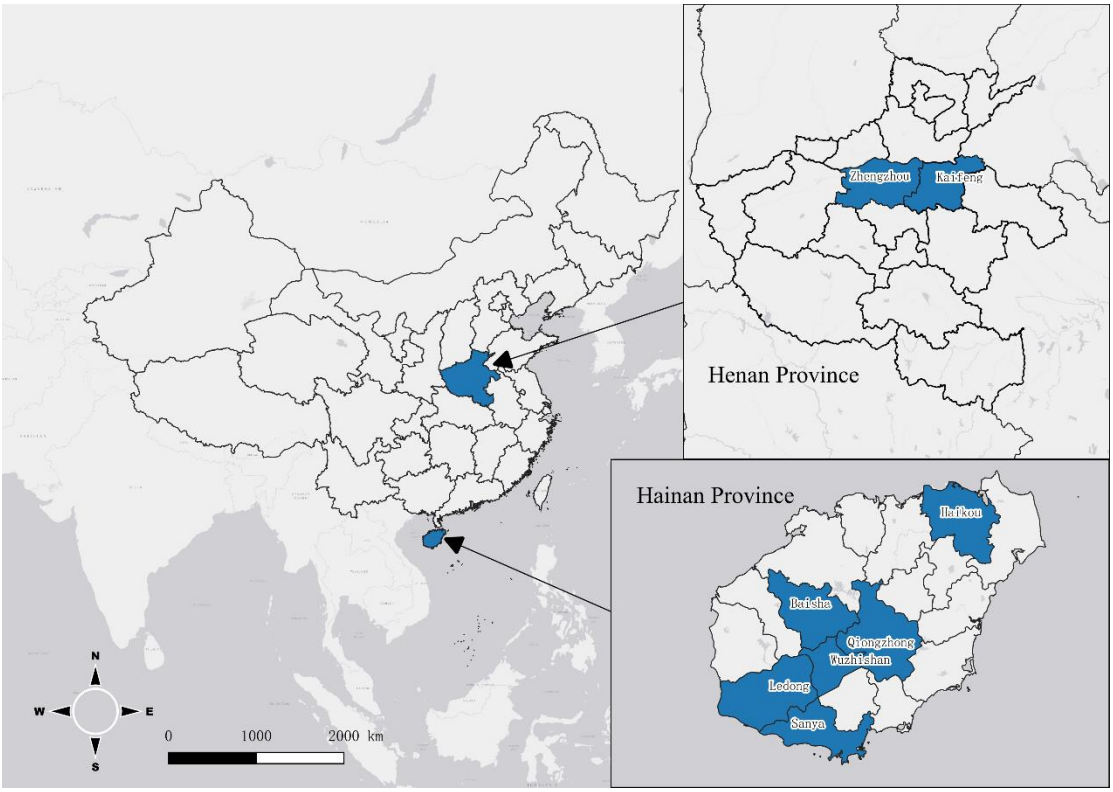

Figure 2.4 Map showing the study sites adopted in this study. Blue colour highlights Hainan and Henan provinces in the background map, which then shows the eight study sites in the two smaller provincial maps. District names of each study site are labelled appropriately.

Hainan is also a province with numerous ethnic minority groups who might use pangolin products as ornaments for some traditional cultural practices. Therefore, I chose Hainan as an appropriate site for gaining an understanding of different types of market for pangolin products. The pangolin population in Hainan is also a unique subspecies, adding further conservation value to this study site (Zhang *et al.* 2010; Challender *et al.* 2014). The Zoological Society of London (ZSL)'s existing long-term conservation research programme in Hainan is another reason why this province was chosen since local connections might be easier to reach with support from ZSL researchers (Nash, Wong & Turvey 2016; Turvey *et al.* 2017).

The second site was Henan province. In contrast to Hainan, this province has been the centre of central Chinese civilization dating back for the past few millennia (Allen & Richards 1999). Humans have largely modified the landscape and primary forests, like the ones survived in Hainan, vanished long ago in Henan (Elvin 2008). As a province with more than 90 million people, not much space was left for nature (Henan Provincial

Bureau of Statistics 2016). This point is best illustrated through a land use survey, which showed that agriculture alone covered more than 48.9% of the total terrestrial land use in Henan (Henan Provincial Bureau of Statistics 2018). Historically, Henan supported populations of Chinese pangolin in its forested areas and was the northernmost province in pangolin distributional range. Yet the current presence/absence of this species within the province remains to be confirmed (Wu *et al.* 2004). From an economic perspective, Henan and Hainan are also different. Henan ranks fifth in terms of GDP per capita in China, while Hainan ranks at 28 out of 31 (National Bureau of Statistics 2019). There is also a cultural difference, in that Henan Province is dominated by Han ethic group while Hainan has a high proportion of ethnic minority group such as Li and Miao (National Bureau of Statistics 2011; Henan Provincial Bureau of Statistics 2016). The differences between the two provinces from cultural, economic and social perspectives allowed the research to investigate and compare the influence of different sociological factors on trade in pangolins.

Several sites were selected from each province to allow within-province comparisons. In total, eight study sites were chosen, two in Henan and six in Hainan (Figure 2.4). The two sites in Henan were Zhengzhou and Kaifeng. Since Henan is my hometown, deciding on study sites considered accessibility of targeted interviewees. However, I was not very familiar with Hainan, so I made a preliminary visit to help with site selection and to test the feasibility of general methods.

2.3.2 Preliminary visit to Hainan

To test if interviews could collect the desired data from target populations, and to learn more about Hainan, I made a preliminary visit to Hainan in December 2015. I actively searched for traditional medicine shops in Haikou and Longlou, two cities in Haikou and Wenchang divisions, respectively. I presented myself to potential interviewees as a university student researching the TCM market and asked the shop assistants directly about information on pangolin scales. The questions asked included: do you sell pangolin scales? how much do they cost? what are they used for? how were sales during the past 1 year? and others. Almost half of the TCM shops I interviewed (5 out of 11) openly admitted to selling pangolin scales. The price ranged from 3 yuan/g to 8 yuan/g (around 0.4 USD/g to 1.1 USD/g) depending on shop location and quality of the scale.

Many shop assistants did not know about the requirement for a permit to sell pangolin scales, but some knew selling pangolin products was illegal. Most shop assistants could name some medicinal values of pangolin scales. The shops selling pangolin scales said that sales volumes were very variable, sometimes with no customers for months and sometimes up to 500g sold in one month.

I also interviewed 13 individual people in a public park in Haikou (N = 13) and asked about their attitude towards wildlife conservation, and particularly their knowledge of pangolins. Most interviewees (8 out of 13) supported protecting wildlife instead of using it. Meanwhile, 11 out of 13 said they had never consumed wildlife products before and would not do so in the future either. Although most people (9 out of 13) knew of pangolins, the majority (7 out of 9) did not know about their conservation status. In Tongguling National Nature Reserve besides Longlou town, I asked the reserve workers questions regarding this reserve. They were very open to questions and said that they believed there was no pangolin left in Tongguling now. However, two local people who lived close to the reserve were interviewed and one said that pangolins might still exist in the forest but only in very low numbers. Questions asked to different groups during pilot and the ways questions were asked were later adopted in the formal interviews as shown to be feasible questioning techniques to obtain meaningful answers.

For the wild meat market, I tried to look for wild meat restaurants in Haikou. Although I could not find any restaurants due to time constraints, people reported useful information on which divisions/regions might have wild meat restaurants. This preliminary visit showed that Hainan was a feasible site for social science studies with easy access to most of my targeted groups that were necessary to meet my study aims. Based on previous knowledge and this preliminary visit to Hainan, I decided to conduct my research in six sites across Hainan Island (see Table 2.1). The chosen sites include cities/counties with different economic status and development stages to increase the representation of survey results to wider populations in Hainan and helped to investigate factors that might influence pangolin trade.

Table 2.1 Factors considered when choosing sites for pangolin research, whose locations are shown in Figure 2.4.

Division Name	Nature reserves present	Wild meat restaurants present	Other
Haikou	No	NA	Capital city of the province (important politically)
Sanya	No	NA	Tourism hotspot (important economically)
Qiongzhong	Yes	Yes	
Ledong	Yes	NA	
Wuzhishan	Yes	Maybe	
Baisha	Yes	Maybe	

2.3.3 Public survey

Undertaking public surveys in China is particularly difficult due to the large number of people. A large sample size is necessary for the results to achieve balanced representation. Thus, the services of helpers or field assistants were secured to help with the public interviews. These helpers were not trained social scientists and they may never have previously conducted scientific interviews. The difficulties of having inexperienced interviewers were downscaled by using questionnaires as the survey format, which was easier to for non-professional researchers to master after a short training (see Ethics section for training details).

Questionnaires used in public surveys consisted of 30 questions (Appendix 1) and could be completed within 6 mins on average. The design of the questionnaire follows the theoretical framework described above. The 30 questions were divided into three parts and comprised:

- demographic information;
- attitude and knowledge towards wild animal consumption; and
- attitude and knowledge of pangolin trade and consumption.

The purpose of the more general section on wild animals was to remove the focus from pangolins and encourage interviewees to provide more honest answers (Pan *et al.* 2016). Moreover, the results might also provide insights on segmenting wild animal consumers which could be potentially helpful for conservation.

Sampling methods are also important for obtaining representative results. Probability sampling is the ideal method as it minimizes the possibility of a biased sample. However, probability sampling is not feasible for such large-scale public surveys with a potential study population counted in the millions. Therefore, quota sampling and chain referral sampling were the two sampling methods used in public surveys. Quota sampling is one of the least-biased options if probability sampling is not feasible (Newing 2010). To complete quota sampling, city centres or town centres of each study site were identified to reduce the geographical region to manageable levels. If city centres or town centres were still too large geographically, districts called "qu" in Chinese administrative division were identified and half of the districts were chosen randomly. Then if needed, a quarter of the sub-districts, called "jiedao" in Chinese administrative division, in the chosen districts were selected randomly, around four in each sub-district, as the final interview sites. Only Haikou and Sanya required such sampling steps. For other study sites with few districts and few subdivisions, all subdivisions were included in the surveys. Sample size was decided beforehand based on the time limit and rough interview efficiency (known from preliminary visits). Each site was assigned with a goal of a set number of interviews. Quota categories were set up based on the age structure of the province. In practice, helpers were asked to approach interviewees spread across age groups and to keep the age structure of the interviewees in line with the provincial age structure. This is one of the ways to increase the representation of sample populations.

The actual sampling process followed to reach the quota was completed using convenience sampling methods in which interviewers tried to survey people in populated places at each interview site (Etikan, Musa & Alkassim 2016). These sites were chosen to be diverse in function and spatially spread out within sites to increase sample representation. The type of places chosen included public parks/plaza, shopping malls, libraries, main business streets, popular restaurants, big supermarkets, residential districts, farmer's markets, universities, and elementary schools and kindergartens to interview parents or grandparents waiting outside. Not all study sites had every type of place, but the point was to diversify the potential interviewees and obtain a more representative sample.

The chain referral sampling (or snowball sampling) method (Newing 2010; Etikan, Musa & Alkassim 2016) was used to collect data in both Hainan and Henan alongside the quota sampling survey in Hainan. The same questionnaire was distributed online through social networks. This method was employed since social connections ("guanxi" in Chinese) are very important in Chinese culture. Through social connections, it was possible to reach out to a very large population within a short timeframe (Xin & Pearce 1996). Provincial age structures were again used as a reference to guide the sampling process to increase representativeness. This chain referral survey was distributed solely online and mainly through a social media app called *WeChat* which was the most popular social media in China (Liu *et al.* 2017). An introductory paragraph was written beforehand to be sent together with the questionnaire link to explain the purpose and confidentiality of this questionnaire. Sometimes red bags (a function provided by WeChat) with small amount of money (0.1 yuan, or 0.014 USD per person on average) were provided to encourage the participation when the link was sent to a large group chat.

Quota sampling street interviews were conducted in the six sites in Hainan. These interviews targeted a sample size of 120 interviewees in Qiongzhong, Wuzhishan, Ledong, and Baisha, respectively, with a sample size of 200 interviewees in Haikou and Sanya, respectively. The differences were due to the higher populations in the latter two sites. Chain referral online surveys were conducted in Haikou and Henan with a target of 300 respondents in Haikou, 600 respondents in Zhengzhou and 400 in Kaifeng, respectively. These target sample sizes were established based on the population of that city/site and the efficiency of the survey method because online surveys are much quicker than street surveys. Online chain referral surveys conducted in Hainan were later found to be biased in terms of population as the survey was dominated by non-locals and removed from the results. Thus, data obtained from street quota sampling in Hainan and online chain referral in Henan were the two main forms of result available for public surveys in this study.

Small gifts, comprising square towels costing *ca*. 1 yuan/towel, or 0.14 USD/towel, were given to interviewees to increase interest in participating. The questionnaire was

provided in two formats, an electronic online version supported by Wen Juan Xing Online Survey Platform (Beeton & Benfield 2002) and a printout paper version. Interviewees were first provided with the online choice that they could either scan a barcode to open the questionnaire directly on their cell phones, or they could use the interviewer's cell phone to access the questionnaire. The latter form appeared to be a popular choice during the survey. If interviewees faced difficulties using online questionnaires, mostly due to the small font, a paper copy would be provided, but their response would still be recorded through the online platform by interviewers. All public interviews were conducted during weekends from 9 am to 7 pm with a 1-hour lunch break from 12 pm to 1 pm.

2.3.4 Market Survey

Questionnaires are less flexible than semi-structured or unstructured interviews, as the two latter allow further discussions to extend beyond the pre-set questions. Thus, semi-structured interviews were developed to survey participants in different markets. This encouraged discussion during which useful information that was not anticipated might emerge. The market survey used in this study focused more strongly on the TCM market for two reasons. Firstly, TCM markets make huge demands on pangolin scale products as others have shown previously (Wu *et al.* 2004; SFA of China 2014; Yin *et al.* 2015; Xu *et al.* 2016). However, basic information such as annual market demand, and the TCM community's attitudes towards pangolin products, remains unknown. Thus, more research is urgently required to determine the scale of such parameters. Secondly, it is relatively easy to obtain access to the TCM market compared to other regular markets such as wild meat and ornaments. This is because people involved in these two markets are more aware of the illegal nature of the trade, which normally remains hidden from view. TCM markets on the other hand are easy to find and identify, whether hospitals, pharmaceutical shops, or wholesale markets. Furthermore, the fact that the TCM market is partially legal also facilitates the interview as the topic is less sensitive (see Chapter 3). Information related to wild meat and ornament markets were also collected to the maximum extent possible within the limited time frame.

TCM market surveys were conducted through interviewing doctors in hospitals, including shop assistants, and sometimes doctors, in pharmaceutical shops, as well as

shop owners in wholesale markets. Access to hospitals was obtained through navigating available social connections. As a result, the hospitals were not chosen through random sampling but though a more targeted convenience sampling method (Etikan, Musa & Alkassim 2016). Therefore, unavoidable biases might exist in these surveys. Due to differences in network availability, the hospital survey was conducted more frequently in Henan than in Hainan. Limited network availability also made pilot testing of the questionnaire not possible for the TCM hospital survey.

Traditional medicine shops in each study site in Hainan were surveyed using a clustered sampling method. For big sites such as Haikou and Sanya, I identified multiple places within each site through an online map (Baidu Map) where pharmaceutical shops were concentrated. In smaller sites, such as the other four sites in Hainan, all pharmaceutical shops in town centres were surveyed. The target sample sizes were 30 shops in Haikou and Sanya, respectively. For smaller sites, all shops visible on the street were interviewed, so no sample size was set. Pharmaceutical shop interviews in Henan province were again conducted using social networks and data that sometime represented multiple branches rather than one shop. For example, a pharmaceutical company with more than 100 branch shops was interviewed, so sales data from these 100 shops were obtained in one interview. Questions asked during the pharmaceutical shop interviews were the same as in the hospital survey, but the wording was changed to fit the different contexts. The list of questions used in the TCM market interviews is shown in Appendix 1. Four online medicine trade platforms were also searched to confirm presence/absence of pangolin medicine in online trade. Information such as the number of sellers, price of products, product type, whether scales were raw or processed, and stock quantity was recorded when available. The results are discussed further in Chapter 3 together with an online ornament market survey.

The wild meat market was another target of this study. However, it was hard to gain access and obtain trustworthy information. In each study site, I asked local guides to help with access to restaurants, and several pangolin meat consumers were identified using social networks and interviewed directly or indirectly. The restaurants interviewed in this study were not necessarily selling wild meat at the time of the interview, but the restaurant owners knew about this market and consumer attitudes to

wild meat.

To gain preliminary background data on the ornament market, one ornamental shop owner in Henan was interviewed through in-depth discussion to learn about the overall situation of wildlife products in ornament markets. Information obtained suggested that only small volumes of pangolin products were present in the ornamental market. Thus, online survey was the only method used to collect data on the pangolin ornamental trade. Keywords such as pangolin, pangolin scale, scale carve, amulet, and scale were searched in three major online shopping platforms. The numbers of shops selling pangolin ornaments, the price of ornaments, the volumes of sales during the past month, and other related information were recorded if available. Results will be discussed further in Chapter 3.

2.3.5 Hunter survey and trade inhibitor survey

Potential hunters are defined in this study as villagers living close to nature reserves which might still support remaining pangolin populations. This target group was interviewed only in Hainan since the presence of wild pangolin population in Henan was uncertain (IUCN 2014; Nash, Wong & Turvey 2016). Nature reserves were selected to follow the study by Nash *et al.* (2016) and surrounding villages were identified based on suggestions from local guides who were either helpers from NGOs or forest rangers from nature reserves or researchers from local research institutes. These people had knowledge of villages that were close to reserves, had a history/tradition of hunting, and were willing to be interviewed by an outsider. Local guides were also needed to help with transportation and translation, as many villagers only spoke local dialects rather than Mandarin. Due to all these requirements to make each interview feasible, a pilot could not be conducted beforehand. In each targeted village, five to 15 villagers were interviewed using a convenience sampling method and sometimes using chain referral method if villagers suggested a key informant. The number of interviews completed in each village largely depended on the number of people available and willing to be interviewed. In most cases, I walked through the whole village and tried to interview every adult I met above 18 years of age.

There are five National Nature Reserves (NNRs), including Bawangling (B),

Diaoluoshan (D), Wuzhishan (W), Jianfengling (JN), and Yinggeling (Y), and two Provincial Nature Reserves (PNRs) including Jiaxi (JX) and Limushan (L) in the study sites (Figure 2.5). Some of the reserves such as Yinggeling ranged across different study sites. Thus, more interviews were collected as more villages were surveyed.

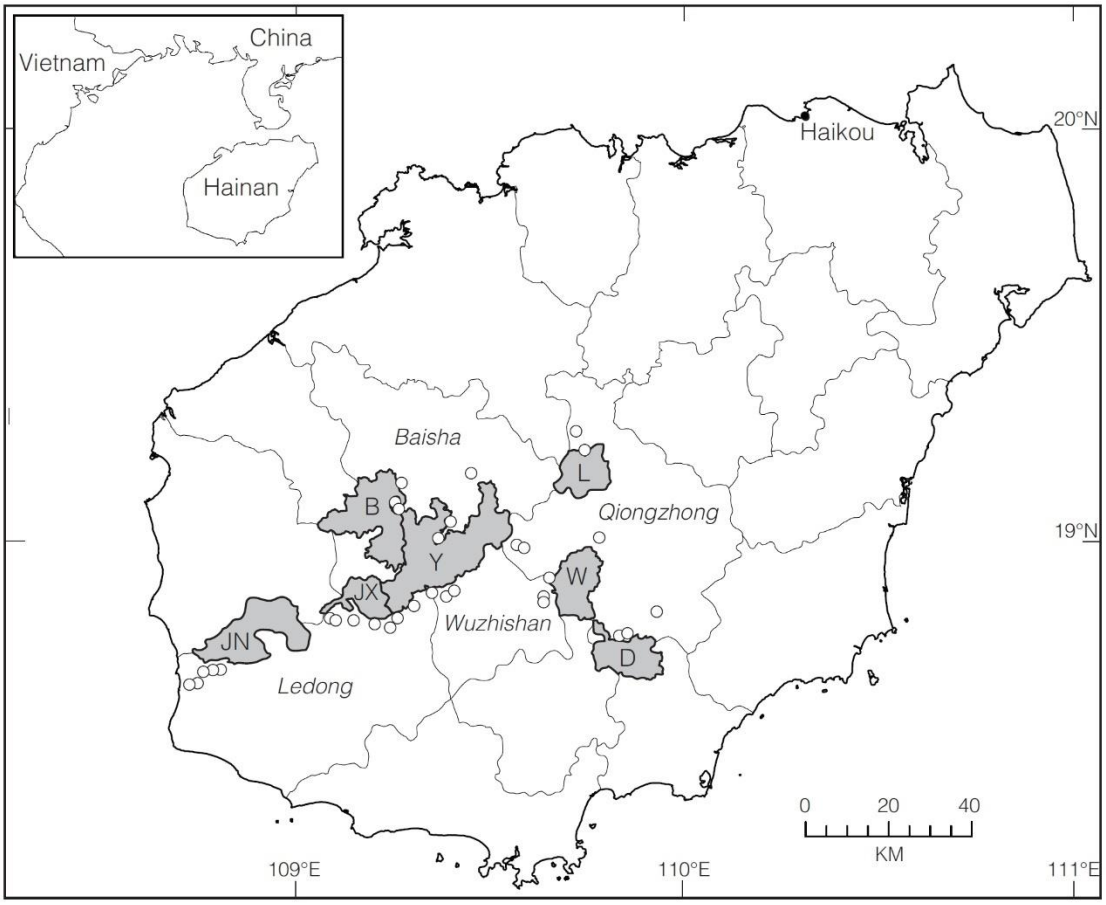

Figure 2.5 Map of NRs in Hainan shown with labels of the name of each study site. Coloured polygons represent nature reserves. Dots represent the location of villages interviewed. *Source*: reserve map obtained from Hainan Province Forestry Administration.

In general, information solicited during interviews focused on knowledge about pangolin and their attitudes towards hunting (see Appendix 1 for the questionnaire). Nature reserve workers or rangers from each reserve were also interviewed and asked about hunting, pangolin information and reserve regulation/monitoring. Local forestry bureau staff were interviewed when accessible and were asked about local hunting activities, selling of wild meat, wildlife farming, and reserve management. I also asked the same set of questions about another species, the Hainan peacock pheasant (*Polyplectron katsumatae*), alongside the pangolin interviews. My aim here was to (i)

remove pangolins as the sole focus of attention in the interviews; and (ii) to provide data for another understudied endangered species (Liang & Zhang 2011).

2.4 Collected data and its analysis

The full sample of data collected during the study are shown in Table 2.2. From the public survey, data on peoples' attitudes, perceptions of social norms, and perceived behaviour controls were used to build the structural equation models, while generalized linear models needed to analyse the influence of these factors towards wild animal behaviours based on TPB. This analysis aimed to help answer what influenced the consumption behaviour of wild mammals. Correlations between demographic characters and wild animal consumption behaviour were analysed using the classification tree algorithm to segment consumer groups. All statistical analyses were performed using RStudio (RStudio Team 2015) and the main packages used included lavaan, rpart, devtools and others.

Table 2.2 Summary of survey data study sites and sub-sites. Two middlemen, one hunter and four consumers were also interviewed but their locations remained confidential thus not shown in this table.

Survey type	Zhengzhou	Kaifeng	Haikou	Sanya	Qiongzhong	Wuzhishan	Ledong	Baisha	**Total**
Quota street public survey			226	209	154	122	119	117	**947**
Chain referral online public survey	790	431							**1221**
TCM survey target hospitals	19	9	4	2	3	1	2	1	**41**
TCM survey target pharmacies	6	6	30	28	17	14	16	17	**134**
Potential hunter survey					46	51	52	20	**169**
Restaurant survey					1	2		2	**5**
Reserve survey					4	2	3	2	**11**

Quantitative data from market surveys were analysed to estimate market demand on pangolin products in all study sites. Qualitative data were analysed using a more unstructured, discursive method called content analysis (Hsieh & Shannon 2005; Newing 2010). Notes taken during interviews were read carefully and codes were developed from the text. Codes were then grouped into categories that formed clusters. Patterns raised from clusters were identified to describe the target groups. Maps used in this study were plotted using QGIS (QGIS Development Team 2019) and flow charts were plotted using XMind (XMind 2019).

2.5 Limitations in methodology

Sampling bias is always a big challenge for conducting representative public surveys. Probability sampling is the method that is least prone to bias, compared to other sampling methods (Newing 2010; Etikan, Musa & Alkassim 2016). Cluster sampling for public surveys was also considered at the planning stage in which study sites would be divided into districts and further into sub-districts. A set number of resident communities (called “ju min qu” in Chinese) in each sub-district would be randomly chosen and residents in the chosen communities would be surveyed. This method has been used in some studies in China, such as attitudes to water prices (Wang, Xie & Li 2010). Equally, it has not been used very commonly, due to the large share of time and labour required (Jim & Chen 2006).

The difficulty of such household surveys in China also stems from access to each household, particularly in large cities. The rate of successful interviews is extremely low in big cities (Gong 2007; Jin & Sun 2008). Although my research sites mainly focussed on less developed areas, it was difficult to conduct door-to-door surveys in big cities such as Haikou. This was evident during my preliminary visit to Hainan during which I visited the administrators of a sub-district and asked if they could assist me with the survey through providing local census data or notifying residents of the upcoming survey. The administrators refused my requests and suggested that I could conduct surveys in other formats as residents were all reluctant to open their doors to strangers. Even national census interviewers who represented the government were often refused entry. I also found that some residential communities required proof of identity while non-residents would be barred from entering. These findings led me to

change my sampling method to quota sampling, and I employed street encountering methods instead of interviewing in residential communities.

Besides the sampling method, the sample size of the public survey was also compromised due to various constraints. China is among the most highly populated countries in the world. Conducting surveys that aim to be representative of a Chinese city would require a vast sample size. Equally, the time constraints of this study did not allow collecting a very large sample size. The final sample size was set at the highest possible level achievable within the given timeframe.

This project also involved asking people about illegal behaviours, including consuming/poaching protected species. Therefore, gaining truthful responses to such questions was an important consideration (Tourangeau & Smith 1996; St. John *et al.* 2010; Jann, Jerke & Krumpal 2011; Kays, Gathercoal & Buhrow 2012; Nuno & St. John 2015). Numerous techniques have been developed to address this problem. Nuno & St. John (2015) reviewed several techniques that asked sensitive questions and presented a nice review. Due to the different designs of these techniques, data obtained can allow different types of analysis. Indeed, one important concern is whether or not correlation analysis remains feasible. I not only sought to understand the proportion of the population that consumed pangolin products, but associating the characteristics of the different consumer populations to the behaviour was also part of the study aims. Techniques that allow further analysis of data beyond the proportions of the population was preferred, of which the randomized response technique is the most commonly used. However, this technique has also been criticised for its possible bias towards giving a "no" answer for self-protection and the complex comprehending process required (Höglinger, Jann & Diekmann 2014; Korndörfer, Krumpal & Schmukle 2014). An unmatched count is another commonly used technique that allows the analysis of variables associated with the behaviour. Nevertheless, some studies, particularly those for rare behaviours (Tsuchiya, Hirai & Ono 2007; Hinsley *et al.* 2019), suggest this technique requires a large sample size of more than 1000 responses which might be hard to obtain for this study.

The Crosswise Model is a newly developed, but very popular, technique (Yu, Tian &

Tang 2007; Jann, Jerke & Krumpal 2011). It minimizes the possibility of choosing self-protective "no" answer that Randomized Response methods are criticized for and allows correlation analysis (Hoffmann & Musch 2015). Thus, I decided to use the Crosswise Model to ask people about their consuming and hunting behaviour. The non-sensitive and universal question used in this model is "what is your birth month?" Assuming that the distribution of births remains uniform (Jann, Jerke & Krumpal 2011). A disadvantage of such sensitive question techniques is that they only apply to close-ended questions. Open-ended questions such as "why do you consume/buy pangolin products?" cannot be asked. For these open-ended yet sensitive questions, I formulated the questions indirectly. For example, instead of asking "why do you buy/consume pangolin products?", I asked "why do you or your family/friends buy/consume pangolin products?".

The Crosswise Model has not been used previously in the conservation sector, nor has it been applied within China. Therefore, I tested its feasibility before officially starting data collection. The question was displayed as in the following table with an explanation of its purpose and how to answer at the top (Table 2.3). The test trials showed that many pilot participants could not understand the purpose or mechanism of the technique. Many participants either answered the question directly through writing their own answer or circling the letter in the table, which invalidates the purpose of its setup. Interestingly, all participants had confirmed beforehand that they understood the questioning technique after I had verbally explained it to them. No one questioned the approach while they were answering the questionnaire, yet their answers indicated that they lacked understanding. I also tried to improve the explanatory text by inviting participants to suggest how it could be re-framed. Nevertheless, the new explanation could still only make sense to a few interviewees.

Table 2.3 Sensitive question: please circle **A** or **B** based on your own situation. Your answer: A / B

	Birth month in Jan, Feb, or Mar	Birth month not in Jan, Feb, or Mar
You have consumed pangolin meat during the past one year	A	B
You didn't consume pangolin meat during the past one year	B	A

A possible explanation for this failure could be that the general public do not have the patience to read or listen to the explanation, nor do they care about the focus of this particular survey. Therefore, they did not bother to ask, even if only to understand the question. Failure to understand the setup can strongly bias the results. If people do not understand, they may choose the answer (i.e., A and B) randomly. This will strongly inflate the proportion of consumers in the results if the proportion of consumers is originally low. Due to this failure of the test trail, I decided to use direct questioning instead of a technique that might inflate the results. Direct questioning may prohibit some honest answers, but the anonymous setup could compensate for some of the reluctance. The final consumer proportion might be lower than reality due to hesitation to admit sensitive behaviours. Nevertheless, the results would be credible as a conservative estimate. Moreover, several conservation studies involving asking sensitive questions have adopted direct questioning and obtained valid results (Zhang, Hua & Sun 2008; Drury 2009a; Zhang & Yin 2014; Challender, Harrop & MacMillan 2015a; Nash, Wong & Turvey 2016).

The potential hunter survey in Baisha only collected half the sample that other sites had collected because it was the last site to be visited. The survey time overlapped with sugar cane harvesting season and villagers were busy with their farm work. Thus, very few people were available for an interview about pangolins. I had planned to come back after the Spring Festival to collect another round of interviews. However, an intense round of media attention was focused on the pangolin issue after the spring festival (see Chapter 8). This could have potentially influence peoples' attitudes towards the interview and their answer to certain questions related to pangolins. As a result, I decided not to collect the further data that I had pre-planned for this aspect of the study.

Besides the pharmacy survey, all physical market surveys were conducted based on the availability of access obtained through social connections (Etikan, Musa & Alkassim 2016). This was again less ideal than using probability sampling, because the sampled population may be biased towards certain groups. For example, large province-level or city-level hospitals were surveyed more often than small community hospitals which outnumbered large hospitals. Nevertheless, interviewing hospitals without gaining access in the first place is nearly impossible in China. One attempt was made in Beijing

before the fieldwork and failed. Targeted convenience sampling (Etikan, Musa & Alkassim 2016) remained the only available option. On the other hand, however, survey results obtained through social networks might be worth giving more credibility than random sampling particularly on the results about sensitive behaviour. This is because interviewees are connected with interviewer through social networks ("guanxi") which promote interpersonal trust. Thus, interviewees might be more truthful with sensitive questions (Xin & Pearce 1996; Farh *et al.* 1998; Chua, Morris & Ingram 2009).

Another problem raised during both potential hunter surveys and market surveys was that additional questions were added into the question lists based on ideas or data from the proceeding interviews. For example, questions related to historical pangolin markets were not asked at the outset of potential hunter interviews. However, I found that interviewees understood the historical markets and were more willing to talk about these compared to current markets. Historical information could help to understand how pangolin populations have changed across time and people's perceptions of hunting activities. Thus, questions related to historical markets were added after I had finished the survey in Qiongzhong. Therefore, data on the historical pangolin market in Qiongzhong were not collected. This was an unavoidable process during qualitative interviews as new information was used to modify existing approaches.

Although the study design was not perfect due to various constraints discussed already, this study has still provided valuable and useful insights into pangolin trade and markets in China, as well as to the possible social science methods available to investigate the trade. The information collected in this study has proven distinctive in terms of perspectives and that were necessary for formulating effective conservation strategies, given the underlying guiding theories. This combination of the selected theoretical framework could also be adopted in future conservation research.

2.6 Ethics and positionality

Research design was approved by the Department of Geography Ethics Review Group, University of Cambridge (#1503). No personal data were collected during the process to protect interviewee privacy unless consent was obtained beforehand. Surveys conducted in Hainan required helpers to assist the data collection. Before conducting

surveys, all helpers received a 30-minute training to ensure that they understood the interview questions correctly and to standardize interview methods. Interviewers were taught not to express any directional attitude or information that might influence the interviewee's response. They were also trained to obtain consent from interviewees beforehand and correctly inform interviewees of the purpose of this survey. All interviewers introduced themselves as university students undertaking a research project for degree. Names of local universities in Hainan were used instead of the University of Cambridge as many helpers were from local universities and a local identity was helpful for gaining trust. In surveys and interviews conducted in Henan, researcher was introduced to interviewees approached through social connections as a research student from the University of Cambridge. Existing interpersonal trust provided credit to this identity and can help to gain participation interest. Since in general the identities of researcher or helpers were all university students, biases from identity perceptions should be minimum. The aim of the research described at the introduction differed based on target groups to fit with the different scenarios. For example, the study was explained as a TCM market research project when conducting TCM market surveys. Conversely, it was explained as research investigating attitudes to hunting when conducting potential hunter surveys. All interviewees gave their consent allowing the use of recorded information and were aware of the purpose of this study.

In conclusion, this chapter has outlined the theoretical framework and general methods used in this study and discussed some unavoidable limitations in study design. The following chapters will discuss the results obtained using these methods.

Chapter 3 Pangolin-related policies and online market scan in mainland China

3.1 Introduction

Regulation is one of the most powerful tools in conservation (De Klemm & Shine 1993; Baruch-Mordo *et al.* 2011). Furthermore, regulation also provides a blueprint for what should happen when conservation through protection operates optimally. Thus, understanding the legal framework for conservation is important. This chapter will describe the current and historical international and national regulations on pangolin protection and pangolin trade. To provide a background understanding of real-life trade, online medicine and ornament markets potentially selling pangolins were surveyed and the results are presented in this chapter. The wild meat market is known either for being hidden underground or being available mostly through physical markets (Sandalj, Treydte & Ziegler 2016; McEvoy *et al.* 2019). Thus, this preliminary online market survey excluded the wild meat market. The aim of this chapter is to provide a background understanding of pangolin trade related regulations, both internationally and within China.

3.2 International policies

The international trade in wildlife is mainly regulated by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This convention has been jointly signed by more than 180 countries and regions, including China, and acts as an important tool for biodiversity conservation. International trade in species listed in a CITES Appendix is regulated by a permit system and sometime taxa specific regulations would be issued as well. All eight species of pangolins are among the over 5800 animal species currently listed in the CITES Appendix. As a result, CITES has the mandate to regulate the international trade in pangolins and pangolin products where a Conference of the Parties think this is necessary. Historically, three of the four Asian pangolin species were listed in CITES Appendix II in 1975, at a time when the Philippine pangolin (*M. culionensis*) was grouped as a single species with

Sunda pangolin (*M. javanica*) until split in 2005 (Feiler 1998; Gaubert & Antunes 2005). This means wild-sourced Asian pangolin products were allowed for commercial trade, when accompanied by an appropriate permit. The Temminck's ground pangolin (*Smutsia temminckii*) was listed in Appendix I while the three other African species were listed in Appendix III. This means Temminck's ground pangolins were banned from commercial trade while trade in other African pangolins was not restricted. China joined CITES as the 63rd Party in 1981 and thus became bound by all CITES related regulations affecting pangolins thereafter (CITES 2018). In 1995, the Temminck's ground pangolins was down-listed to Appendix II and the other three African pangolin species were up-listed to the same regulatory Appendix (UNEP-WCMC (Comps.) 2018). In 2000, a zero-export quota was imposed for the four species of Asian pangolin, thereby banning all international trade in wild specimens for commercial purposes, while still remaining listed in Appendix II. Meanwhile, the four African species listed in Appendix II could be traded commercially with appropriate permits (CITES 2000). Despite the existence of the zero-export quota, 14 records, containing 6,887 skins/leather products and 2,800 kg of scales, are listed in the CITES trade database and involve wild Asian pangolin species. All products involved were identified as Sunda pangolin, traded for commercial purposes between 2001 and 2018 (CITES 2019). Countries involved in these trade records include Myanmar, China, Japan, Malaysia, Mexico, Germany, Switzerland, USA, and Singapore. It should be noted that these trade volumes are much smaller when compared to pre-ban levels of legal trade or contemporary illegal trade, which often involved products measured in tons, suggesting the implementation of CITES had a positive impact overall for pangolins (Xu 2009; Challender, Harrop & MacMillan 2015a). Despite some attempts to implement CITES, trade permits were found to be fraudulent in some instances, indicating that CITES still needs stronger enforcement of its regulations by all Parties (CITES Standing Committee 2017a).

The 17th Conference of the Parties (CoP) to CITES held in 2016 up-listed all eight species of pangolins to Appendix I, which prohibited all commercial international trade of wild specimens from 2017 (CITES 2016c). A resolution was also adopted to guide the effective implementation of the listing in which Parties were encouraged to take a strategic and multi-faceted approach to tackle illegal pangolin trade and conserve

pangolin populations (CITES 2016b). These actions include revising trade policies, strengthening law enforcement, raising public awareness, understanding consumer motivations, securing pangolin stocks with adequate control measurements, and preventing laundering through breeding facilities (CITES 2016b).

CITES also pays close attention to stockpiles, confiscated products, and captive breeding of listed species, which could directly or indirectly influence international trade (for example Articles 17.170 and 14.69). Two additional Decisions (17.239 and 17.240) were approved during the 17th CoP requesting more information on the overall status and trade of pangolins and their products. China provided some information on its pangolin scale stockpiles in response to a questionnaire developed by IUCN, who were contracted to help implement these two decisions. However, the Chinese government still did not reveal the total quantity of scales stockpiled in their response, which is a key piece of information needed for trade regulation and monitoring. Responses from all relevant Parties were summarized in the report "Implementation of CITES Decisions 17.239 b) and 17.240 on Pangolins (*Manis* spp.)" (Challender & Waterman 2017).

During the 69th meeting of the CITES Standing Committee, a Working Group on stockpiles was formed, and pangolins were among the discussion topics. However, China did not respond to the Notification issued by the Working Group to provide more information on their pangolin scale stockpile (CITES Standing Committee 2017b; CITES Standing Committee 2018). The Working Group specifically suggested during the 70th meeting of the CITES Standing Committee that quantification of stockpiles (including pangolin stockpiles) should be one of the reporting requirements for declared stockpiles. A CITES Notification in 2018 (No. 2018/082 dated 1 November 2018) reaffirmed that "in the interim and until a decision is made by CoP18, Parties should treat specimens, including stockpiles, of Appendix I species of pangolin obtained when the species was listed in Appendix II, as Appendix I specimens and regulate trade in accordance with Article III of the Convention." (CITES Secretariat 2018). CoP18 issued decision to standing committee to continue investigate on stockpiles and the management and report their findings during CoP19 for discussion (CITES Secretariat

2019). Thus, no final decision has been issued by CITES regarding trade in pangolin stockpiles so far.

3.3 Policies towards pangolins in mainland China

3.3.1 Pangolin protection

At the national level, the Chinese pangolin (*Manis pentadactyla*) is protected and regulated under the Wild Animal Protection Law of the People's Republic of China. This Wild Animal Protection Law first came into force on 1st March 1989 (National People's Congress of China 2016). "Regulations for the Implementation of the People's Republic of China on the Protection of Terrestrial Wild Animal" published in 1992 which was subsequently revised in 2011 and 2016 to better assist implementation of the Wild Animal Protection Law with regard to the terrestrial animal (State Council 2016). Another element of the Wild Animal Protection Law is the List of Protected Animal Species in which the Chinese pangolin was listed as a Class II Protected Species. This list was first published in January 1989 and was amended in 2003, 2020, and 2021. The 2020 amendment raised the Chinese pangolin to Class I Protected Species and the 2021 revision included the Sunda pangolin and Indian pangolin (*Manis crassicaudata*) under Class I Protected Species as well (SFA of China 2003; SFGA of China 2020; 2021).

In 1993, China legally incorporated non-native species that were listed in CITES Appendix I and II into the national wildlife protection framework (SFA of China 1993). The protection levels of non-native CITES species should be consistent with the protection class of its taxonomically closest native protected species. Thus, pangolin species not native to China are also protected as Class I Protected Species, in the same way as the Chinese pangolin. The Supreme People's Court has provided interpretations of existing wildlife-crime related regulations and the sentencing for different types of wildlife crimes with reference to the Criminal Law of China and on how CITES species should be incorporated into national wildlife protection classifications (Supreme People's Court of China 2000; Supreme People's Court & Supreme People's Procuratorate 2014). The Wild Animal Protection Law was revised in 2016 placing

greater emphasis on the conservation of wild animals and their habitats. Moreover, consuming illegal wildlife products was recognised as illegal for the first time. By contrast, the previous version only regarded unlicensed hunting, transportation, and trading as illegal behaviours. As a result, this Amendment of the Wild Animal Protection Law provided stronger legal support for the protection of pangolin populations in China. Due to the potential link between COVID-19 pandemic and wildlife trade, the Wild Animal Protection Law and regulations related to farming wildlife have been revised and farming terrestrial animals for food was restricted to a few species of domesticated animals or animals with well-established commercial farming scheme. However, since farming for traditional Chinese medicine (TCM) is not restricted, farming pangolins could still prove to be legal.

3.3.2 Traditional Chinese Medicine (TCM) market regulation

Although unlicensed trade in pangolins and pangolin products was banned in China under the Wild Animal Protection Law in 1989, the trade of pangolin scales for TCM was not specifically regulated until 2006. A document released by State Forestry Administration (SFA, now State Forestry and Grassland Administration) in 2006 asked individuals and companies to report the quantities of pangolin scales in possession to their respective local forestry administration, in order to estimate the total quantity of pangolin scales in hold nationally (SFA of China 2006). In 2007, a notification regulating pangolin scale trade for medical use was released by SFA (SFA of China 2007b). Subsequently, a list of hospitals was published to which the provincial forestry administration could grant permits to trade in pangolin scales upon application (SFA of China 2008b). These regulations have been active since 2008. Thereafter, a quota for the use of pangolin scales was released each year by SFA to selected provinces to supply the certified trade. The most recent publicly accessible quota document is for 2014–2015 (SFA of China 2008a; SFA of China 2009; SFA of China 2010; SFA of China 2011; SFA of China 2012; SFA of China 2013; SFA of China 2014). After 2015, responsibility for issuing quotas was decentralised to each province. Thus, no further information on the national quota is publicly available and the provincial quotas are also not available to the general public. The national quota totals from 2008 to 2015 are plotted in Figure 3.1. The quota document specified that quotas should be issued upon

permit application from pangolin scale stockpile holders and that scales purchased from certified pangolin farms or legally imported from other countries were not included in the size of the quota.

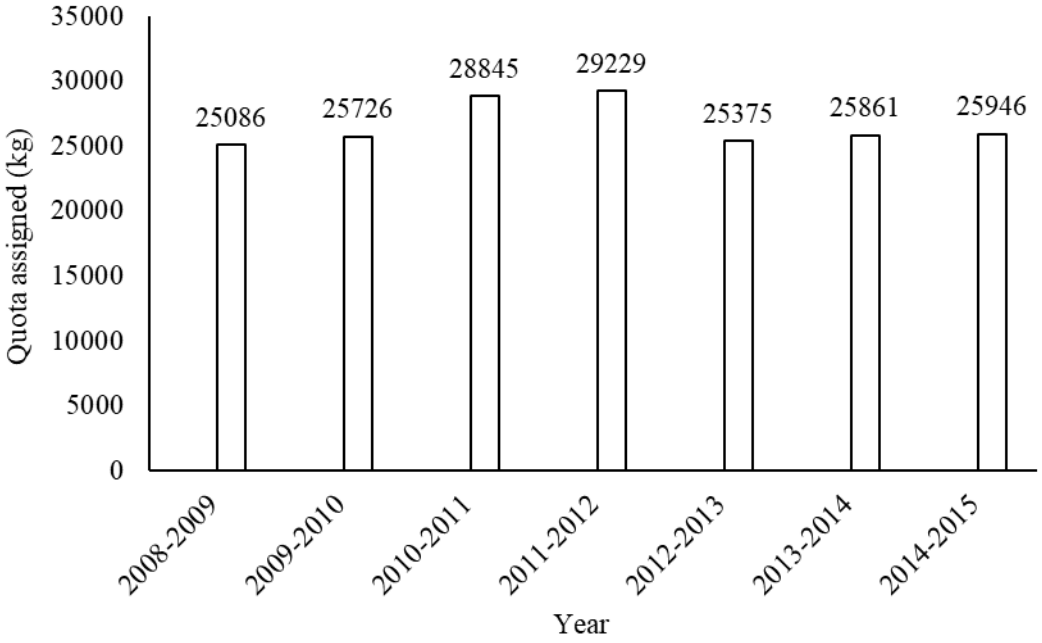

Figure 3.1 The total annual pangolin scale use quotas from 2008 to 2015. Quantity in plot is rounded to integer. *Source*: SFA of China

3.3.3 Regulation of Pangolin farms

Farming of pangolins is allowed in mainland China with certifications issued by a provincial level forestry administration. The required standards for granting farming permits vary by province and are not publicly available. Although Hu (2016) asked all provincial forestry administrations to provide information related to pangolin farming permits, only a few responded. The available information suggested that more than 10 pangolin farms held permits at the time, but there were also farms operating without permits (Hu 2016). No data were available on whether these legal farms had obtained wildlife trade permits to trade pangolin scales as TCM products or how many pangolins they held. Legal trade permit is in theory feasible to be issued if pangolins were captive bred to the second generation. However, the current situation regarding pangolin farms in China is unclear and there is no evidence to suggest commercial pangolin farming has been successful (Hua *et al.* 2015; Li 2017; Challender *et al.* 2019). This increases

the need to understand the current levels of existing pangolin farms in China to prevent the laundering of animals into the trade.

3.3.4 Sentencing for pangolin related crimes

Crimes involving pangolins or pangolin products are divided into three tiers, depending on their level of severity (National People's Congress of China 1997; National People's Congress of China 2016). The interpretation from the Supreme People's Court provides more detailed instructions on how to identify each tier. Crimes involving less than eight pangolins are a 'serious offense', between eight and 16 are considered as 'very serious offense', and 16 or more individuals are considered as 'extremely serious offense'. These tiers can also be defined by the monetary value involved. Products worth more than RMB100,000 (around USD14,393) or generating a profit of more than RMB50,000 (around USD7,196.5) are very serious offenses, while products worth more than RMB200,000 (around USD28,786) or generating a profit of more than RMB100,000 (around USD14,393) are considered extremely serious offenses. The monetary value threshold for "non-profit smuggling", including tourists carrying souvenirs made of illegal wildlife products, and of less than RMB100,000 (around USD14,393) can be exempt from criminal penalties (Luo 2014; Supreme People's Court & Supreme People's Procuratorate 2014).

Different tiers correspond to different penalty levels. According to the Chinese Criminal Law, Article 341, serious offenders would either be sentenced to a fixed-term imprisonment of not more than five years or criminal detention and a fine would be applied. Very serious offenders would be sentenced to a fixed-term imprisonment of five to 10 years with a fine. Extremely serious offenders would be sentenced to a fixed-term imprisonment of more than 10-years with a fine or confiscating properties.

3.4 Pangolin-related policy in a wider framework

Pangolin-related policies in China are part of the wider TCM development-related agenda and policy frameworks on building an "Ecological Civilization". TCM is a

valuable and unique part of Chinese culture that is strongly supported by the government. Nationally, “Opinions on Supporting and Promoting the Development of Traditional Chinese Medicine” in 2009 and the “Outline of the Strategic Plan on the Development of Traditional Chinese Medicine (2016–2030)” in 2016 are two examples of recent policies supporting the development of traditional medicine within China (State Council 2009; State Council 2016a). In 2017, the first Traditional Chinese Medicine Law was established to provide legal support to TCM development and regulation (National People's Congress of China 2017). Internationally, China is also trying to promote TCM to the wider world with policy initiatives such as the “Traditional Chinese Medicine “Belt and Road” Development Plan (2016–2020)” (State Administration of TCM & NDRC 2016). The rising demand for TCM products due to the expanding TCM industry in China is an expected trend. However, the annual quotas for pangolin scale use remained stable from 2009 to 2015, which might fail to consider the change in the market.

Sustainable development has always been a focus within the Chinese government’s development agenda, particularly regarding sustainable resource use, but less so for the ecology or the environment. For the first time, a “good ecological environment” was included as one aspect of building a moderately prosperous society during the 16th National Congress of the Communist Party of China in 2002 (Jiang 2002). The concept of Ecological Civilization was introduced at the 17th National Congress in 2007, and then explained in more detail at the 18th National Congress in 2012 (occupying a full chapter in the Congress report) (Hu 2012). The first Environmental Protection Law in China is formulated in 2014 and came into effect from 2015 which highlighted the importance of Ecological Civilization and conserving biodiversity (National People's Congress of China 2014). In 2017, the 19th National Congress further strengthened the importance of Ecological Civilization in the overall development agenda and proposed explicit actions be taken. In 2018, Ecological Civilization was included in the Constitution (National People's Congress of China 2018). Under the larger framework of Ecological Civilization, pangolin conservation has gained a strong background of support.

3.5 Legal and illegal trade

3.5.1 Legal trade

Under current policy, there is only one example of a legal pangolin trade in China. This refers to certified hospitals selling labelled pangolin scale products that are manufactured by permitted companies using legally sourced pangolin scales. These pangolin scale products must be sold with a trading permit attached to the smallest package of the products in that shipment (Figure 3.2). The Health Commission, Forestry Administration, Administration of Industry and Commerce, Food and Drug Administration, and Administration of TCM at all levels are accountable for monitoring and regulating the market (SFA of China 2007b). The quality of pangolin scales is regulated under the national drug standards specified in the Pharmacopoeia as well as by some provincial-level regulations regarding processing methods (Chinese Pharmacopoeial Commission 2015). In the Pharmacopoeia, pangolin scale refers specifically to scales of the Chinese pangolin, thereby indicating scales of other pangolin species should not be used in TCM. The pangolin scale was removed from Pharmacopoeia in 2020 yet some patent drugs still contain pangolin scale as ingredient and the legal trade system has not been stopped (Chinese Pharmacopoeial Commission 2020). Therefore, the impact of removal in real-life is unclear.

Figure 3.2 Trade permit sticker (top left corner) on the smallest package of the product.

Legal sources of pangolin scales under current regulation system could include:

- the quotas issued by SFA or provincial level forestry administrations,
- scales from certified pangolin farms, and
- scales seized from illegal trade (SFA of China 2007b; Tian Cheng Auction Company 2013).

Currently, CITES has banned all international trade of wild-sourced pangolin products for commercial purposes. Thus, China cannot legally import pangolin products unless from stockpiles for which the management decision has not been decided. The 2016 up-listing of all pangolin species to Appendix I also meant that CITES recommended that seized pangolin products are not returned into the market. Since this is only a recommendation and no national regulation has banned trading seized pangolin products, it is possible that seized pangolin products from international trade might be included as stockpile and enter legal trade system. Meanwhile, there is no evidence for any successful commercial pangolin farming based on known information (Hua *et al.* 2015; Li 2017). As a result, the legal source of scales available for the current legal market is through the quotas assigned from existing stockpiles and importing stockpile scales from other nations, and assuming zero harvests from farms and stockpile international trade is allowed. No data are available on how many pangolin scales remain in stockpiles to support these annual quotas. However, the stockpiles are unlikely to become a sustainable source of supply since commercial farming has not proved successful and wild populations remain on the edge extinction. Although the stockpile might be of sufficient size to meet market demand for near future, the uncertainty of long-term future supply capacity still requires attention.

Lack of understanding of current market demand is another barrier to trade regulation besides the unpublicized stockpile quantity. Actions such as conducting market research, actively planning the release of stockpiles according to a specified timeline and encouraging the use of substitutes are needed to ensure legal trade is under control and stakeholders who are dependent on pangolin scales are well-prepared for the possible future market closure when the stockpiles run out, and before commercial farming techniques are developed.

3.5.2 Illegal trade

The Wild Animal Protection Law of China makes clear that trade involving wild pangolin meat, body parts, uncertified scale products, or unlicensed selling is illegal and prohibited. Nevertheless, evidence shows that illegal pangolin trade is widespread in China (Yin *et al.* 2015; Nash, Wong & Turvey 2016; Xu *et al.* 2016; Cheng, Xing & Bonebrake 2017). From 2008 to 2016, 206 pangolin related seizures in 68 cities in 17 provinces, were reported. These seizures involved 23,109 individuals and 21,377 kg of scales, equivalent to a total of around 65,849 individual pangolins (Cheng, Xing & Bonebrake 2017). A TCM market survey conducted by TRAFFIC China in 2016 also revealed a similar pattern—62% of TCM shops in 19 cities were illegally selling pangolin scale products (Xu *et al.* 2016). Multiple administrations have responsibility for enforcing trade policy and eliminating illegal trade (SFA of China 2007b). However, the current situation suggests enforcement efforts should be strengthened and all relevant departments should be more collaborative. There is also a need for information on whether these enforcement agencies self-evaluate their own actions, which is important for improving implementation strategies.

3.6 Online market survey

This online survey aimed to provide a general understanding of pangolin trade before conducting fieldwork. Moreover, although the selling of pangolin medicines in physical stores has been reported previously by many researchers, online trade has not been investigated systematically (Yin *et al.* 2015; Xu *et al.* 2016). Also, the use of pangolins as ornaments in China is little known or reported (Ruan 2019). Thus, the survey aimed to add new information to existing knowledge.

3.6.1 Survey methods

An online search was conducted in August 2016 before the fieldwork and in May 2019 again after the fieldwork on three online shopping platforms and four medicinal trade platforms looking for pangolin made products. The survey was repeated on a second occasion to update the results after a 3-year interval. Results documented in 2019 were included to ensure result accuracy. Platforms and search strings used were summarized

in Table 3.1. Photos and descriptive text provided by shops were used to identify whether or not the products were made of pangolin body parts. Uncertainty with identification exists but all shops identified were at least trying to sell real wildlife products since wordings such as "natural" or "real" were found in the descriptions. Product type, price, available stock, the origin of products, trade permit, and sale information related to the pangolin products were recorded if openly posted.

Table 3.1 Trade platforms investigated during the survey and search strings used were shown as below.

Target products	Platform searched	Search strings used
Ornament	1) Jingdong 2) Taobao 3) Alibaba	1) “chuanshanjia” (pangolin) 2) "mojinfu wuzhi" (name of an amulet with a specification of five fingers) 3) “jiapian diaoke” (scale carving)
Medicine	1) Hezongyy 2) China Medicine Market 3) Jiuzhoutong 4) Quanyaotong	1) “paoshanjia” (processed pangolin scale) 2) “chuanshanjia” (pangolin) 3) “jiazhu” (processed pangolin scale) 4) “shanjiapian” (pangolin scale)

3.6.2 Survey results

Ornaments potentially using pangolin body parts were found in all three online platforms searched using the latter two more specified search strings. In total, 11 shops were found selling potential pangolin made ornaments. Direct searches for ‘pangolin’ yielded no results in two out of the three platforms. This is probably due to filters set by those platforms, aiming to reduce illegal pangolin trade (TRAFFIC 2017).

Two main types of ornaments were found in those shops. The first type was pangolin scale carvings used as amulets or pendants (Figure 3.4a) or massage tools. Prices of these scale carvings ranged from 208 yuan/piece to 980 yuan/piece (around 30 USD/piece to140 USD/piece). Stock information was always available. A Taobao shop advertised that it had 15 pieces in stock, while an Alibaba shop labelled 4000 pieces as in-stock while another labelled two pieces. Sales records were labelled as zero for all observed shops. Amulets made of pangolin claws were also found (Figure 3.4b). These

amulets, "mojinfu", are culturally associated with tomb-raiding and became famous through the prevalence of some tomb-raiding themed fictions and TV series (Ruan 2019). The price of these “mojinfu” varied from 120 yuan/piece to 2559.83 yuan/piece (around 17 USD/piece to 364 USD/piece). Shops on Jingdong were all labelled as out of stock and shops on Taobao and Alibaba with stocks varied from 73 to 2009 pieces. Again, sale records are all zero.

Figure 3.4 Ornaments made of pangolin body parts found on the three platforms, here showing (a) pangolin scale carving as an amulet or pendant and (b) an amulet made of a pangolin claw. *Source*: photos provided by shops

Among the four online medicine markets, two were found selling pangolin products: China Medicine Market and Quanyaotong. Five sellers were identified in China Medicine Market. Provided locations of the sellers included: Anguo, one of the two largest medicine trading centres in China; Nanning; Zixing. These three locations are all in different provinces. Locations have been listed as the origin of the pangolin products included Yunnan, Sichuan, and Guangxi provinces. Product origins and seller locations were not correlated. The types of product were surprisingly diverse. Raw scales (one post labelled scale for carving), processed scales, live pangolins, and pangolin claws/specimens were all found in posts through photos or description provided by these five sellers. At least three species of pangolins were involved in those posts based on Cota-Larson's pangolin ID guide as shown in Figure 3.5 (Cota-Larson 2017). Price was not always listed but some were shown. Live pangolin was labelled

as 1000 yuan/kg (around 142 USD/kg), raw scale price ranged from 2500 yuan/kg to 3500 yuan/kg (around 355 USD/kg to 498 USD/kg), and one processed scale post was labelled as 1600 yuan/kg (around 227 USD/kg). Stock information was provided in some posts. Stock quantity ranged from 80kg to 1000kg. One shop was identified on Quanyaotong platform selling processed scales. Price was not directly available, but the stock was shown as 3.5kg. The origin of these pangolin scales was labelled as Yunnan and they were manufactured by a company in Jiangxi, which were then sold on this platform by a company in Fujian.

Figure 3.5 Product photos found in some of the posts on China Medicine Market with (a) likely showing a Sunda pangolin, (b) likely showing scales from White-bellied pangolin, and (c) showing some large scales not derived from the above two species, but probably from Indian pangolin (*Manis crassicaudata*) or Temminck's ground pangolin (*Smutsia temminckii*) or Giant ground pangolin (*Smutsia gigantea*). ID based on Cota-Larson's pangolin guide (2017). *Source*: photos provided by sellers

3.6.3 Legality of online trade

Trade in pangolin made ornaments was straightforwardly illegal since the current legal market can only involve use for TCM. For the online medical trade survey, only one seller provided trade permit information or indicated s/he held trade permit(s). However, this is a requirement if pangolin trade is to occur legally (see Section 2.4.1 for explanation). The one seller who indicated holding of a trade permit did this though putting the physical permit at the back of the product so that the title of the certificate was visible in the product photo. From product photos provided or the description of the products, no trade certification sticker (Figure 3.3) was visible on products or mentioned, even on the product from the seller who provided the trade certificate. It was also unclear if the seller requires buyers to be qualified, i.e. did buyers hold trade

permits? Thus, the trade was very likely illegal since neither buyers or sellers were required to hold trade permits and trade certification stickers were missing from all product photos.

Illegal trade of pangolin products as ornaments and medicine was found to be ongoing in most online trading platforms in the survey. This indicates that stronger law enforcement is required to ensure effective policies to regulate the pangolin trade. This preliminary survey also indicates the urgent need to understand these markets more widely. Such an understanding will assist law enforcement and guide demand reduction interventions, through the theoretical framework outlined in Chapter 2.

3.7 Discussion and conclusions

All pangolin species are now protected from all commercial international trade through listing on CITES Appendix I which prohibits wild-sourced products for commercial international trade. Each Party is encouraged to strengthen their commitments to CITES and implement relevant legislation accordingly. Although recommendations from the Resolution and the Notification on international pangolin stockpile trade are on a voluntary basis, they are crucial for pangolin conservation and for tackling illegal trade. The Chinese government is encouraged to effectively implement the CITES listing and Resolution Conf. 17.10 on *Conservation of and trade in pangolins*, as well as recommendations from the CITES Standing Committee. It might also be helpful if CITES could implement a mechanism for monitoring progress on the implementation of the pangolin resolution, in the same way that progress on the implementation of the CITES Resolutions on African and Asian elephants, Asian big cats and rhinos are regularly monitored by the Standing Committee (CITES 2016a). This is an active way to encourage Parties to measure the efficacy of their implementation on a regular basis.

Pangolin populations, densities and distributions in China are poorly understood. Even though “Regulations for the Implementation of the People’s Republic of China on the Protection of Terrestrial Wildlife” requires wildlife censuses to be conducted once every 10 years, no pangolin data were collected during the 2008 census. Research

capacity from individual researchers or institutes to provide up-to-date nationwide information important for pangolin conservation. Thus, the national wildlife censuses should be conducted at the frequency required by law, to provide data that are otherwise difficult to obtain. The recent review study on methods to estimate wild pangolin population should be considered for understanding pangolin populations in China (Ingram, Willcox & Challender 2019; Willcox *et al.* 2019).

Trade in pangolin scales is legal under stricter protocols in China. However, the current legal market for pangolin scales in China is supplied from stockpiles of finite size. Once these stockpiles are depleted, and if commercial farming continues to remain unsuccessful (Hua *et al.* 2015; Li 2017; Challender *et al.* 2019), the only option will be to close the current legal market. Therefore, the government authorities and the TCM industries should collaborate to establish a clear timeline for stockpile use and be prepared for possible market closure in the near future. Relevant stakeholders also need to work together to keep track of the pangolin scale stockpiles and prevent laundering. Understanding the demand for pangolin products, especially the demand from the legal market, and the stockpile data, are central for combating illegal trade and anti-laundering. Research is urgently required to analyse demand on pangolin products in China, one of the main questions that this study sought to shed at least some light (see Chapter 2).

How long the stockpiles can last and whether the quantity supplied can meet the permitted market demand are important questions, but not as yet with clear answers. Knowing the size of the stockpiles and understanding markets are crucial for answering these questions. However, besides lack of research to reveal the unknowns related to pangolin markets, much of the existing information related to the legal pangolin market is not publicly available, such as the total quantity of scale stockpiles and recent annual scale-use quota. This is problematic for conservationists and the public wanting to contribute to combatting illegal trade and monitor legal trade. Increasing the transparency of the stockpile management process, for example, will provide information on the quantities of scales held in stockpiles, will help to assist market monitoring and contribute to more efficient enforcement.

Seizure reports (Xu *et al.* 2016; Cheng, Xing & Bonebrake 2017; Heinrich *et al.* 2017) and online market surveys indicate that illegal trade in pangolins and their products is ongoing. No evidence is available to argue for the opposing position or suggest that pangolin populations have recovered following the implementation of regulation. This also makes it difficult to quantify the efficiency of existing pangolin related policies. Evaluation of the enforcement impact should be part of the standard routine and the evaluation results could be shared openly for third party invigilation. Many government departments have the mandate to combat illegal pangolin trade while evaluation of enforcement strategies and conservation interventions could inform more targeted decision making in the future (Keane *et al.* 2008; Stokes 2010; Denninger Snyder, Mneney & Wittemyer 2019). Accountability for trade regulation and conservation should be identified more clearly among these departments as current regulations are not clear on this aspect. Raising public awareness of illegal pangolin trade is needed, especially in differentiating legal and illegal products and how to report illegal products and activity.

The widespread illegal trade in pangolins, both online and offline, suggests there is still a long way to go to eliminate trafficking and protect pangolin populations in China (Yongping 2009; Yin *et al.* 2015; Xu *et al.* 2016). The complex trade network reflected from product origins and selling places in the online survey results strengthened the need to understand the trade for better enforcement. Moreover, the availability of illegal pangolin products online pointed out the need for research not only within physical markets but on online platforms as well. The diverse nature of demand on pangolin products is proven through this preliminary online survey. Live pangolins for farming, scales used as medicines, carving materials, pendant, amulets, and pangolin claws for amulets are all product types currently being actively demanded in medicine and ornament markets. The social-cultural context behind those demand requires further investigation.

Recent policies on Ecological Civilization provide stronger legal support for protecting pangolins and their natural environment (Jiang *et al.* 2019). On the other hand, it is also

important to note that national and international promotion of TCM might increase demand for pangolin scales as a medicinal ingredient. The annual stockpile quota needs to take the potential increase in the demand of pangolin ingredients within TCM into consideration. All stakeholders should work together to help reduce illegal pangolin trade and ensure legal trade is strictly controlled.

In conclusion, this chapter has provided a detailed background overview of the policy framework in mainland China and touched on the real-life pangolin trade through surveying several online markets. The next chapter will delve more deeply into what's happening on the ground and starts by answering questions related to consumers using data collected through public surveys.

Chapter 4 Portraying wild animal products and pangolin products consumers

4.1 Introduction

China is regarded by many as one of the largest global demand markets for wildlife products, and one that involves many and diverse species (Gao & Clark 2014; Sato & Hough 2016). Numerous studies have tried to understand the reason for such high demand and to look for actual or potential factors that might influence more sustainable consumptive behaviour in China in future (Yang *et al.* 2007; Gratwicke *et al.* 2008; Fabinyi 2012; Zhang & Yin 2014). Delineating consumer profiles was also an area of focus (Drury 2009b; HSI & Aita Foundation 2016; USAID Wildlife Aisa 2018). The logic behind these two approaches was that these areas of knowledge could contribute to changing consumer behaviour, thereby reducing demand. Previous researches have also acknowledged the importance of this knowledge in designing effective behaviour change or demand reduction interventions (Lucas *et al.* 2008; Olmedo, Sharif & Milner-Gulland 2018; Veríssimo & Wan 2019).

Although numerous consumer studies have been conducted in China (Zhang, Hua & Sun 2008; Vigne & Martin 2011; Fabinyi 2012; Zhang & Yin 2014), few have looked at pangolin consumers in detail, especially consumers of different pangolin products. This chapter aims to provide more information on consumers of different types of pangolin products, namely food products, medicinal products, and ornamental products. Moreover, public perceptions of consuming wild animal products in general were also investigated at the same time. Thus, this chapter includes the following sections. Firstly, materials and methods used to collect and analyse the data would be presented, followed by the demographic description of the sampled population. Secondly, I discuss data related to the public's view on wild animal products and factors influencing the consumption behaviour. Thirdly, the public's understanding of pangolin products and trade will be presented to profile pangolin consumers. Next, the limitations related to the study design will be discussed. This is followed by a discussion and a summary of the main message from this chapter. Questions that will be covered in this chapter

include:

- who are the wild animal and pangolin product consumers?
- what are the factors and motivations that lie behind consumptive behaviours?

4.2 Materials and methods

The public survey was conducted in both Henan and Hainan provinces covering eight sites with different economic and cultural characteristics. As described in Chapter 2, online snowball sampling was used in surveys in Henan, while street quota sampling and online snowball sampling were used in surveys in Hainan Province. The differences in the survey methods and their potential impact will be discussed later in this chapter (see Section 4.4). The questionnaire contains three parts. The first part asked about the demographic information of the respondents. The second part focused on people's attitude towards consuming wild animal products designed using the Theory of Planned Behaviour (TBP). The last part of the questionnaire investigated the extent of people's knowledge and attitude towards pangolin products in more detail. During the sampling process, provincial gender and age structure of these two provinces were used as a reference (National Bureau of Statistics 2011). The gender and age structures of survey participants were monitored in real-time during survey to ensure the gender and age structures in each province resembled the provincial ones to the maximum extent possible. This means gender and age groups that were few in number were specifically targeted to increase their overall representation. Ethnic group, long-term residence city, occupation, average annual income, and education level were the other demographic data collected during the first part of the survey (Appendix I).

The second part of the questionnaire focused on people's understanding of, and perceptions towards, wild animal products in general. At the start of the questionnaire, the first requirement was to formulate a definition to clarify and explain to interviewees verbally during face-to-face surveys. A clear definition of the behaviour is necessary to avoid biases caused by ambiguous terms (Ajzen 2002). The definition of wild animal products that I used in this study was: those products originating from a wild animal population; product types including but not limited to food, ornaments, medicines and

so on; products from farmed animals were not included. Furthermore, if the interviewees were not sure about product origin, it should be classified as wild-sourced. Special note: purchasing or using wild animal products are not necessarily illegal, it could depend on specific regulations related to that animal" (Appendix I).

The third part of the questionnaire focused on pangolin and pangolin trade to better understand consumer segmentation, what the public knew about pangolin and its trade, and how they viewed it. Pangolin products based on their functional use were divided into three groups: medicine, food, and ornaments. Knowledge of the food and medicinal uses of pangolin products is longstanding. However, ornamental uses (Liu *et al.* 2016; Xu *et al.* 2016), and the traditions of using pangolin made ornaments had been little reported in China (Soewu & Sodeinde 2015). Nevertheless, recent news indicates that pangolin made ornaments have started to emerge in China (Ruan 2019). Moreover, the online market survey demonstrated the presence of pangolin made ornaments in the market (see Chapter 3). Thus, the functional use of pangolin products as ornaments was included in the questionnaire.

Statistical methods were used in this chapter to model consumptive behaviour and delineate consumer groups, and they included Structural Equation Modelling (SEM), Classification Tree Modelling (CTM), and Generalised Linear Regression (GLM) (Topa & Moriano 2010; Ishikawa *et al.* 2013). Consumers were defined in this study as people who have either consumed within the last two years or intended to consume in future. In other words, wild animal consumers were participants who answered "very likely to consume" in Q16 or answered "yes" in Q17 while pangolin products consumers were defined as answering "yes" in Q25 (see Appendix I). Different models were used for different consumer groups in different provinces. Principal Component Analysis (PCA) was also used in this chapter to understand wild animal consumer data structures in both provinces and see i) whether consumers (have consumed or planned to consume) and non-consumers can be distinctively separated with the given factors and ii) whether some variables dominating the explanatory power thus worth more attention or reduce unimportant variables in further analysis. RStudio under R version 3.5.2 was the platform used to perform all statistical analysis (RStudio Team 2015).

The main packages used included rpart (for classification tree model), lavaan (for SEM), devtools (for PCA), and stats (for GLM).

SEM was selected as the first-choice analysis due to its strong statistical power in providing causal explanations incorporating latent variables. Variables such as attitudes and perceptions cannot be measured directly and the Likert-scale style questions used in surveys were indirect measures that aimed to reflect on different aspects of these variables (Muthén 2001). Thus, the concept of latent variable could help to better model the behaviour. Furthermore, many studies have used SEM to validate TPB (Mayhew *et al.* 2009; Topa & Moriano 2010; Sentosa & Mat 2012). In this study, TPB provides the predefined structure and SEM validates the data fitness to this structure. Thus, only TPB related variables were used for modelling (Q8 to Q17 in the questionnaire). Model fitness would suggest whether TPB could provide a good explanation towards the interested behaviour. The fitness of the model was evaluated using the model index suggested by previous studies (Hooper, Coughlan & Mullen 2008). Coefficients generated in SEM should indicate the strength of each variable in contributing to the final behaviour.

The high statistical power of SEM, however, also requires high data accuracy and good sample size (Maas & Hox 2005). As a result, a Classification Tree Model (CTM) was used in cases where the SEM might fail. CTM was chosen due to its strong ability to identify relationships between variables and the targeted value, handling various data types, and accepting some degree of data errors (Rokach & Maimon 2008). It has also been used by other studies to segment target audience and understand study behaviour (Ishikawa *et al.* 2013; Vuik 2017). CTM identifies variables that correlate with consumptive behaviour and can best be distinguished by comparing consumers vs. non-consumers. Wild animal consumer models used variables from questionnaire Parts One and Two while pangolin consumer models included data from Part Three as well. Questions on supportiveness and legality of pangolin trade (Q26 and Q28) were excluded from the GLM model as they were found to be masking other more interesting variables that can provide more insights on consumer profiles. These two questions will be discussed further in later chapters. Most optimal models have been computed using

CART function, and then pruning was applied based on the lowest complexity parameter value to avoid overfitting (Therneau & Atkinson 1997). A successful CTM can delineate different consumer groups, if more than one, but cannot provide a causal explanation of the consuming behaviours as SEM could. However, CTM was still preferred over GLM due to its higher explanatory power which comes from the hierarchical nature of this algorithm and the ability to segment potential homogenous consumer groups (Ishikawa *et al.* 2013; Rokach & Maimon 2008).

GLM was only performed if and when CTM failed, as it can provide a list of variables that correlate with the interested behaviour, i.e., consumption of wild animal or pangolin. A null model was firstly built with all variables and both direction stepwise removal was used to find the best fit model with the lowest Akaike information criterion (AIC). Variable coefficients were standardised in the final model using *beta* to identify the most influential factors. Qualitative data such as people's knowledge of pangolins were analysed using content analysis (Newing 2010). Qualitative responses were coded and grouped into clusters. The meaning of each cluster was described and the frequency of clusters appearing in responses was recorded and described.

4.3 Results

4.3.1 Demographic data of participants

In total, 1221 and 947 responses were collected from Henan (using snowball sampling) and Hainan provinces (using street encounter sampling), respectively. Snowball sampling in Hainan was less successful as only respondents from the two sites of Haikou and Sanya, were numerous enough to be included, and age and gender control was not feasible due to low response rate. It was later found out also that respondents to the Hainan snowball survey were mainly people wintering in Hainan or who had only moved to Hainan recently. These new migrants are not representative of Hainan population, so this part of the data was excluded from the analysis. For the available data, although the provincial gender-age structures were used as a reference during data collection, the differences between the sampled gender-age structures and the provincial ones were significant for both provinces (paired t-test, $P < 0.05$). Thus,

variation in gender and age would be considered when interpreting the wider patterns if they were found to be important factors for the interested behaviour(s). The education levels of participants were higher than the census data for the two provinces (z test, $P < 0.05$). Unfortunately, this was an unavoidable bias due to the innate nature of the surveys in which illiterate people would have more difficulty in participating (Hainan Provincial Bureau of Statistics 2008; Henan Provincial Bureau of Statistics 2016). The income and education levels of participants in the two provinces were significantly different from each other due to the different stages of their economic development (paired t-test, $P < 0.05$).

4.3.2 Public surveys of wild animal products

The survey showed that, in general, the public holds negative feelings towards wild animal products and their consumption (Figures 4.1, 4.2, and Table 4.1).

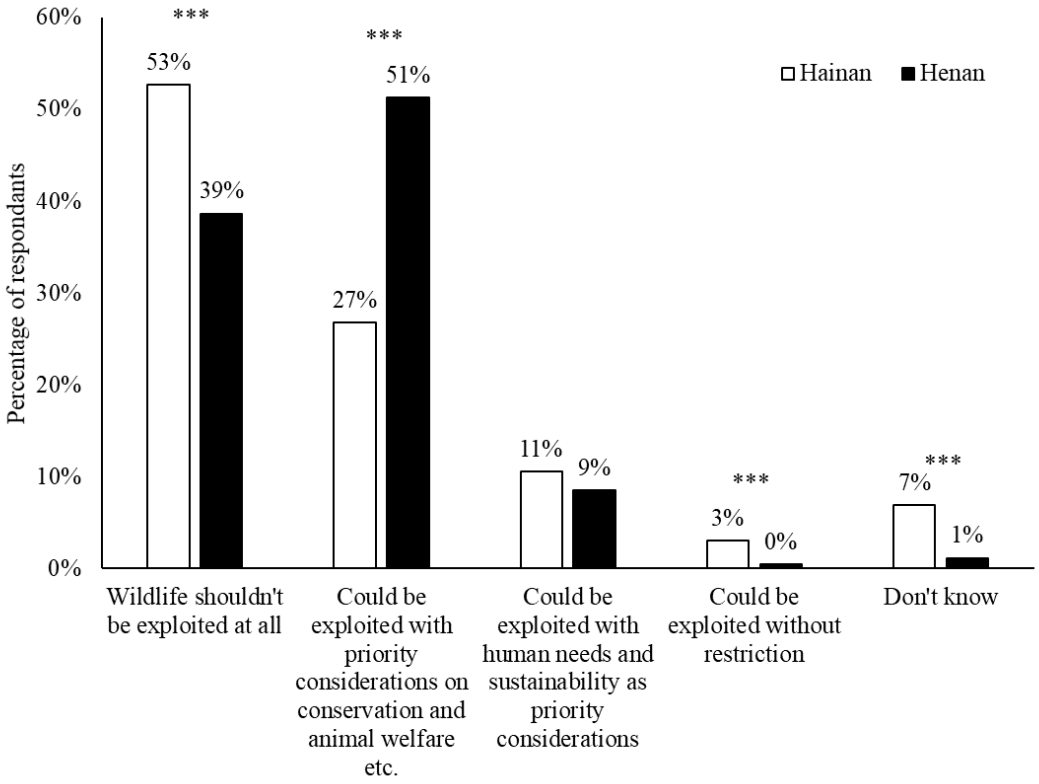

Figure 4.1 Public attitudes towards wild animal exploitation (Q8) in Henan Province using snowball sampling (N = 1221) (black) and Hainan Province using street encounters (N = 947) (white). *** indicates significant differences between the two provinces (z-test, $P < 0.05$).

Table 4.1 People's attitude and perceived norms regarding consumption of wild animal products in Henan Province using snowball sampling (N = 1221) (labelled with a) and Hainan Province using street encountering sampling (N = 947) (labelled with b). Significantly different (z-test, P < 0.05) proportions between provinces are labelled with ***.

Statement	Totally agree	Largely agree	Neutral	Largely disagree	Disagree	Don't know
Q9. Buying or consuming wild animal products provides more advantages than disadvantages to humans	*** 5% (a) 11% (b)	6% (a) 6% (b)	*** 14% (a) 19% (b)	*** 38% (a) 21% (b)	32% (a) 34% (b)	*** 4% (a) 9% (b)
Q10. Buying or consuming wild animal products provides more advantages to nature than disadvantages	*** 3% (a) 10% (b)	*** 3% (a) 5% (b)	*** 10% (a) 14% (b)	*** 31% (a) 20% (b)	*** 49% (a) 42% (b)	*** 3% (a) 9% (b)
Q11. Buying or consuming wild animal products is an enjoyable process	*** 1% (a) 5% (b)	3% (a) 3% (b)	18% (a) 18% (b)	*** 27% (a) 20% (b)	45% (a) 43% (b)	*** 5% (a) 11% (b)
Q13. People around you support buying or consuming wild animal products	*** 1% (a) 5% (b)	4% (a) 3% (b)	26% (a) 27% (b)	*** 38% (a) 22% (b)	*** 20% (a) 28% (b)	*** 10% (a) 15% (b)

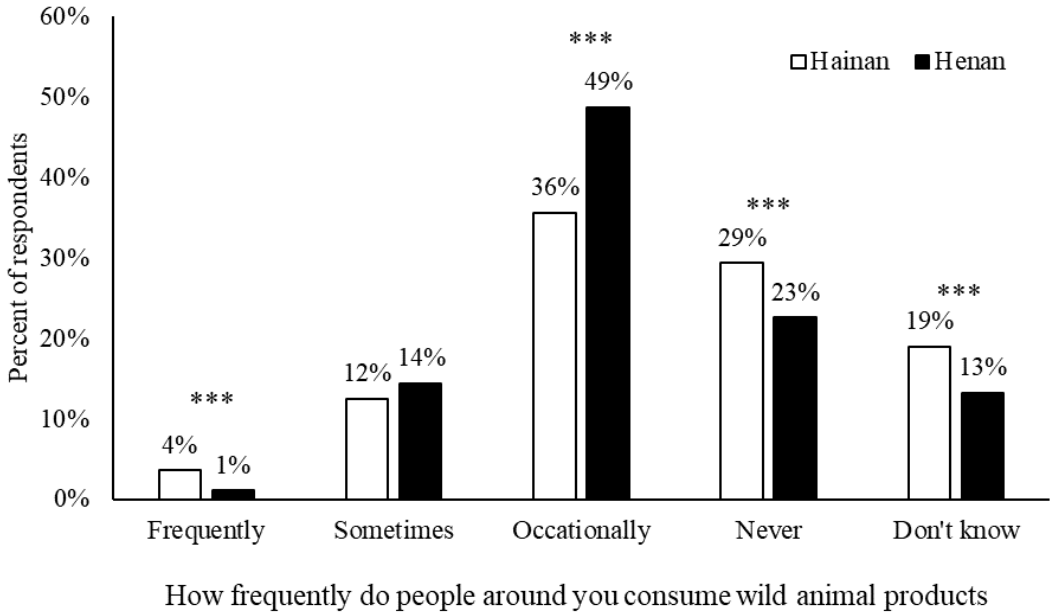

Figure 4.2 Participants' answers to Q12 "How frequently do people around you consume wild animal products" in Henan Province (N = 1221) (black) and Hainan Province (N = 947) (white). *** indicates significant differences between the two provinces (z-test, P < 0.05).

A total of 6.3% of interviewees from Henan and 12.6% of those from Hainan province admitted they had consumed or purchased wild animal products during the past two years (Q17). The percentage in the Henan survey was significantly lower than that of Hainan Province (z-test, $P < 0.05$). Some interviewees said they intended to consume or purchase in future, as also shown in Figure 4.3 (Q16). The percentages of "very likely" and "largely likely" in Henan survey results were again lower than those of Hainan with P values lower than 0.05 in z-tests. In total, 157 consumers (16.6%) were identified from Hainan respondents and 94 consumers (7.7%) were identified from Henan respondents.

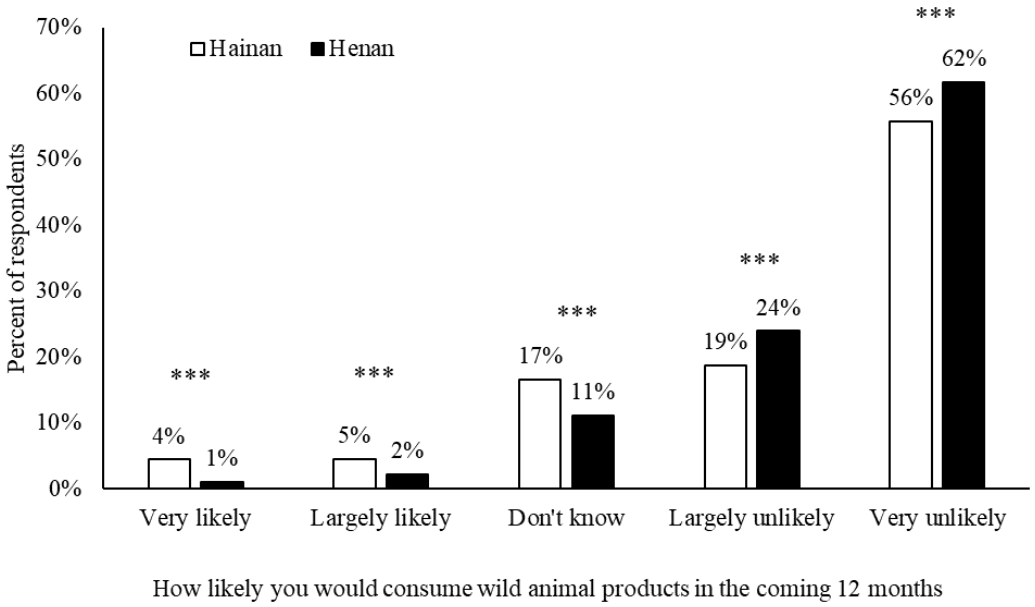

Figure 4.3 Participants' answers to Q16 "How likely would you be to consume or purchase wild animal products in the coming 12 months?" in Henan Province (N = 1221) (black) and Hainan Province (N = 947) (white). *** indicates significant difference (z-test, $P < 0.05$) between the two provinces.

The outputs of SEM contained warning messages that the standard errors cannot be computed for the output models. This means that the model might have too many unknown variables to calculate, and the best final model might not be identified. Some fit indices also show that the output models cannot fully explain the given data very well (normed-fit index and comparative fit index both lower than 0.95) (Hooper, Coughlan & Mullen 2008). Therefore, SEM models were rejected. PCA results (Figure

4.4) showed that consumers cannot be fully separated with the given variables and no variables can be removed due to the low percentage of variance explained by the first three principal components (only around 40% explained). Full results see Appendix II.

Figure 4.4 PCA of Hainan and Henan Provinces wild animal consumer related variables (Q1 to Q15) with red colour representing consumers and blue representing non-consumers.

Data were re-analysed using CTM to understand factors correlating with the consumption of wild animal products (code see Appendix II). Demographic variables and TPB variables were all used in the analysis. However, only the Hainan model computed valid outputs, so the Henan model was rejected (Figure 4.5). The CTM specified four groups of people, the four red boxes in Figure 4.5, who might be consumers of wild animal products. This right-most consumer group (Group 1) provided their occupational information in Q5 rather than selecting "others" in response, equally nor did they list themselves as students. This group thought that consuming wild animal products was enjoyable and was beneficial to people. This group supported the largest proportion, 5% of the total population, among the four consumer groups. The second consumer group (Group 2) was capable of buying wild animal products (both financially and access-wise), had high education levels, including university or postgraduate degrees, and thought consuming wild animal products was not very enjoyable. They also believed such behaviour provided no benefits to nature. The two remaining groups also thought consuming wild animal products was not enjoyable ("sad" in case of Group 4 and "don't know" in case of Group 3), but believed that consumption behaviour provided benefits to humans. These two groups also believed they were not capable of buying wild animal products, either due to lack of access to products or financial capacity. These two groups of consumers did not work as technicians or freelancers or students. Group 4 also knew people around them have consumed wild animal products before at least occasionally. Relevant variables shown in Figure 4.5 are listed in the following table with the corresponding questions in the questionnaire (Table 4.3)

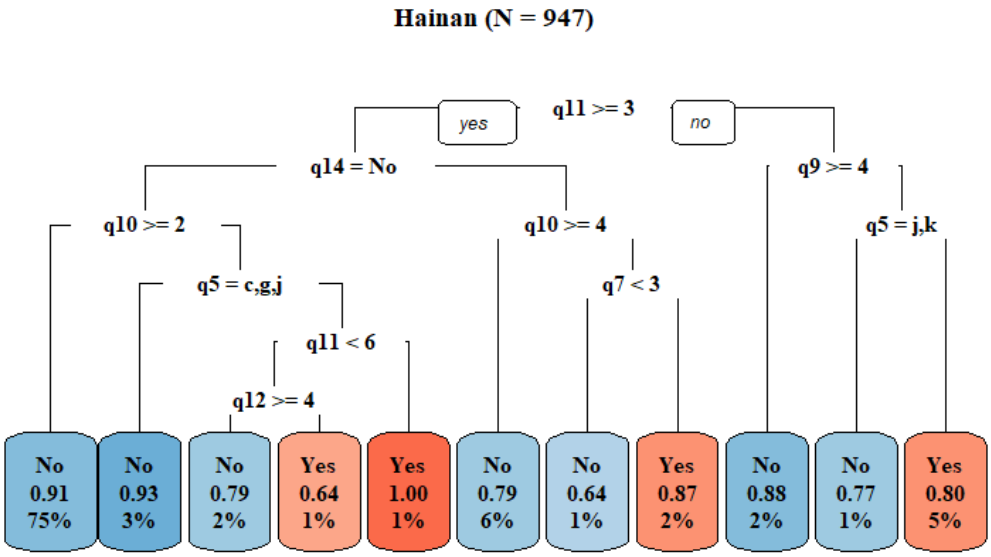

Figure 4.5 Factors correlating with people's consumptive behaviour. Consumers are represented by red and blue represents non-consumers. The percentages in the results show the percentage of interviewees grouped into this class and the numbers in the middle of each box show the correct rate of classification. Heavier colours indicate higher correct rate of classification.

Table 4.3 Variables found to be relevant to people's wild animal consumptive behaviour in the Hainan classification tree model.

	Question	Data type	Data description	Variable description
Q5	Occupation	Categorical	11 categories	Demographic
Q7	Highest education experience	Ordinal	4 categories	Demographic
Q9	Buying or consuming wild animal products provides more benefits to human than harms	Ordinal	5-point scale + don't know	Instrumental attitude
Q10	Buying or consuming wild animal products provides more benefits to nature than harms	Ordinal	5-point scale + don't know	Instrumental attitude
Q11	Buying or consuming wild animal products is an enjoyable process	Ordinal	5-point scale + don't know	Experiential attitude
Q12	How frequently do people around you buy or consume wild animal products?	Ordinal	4 categories + don't know	Descriptive perceived norms
Q14	Suppose you want to buy or consumer wild animal products, will you be able to do so?	Binary	Yes/No	The capacity aspect of perceived behaviour control

Since decision tree modelling failed for Henan data, GLM model was used to

understand consumer profiles. Two GLM models were built separately one with demographic variables and another with TPB variables. The final demographic variable model included two variables in which one, (Q4 Long term address) was significantly correlated with consumption behaviour (standard variable coefficient: -0.0632, SE: 0.0159, z value: -2.212, p value: 0.0271). This means that respondents from Zhengzhou were more likely to be consumers compared to respondents from Kaifeng, yet the influence was weak suggesting by the low standardized coefficient. For the TPB variable model, eight variables were included in the final model with six significant ones (P value < 0.05) shown in the Table 4.4. The results suggested that consumers were more likely to hold utilitarian values towards nature, believed consume wild animal products is beneficial to people and is an enjoyable process, believed people around them often consume wild animal products, had access and financial capacity to consume, and knew relatively more wild meat restaurants than non-consumers.

Table 4.4 Significant variables in Henan wild animal product consumer GLM model built from TPB variables (N = 1221).

Question	Std. Estimate	Std. Error	Z value	P value
Q8 Utilitarian value towards nature	0.0752	0.010201	2.714	0.0067
Q9 Buying or consuming wild animal products provides more benefits to human than harms	-0.0782	0.006617	-2.706	0.0069
Q11 Buying or consuming wild animal products is an enjoyable process	-0.0847	0.008142	-2.79	0.0054
Q12 How frequently do people around you buy or consume wild animal products?	-0.1248	0.009314	-3.91	<0.0001
Q14 Suppose you want to buy or consumer wild animal products, will you be able to do so?	0.1591	0.026506	5.708	<0.0001
Q30 Number of wild meat restaurant known	0.0609	0.009751	2.205	0.0277

4.3.3 Public survey on pangolin product consumers

Around 80% of respondents (78.9% in Hainan and 83.5% in Henan) recognized

pangolin from the photos provided. One photo showed a pangolin standing and one photo showed a pangolin crawling up into a ball (photo obtained from internet) (see Appendix I). These high percentages provide credibility to the results that people are expressing their attitude towards the animal pangolin rather than other animals. Public attitudes and knowledge towards pangolin trade will be discussed in more detail in other chapters, depending on the types of products they seek, whether medicine or food. This chapter will summarise public knowledge of pangolins and delineate pangolin consumers.

An open-ended question in the survey asked respondents what they knew about pangolins and the answers were coded and grouped into eight clusters: ecological knowledge, culture-related information, medicinal use, protection/threat level, trade-related knowledge, food, ornament, and don't know/blank. The frequency of each cluster from Hainan and Henan respondents' answers were plotted in the following diagrams (Figures 4.6).

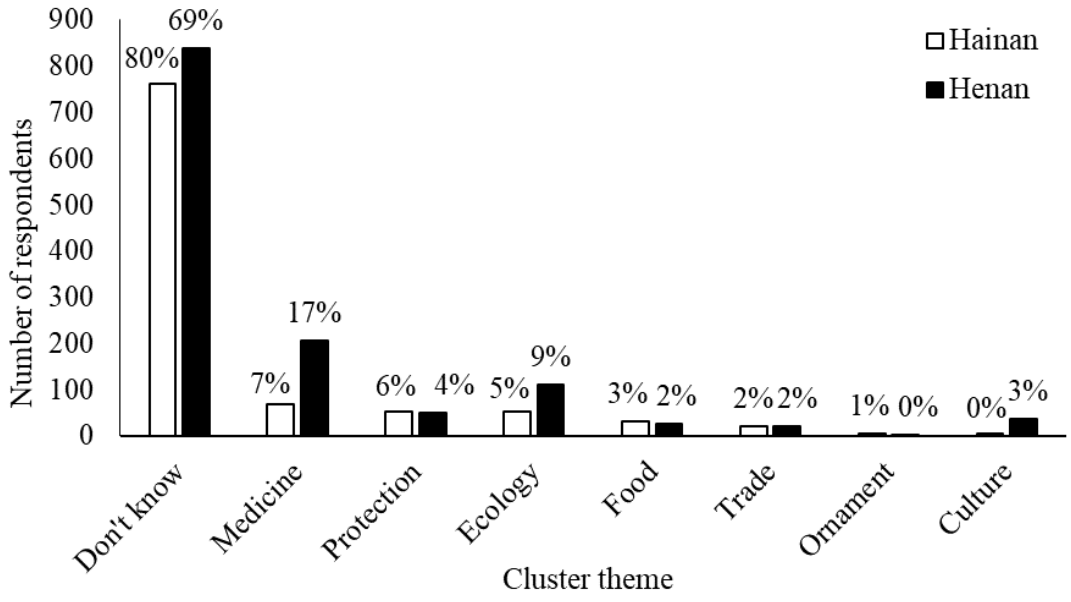

Figure 4.6 Respondent's knowledge about pangolin reflected through questionnaire results from Henan and Hainan Provinces, with the percentage of respondents above each bar. White bar shows Henan (N=1221) and black bar represents Hainan (N=947).

Besides understanding what the public knew about pangolins, it was also important to understand how they came to gain this knowledge since it can help in choosing which information channels to use for education or other conservation interventions (Syme, Nancarrow & Seligman 2000). Q21 in my survey asked respondents where they learned about pangolins. In both provinces, TV programmes were the most selected knowledge channel and far outweighed all other options (Figures 4.7).

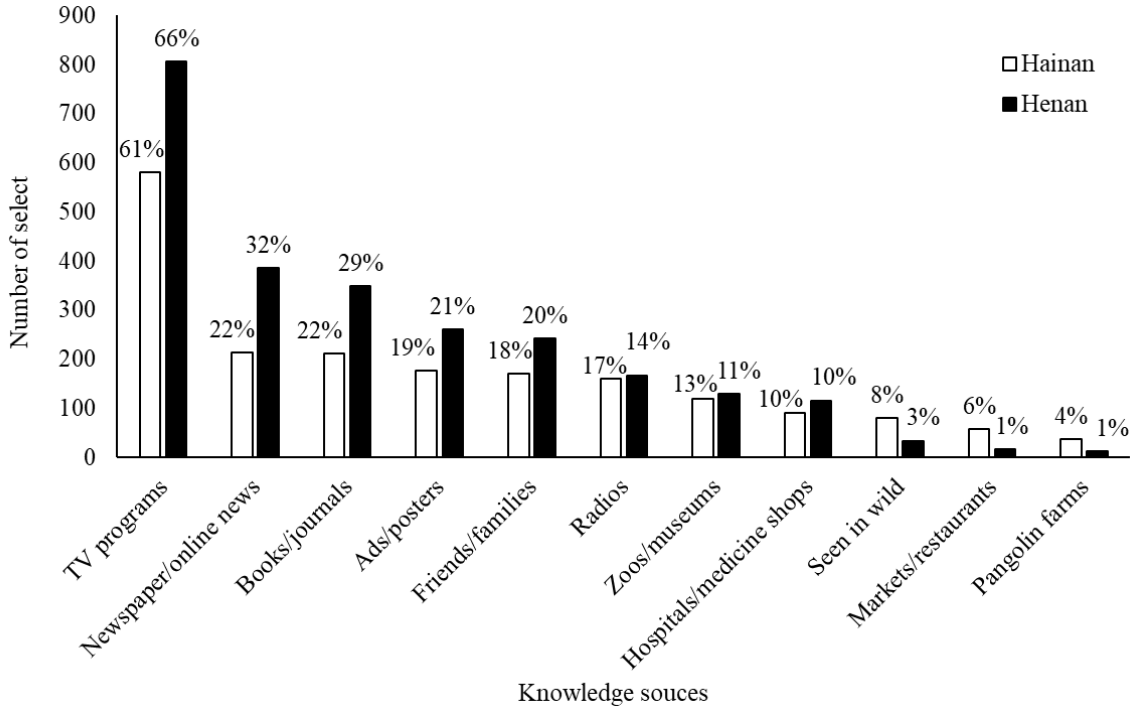

Figure 4.7 Sources of knowledge selected by Henan and Hainan respondents with the percentage of respondents above each bar. White bar shows Henan (N=1221) and black bar represents Hainan (N=947).

Results showed that a small proportion of respondents have consumed pangolin products in both provinces (Figure 4.8). However, there were significantly more medicine consumers compared to food consumers and ornament users (z-test, $P < 0.01$) in Henan Province. Hainan and Henan had a similar proportion of medicine consumers, but Hainan had significantly more food and ornament consumers than that of Henan (z-test, $P < 0.01$).

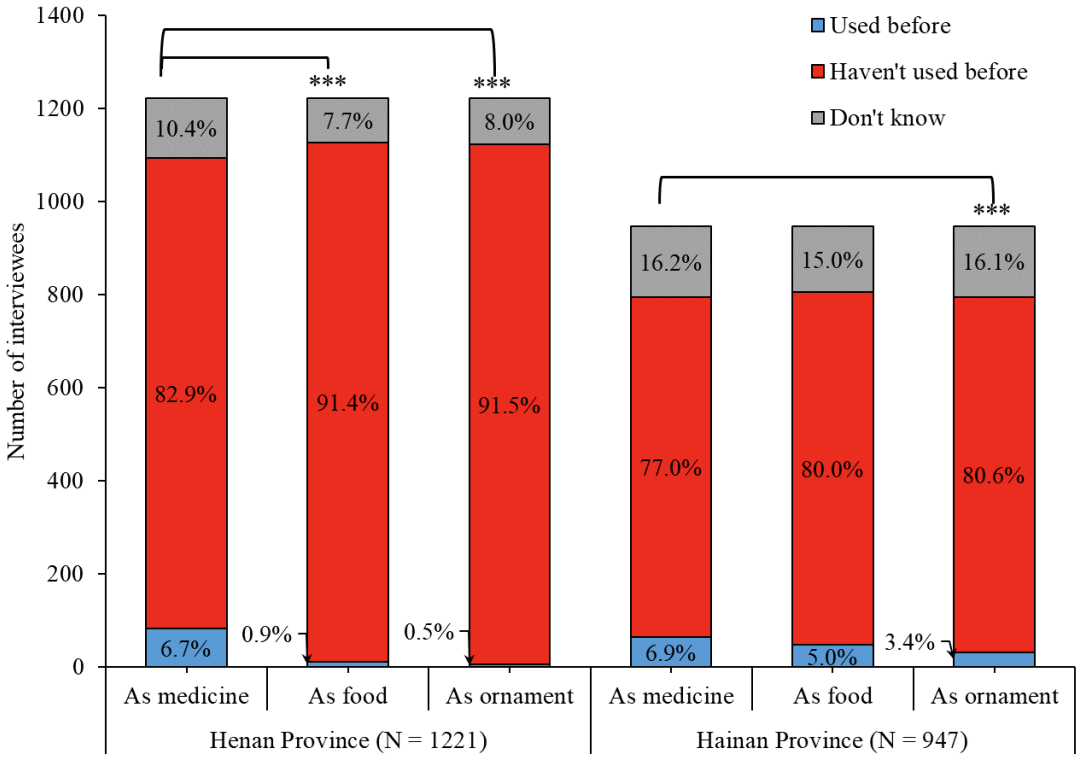

Figure 4.8 Respondents' patterns of consuming pangolin products during the past two years from the public survey conducted in Henan Province and Hainan Province. Asterisks show the proportions are significantly different from each other within one province (z-test, $P < 0.01$).

Respondents who have recently consumed any type of pangolin products were identified as consumers. In total, 93 (9.8%) and 86 (7%) pangolin consumers were identified from Hainan and Henan respondents, respectively. Demographic variables were entered in GLM to portray consumers (RStudio Team 2015). In Hainan GLM, only one variable, Q6 (average annual income), was included in the final model after stepwise selection (standard variable coefficient: 0.0895, SE: 0.0085, z value: 2.762, p value: 0.006). Thus, people in Hainan Province with higher average annual incomes were more likely to consume pangolin products than people with lower average incomes. For Henan pangolin consumers, three variables were included in the final GLM model with one significant variable, Q7 (highest education level), correlated with the consumption behaviour (standard variable coefficient: 0.0640, SE: 0.0147, Q7 z value: 2.199, p value: 0.028). Therefore, higher education degree holders in Henan were more likely to be consumers of pangolin products.

Self-identified pangolin consumers also provided some interesting insights on wild animal consumer delineation. Some respondents (three in Henan and 10 in Hainan) claimed not to have consumed wild animal products during the past two years (Q17). However, they were found to be pangolin product consumers through Q25. They also believe all of the pangolin products were wild-origin (Q24), which fits the wild animal consumption category. A total of 31 self-identified non-wild animal consumers in Henan and 12 in Hainan have consumed pangolin products without knowing whether or not the products were of wild-origin.

Although only three types of pangolin products were identified, the motivation for consuming each type could vary. Q27 asked the respondents why they thought people consumed pangolin meat products. Seven reasons were provided with "other" option to add reasons beyond the options provided. In Henan, the most cited reason was curiosity about the taste, followed by possible medicinal value and then to show off their power and status (Figure 4.9). In Hainan, medicinal value, healthcare benefits, and showing off power/status were the top three selected motivations.

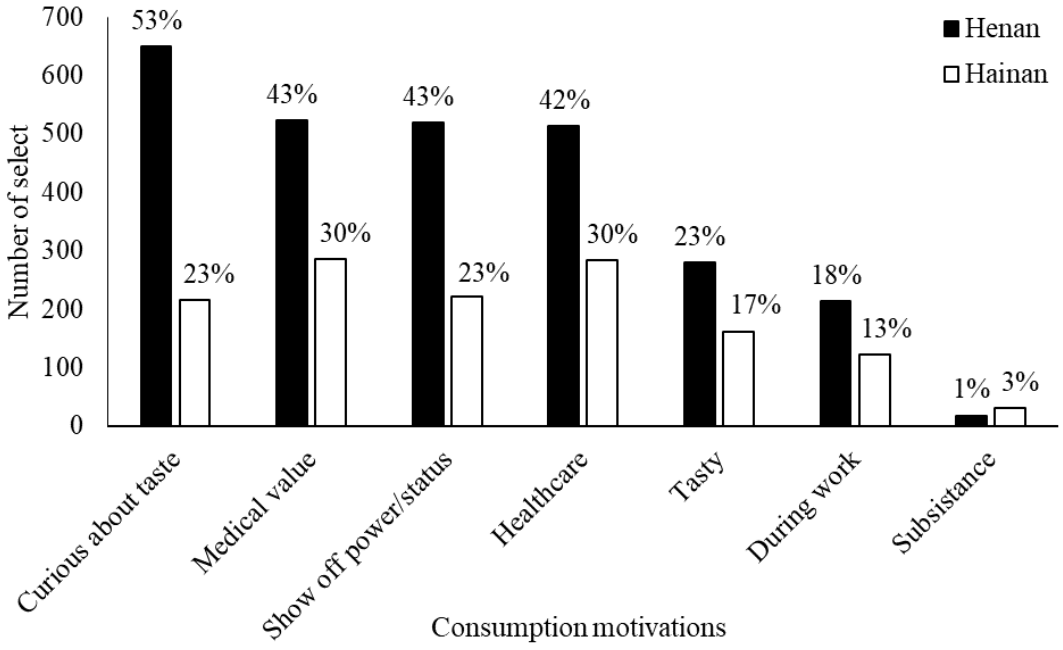

Figure 4.9 Understanding among Henan and Hainan respondents on the motivations to consume pangolin meat products. Percentage of respondents is shown above each bar.

Four pangolin meat consumers were traced to ask about their motivation to consume, the price, access to products, and so on. The latter aspects are discussed in Chapter 7, while motivations to consume will remain the focus here. The four consumers provided three different reasons and scenarios for eating pangolin dishes. One consumer particularly liked the taste of pangolin meat. Since pangolins were rare and expensive, this consumer often invited business friends and colleagues when pangolins were available in restaurants to socialize for work. Two consumers ate pangolin dishes at their workplaces during meals to which they were invited by others. People who ordered pangolin dishes used them to show respect to their guests due to their high price and rarity. The last consumer regularly enjoyed eating wild meat dishes as a habit. Holding a wild meat party was one way to maintain friendships and social connections. Pangolins were previously consumed due to their potential healthcare benefits, but this was infrequent due to their high cost.

The correlations between knowledge and attitude variables with pangolin consumption behaviour were modelled for both Hainan and Henan Provinces using GLM (see Tables 4.5 and 4.6). The results from Hainan showed that pangolin consumers were more likely to think people around them supporting consumption of wild animal products and the consumption was beneficial to humans. They were more likely to report pangolin related knowledge but were less likely to obtain such knowledge from TV or online/paper news while more likely to obtain from hospitals/pharmacies, broadcast, or pangolin farms. They were more likely to think pangolin products were from farms rather than from the wild and consumption was not due to curiosity of tastes. They knew relatively more wild meat restaurant than non-consumers. The Henan model on the other hand suggested that consumers were more likely to know about the medicinal value of pangolins but not likely to report on ecology knowledge. They were less likely to gain their knowledge from TV but more from hospitals/pharmacies. They were more likely to think pangolin products originated from farms and believe the consumption motivations were not due to curiosity of tastes or potential healthcare benefits.

Table 4.5 Variables significantly correlated with pangolin products consumption in Hainan GLM model (N = 947).

Question	Std. Estimate	Std. Error	Z value	P value
Q9. Buying or consuming wild animal products provides more advantages than disadvantages to humans	-1.0186	0.1047	-1.992	0.0464
Q13. People around you support buying or consuming wild animal products	-1.3129	0.1105	-2.659	0.0078
Q20 Don't know much about pangolins	-0.8078	0.3074	-1.969	0.0490
Q21 Know about pangolins from TV	-1.4508	0.2607	-3.402	0.0007
Q21 Know about pangolins from broadcast	0.8735	0.3265	2.125	0.0336
Q21 Know about pangolins from hospital/pharmacy	0.8004	0.3389	2.397	0.0166
Q21 Know about pangolins from online/paper news	-1.0135	0.3444	-2.097	0.0360
Q21 Know about pangolins from farms	0.7902	0.4628	2.589	0.0096
Q24 Origin of products (captive or wild)	-1.1525	0.0681	-2.72	0.0065
Q27 Curious about taste	-1.3454	0.3322	-2.745	0.0061
Q30 Number of wild meat restaurant known	0.8056	0.1430	2.191	0.0284

Table 4.6 Variables significantly correlated with pangolin products consumption in Henan GLM model (N = 1221).

Question	Std. Estimate	Std. Error	Z value	P value
Q20 Know about ecology of pangolins	-2.5209	1.0343	-2.169	0.0301
Q20 Know about medicinal value of pangolins	1.2409	0.2790	3.038	0.0024
Q21 Know about pangolins from TV	-1.1239	0.2481	-2.449	0.0143
Q21 Know about pangolins from hospital/pharmacy	1.8908	0.2974	4.734	< 0.0001
Q24 Origin of products (captive or wild)	-1.4989	0.0648	-3.284	0.0010
Q27 Healthcare benefits	-1.9648	0.2793	-3.646	0.0003
Q27 Curious about taste	-1.4348	0.2617	-2.811	0.0049

4.4 Discussion

Overall, this chapter has provided some insights into four aspects of wildlife trade: the public's knowledge and attitude to pangolins and their trade, as well as the consumer profiles of wild animal/pangolin products and motivations behind consumptive behaviours.

4.4.1 Public's knowledge and attitude about wildlife/pangolin trade

For attitudes towards consuming wild animal products, respondents from the two provinces held a generally negative view and a very small proportion of interviewees admitted past consumptive behaviour or expressed future tendency to consume pangolins (16.6% in total for Hainan Province and 7.7% for Henan Province). The percentage from Henan Province resembles the USAID Wildlife Asia survey but not the Hainan Province (7% recent pangolin consumers) (2018). There is not enough information to investigate the reason behind such observation but economic status of the interviewed cites might be a factor. USAID's survey was conducted mainly in big cities such as Beijing and Nanning, while studies in Hainan were much economically underdeveloped than those cities and study sites in Henan. However, in contrast to results from USAID survey that comparatively smaller cities such as Nanning have less

recent pangolin consumers than Beijing or Shanghai, results from this study showed long-term address having a positive correlation with pangolin consumption that the capital, Zhengzhou, is more likely to host consumers than Kaifeng, which is a smaller city. This inconsistency requires further understanding.

Although the general patterns of people's attitudes were similar within the two provinces, there were two significant differences at a finer resolution. Firstly, answers from Henan participants from the behaviour model questions (Q8 to Q15) were more concentrated around mid-point or the neutral option compared to the Hainan respondents who selected more extreme answers. Another significant difference between the two provinces was that Hainan Province, in general, had a higher percentage of wildlife product consumers than Henan Province. The proportion of participants holding pro-consumption beliefs was also higher. For example, more Hainan participants (11%) believed that consuming products of the wild animal was in general beneficial to humans than Henan participants (5%).

A range of factors could potentially explain these observations including the different sampling methods, cultural difference, and distance to the natural world. Hainan is a province with a high proportion of ethnic minority groups, most commonly Li and Miao (National Bureau of Statistics 2019). These two groups made up to a third of the total interview participants (342 out of 947). Their unique local cultures, lifestyles, and values might lead to expressing habits that differ from the ones of Henan Province which might be more used to moderate expressions or perspectives (Yao *et al.* 2010). On the other hand, Hainan Province has a better-preserved natural environment than Henan, which also means that people in this province are closer to nature and might be more connected than Henan citizens (Brody, Highfield & Alston 2004; Reibelt *et al.* 2017). Thus, they may hold stronger views towards nature-related questions about which Henan citizens might be relatively more indifferent. More connection with nature also means more opportunities to hunt or consume wild animal products due to greater access which might partially explain the higher proportion of consumers in Hainan (Read *et al.* 2010).

4.4.2 Delineating wild animal and pangolin product consumers

For wild animal product consumers, this survey provides a preliminary understanding of their profiles in Hainan and Henan provinces, China. Four groups of consumers were identified in Hainan, each with different characteristics that correlate with their consumption patterns. Notably, occupation, education level, benefiting human and nature, enjoyableness, perceived norms, and perceived behaviour control are the factors showing significant correlation with consumptive behaviour. The differences between each group suggest that the underlying motivation or factors causing the consumptive behaviour might be different. This is supported indirectly by the diverse consumption motivation behind pangolin meat consumers. The purpose of consuming can vary widely and understandably the consumer profile could differ as well.

Results from Henan suggested some overlapping variables from those in Hainan. Benefiting to humans, perceived norms, enjoyment, and perceived behaviour control are again significant. The similarity across provinces might highlighted some key features that shared by wild animal consumers on a more general pattern. However, long-term address and knowledge of wild meat restaurant were two other significant factors in Henan model but benefits for nature, occupation, and education level were not significant. The differences are also worth noticing for site specific interventions.

It is also interesting to notice that the attitudes towards enjoyment and perceived behaviour control, influenced consumption behaviours differently in the two study provinces. In Hainan, consumers tended to think consumption was sad or did not know how to describe the feeling and think they were not capable to self-consume either financially or access-wise. Yet, Henan province consumers believed consumption was enjoyable and consumers perceived themselves as capable to consume wild animal products. Such difference might suggest the two provinces are dominated by different consumption scenarios. For Henan province, consumption might be more conducted or initiated by consumer themselves while Hainan province might have more invited style consumption in which consumers might not be self-willingly to consume. However, the question asking about self-willingness to consume were not significant factor in the final model. Thus, such observation might require more studies to investigate.

The CTM model for the profile of pangolin consumers failed to provide valid outputs probably due to the small proportion of consumers. However, factors were found to be significantly correlated with consumptive behaviour using GLM. The demographic factor in Henan was education level while the factor in Hainan was average annual income. The difference between the two provinces might be due to the economic development stage and the consumed product types. Henan is more developed economically, and the average annual income of the province is higher (National Bureau of Statistics 2011). Pangolin products are relatively more expensive in both the food and medicinal markets compared to other similar products (Yin *et al.* 2015; Hu 2016; Xu *et al.* 2016). Thus, income level might be more of a deterministic factor in a less-developed province such as Hainan than in Henan.

Moreover, significantly more pangolin meat consumers were identified from Hainan than Henan Province (Figure 4.8). From a price perspective, having one pangolin dish is more expensive than having one prescription containing pangolin products (Drury 2009a; Zhang & Yin 2014; Sandalj, Treydte & Ziegler 2016; Xu *et al.* 2016). This could also contribute to the observed different factors in the two provinces. However, this could not explain why education level is positively correlated with consumptive behaviour in Henan Province, i.e., proportionally more people with higher degrees are more likely to consume pangolin products, especially when consumers of pangolin medicinal products are the dominant type in Henan. More in-depth researches are needed to answer this question.

Knowledge and attitude-wise, Henan province consumers showed a clear profile of medicinal consumers who would have some knowledge of the medicinal value and obtain their information mainly from hospitals/pharmacies. The question on motivation specifically asked about meat products which does not align with the main consumer group in Henan. However, it still provides some interesting insights that medicinal products consumers do not think meat products are consumed for their healthcare benefits. Consumers in Hainan are more complex comparing to Henan consumers since consumption as food is also common in identified consumers. However, some shared

factors across province can be identified and are useful for conservation planning. For example, in both provinces, consumers did not receive information about pangolins from TV but from hospitals/pharmacies. On the other hand, TV was the most selected information sources in both provinces followed by news and books. This suggest that the importance of hospital/pharmacy as information source, especially for accessing actual consumers, should be highlighted and use in application. Moreover, both provinces rejected the hypothesis that people might consume pangolin meat due to curiosity which is an often-mentioned motivation for wildlife dish consumption (Li & Wang 2021). Consumers from both provinces believed that pangolin products were more farm-origin than wild sourced, which is not true. Such information might be good to use for behaviour change yet caution is needed as backlash is possible. Researches have shown that consumers might have a preference on wild sourced products than farmed products (Dutton, Hepburn & Macdonald 2011; Shairp *et al.* 2016). Therefore, educating the general public about the wild nature of pangolin products might stimulate consumption rather than reduce.

Some more general points emerge from this analysis on consumer profiles, and it might be worth notifying conservation practitioners of the outcomes. Firstly, when thinking of wild animal products consumers, a picture tends to emerge of them being less knowledgeable and they consume because they do not know the importance of biodiversity, and so on. However, the results from wild animal consumers in Hainan show one group of consumers are characterized by having higher education degrees (Figure 4.5). This result cross-validates with some wildlife consumption attitude surveys in China highlight the involvement of young highly educated males in consuming wildlife products (Zhang, Hua & Sun 2008; Zhang & Yin 2014). This pattern appears again in the pangolin consumer analysis that people with high education degree are more likely to be consumers. Pangolin related conservation awareness (Q19) was also found to be uncorrelated with consumptive behaviour. Therefore, lack of knowledge or understanding of nature or biodiversity might not be one of the underlying causes for consuming wild animals. Similarly, results from this study showed pangolin consumption is not correlated with consumer age. This contrasted with results from a previous survey which identified the younger generation being more involved in the consumption of pangolin (HSI & Aita Foundation 2016). The contrast

requires further investigation to understand.

Another point worthy of attention is the capacity aspect of perceived behaviour control in the TPB, i.e., Q14. In the consumer profile described above, people who think they are not capable of consuming wild animal products are identified as consumers (Groups 3 and 4). This could be due to the consumption scenario that the consumers were invited to consume rather than self-choice. Yet, this also very possibly reflects that these consumers are trying to distance themselves from the consumptive behaviour, as more specifically defined by James Serpell as *shifting responsibility* (Serpell 1996; Te Velde, Aarts & Van Woerkum 2002). The consumers believe they are not capable of consuming wild animal products for reasons of finance or access. Thus, there must be someone else who enabled, or will enable, their consumptive behaviours. As a result, the enablers are the ones responsible for the consumption rather than the consumers themselves. One interviewee described himself as non-consumers but later admitted he has consumed pangolin, turtle, swan and other wild animals previously, yet he shifted the responsibility of consumption when saying "I'm not the one who bought or asked for it." Consumer psychology such as "shifting responsibility" is important to understand and address if changing consumer behaviours are desired (Te Velde, Aarts & Van Woerkum 2002; Šedová, Slovák & Ježková 2016).

Moreover, demographic profiles for pangolin consumer were found to be differed from that of wild animal products consumer within each province. Wild animal consumers in Hainan province were characterized by high education level and certain occupation while pangolin consumers correlated with average annual income. In Henan, wild animal consumers tend to be from Zhengzhou while pangolin consumers tend to have higher education level. The difference in consumer profile is likely due to the different perceptions on whether pangolins are wild-origin or not. Yet it also highlighted the diversity within the term wildlife consumption and that behaviour change needs species and motivation-based understanding to accurately describe and segment consumer group.

In addition, it is interesting to note that many Hainan consumers believe consuming wild animal products provides more benefits than harm to nature (Groups 3 and 4 regarding Q10). Such beliefs seem contradictory to the broader understanding that wild animal harvesting is often unsustainable and undermines biodiversity (Bennett & Robinson 2000; Flesher & Laufer 2013). Further study is needed to understand why such a belief exists and how strongly this belief contributes to the final pattern of consumption.

4.5 Conclusions

This chapter adds to the body of knowledge on trade in wildlife and wildlife products. In particular, the case study of pangolin consumers has added to the understanding of their behaviours and profiles. Diversity exists in consumer groups, products, motivations, and attitudes involved in pangolin consumption in mainland China. This diversity adds more complexity to understanding the trade and designing effective conservation interventions. However, it is also a useful case illustrating the importance of focusing on more specific demand functions rather than whole species for a more accurate understanding and more targeted interventions. Answers to surveys may change depending on the resolution used in question as shown in this study. This pattern applies for other species threatened mainly by illegal wildlife trade such as rhino and tiger (Ellis 2013; Gao *et al.* 2016; Truong, Dang & Hall 2016). The data gathered and the analyses undertaken in this study could be of use for future conservation interventions. The importance and potential of social science methods are increasingly recognized by conservationists and are proven in this study as well (Fox *et al.* 2006; Bennett *et al.* 2017).

On the other hand, this study also provides directions for some future investigations for both pangolins and other species. For example, it might be interesting to look at the source and the underlying logic of "consuming of wildlife products provides more benefits than harms to nature" held by some identified consumers in Hainan. Also, more investigations into the provincial differences in consumer profiles and attitudes would help increase the geographic knowledge of pangolin consumers as regional differences

in attitudes or consumptive patterns have been revealed in many studies (Zhang, Hua & Sun 2008). China covers a large geographical area and is home to many different cultural groups. It is very important to understand how landscape and cultural diversity influences the relationship between people and nature.

The next chapter will explicitly focus on the demand and trade of pangolin products in traditional Chinese medicine markets which takes up a high proportion of consumers in both provinces as shown in this chapter.

Chapter 5 Knowledge and attitudes about the use of pangolin scale products in Traditional Chinese Medicine (TCM) within China

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5.1 Introduction

Pangolins (Mammalia: Pholidota) are a highly specialized order of mammals covered with scales instead of fur. They feed mostly on ants and termites, and play an important role in tropical and subtropical ecosystems across Asia and Africa by regulating populations of these insects (Ofusori & Caxton-Martins 2008; Cabana *et al.* 2017). However, all eight species of pangolins are threatened with extinction by illegal harvesting and trading of wild populations, which often involves confiscated pangolin products measured in tons (Aisher 2016; Challender & Hywood 2012; Challender, Waterman & Baillie 2014). Pangolins are recognized as global conservation priorities on the basis of evolutionary history (Collen *et al*. 2011), and the heavy exploitation of wild pangolin populations has led to the upgrading of IUCN threat category for all pangolin species in 2014: four African species were moved to Vulnerable, two Asian species to Endangered, and the other two Asian species to Critically Endangered (IUCN 2020).

Products involved in the illegal pangolin trade can be grouped into three types: meat, scales, and body parts. Pangolin scales account for a large portion of the reported illegal trade. Heinrich *et al.* (2017) summarized international confiscation reports from 2010 to 2015 and found that more than 55,000 kg of scales were confiscated during this period. If the average weight of scales on one pangolin is around 500 g (Zhou *et al.* 2012; Challender & Waterman 2017), these data indicate that more than 100,000 pangolins were trafficked from 2010 to 2015. China has been identified as one of the major demand countries, and Traditional Chinese Medicine (hereafter TCM) has been shown to be linked with illegal trade in pangolin scales through illegal products found

in markets and shops (Yin *et al.* 2015; Xu *et al.* 2016).

TCM dates back more than 5000 years and is still widely used today in China (Chen & Xie 1999). In 2016, TCM hospitals and clinics treated 962 million patients in China, and medical services provided through TCM treatment accounted for 15.8% of the total medical service provided in that year (Tang, Liu & Ma 2008; National Health and Family Planning Commission of the PRC 2017). The use of pangolin scales in TCM can be traced back to AD 480 when prescriptions containing this ingredient were documented in the *Bencao jing jizhu*, which was later cited in the famous Compendium of Materia Medica (Li 1578).

In addition to illegal pangolin products found in TCM markets, a legal market for pangolin scale medicine also exists to support TCM use in China (Xing *et al.* 2020). Regulations specify that: i) pangolin scales can be legally traded for medicinal purposes by 711 certified hospitals in China; ii) the quantities of scales that can be traded every year are regulated through a quota system assigned by the Forestry and Grassland Administration at different administrative levels; iii) certification is required to trade and farm pangolins or pangolin products, and manufacture pangolin products; before 2017, importation of African pangolins and their products was still allowed with appropriate certification, but thereafter all pangolin species were included in CITES Appendix I at CoP17 (Johannesburg, 2016) and importation was banned; iv) products from legal pangolin farms can be traded if relevant certification is issued. However, there is no evidence of successful commercial farming to date (Hua *et al.* 2015; Hu 2016; Li 2017). The only legal source of pangolin scales in the current TCM market in China is therefore the quota assigned by the Chinese government.

The pangolin scale quota system started in China in 2008. Sources of pangolin scales assigned in the quota included private-held or government-held stockpiles. Data on quotas assigned to the market are publicly available for the period 2008 to 2015. These data show that a total of 186,067 kg of pangolin scales were released to trade, with a mean annual quota of 26,581±1580 kg. The legal pangolin scale market is therefore of considerable size and requires similar levels of conservation attention to that focused on the general illegal scale trade. Even though large quantities of pangolin scales have

been traded legally or illegally for TCM use, little attention has been paid to research in this area. This is particularly the case for TCM practitioners, who are key stakeholders in the pangolin scale trade since they are directly involved in using scale products and are important in making medical decisions (Bennett, Smith & Irwin 1999). The few existing studies of pangolin scale trade have focused only on the presence/absence of illegal scale trade or analysing illegal trade reports, which revealed important findings such as the widespread availability of illegal products in TCM markets and key transit cities along illegal trading routes (Yin *et al.* 2015; Xu *et al.* 2016; Cheng, Xing & Bonebrake 2017). However, knowledge and attitudes of TCM practitioners about pangolin scale medicines are also crucial for regulating pangolin scale trade, since this stakeholder group has the potential to influence consumer behaviours and decide or guide consumption (Tan & Freathy 2011; Doughty *et al.* 2019).

Based on these key gaps in the knowledge of the pangolin trade, I aim to provide new insights into how TCM practitioners and other TCM-related stakeholders (sellers and the general public) in two provinces in China understand and view this trade. I hypothesise that practitioners and other key stakeholders may not fully understand the legality and conservation impacts of pangolin trade, which might influence their attitude and consequently their behaviour. The insights gained through this approach should enable more effective identification of possible interventions that can provide essential information for TCM-related stakeholders to support effective pangolin conservation and better control of legal scale trade.

5.2 Materials and Methods

Between October 2016 and April 2017, interviews were conducted to collect information on knowledge about, and attitudes towards, trade in pangolins and pangolin scale products in TCM in nine administrative regions across two Chinese provinces: Henan Province (Kaifeng, Yuzhou and Zhengzhou municipalities) and Hainan Province (Baisha, Haikou, Ledong, Qiongzhong, Sanya and Wuzhishan counties) (Figure 5.1). These provinces were chosen because I had access to readily available local contact networks in both regions. Furthermore, Henan and Hainan also vary greatly in terms of local culture, economy, human population, topography, and geographical location (National Bureau of Statistics 2020), which can increase site representation and reveal

more general patterns about knowledge and attitudes across China. Target respondents included four stakeholder groups: (i) doctors currently working in hospitals (either TCM hospitals or hospitals containing TCM departments; one per hospital); (ii) shop owners or assistants from TCM shops (one per shop); (iii) sellers from TCM wholesale markets (one per wholesale shop); and (iv) members of the general public living in urban centres (towns and cities). TCM consumers are difficult to pinpoint before interview, so I targeted the general public as potential consumers, and past consumption was queried during interviews to help identify actual consumers.

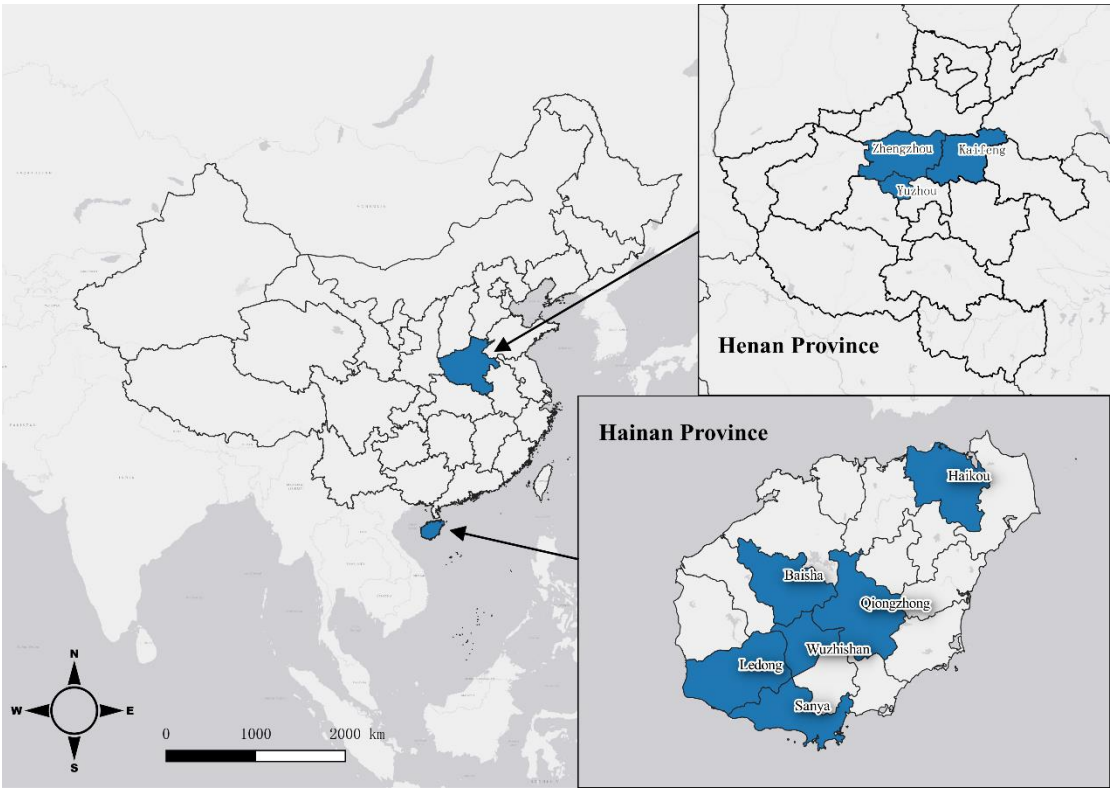

Figure 5.1 Map showing study areas across China. Hainan and Henan provinces highlighted in background map, and study municipalities/counties highlighted in the two province-level inset maps.

Interviews with TCM practitioners/sellers were conducted face-to-face in Mandarin by the lead author. I accessed doctors in both Henan and Hainan, and wholesalers and TCM shops in Henan through social connections, primarily through introduction of potential respondents by friends or family members. I tried to reach as many of these respondents as possible within the research time period with no set sample size. I accessed pharmaceutical shops in Hainan through cluster sampling, which involved use of an online map (Baidu Map, similar to Google Map) to identify areas within each county

where pharmaceutical shops were concentrated, and then conducted interviews in all shops in those areas. I aimed to survey 30 shops per county or all shops present in town centres. Shops that were found not to sell TCM products were removed from analysis.

Public surveys in Henan were conducted using online snowball sampling, and questionnaires were sent out through social connections in Kaifeng and Zhengzhou using online social media including WeChat and QQ. The target sample size for each municipality was 600 and 400, respectively. Public surveys in Hainan were conducted face-to-face in Mandarin by the lead author and local volunteers using street encounter sampling. Locations of streets were selected to cover a wide geographic spread and include diverse functional sites to maximise representation in the sample by including people with diverse socio-economic backgrounds. The target sample sizes were 200 for Haikou and Sanya, and 100 for other counties. Online snowball surveys were also attempted in Hainan but had a low participation rate, and so were excluded from analysis.

During public surveys, responses were entered directly into the Wenjuanxing survey platform (https://www.wjx.cn/) by respondents or with assistance from interviewers if needed. The age and gender structure of respondents was monitored during the survey to compare with the known age and gender structure of each province (National Bureau of Statistics 2011; Henan Provincial Bureau of Statistics 2016). Age and gender groups with lower proportions of respondents compared with the provincial population structure were targeted to recruit more respondents and improve representation in the overall sample. To increase participation rates, I offered tokens of thanks to potential participants costing around 0.1 USD each, comprising cotton towels in street surveys, and red bags in online snowball surveys.

I developed two Chinese-language question lists targeting TCM practitioners/sellers and the general public, respectively (see Supplementary File). The interview targeting TCM practitioners/sellers was semi-structured and focused on four aspects of pangolin scale trade, both legal or illegal: (i) demand for pangolin scale medicine, including commonly targeted symptoms and whether medicinal substitutes exist; (ii) related legislative or institutional regulations of which they were aware; (iii) knowledge and

attitudes towards pangolin scale trade (knowledge includes trade volume and product price and their long-term or seasonal fluctuations, and source of products; attitude refers to supportiveness towards trade); and (iv) knowledge about pangolins, such as conservation status or any ecological knowledge. Each interview took 10 to 30 minutes to complete. The public survey used a set questionnaire focused more on the latter three topics, with most questions in multiple choice format, and which took 10 minutes on average to complete. Project design was approved by the Department of Geography Ethics Review Group, University of Cambridge (#1503). All respondents were kept anonymous and only respondents who provided oral or written consent were included in the study.

The question lists produced both quantitative and qualitative data. Quantitative data were analysed in RStudio with z-tests to compare proportions and binomial logistic regression to understand factors affecting the public's supportiveness towards trading pangolin medicine, with binomial regression models developed separately for each province (RStudio Team 2015). Variables included in the maximal model were: respondent age, gender, education, ethnic group, annual income, study area, knowledge of pangolin population status in China, knowledge of source of pangolin products in market, previous consumption of pangolin medicine, knowledge of pangolin medicine legality, and knowledge of whether pangolins are protected animals. Stepwise selection was performed using *stepAIC* to find the best-performing model with the lowest Akaike information criterion. Coefficients for variables in the model were standardized using *beta* to identify the most influential factor. Qualitative data were analysed using content analysis (Newing 2010). Responses to open-ended questions were coded according to response type, codes were grouped into categories that formed clusters, and cluster patterns were identified to describe the target groups. Maps used in this study were plotted using QGIS (QGIS Development Team 2019).

5.3 Results

A total of 2301 respondents were interviewed (Table 5.1), including doctors from 41 hospitals, 37 shop owners and 53 shop assistants from 90 TCM shops, 2168 members of the general public (1221 in Henan, 947 in Hainan), and two sellers from TCM wholesale markets in Yuzhou and Zhengzhou (Henan), respectively.

Table 5.1 Number of respondents in each administrative region.

Province	Municipality/County	Doctors surveyed	Sellers surveyed	Members of the public surveyed
Henan	Kaifeng	9	6	431
Henan	Yuzhou	0	1 (wholesaler)	0
Henan	Zhengzhou	19	8 (including 1 wholesaler)	790
Hainan	Baisha	1	11	117
Hainan	Haikou	4	24	226
Hainan	Ledong	2	7	119
Hainan	Qiongzhong	3	14	154
Hainan	Sanya	2	13	209
Hainan	Wuzhishan	1	8	122
Total		**41**	**92**	**2168**

5.3.1 TCM practitioners and sellers

The medicinal value of pangolin scales was supported by most respondents working in hospitals (97.6%). In the 41 hospitals surveyed, only one doctor expressed uncertainty about the medicinal value of pangolin scales. However, the hospital in which this doctor worked also sold pangolin scales. Most doctors also showed a good understanding of the medicinal use of pangolin scales in TCM. Doctors from 31 hospitals (75.6%) listed specific symptoms that could be treated with prescriptions containing pangolin scales. These symptoms can be grouped into six categories (Table 5.2). Among the symptoms, stimulating milk secretion, mammary gland hyperplasia, infertility, liver disease, and tumours were mentioned regularly by doctors from different hospitals.

Table 5.2 Symptoms that pangolin scales are used to treat, based on interviews of TCM doctors.

Categories	Examples
Gynaecological disorders	Infertility (caused by fallopian tube obstructions or other disorders), uterine fibroids, blockages in mammary glands, mammary gland hyperplasia, irregular menstruation, problems with milk secretion
Liver diseases	Tumours or swelling, cirrhosis, hepatitis B
Other tumours and swellings	Angiomas, rhinitis, desmoid tumours, goitre, swollen spleen, benign prostatic hyperplasia, adenoid hypertrophy
Symptoms related to blood circulation	Blood stasis/circulatory problems, cerebral thrombosis, vasculitis, bruises
Bone-related symptoms	Fractures, joint pain and rheumatoid arthritis, lumbar disc protrusion
Skin disorders	Acne, suppuration

Doctors from 28 hospitals (68.3%) answered whether pangolin scales could be substituted by other ingredients. Eight doctors (28.6%) suggested they could always be substituted, and listed potential substitutes including: *wangbuliu* (seeds of *Vaccaria segetalis*), *tongcao* (stem pith of *Tetrapanax papyriferus*), *lulutong* (infructescence of *Liquidambar formosana*), *congrong* (*Cistanche salsa*), *danshen* (root of *Salvia miltiorrhiza*), *duzhong* (bark of *Eucommia ulmoides*), and other scale-like animal-derived materials such as shell of Chinese pond turtle (*Mauremys reevesii*) and pig hoof. Eight other doctors (28.6%) thought that pangolin scales could be substituted for some but not all symptoms. Furthermore, the substitutes might be less effective than pangolin scales, but an increased dosage of substitutes or a change in prescription (e.g. switching to a prescription that originally did not contain pangolin scales) might compensate for this difference in effectiveness. Four doctors (14.3%) thought it was possible to use substitutes, but these would always be less effective than pangolin scales, so a longer prescription period might be needed. The eight remaining doctors (28.6%) thought there was no substitute for pangolin scales, especially when treating diseases such as uterine fibroids and mammary gland hyperplasia. One doctor explained how they had unsuccessfully tried to remove pangolin scales from a prescription: “We have a patent-protected drug developed by our doctors to treat mammary gland hyperplasia, which contains pangolin scales as an ingredient. We once changed the prescription to avoid

using pangolin scales, as they are expensive and not all patients can afford them for long-term use. However, patients complained that the medicine was less effective, so the prescription was changed back."

TCM doctors play a key role in deciding whether or not their patients use pangolin scales. When asked about patients' attitudes towards prescriptions containing pangolin scales, only six out of 41 doctors (15%) said their patients might ask for cheaper substitutes for pangolin scales since they were relatively more expensive compared to other ingredients used in TCM. The other 35 doctors (85%) said their patients never questioned using pangolin scales in their medicines.

Results from TCM shop surveys showed that 43 out of 90 respondents (47.8%) commented about the medicinal value or healthcare value (i.e. non-specific medicinal use or for general healthcare) of pangolin scales. Answers varied from general terms, such as "many uses", to detailed explanations of medicinal value and commonly targeted symptoms. Five respondents specifically mentioned that pangolin scales were also used for general healthcare, of which production of pangolin scale wine was a commonly cited example. One respondent said that "people spend thousands of yuan to buy [a few kilograms of roasted pangolin] scales to put in Chinese spirits".

Nevertheless, while many doctors knew about the medicinal or healthcare value of pangolin scales, very few knew about regulations around pangolin products. Doctors generally had little knowledge of the legality of the pangolin scale trade or the protected status of pangolins. Only five out of 41 doctors (12.2%) said that pangolins were protected animals, and only two (4.9%) said that pangolins could not be sold in the market (the term 'market' here may or may not include hospitals). When asked about regulations regarding the prescription and sale of pangolin scales, no doctor mentioned the permit required for legal sale of pangolin scales or the quota system. When asked about restrictions on hospital usage or stocking of scales, most doctors responded that scales were "stocked as needed" or "prescribed as needed". One hospital was found to ask their doctors to systematically add pangolin scales to every patient in every prescription.

Similarly, results from pharmaceutical shop interviews showed that only 19 out of 90 respondents (21.1%) mentioned that pangolins were protected animals, and only two (2.2%) specifically mentioned that pangolin products were not allowed to be sold. Among these 19 respondents, 11 were shop owners; the reporting rate on this topic from shop owners (11 out of 37, 29.7%) was higher than from shop assistants (8 out of 53, 15.1%) but the difference was not statistically significant (z-test, $p = 0.10$).

Conversely, sellers in wholesale markets showed a detailed understanding of the pangolin scale trade and related regulations. The wholesaler from Zhengzhou Wholesale Market correctly reported that pangolins were listed as Class II Protected animals (at the time of interview) and that pangolin scales were regulated by the government. The wholesaler from Yuzhou Wholesale Market said it was illegal to sell pangolin scales, but a lot of shops ran a hidden trade. In terms of their medicinal value, the wholesaler from Zhengzhou believed that pangolin scales could not be substituted because they were very effective even in small dosages, especially when treating tumours and liver diseases. One wholesaler and two shop owners also mentioned the widespread counterfeiting of pangolin scales in markets, including the use of fake scales made of pig or goat hoof, smoking scales with chemicals to increase their weight, and including pangolin nails within scale products.

5.3.2 General public

The general public in Henan and Hainan generally showed little knowledge of the pangolin trade. When asked about their knowledge of pangolins, only 7.2% of respondents from Hainan and 16.9% from Henan mentioned the medicinal value of pangolins. Although most respondents in both provinces did not support trade in any pangolin products, respondents from both provinces were significantly more supportive of the trade of pangolin medicine products compared to trade for food or ornaments (z-test, $p < 0.01$) (Figure 5.2).

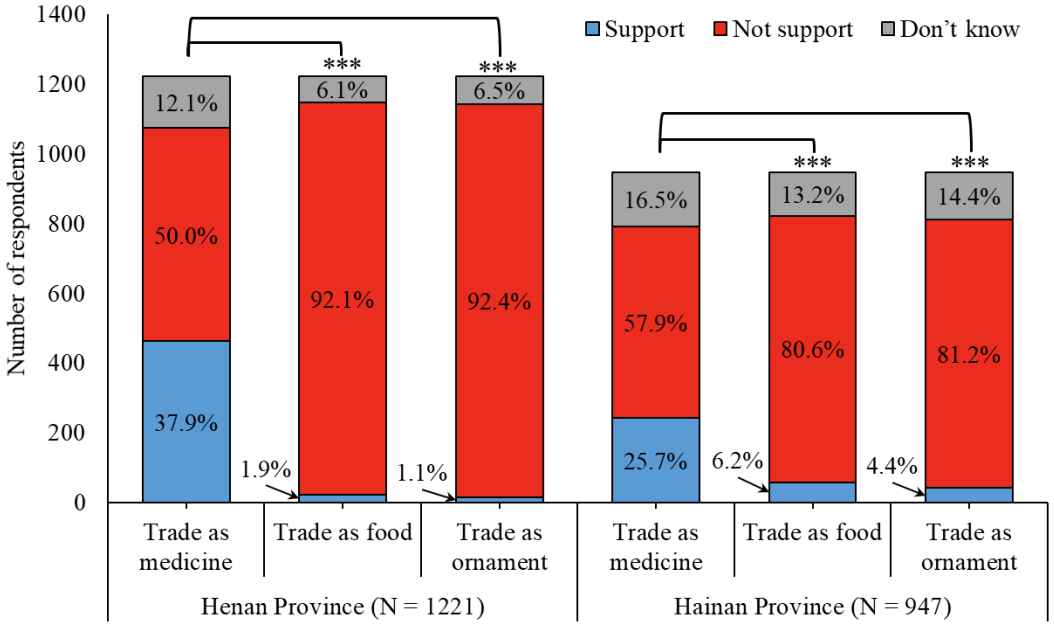

Figure 5.2 Respondents' attitudes towards trade in pangolin products for different purposes. Asterisks show "support" proportions that differ significantly from each other within a province.

Most respondents (66.3% in Hainan, 76.2% in Henan) knew that pangolin populations in China were threatened to some degree, whether Critically Endangered, Endangered or Vulnerable. However, more than 20% (25.6% in Hainan, 21.4% in Henan) were not aware of the level of threat faced by pangolins. Between 25% (Hainan) and 41% (Henan) of respondents believed that pangolin scale medicines could be traded legally. This was again significantly higher than perceptions about legality of trade for food and ornaments (z-test, $P < 0.01$) (Figure 5.3). However, 44% (Hainan) and 59% (Henan) of respondents did not know the source of these products, and only 4–10% correctly understood that all pangolin products were wild-sourced (Figure 5.4).

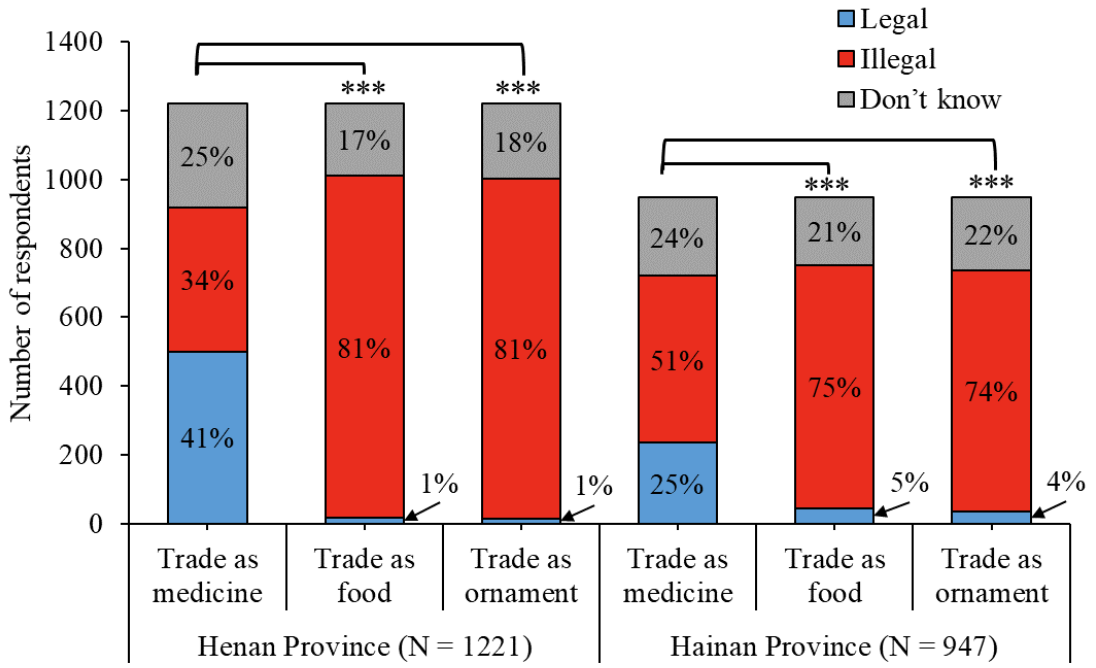

Figure 5.3 Respondents' knowledge of the legality of trading pangolin products for different purposes. Asterisks show "legal" proportions that differ significantly from each other within a province.

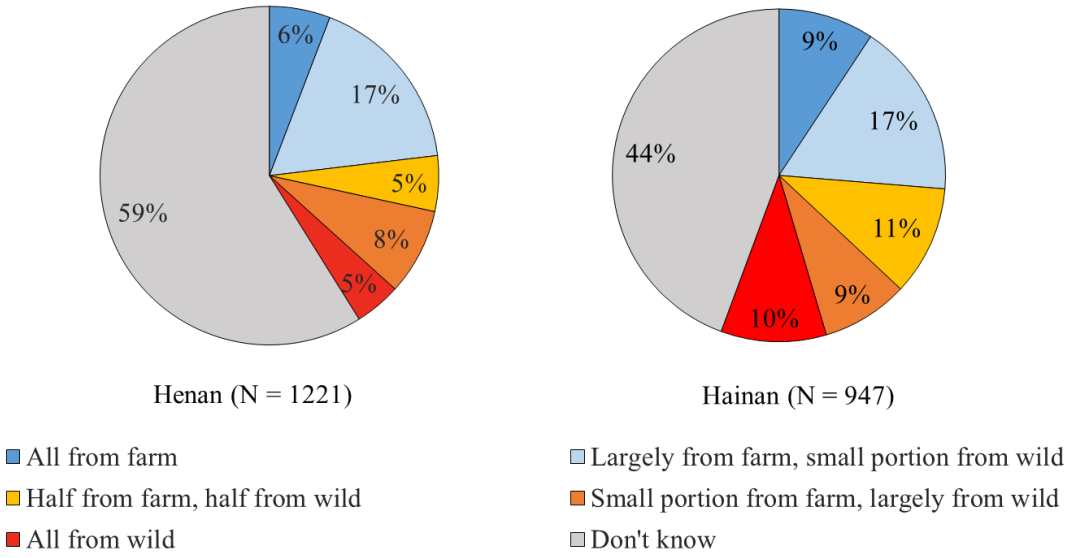

Figure 5.4 Respondents' knowledge about source of pangolin products sold in markets.

Table 5.3a Binomial model with lowest AIC for Henan Province (N_{Henan} = 1094).

Henan model	Std. Estimate	Std. Error	z value	P value
(Intercept)	0.0000	0.72522	-1.816	0.06938
Gender	-0.2833	0.17177	-2.444	0.0145
Occupation (professional)	0.46521	0.30268	2.365	0.01805
Occupation (civil servant)	0.55655	0.35042	2.867	0.00414
Occupation (freelancer)	-0.32176	0.28820	-1.662	0.09649
Education	0.34655	0.18782	1.847	0.06474
Pangolin population status in China	0.37346	0.05607	2.191	0.02847
Past consumptive behaviour	0.882595	0.17412	4.530	5.9e-06
Medicine legality	3.679018	0.11804	17.175	< 2e-16

Table 5.3b Binomial model with lowest AIC for Hainan Province (N_{Hainan} = 792).

Hainan model	Std. Estimate	Std. Error	z value	P value
(Intercept)	0.0000	0.29319	0.915	0.360357
Age	0.552367	0.05354	2.443	0.014581
Source of commodities	-0.84557	0.05555	-3.798	0.000146
Past consumption behaviour	0.8357	0.17028	3.856	0.000115
Medicine legality	3.42867	0.12441	14.624	< 2e-16

Binomial regression model results for Henan (Table 5.3a) show that female respondents, respondents who thought that pangolin populations were not threatened or did not know their status, respondents who work as professionals or civil servants, respondents with previous experience of consuming pangolins, and respondents who thought pangolin scale medicines were legal, were significantly more likely to support trade. More highly educated respondents were also more likely to support trade, but this result was not statistically significant. Freelancers were more likely not to support the trade but this was also not statistically significant. Hainan model results (Table 5.3b) show that older

respondents, respondents with previous experience of consuming pangolins, respondents who thought pangolin scale medicines were legal, and respondents who thought pangolin products originated from farms or who did not know their origin, were significantly more likely to support trade.

5.4 Discussion

This study shows that most TCM practitioners in sampled hospitals and pharmaceutical shops across two Chinese provinces believe pangolin scales have high medicinal value. The results also confirm the important role that these TCM practitioners, rather than end consumers, play in deciding consumption of medicinal pangolin scale products. Few patients questioned the use of pangolin scales in prescriptions, and if so, they asked for substitutes due to the relatively high price of scales rather than for conservation reasons. These findings highlight the need to engage more widely across the TCM community to support pangolin conservation and regulation of pangolin trade. Previous studies on the use of rhino horn, bear bile, and saiga horn have also highlighted the importance of understanding and working with TCM practitioners as a key stakeholder group in trade regulation (Cheung *et al.* 2018; Doughty *et al.* 2019; Randolph *et al.* 2019; Moorhouse *et al.* 2020). However, few studies or conservation interventions involving Chinese TCM practitioners have been conducted or developed to date.

This previous lack of conservation targeting might help to explain my earlier observation that doctors in hospitals and shop assistants in pharmaceutical shops possessed little knowledge of the legality of pangolin trade, since no education or awareness-raising programmes have targeted this stakeholder group. In contrast, shop owners and wholesalers were found to have a better understanding of relevant regulations. Similarly, wholesalers in China have been shown to be more aware of the illegal nature of saiga horn trade and more cautious about openly discussing the topic than retailers (Li, Zhao & Bennett 2007). These observations probably reflect the fact that conservation interventions have so far focused more on up-stream sellers/manufacturers (TRAFFIC 2015; Xu *et al.* 2016). Future conservation programmes should therefore also target other end sellers to improve their awareness of relevant legislation and conservation information about pangolins. Without this knowledge, these important decision-makers will not be able to make informed choices

to avoid or refuse illegal products.

The results from the general public survey revealed that the sampled general public has little understanding of the source of pangolin products (Figure 5.4). Many respondents did not know where these products came from, while some believed that pangolin products were obtained from farmed animals. Awareness of the source of pangolin products was also found to be an influential factor that correlated with people's attitude towards the trade in the regression model for Hainan (Table 5.3b). This finding further highlights the need for targeted education on the source of pangolin products, which may alter people's attitudes towards pangolin products and their subsequent behaviours. Moreover, without understanding that pangolin products are all wild-sourced and threaten the survival of wild pangolin populations, the causal relationship between products sold in markets and conservation of threatened wild pangolins will not be appreciated.

The models show that awareness of the legality of pangolin products was the strongest factor influencing people's supportiveness towards pangolin medicine in both provinces, as suggested by the highest standardized coefficient in regression models (Table 5.3a and 5.3b). This finding suggests that improving conservation awareness around legality of the trade might produce a more uniform and stronger positive impact on reducing demand for illegal pangolin products compared to other educational topics, such as awareness-raising about wild pangolin population status, since other such factors have a weaker effect or are not significant in regression models. Improving awareness of legality is also highlighted as an important activity by in this study evident from the lack of evidence to suggest that the public can differentiate accurately between legal versus illegal pangolin scale products. Indeed, the opposite conclusion is indirectly supported by the observation that end sellers, who are often the key decision-makers for pangolin scale consumption, lacked knowledge on relevant regulations.

More positively, this study shows the feasibility of encouraging TCM practitioners to use sustainable substitutes to replace pangolin scales. More than 70% of doctors that were interviewed agreed that at least some current use of pangolin scales in TCM could be substituted by other ingredients. This finding is supported by previous studies that

compared the medicinal effect of pangolin scales with other TCM ingredients such as pig hoof and different plant products (Li *et al.* 2008; Ge *et al.* 2009; Zhang *et al.* 2009; Burgess *et al.* 2020; Xing *et al.* 2020). Most of the potential substitutes are from domesticated or cultivated species and are thus unlikely to be of conservation concern. However, there is still a need to evaluate the potential impacts to wild populations if the demand for substitutes is likely to increase (Phelps, Carrasco & Webb 2014).

TCM communities could switch to other more sustainable substitutes if sufficiently motivated. One motivation for TCM doctors to use substitutes for pangolin scales could be caring for the wellbeing of their patients. Since the quality of illegal or counterfeit products cannot be guaranteed, the fact that illegal and counterfeit pangolin scale products are widespread in markets could therefore help motivate TCM practitioners to reconsider their choice of prescription (Yin *et al.* 2015; Xu *et al.* 2016). Two recent changes in policy might promote practitioners to actively consider using substitutes for pangolin scales if they are made aware of these changes.

Firstly, the National Healthcare Security Administration and the Ministry of Human Resources and Social Security (2019) recently updated the "*National Drug Catalogue for Basic Medical Insurance, Work-Related Injury Insurance, and Maternity Insurance*", and pangolin scales were removed from this catalogue. This means pangolin scales are no longer covered by national health insurance, meaning that practitioners might now actively consider substitutes to help reduce patients' medical expenses. Moreover, in early June 2020, all Asian pangolin species (*Manis* spp.) were uplisted from Class II to Class I Protected Species in China, and pangolin scales were removed from the official list of Chinese Pharmacopoeia due to the heavily threatened status of wild pangolin populations (National Pharmacopoeia Committee 2020). This national policy change means that pangolin scales should no longer be regarded as an authorised medicine, although the ingredient is still present in some of the patent drugs included in the pharmacopoeia, and the legal pangolin scale market has not been closed. However, this removal could still serve as a strong signal to the TCM community that legal usage of pangolin scales might end in the near future and make exploration of effective substitutes a more pressing issue than before. Therefore, targeted education or awareness-raising programmes focusing on regulations and current market status might

facilitate TCM practitioners to participate willingly in pangolin conservation by refusing illegal pangolin products and choosing sustainable substitutes when possible.

The use of pangolin scales as a general healthcare product (in contrast to a specific medicinal product or prescription) was not acknowledged by TCM doctors from hospitals in this survey. This alternative potential use is also not acknowledged by the National Health Commission of China in their official list of 114 TCM ingredients that can be used for non-medicinal uses or for general healthcare (National Health Commission of China 2002), which does not contain pangolin scales or other pangolin products. TCM practitioners, rather than conservationists, are seen by the Chinese public as authorities in the healthcare domain (Si, Song & Gao 2013; Burgess *et al.* 2020), and so demand reduction campaigns should consider inviting authorities from the TCM community to speak out to guide demand. As such, TCM practitioners are important stakeholders who are currently underrepresented in pangolin conservation, but who have the ability to lead the public towards a more sustainable lifestyle.

Finally, it is important to recognise some limitations of this study. The failure of snowball online surveying in Hainan led to using different sampling methods in the two study provinces. In addition to differences in knowledge of pangolin population status and source of products between the two regression models, the Henan model highlighted female respondents and respondents working as professionals or civil servants whereas the Hainan model highlighted older respondents as more likely to support trade. Although these province-level differences suggest that conservation campaigns might need to be regionally modified to accommodate local variation (Olmedo, Sharif & Milner-Gulland 2018; Wallen & Daut 2018), they might also be due to different sampling methods rather than underlying regional differences in attitudes and awareness. Secondly, only certain administrative regions in each province were surveyed, and the sample size is inevitably low compared to the total population living in each region. For reference, the population of Kaifeng is 2 million, the population of Zhengzhou is 7 million, and the population of Baisha (the least populous region included in this study) is 30,000. Assessing the representativeness of the patterns seen in this study across wider demographic and geographical scales therefore needs further validation. Thirdly, although knowledge and attitudes of direct consumers are important

to understand for trade regulation, individuals belonging to this stakeholder group are hard to pinpoint and under-reporting is common in self-reporting surveys such as ours (Krumpal 2013). This study therefore represents an assessment of people who currently support the pangolin TCM trade, rather than those who specifically report past experience of consuming pangolins. However, it is possible that factors influencing support towards trade may differ from those influencing actual consumption of products. To be successful at effecting behaviour change, campaigns that aim to change consumption may therefore need to be based upon further evidence. Moreover, only two wholesalers were interviewed, one from each wholesale market. Although these respondents showed a good understanding of the wholesale market they worked in, a greater sample size is definitely required to understand knowledge and attitudes of this stakeholder group.

Despite the potential caveats of the study, the results suggest three potential directions of promise for future interventions to support pangolin conservation in China. Firstly, awareness and education programmes should focus more on end sellers and their lack of understanding about relevant regulations and the illegal market. As key decision-makers in pangolin scale consumption, their knowledge on product legality links closely with trade management on the ground. Secondly, interventions that target the general public should highlight the connection between products in markets and populations of wild pangolins, and combine these perspectives with practical guidelines on what the public could do to participate effectively in combating illegal trade and reducing demand on pangolin products. These guidelines could include how to identify and report illegal products, how to identify pangolin scale ingredients in prescriptions, and the importance and feasibility of actively consulting TCM practitioners for potential substitutes. Audience segmentation is preferred for public campaigns when possible, and the results suggest more localized segmentation might be needed. Thirdly, the TCM community should be recognised as a key stakeholder in pangolin trade and become more closely integrated into pangolin conservation activities. The role of TCM practitioners as healthcare professionals could help to reduce excessive and illegal demand not only on pangolins, but potentially also on many other wildlife products. Therefore, I strongly urge that the TCM community should become more heavily involved in future efforts to conserve pangolins and other wildlife threatened by

unsustainable medicinal trade.

Chapter 6 The scale of the problem: understanding the demand for medicinal pangolin products in China

Submitted for publication

6.1 Introduction

China plays an important role in regulating legal wildlife trade and combating illegal wildlife trade for global biodiversity conservation (Esmail *et al*. 2020). In particular, frequent seizures of large quantities of pangolin products have attracted the attention of conservationists worldwide. Threats to wild pangolin populations from trade are not recent. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has placed most pangolin species under regulation since 1975, the year the convention came into effect, and a stricter zero trade quota was applied to the four species of Asian pangolins in 2000 to further reduce pressures from trade (CITES 2000). In 2016, all eight pangolin species were up-listed to CITES Appendix I, banning all commercial trade (CITES 2016c). However, this legislation has not been able to prevent huge-scale ongoing trafficking in pangolin products (Cheng, Xing & Bonebrake 2017; Heinrich *et al.* 2017; Challender, Nash & Waterman 2020).

Pangolin products in trade can be broadly grouped into three types: foods, medicines, and ornaments (Challender, Waterman & Baillie 2014; Heinrich *et al.* 2017). Confiscation reports show that each product type is supplied through different trading chains and sold in different end-markets. The current trade of pangolin products is truly international, with over 70 countries across four continents identified as being involved in the trade in various ways (Heinrich *et al.* 2017). Among these countries, China is under the spotlight as one of the main demand markets. All three types of pangolin products are traded in China, with meat and medicinal products reported most frequently (Xu *et al.* 2016; Yang *et al.* 2007). Traded medicinal pangolin products are commonly associated with Traditional Chinese Medicine (TCM; Yin *et al.* 2015).

TCM has been developed and used in China for many centuries and is still widely practiced today (Chow & Liu 2013). In 2016, TCM hospitals and clinics treated 962

million patients in total, and medical services using TCM treatment accounted for 15.8% of all medical services provided in China (National Health and Family Planning Commission of the PRC 2017). The use of Chinese pangolin (*Manis pentadactyla*) scales in TCM can be traced back to AD 480 in a medical text entitled "*Bencaojing jizhu*", which was later cited in the "Compendium of Materia Medica" (Li 1578). Chinese TCM practitioners generally approve the perceived medicinal value of pangolin scales and use them in prescriptions targeting a wide range of symptoms or illnesses (Wang, Turvey & Leader-Williams 2020). However, pangolin scales have recently been removed from the "Pharmacopoeia of the People's Republic of China", although some patented medicines or *zhongchengyao* in the Pharmacopoeia still contain pangolin scales as an ingredient (National Pharmacopoeia Committee 2020). The impact of this change in listing has yet to be recorded.

The Chinese pangolin had been listed as a Class II Protected Species in China since 1989, and was recently uplisted to Class I Protected Species in 2020 (SFA of China 1989; SFGA of China 2020), with an aim of providing more deterrence and resources for combating illegal trade. However, the Chinese government still permits a pangolin scale market to operate nationally for medicinal usage, with specific requirements on sources of supply, manufacturers, sellers, annual quotas allowed for sale, and a product labelling system. The market requirements were released by China's State Forestry Administration (SFA, now State Forestry and Grassland Administration) and came into effect in 2008. This document also specifies 711 hospitals in China that are allowed to sell medicines to patients containing pangolin scales (e.g., patent drugs or *zhongchengyao*) and pangolin scale medicines (individual ingredients to be used in prescriptions) (SFA of China 2007b, 2008a). All manufacturers and traders are required to hold corresponding permits. There are 209 certified manufacturers in China, which are allowed to produce over 60 types of medicines containing pangolin scales (Xu *et al.* 2016). All pangolin scale medicines must carry certificates attached to the smallest packages, to differentiate clearly between legal and illegal products in end-consumer markets. Therefore, illegal trade or illegal products can be identified if (i) trade participants such as manufacturers or hospitals do not hold corresponding permits, and/or (ii) traded products do not have certificates on the smallest packages. Trade volume is regulated through an annual quota, which has a mean of 26.58 ± 1.58 tons

based on released data from 2008 to 2014 (range, 25.09–29.23 tons; SFA of China 2008b, 2009, 2010, 2011, 2012, 2013, 2014).

Because China constitutes one of the largest demand markets for pangolin products, it is essential to understand the nature of TCM-related demand in order to inform management options. Important questions remain concerning the trade volume of pangolin scales (both legal and illegal) in China, the size of demand from the legal market, and whether legal supply is the main source for traded products. These questions are difficult to answer, as the geographic scale over which trade takes place is vast, and illegal trade is a sensitive topic to investigate. This study is one of the few to address these globally important conservation concerns.

6.2 Materials and methods

I conducted face-to-face semi-structured interviews in Mandarin between October 2016 and April 2017 across nine Chinese administrative regions (municipalities/counties) in Henan Province (Kaifeng, Yuzhou, Zhengzhou) and Hainan Province (Baisha, Haikou, Ledong, Qiongzhong, Sanya, Wuzhishan) (Figure 6.1). Pangolins historically occurred in both provinces (Zhang *et al*. 1997). These study regions were chosen for several reasons. First, there were readily available local networks in both regions that could help us gain access to respondents. Second, Henan and Hainan differ greatly in terms of geographic location, local ecology and biodiversity, culture, economy, and human population (National Bureau of Statistics 2020). Henan has a high human population density and a long history of TCM utilization. In contrast, Hainan is less economically developed and is culturally distinct; local Li and Miao ethnic groups do not have a history of using pangolin scales for medicine, and consumption of pangolin products is a recently developed behaviour (Wang, Leader-Williams & Turvey 2021). These regional variations provide increased site diversity, with the potential to indicate more general patterns of pangolin product usage across other areas of China that were not logistically feasible to cover in this study. The resulting dataset also allowed us to statistically investigate determinants of geographical variation in patterns of pangolin scale trade.

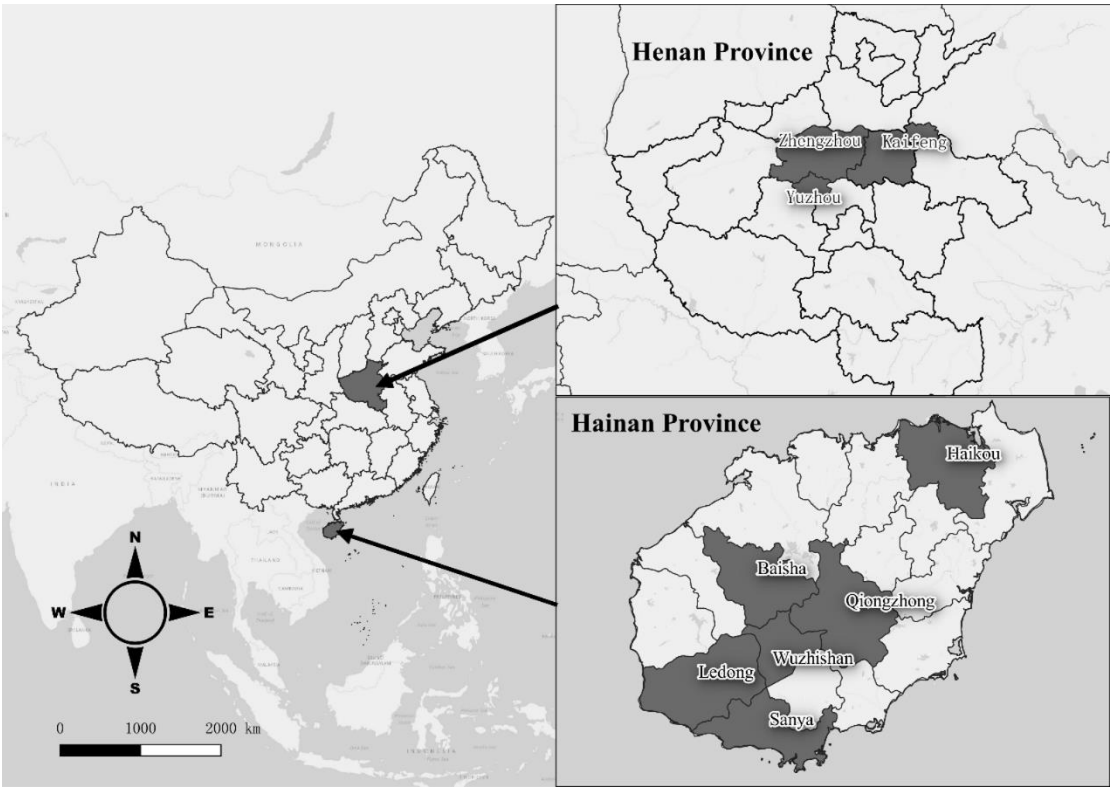

Figure 6.1 Map showing study sites across China. Hainan and Henan Provinces are highlighted in the background map, and study municipalities/counties are highlighted in the two provincial-level inset maps.

Interviews included questions about annual sales of pangolin scale products and other trade-related information (Supplementary Material), and took about 30 minutes to complete if respondents answered all questions. Some respondents did not know or provide answers to all questions, and others provided further information on sale data by asking colleagues. Interviews were carried out in a semi-structured and discursive manner; I avoided reading questions directly from a questionnaire, and instead asked them in a more nuanced way according to the context of the specific interview conversation to gain more trust and connection with respondents.

I explained that the aim of this study was to better understand the pangolin scale medicine market, as well as how data would be used and other relevant information before each interview. All respondents remained anonymous and provided oral consent for participating. I did not ask directly about the legality of trade behaviours or medicinal products during interviews, but instead asked indirect questions such as respondents' knowledge about pangolin trade-related regulations. Illegal trade was also identified through comparing certified hospitals with interviewed hospitals, and looking

for trade certificates on products when these were on view. Interview methods and questions were piloted before the main study in five pharmaceutical shops in the town centre of Longlou, Hainan, and no changes were subsequently made to the study protocols. Research design was approved by the Department of Geography Ethics Review Group, University of Cambridge (#1503).

Respondents in this study included doctors from hospitals (either TCM hospitals or hospitals containing TCM departments), shop owners or assistants from TCM shops, and sellers from TCM wholesale markets. I accessed doctors in Henan and Hainan, and wholesalers and TCM shops in Henan, through social connections (primarily through introductions to potential respondents by friends or family members); these respondents could therefore not be specifically selected by interviewers. All hospitals interviewed had TCM departments or sold TCM medicines. No target sample size was set for hospitals, wholesale markets, or Henan shop survey. Instead, I aimed to interview as many respondents as possible in the time available. Pharmaceutical shops were located in Hainan through cluster sampling, which involved using an online map (https://map.baidu.com/) to identify areas within each county town/city centre where pharmaceutical shops were centralized. Interviews were then conducted in all shops in those areas. Respondents from shops were approached based on their availability at that moment and their willingness to participate. A maximum of 30 shops were sampled for cities in Hainan where many pharmaceutical shops were located, and surveyed all shops in smaller counties that had fewer than 30 shops.

I investigated three main types of pangolin scale products in this study: raw scales, roasted scales (scales treated using standardized TCM procedures including *paoshanjia* and *cushanjia*), and scale powder (fine powder produced by blending and sieving roasted scales). Some patent drugs also contain pangolin scales as ingredients, but these medicines were not included in this study as the quantity of pangolin scales that they contain was difficult to estimate. Therefore, only three types of pangolin scale medicines were considered, rather than all medicines containing pangolin scales. To calculate the total quantity of scales being traded, I used numerical conversions between these three types of products based upon Hu and Li (2007), who specified that weight loss of raw scales after the traditional processing method was 20-25%. The size and

weight of one scale differs considerably across different pangolin species, animals of different ages, and different parts of the body. Therefore, I used the lower boundary of this range (20%) to provide a conservative estimate of the final quantity, and assumed one kilogram of raw scales would produce 0.8 kilogram of roasted scales. I also assumed one kilogram of raw scales would produce 0.53 kilogram of scale powder if they were blended and sieved after roasting, based upon information obtained from two TCM practitioners who independently reported the percentage loss as around one-third due to sieving; this ratio is supported by written descriptions on packages of pangolin scale powder medicine observed during this study, which stated "1.4g of powder = 6g of roasted scales". The lower boundary of these estimations was again used (33.3%) as a conservative ratio. I calculated mean amounts of scales sold by hospitals or shops and mean prices if this information was provided, using midpoints of ranges if these were reported.

Generalized linear models (GLMs) were used to investigate potential correlations between annual sale quantities of pangolin scale products (response variable) and potential predictor variables. Separate analyses were conducted for results from hospitals and shops. Predictors used in GLMs are shown in Table 6.1. All predictors were first included in maximal models, and stepwise selection was then used to find the best-performing models with the lowest Akaike Information Criterion corrected for small sample size (AICc). Additional GLMs were conducted to investigate potential correlations between whether hospitals or shops admitted selling pangolin scale products or not, and the same set of potential predictor variables (excluding price data). One-sample t-tests were also conducted to compare means of sales between years. All statistical analyses were performed using R version 3.5.2 (RStudio Team, 2015).

Table 6.1. Predictors included in GLMs investigating sale of pangolin scale products in hospitals and shops, and variable type. 3A-grade refers to the Chinese system for evaluating hospitals (3A is the highest grade).

Predictors	In both models	In hospital model	In shop model
Mean sale price	Continuous		
Municipality/county	Categorical		
Municipality/county population	Continuous		
Municipality/county GDP	Continuous		
Province	Categorical		
TCM-specialized hospital		Binary	
3A-grade hospital		Binary	
Chain-shop or private-owned			Binary

6.3 Results

I interviewed doctors or sellers from 41 hospitals and 134 pharmaceutical shops in eight municipalities/counties (Tables 6.2 and 6.3). One main respondent was identified for each hospital/shop. Pangolin scale products were sometimes on display, and I observed both legal and illegal products being sold (i.e. products with and without trade certificates) by both legal and illegal sellers (i.e. certified and non-certified hospitals and all pharmaceutical shops). Hospitals with legal trading permits were also found selling products without the legally required certificates, while legal products were also found in hospitals that were not certified to sell pangolin products

Table 6.2 Summary of hospital survey data for Henan and Hainan Provinces. A total of 20 hospital respondents reported sale quantity data, and 25 hospital respondents reported price data.

Province	City	Number of hospitals surveyed	Number of hospitals selling pangolin scales	Number of hospitals with permit	Mean processed scale price in hospitals (yuan/kg±SD)	Mean amount of roasted pangolin scales sold by hospitals in one year (kg±SD)	Total amount of raw pangolin scales sold by hospitals in one year (kg)
Henan	Kaifeng	9	7	1	6355±3922	57.9±99.7	289.4
Henan	Zhengzhou	19	16	5	7748±2860	123.7±210.8	1855.1
Hainan	Baisha	1	0	0	NA	NA	NA
Hainan	Haikou	4	2	1	4850±2192	20.4±8.9	51
Hainan	Ledong	2	1	0	3300	9.0	11.3
Hainan	Qiongzhong	3	0	0	NA	NA	NA
Hainan	Sanya	2	1	1	5450	3.2	4.1
Hainan	Wuzhishan	1	0	0	NA	NA	NA
						Total amount of raw pangolin scales sold by all surveyed hospitals in one year	**2210.9**

Table 6.3 Summary of pharmaceutical shop survey data for Henan and Hainan Provinces. A total of 21 shop respondents reported sale quantity, and 56 shop respondents reported price data.

Province	City	Number of shops surveyed	Number of shops selling pangolin scales	Mean processed scale price in shops (yuan/kg±SD)	Mean amount of roasted pangolin scales sold by shops in one year (kg±SD)	Total amount of raw pangolin scales sold by shops in one year (kg)
Henan	Kaifeng	6	6	6760±830	3.8±5.6	18.8
Henan	Zhengzhou	7	5	7140±2870	3.0±1.9	11.3
Hainan	Baisha	16	4	7750±1848	0.012±0.004	0.03
Hainan	Haikou	30	10	4531±3413	0.33±0.16	1.2
Hainan	Ledong	16	2	6250±3182	9.0	11.3
Hainan	Qiongzhong	17	5	5840±4379	0.5	1.3
Hainan	Sanya	28	8	7292±2411	0.7±1.2	3.6
Hainan	Wuzhishan	14	6	7100±1291	0.8±1	2
					Total amount of raw pangolin scales sold by all surveyed shops in one year	**49.4**

Of the 41 hospitals, 27 (64.9%) were found to sell pangolin scale products, and eight (29.6%) held a legal permit to do so (Table 6.2). Six of these eight certified hospitals (four in Henan and two in Hainan) reported sales data. In total, these hospitals had sold approximately 778.1 kg of roasted scales during the previous year, which was estimated as equivalent to 972.6 kg of raw scales (940.8 kg from Henan hospitals and 31.8 kg from Hainan hospitals). The annual quantity of scale products sold varied considerably across hospitals. Among the 20 hospitals (both certified and uncertified) that reported sale data, 10 hospitals reported selling less than 20 kg per year, while four hospitals reported annual sale quantities of over 200 kg of roasted scales; three of these four hospitals did not hold permits. The four hospitals with the highest annual sale quantities were all in Henan Province (three in the provincial capital Zhengzhou, and one in Kaifeng). Sale quantity was not found to correlate with any potential predictor variables included in the GLM ($P > 0.1$ or NA, $N_{hospital} = 19$). Whether hospitals admitted selling scale products was statistically correlated with local population size ($P = 0.03$, $N_{hospital} = 41$), with cities or counties with higher human populations more likely to admit sales.

Two hospitals in Zhengzhou also provided longer-term sales data in the form of weights of roasted scales purchased each year from 2012 to 2016, in addition to sale data for 2017 (Figure 6.2). Both hospitals purchased pangolin scale medicines multiple times in one year depending on remaining stocks, meaning that the purchased quantity can indicate the sale quantity of that year. The mean of sales across the previous five-year period did not differ from sales for 2017 for either hospital (one-sample t-test, $P_{hospital\ 1} = 0.208$; $P_{hospital\ 2} = 0.998$).

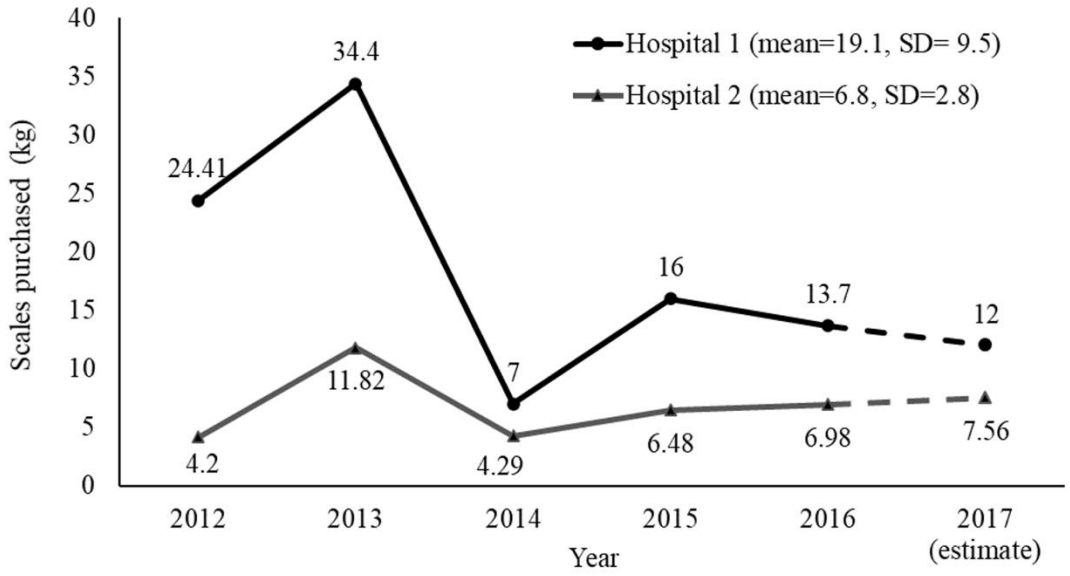

Figure 6.2 Amounts of roasted pangolin scales purchased by two hospitals from 2012 to 2016.

Over a third (n = 46, 34.3%) of the 143 surveyed pharmaceutical shops were found to sell pangolin scale products. Among shops selling TCM, more than half sold scale products (Figure 6.3). Sale quantity again varied across shops. Most shops reported very low sale quantities (10 out of 21 shops reported less than 0.1 kg sold in 2017). Sale quantity was not found to correlate with any potential predictor variables included in the GLM ($P > 0.1$ or NA, $N_{shop} = 21$). Whether shops admitted selling scale products was statistically correlated with whether they were chain-shops or not ($P = 0.003$, $N = 128$), with chain-shops more likely to admit sales.

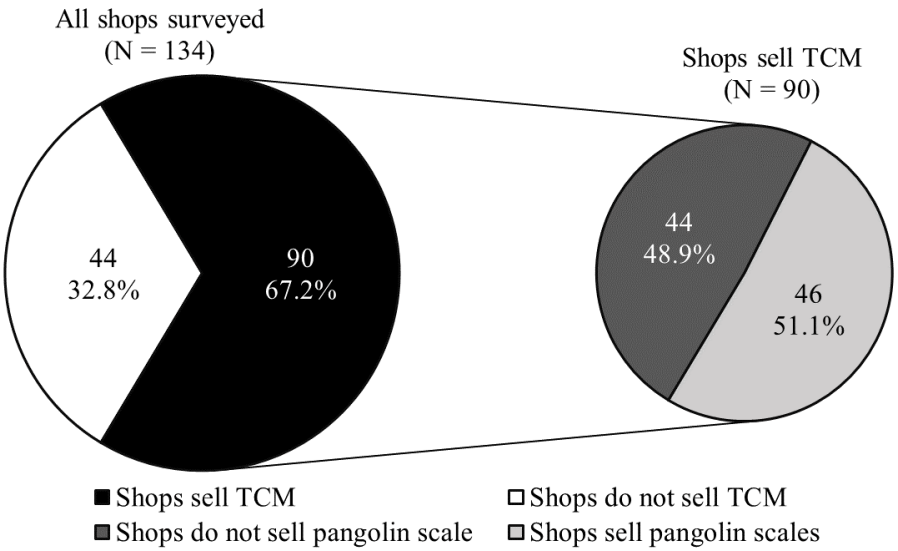

Figure 6.3 Percentage of shops selling TCM products and pangolin scale products. Shops that reported not selling TCM or that refused interviews (n=6) were grouped as "do not sell TCM".

Pangolin scale products were sold in both of the TCM wholesale markets I surveyed in Zhengzhou and Yuzhou. Zhengzhou TCM wholesale market had collectively sold approximately 200 kg of roasted scales every year for the past few years, corresponding to an annual sale of approximately 250 kg of raw scales. Yuzhou TCM wholesale market collectively sold 2–3 tons of raw scales per month, corresponding to an annual sale of around 24 tons of raw scales. Trade in wholesale markets could be legal if both traders and buyers hold trade permits and trading certified products; however, information on permits and certificates was impossible to obtain, so these sale quantities could not be linked directly to legal or illegal trade. Because I only interviewed one seller from each wholesale market, as well as the difficulty of determining trade legality in the markets, these reported sale quantities were only used as anecdotal information and were not analysed further.

A total of 11 shop respondents provided information on variation in demand for pangolin scales over the past few years. Eight out of 11 shop respondents said that demand was stable because TCM products were typically purchased by relatively wealthy consumers, whereas the remaining three respondents said that demand fluctuated with price. Two respondents (one hospital respondent and one shop respondent) provided information on seasonal variation in demand; both respondents considered that TCM sales in general were lower during summer months, because TCM

"tasted bad" (referring to the bitter taste of most TCM products) and people did not like to take it when their appetite was already reduced due to hot weather.

6.4 Discussion

This study has revealed that illegal pangolin scale trade occurs widely in hospitals and pharmaceutical shops across Henan and Hainan provinces. Government regulations specify that only 711 listed hospitals in China are legally allowed to sell pangolin scale products directly to consumers (SFA of China 2007b; SFA of China 2008a), meaning that unlisted hospitals and all pharmaceutical shops were not allowed to sell pangolin medicine in this manner. However, the results showed that over 45% of surveyed hospitals and over 30% of surveyed pharmaceutical shops within these two provinces sell pangolin scale products illegally. Although I could not assess legality of trade within wholesale TCM markets directly, the quantity of pangolin scales estimated as being sold annually within Yuzhou wholesale market alone is around 24 tons. Yuzhou is only one of 12 major TCM wholesale markets in China; since the mean annual quota for pangolin scales for all of China between 2008 and 2015 was 26.58 ± 1.58 tons, illegal products are thus very likely to be present in these wholesale outlets. This study therefore highlights the urgent need for further investigation into quantities of legal and illegal pangolin products in trade across China.

The presence of illegal pangolin scale products in pharmaceutical shops and wholesale outlets has also been reported by previous researchers (Xu *et al*. 2016; Yin *et al*. 2015). However, little research has been conducted on trade of pangolin products in Chinese hospitals. The co-occurrence of legal and illegal trade for the same type of product makes the trade in hospitals more complex to regulate than for other types of sellers. Nevertheless, the results show that many hospitals sell pangolin scale products illegally, as they do not belong to the list of 711 certified hospitals. Moreover, illegal products are sold not only by uncertified sellers but also by certified hospitals. From the results, four certified hospitals in Henan sold 940.8 kg of raw scales, which greatly exceeds the mean quota assigned to the whole of this province between 2008 and 2015 (343.8 ± 279.8 kg) (SFA of China 2008b, 2009, 2010, 2011, 2012, 2013, 2014). However, a total of 60 hospitals in Henan are certified to trade pangolin scale medicines; if the results are typical for these other hospitals, then actual levels of pangolin scale products traded

within certified hospitals might be more than an order of magnitude greater than provincial legal quotas. Illegal pangolin scale products must therefore be widely traded within the legal market to account for this level of trade. Indeed, during interviews at certified hospitals, I observed pangolin scale products that were not accompanied by trade certificates, suggesting that these products were illegal.

The five-year sale data provided by two hospitals suggest that sales have not varied significantly during recent years, and annual quotas assigned by the Chinese government based upon stockpile holder applications and market demand (SFA of China 2007b) also remained at similar levels between 2008 and 2015. However, the quantity of pangolin scale products involved in the three types of sale channels varied substantially, both between different groups of sellers and within the same seller group. The largest seller was Yuzhou TCM wholesale market, one of the 12 major TCM wholesale markets in China, and one of the four major TCM markets that were established during the early Qing Dynasty (AD 1700s) (Han 2015). By contrast, Zhengzhou TCM wholesale market is much smaller, and sellers probably purchase products from larger wholesale markets such as Yuzhou. Patterns of sales across shops and hospitals are more complex. None of the variables investigated in this study were found to predict reported variation in sale quantities, and the observations suggest that this variation is more related to individual doctors' preferences and specialities rather than external factors, posing difficulties in estimating accurate provincial-level or national-level trade volumes across China. Similarly, the results demonstrate that sale of pangolin products was more likely to be reported by chain-shops rather than by private non-chain shops; however, this result might suggest either variation in sales between different types of shops, or that owners of private non-chain shops know more about the illegal nature of pangolin scale trade and are thus less likely to admit sales.

Since considerable variation was observed in sales within each seller group, and the study could only survey a small number of cities in two provinces in China, wider extrapolation of regional data to the countrywide scale can only provide a simplistic and approximate estimate of wider levels of trade across China. However, such extrapolation still remains useful in providing a potential indication of the general quantities of pangolin scales likely to be involved in trade at a national scale. There

were around 489,000 pharmaceutical shops in China in November 2018 (China Data Centre for Food and Drug Administration 2019). If mean sales from the surveyed shops are extrapolated to the countrywide scale, the amount of raw pangolin scales traded by pharmaceutical shops in China could exceed 180 tons per year. Estimates based on hospital data show comparable patterns. There were 4,939 TCM hospitals in China at the end of 2018 (Department of Planning Development and Information Technology of China 2019). Extrapolation of sales data from the surveyed hospitals to the countrywide scale suggests that estimated sales of raw pangolin scales by hospitals across China could reach 260 tons per year. Even in terms of legally authorised trade, extrapolating data from the six certified hospitals for which I have sale data to the total number of certified hospitals in China gives an estimated annual sale of 115.3 tons, which is much higher than the mean annual national legal quota of 26.58 tons.

Although these extrapolations are all approximations, taken together, they indicate that currently traded levels of medicinal pangolin products are likely to be extremely high and well above legally permitted levels. Indeed, there is no reason to suspect that I sampled sellers who conducted a much greater volume of trade in pangolin products compared to hospitals, pharmaceutical shops or wholesale markets elsewhere in China, and larger TCM wholesale markets are found in other Chinese provinces (Xu *et al.* 2016). The results also indicate that sale of medicinal pangolin products was more likely to be reported by hospitals in cities with higher populations, suggesting a greater demand for pangolin products in such regions. Thus, use of pangolin products could be even higher across heavily urbanized areas of China than might be expected based upon data from less populated Hainan. In addition, patent drugs were not investigated in this study, but this group of pangolin scale products constitutes a segment of the legal trade and shares the annual national quota with prescription medicines. This further widens the potential gap between trade volumes estimated in this study and the quantities that can be provided through legal supplies.

Collecting accurate data using social science research methods can be challenging, especially for sensitive topics such as illegal activities. Researchers in this study tried to build trust with respondents by providing maximum anonymity and maintaining a neutral position during interviews (cf. Cunliffe & Alcadipani 2016). All hospital

respondents were approached through social network connections, which further helped to establish trust (van Uhm 2016). Respondents were not pushed to answer questions and were free to withdraw at any point during the interview. Despite these protocols, I consider it more likely that respondents would have under-reported rather than over-reported sales behaviour due to the sensitive nature of the subject and the direct questioning technique (Olmedo *et al.* 2021). Therefore, I interpreted the findings as providing a conservative baseline estimate of trade volumes. Actual levels of trade in medicinal pangolin products might therefore be even higher than estimated.

Using an approximate ratio of 0.5 kg of raw scales per pangolin (Zhou *et al.* 2012; Challender & Waterman 2017) suggests that scales from more than half a million pangolins might be sold annually by these vendor groups in China. In context, Wu *et al*. (2002) estimated that the total population size of wild pangolins within China was 50,000–100,000 individuals at the start of the twenty-first century. The Chinese pangolin population has since experienced a precipitous population decline (Wu *et al*. 2004; Nash *et al*. 2016), indicating that the great majority of traded scales must come from illegal international trade as well as from permitted annual quotas. This finding highlights the important role that China needs to play in global pangolin conservation.

In addition to the need to understand and reduce consumer demand for pangolin products, collaborating with the TCM sector to encourage the use of substitutes and raise awareness about legislation has been proposed as a potential mitigation strategy to support pangolin conservation (Luo *et al.* 2011; Wang, Turvey & Leader-Williams 2020). Targeting illegal trade in pharmaceutical shops and uncertified hospitals within China also represents a management option that is important for pangolin conservation at a global scale. Another proposed option is to increase supply through farming. However, although conservation breeding has been carried out for some pangolin species in zoos (Parker & Luz 2020), efforts to establish commercial-scale pangolin farming have so far been unsuccessful (Challender *et al.* 2019). More generally, the effectiveness of farming wildlife to relieve pressure on wild populations requires comprehensive and critical evaluation to ensure that it does not have unforeseen negative consequences such as increasing demand or providing a cover for laundering of illegal products (e.g., Kirkpatrick & Emerton 2010; Lyons & Natusch 2011; Turvey

et al. 2021). Indeed, beside the technical difficulties, farming pangolins to replace wild-sourced products has many other barriers, and more research is needed to understand the complex dynamics of pangolin trade to ensure that commercial farming would not pose additional threats to wild pangolin populations; pangolin farming is highly unlikely to displace wild collection in the near future and is considered unlikely to benefit the conservation of wild populations (Challender *et al.* 2019; Chen & 't Sas-Rolfes 2021). Furthermore, even if commercial farming has the potential to provide a sustainable source of pangolin products for markets in the future, it does not solve the current issue that estimated trade volumes far exceed the legal stockpile.

The results highlight some of the complex issues involved in opting to better regulate wildlife trade, such as the trade in pangolins, either through use or protection. Without any evidence of success in farming pangolins (Challender *et al.* 2019), it also might not be wise to rely solely on trade bans, which have been shown to stimulate trade or poaching in some situations (Rivalan *et al*. 2007; Conrad 2012; Challender & MacMillan 2014). Instead, I recommend that urgent attention should be paid to revising existing policies and practices associated with legal trade in China. The need for these adjustments is evident from one of the main findings of this study, the major discrepancy between the legal pangolin scale supply and sales in certified hospitals. The recent removal of pangolin scales from the Chinese Pharmacopoeia offers a good opportunity to promote much tighter management controls for the legal pangolin scale trade.

First, I suggest that the use of pangolin scales in prescriptions could be regulated in terms of which priority symptoms qualify for using pangolin scale medicines. Similar regulations have been put in place within China to regulate deer musk medicinal trade, in which only four drugs are allowed to use natural deer musk in their production (China Food and Drug Administration 2005). This approach could help to regulate demand from lower-priority uses, or uses merely for higher profit (Wang, Turvey & Leader-Williams 2020). Second, the Chinese government could estimate the quantity of scales that can be sold legally by each certified hospital and plot a timeline for using the remaining stockpile based on remaining quantities. Flexible management of the size of quotas should be allowed to accommodate changing demand size across time. TCM

practitioners should be made aware of this timeline to prepare for any future switch to other ingredients when the pangolin stockpile becomes depleted. Third, guidelines on the use of substitutes to replace pangolin scales could be produced by TCM authorities to promote active choice of substitutes by practitioners. TCM-specialised education programmes should also reconsider their content related to pangolin scales due to the unsustainable nature of this medicine, including through promotion of substitution guidelines and related regulations. Effective demand-reduction interventions need to be both evidence-based and locally adaptable (Bennett & Dearden 2014). The use of pangolin scales in TCM is part of Chinese culture and closely connected to the TCM community, and so any regulation change or conservation interventions should include voices from local TCM communities to maximize success.

Finally, stronger enforcement is also required, given that many illegal trade behaviours are semi-open amongst the groups of sellers I surveyed (Wang, Turvey & Leader-Williams 2020). The results indicate that respondents in hospitals in areas with higher populations and sellers from chain-shops were both more likely to admit selling medicinal pangolin products. Although this greater level of admission might differ from actual variation in trade (e.g. due to increased reticence by other interviewed groups), such open admission might also indicate that awareness of the illegal nature of this behaviour is particularly poor amongst these stakeholders, and that law enforcement is particularly inadequate. These groups could therefore represent priority targets for both education and enforcement.

Overall, my study shows that illegal trade in pangolin scale is widespread in China, and pharmaceutical shops, wholesale markets and hospitals are all potential contributors. Legal products are now observed in illegal sale channels, hospitals holding legal permits also sell illegal products, and the amount of scale products sold by certified hospitals probably greatly exceeds the capacity to supply scales legally. Even considering the great variation in observed sale quantities and the difficulties of extrapolating estimates of countrywide sales of pangolin scale products by different seller groups, it is extremely unlikely that all products derive from the legal supply, and estimated sale quantities might be more than ten times higher than allowed by quotas. Indeed, a high proportion of vendors were observed conducting trade without sale

permits, directly suggesting that much of this trade is illegal. The findings highlight the need to better regulate and re-think the current legal market. More detailed regulations are needed to ensure a close legal trade framework that will prevent legal products leaking out of allowed trade routes, and will restrict the sale of illegal products. Re-design of existing legal market management strategies, combined with large-scale demand-reduction interventions and stronger enforcement of existing regulations, is therefore an urgent policy priority in China for both global pangolin conservation and public health concerns.

Chapter 7 Exploitation histories of pangolins and endemic pheasants on Hainan Island, China: baselines and shifting social norms

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7.1 Introduction

Unsustainable harvesting of wildlife, in particular hunting for meat consumption, has been recognized as a major cause of global biodiversity loss (Bennett & Robinson 2000; Corlett 2007; Benítez-López *et al.* 2017; Grooten & Almond 2018). Many different motivations underlie hunting for meat consumption, from meeting subsistence protein needs to a demand for luxury dishes. Drivers and patterns of wildlife exploitation also vary across cultures and geographic regions (Fa, Currie & Meeuwig 2003; Sandalj, Treydte & Ziegler 2016). In particular, biodiversity in regions with very high human population densities, such as China, is often under intensive pressure from exploitation and other human activities (Zhang & Yin 2014; USAID Wildlife Asia 2018). As a result, many hunting-induced population declines and regional extinctions have been documented in China across a diverse range of species (Greer & Doughty 1976; Thapar 1996; Rookmaaker 2006; Turvey, Crees & Di Fonzo 2015), and further population collapses of formerly widespread and abundant species, such as the Chinese giant salamander (*Andrias davidianus*) and yellow-breasted bunting (*Emberiza aureola*), continue to occur due to extensive and unsustainable demand for the wild meat market (Wang *et al.* 2004; Kamp *et al.* 2015; Cunningham *et al.* 2016). Exploitation of wildlife in China has occurred throughout recent history, but has escalated rapidly during the past few decades (Cunningham *et al.* 2016). Historical patterns of wildlife consumption, and the extent to which such patterns might have become modified during recent periods of socio-cultural change, are therefore important to understand when

designing conservation management strategies for species threatened by overexploitation (Huber 2012; Duffy *et al.* 2016).

Pangolins (Family Manidae) are recognised as international conservation priorities. They are heavily trafficked for consumption, and have also been identified as potential intermediate hosts in the COVID-19 pandemic of 2020 (Choo *et al.* 2020; Zhang, Wu & Zhang 2020). The enormous volumes of pangolins seen in wildlife trade has led to recent revision of their IUCN Red List status, with the Chinese pangolin (*Manis pentadactyla*), Sunda pangolin (*M. javanica*) and Philippine pangolin (*M. culionensis*) now listed as Critically Endangered, and the five other pangolin species listed as Endangered or Vulnerable (IUCN 2020). China is one of the main destination markets for international pangolin trade due to demand for meat, body parts, and scales. Much research attention has been focused on the international trade of pangolin products and hunting of pangolins in source countries, mainly in Africa (Challender & Hywood 2012; Soewu & Sodeinde 2015; Cheng, Xing & Bonebrake 2017; Ingram *et al.* 2019). Conversely, hunting pressure on native pangolin populations within demand countries such as China has been relatively neglected (Yang *et al.* 2007; Xu *et al.* 2016).

The Chinese pangolin was formerly distributed widely across central and southern China (see Chapter 1). However, its range has declined severely during recent decades, making evidence-based conservation of its remaining populations an important but difficult goal (Wu *et al.* 2004; Yang *et al.* 2018). This population decline has resulted in China uplisting the species from Class II to Class I Protected Species under national wildlife protection law in 2020 (SFGA of China 2020). However, due to their cryptic behaviours and nocturnal habits, and their low reproductive rates and population densities across a wide geographic range, estimating current pangolin population sizes and distribution is challenging. Few studies have attempted to estimate population densities, abundance or trends using standard census techniques or camera traps. In contrast, social science approaches offer some alternative promise for gaining evidence on these population parameters to guide conservation. One such study was conducted in 2015 on Hainan Island, China's southernmost province, where rural household

interview surveys suggested that a small pangolin population might still persist within the island's remaining tropical forests (Nash, Wong & Turvey 2016). It is therefore urgent to (i) assess levels and drivers of potential exploitation of surviving pangolin populations on Hainan, and better understand the socio-cultural context within which local people interact with pangolins, and (ii) inform conservation interventions to reduce exploitation and demand at the community level.

Collecting conservation-relevant data on sensitive behaviours using social science methods is often difficult, due to interviewee reticence in reporting accurate information on potentially illegal activities (Nuno & St. John 2015; Hinsley *et al.* 2019; Jones *et al.* 2020). However, whereas absolute baselines on human-wildlife interactions are difficult to obtain, it is still possible to detect differences in the timing or magnitude of reported interactions with different exploited species that occur within the same landscapes, thus providing a relative between-species signal for use in conservation planning (Turvey *et al.* 2015). Rural subsistence communities in Hainan are known to exploit and consume other threatened and protected species in addition to pangolins (Gaillard *et al*. 2017; Gong *et al*. 2017; Xu *et al*. 2017). In particular, galliform birds are hunted for food across China (Liang *et al*. 2013; Zhou, Xu & Zhang 2015; Kong *et al.* 2018; Chang *et al.* 2019). The island's Endangered endemic pheasant, the Hainan peacock-pheasant (*Polyplectron katsumatae*), is a Class I Protected Species that also occurs within remaining tropical forests across Hainan, and is threatened by illegal hunting and habitat destruction. The peacock-pheasant population is thought to have declined rapidly since the 1950s, with an estimated population loss of almost 80% compared to historical levels (Liang & Zhang 2011). As pangolins and peacock-pheasants share similar threats, protection status, and inferred distributions across Hainan, they may constitute a useful species pair for assessing reported patterns of hunting and consumption.

An interview survey was conducted in Hainan to establish a new baseline on past and present hunting practices associated with pangolins and peacock-pheasants in low-income subsistence communities across the island, including targeted interviews with

hunters, consumers, restaurants, and wild meat dealers. The results demonstrate different patterns and perceptions of hunting and consuming of these species, associated with policy changes in recent decades and their conflict with local traditions. These findings can guide evidence-based conservation planning for these protected species by informing local-adapted interventions based upon understanding of historical behaviour patterns.

7.2 Materials and Methods

7.2.1 Interview

Household interviews were conducted from November 2016 to April 2017 around seven terrestrial protected areas in Hainan: Bawangling, Diaoluoshan, Jianfengling, Wuzhishan and Yinggeling national nature reserves, and Jiaxi and Limushan provincial nature reserves. All of these reserves contain monsoon forests that represent potential pangolin and peacock-pheasant habitat. However, recent baseline distributions and local occurrence data for both species are unavailable. The reserves are all surrounded by numerous low-income rural communities mainly comprising Li and Miao ethnic minorities. Local people often utilise resources collected inside the reserves (Fauna & Flora International China Programme 2005; Turvey *et al.* 2017). I sampled villages identified by local guides that were within walking distance of reserves, in which inhabitants were known to hunt wildlife within nearby forests and were also open to be interviewed by outsiders. I interviewed 3-13 villages adjacent to each reserve, covering 42 villages within four administrative counties (Baisha, Ledong, Qiongzhong, Wuzhishan) in total (Figure 7.1).

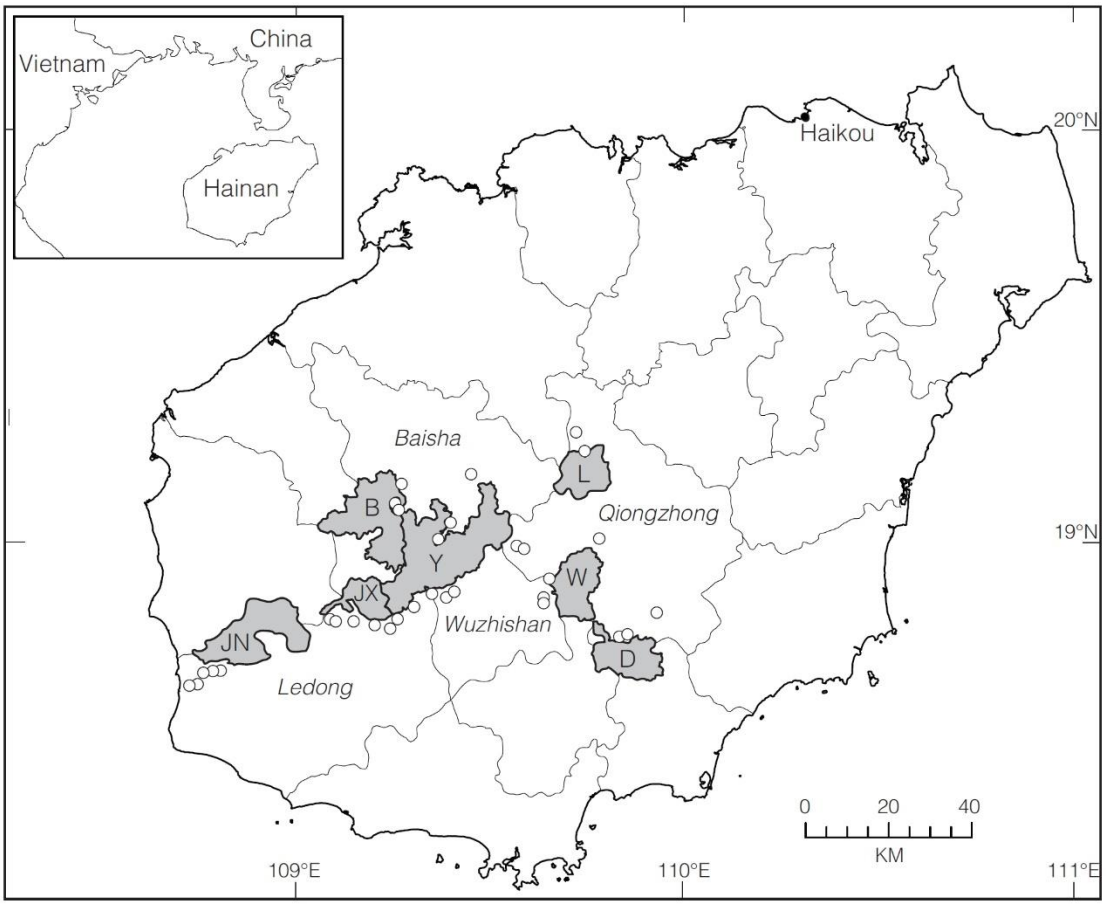

Figure 7.1 Locations of 42 villages around nature reserves in Hainan included in this study.

From one to 11 interviews were conducted per village. Interviewees were initially identified through introductions by local guides. Snowball sampling was then used to identify subsequent potential interviewees who might hunt or hold hunting knowledge (Newing 2010). Most interviews were conducted with village inhabitants on a one-to-one basis. A small number of interviews were instead conducted in groups, during which no attitudinal or demographic questions were asked. Rangers and reserve staff were also interviewed when available and were not asked about their perceptions on current hunting behaviour. Villagers younger than 18 years old were not interviewed, only one interviewee was interviewed per household to ensure independence of responses, and both males and females were interviewed. No maximum sample size was set for interviewees in each village. I explained that anonymous interviews were being conducted to understand people's perceptions and knowledge of hunting. Verbal consent was obtained before all interviews, and informed respondents they could stop

at any time. Cotton towels (about 0.2 USD each) were given as gifts to increase participation rates and show gratitude for the interviewee's time. The choice of gift was given careful consideration, and aimed at being useful but not too expensive for interviewees, so that motivation to participate would not be mainly due to receipt of the gift. Research design was approved by the Department of Geography Ethics Review Group, University of Cambridge (#1503).

An anonymous questionnaire was used to collect data on interviewees' reported hunting experiences, intentions, and attitudes, with a specific focus on the hunting of pangolins and peacock-pheasants. Basic demographic data on interviewees' age, gender, ethnic group, income level and education level were also collected. However, names or other personal information that could otherwise identify individuals were not recorded. The questionnaire consisted of a series of multiple-choice and open-ended questions that took up to 30 minutes to complete (see Supplementary material). Part of the questionnaire design was based on the Theory of Planned Behaviour, and aimed to investigate people's attitude towards hunting (Ajzen 2002, 2006). Specifically, I used Likert scales and multiple-choice questions to determine interviewees' experiential and instrumental attitudes towards hunting (i.e. whether they feel hunting benefits themselves or others), injunctive and descriptive social norms (i.e. whether people around them approve and/or practice hunting), and perceived behaviour control (i.e. whether or not they are capable of hunting and whether they feel hunting is a self-willing behaviour). Questions were also asked about hunting practices during the previous 2-year period and about their future intentions to hunt, and whether interviewees held utilitarian values about nature (Gamborg & Jensen 2016). In addition to asking about hunting wildlife in general, specific questions were also asked about hunting of pangolins and peacock-pheasants, and interviewees' knowledge of these two species. Interviewees were also asked to validate whether they could recognise pangolins and peacock-pheasants by showing pictures to aid identification (sourced from https://www.pangolins.org/ and https://www.arkive.org), and further asked them to provide descriptions of key morphological characters (e.g. scales on pangolins; eyespot-patterned tail feathers of peacock-pheasants). All interviews were conducted in Mandarin, and answers were recorded in Chinese. The majority of interviewees

spoke Mandarin, but some older people spoke only Li and Miao languages, and interviews were carried out with translation assistance provided by bilingual local guide.

Additional targeted interviews were carried out with professional hunters, potential wild meat selling restaurants, wild meat consumers and wild meat dealers, with potential interviewees accessed through social networks and introduced by trusted middlemen. Because recruitment rates were expected to be low, a maximum sample size was not set, and results are presented in a descriptive manner. High confidentiality was assured for these interviewees to encourage participation. Demographic questions were not asked and interview questions mainly focused on interviewees' personal hunting, selling, or consuming behaviours.

7.2.2 Analyses

Binomial general linear models (GLMs) were used to identify factors that correlated with interviewees' self-reported hunting behaviour (with self-reported hunters defined as interviewees who said it was "possible" or "largely possible" that they would go hunting in the future, and/or who admitted to hunting during the previous two-year period). The maximal model included 16 variables: respondent age, gender, education, ethnic group, occupation, annual income, county, nearby reserve, and eight other variables associated with the Theory of Planned Behaviour (Ajzen 2002, 2006). Stepwise selection (*stepAIC*) was used to find the best-performing model with the lowest Akaike information criterion (AIC). The variable coefficients were standardised in the final model using *beta* to identify the most influential factor. Two additional binomial GLMs were built following the same procedure, to determine potential demographic predictors for interviewees who reported knowledge about pangolins or peacock-pheasants. Spearman rank correlations and z-tests were calculated to investigate knowledge distribution patterns among interviewees. All analyses were performed in RStudio under R version 3.5.2 (RStudio Team 2015). Answers to open-ended questions on interviewees' knowledge about pangolins or peacock-pheasants were analysed using thematic analysis, and responses were coded into different categories, then grouped into themes to reveal general patterns (Gavin 2008; Newing

2010). Price data were inflated to prices in 2017 in Chinese yuan using the consumer price index (National Bureau of Statistics 2020).

7.3 Results

Interviews were conducted with 169 individuals or groups in 42 villages, including 34 rangers and reserve staff, 131 villagers, and four villager group interviews (group sizes ranging between 4-10 villagers) (Table 7.1). Successful interviews were conducted on one active professional hunter, three wild meat dealers, five restaurant owners, and four wild meat consumers across Hainan. The locations of these 13 interviewees remained confidential and were not recorded.

Table 7.1. Number of interviewees grouped by reserve and administrative county.

Nearby Nature Reserve	Baisha	Ledong	Qiongzhong	Wuzhishan	**Total**
Bawangling	5 (3 villages)				5
Diaoluoshan			16 (3 villages)		16
Jiaxi		20 (5 villages)			20
Jianfengling		26 (7 villages)			26
Limushan			20 (3 villages)		20
Wuzhishan			2 (1 village)	40 (7 villages)	42
Yinggeling	15 (4 villages)	6 (2 villages)	8 (4 villages)	11 (4 villages)	40
Total	20	52	46	51	**169**

Most interviewees expressed negative attitudes toward hunting, although a relatively high proportion agreed that hunting was an enjoyable activity (Table 7.2). Most interviewees also reported that hunting was an uncommon activity, with only 16 out of 131 interviewees (12.2%) considering that hunting was frequently or sometimes

practiced. Self-reported hunting behaviour was also uncommon, and only 13 interviewees (10%) self-identified as active or potential future hunters. GLM results showed that age and perceived local supportiveness for hunting were significantly correlated with self-reported hunting behaviour, with self-reporters tending to be younger and feel that people around them supported hunting (Table 7.3).

Table 7.2 Attitudes toward hunting held by interviewees on Hainan (N=131). The highest percentage answer for each question is highlighted in bold.

Statement	Totally agree	Largely agree	Neutral	Largely disagree	Totally disagree	Do not know
Hunting provides more advantages than disadvantages to people	12.2%	3.1%	4.6%	12.2%	**62.6%**	5.3%
Hunting provides more advantages than disadvantages to nature	2.3%	5.3%	6.9%	16.0%	**55.7%**	13.7%
Hunting is an enjoyable activity	24.4%	7.6%	14.5%	5.3%	**38.9%**	9.2%
People around you support hunting	1.5%	1.5%	6.9%	14.5%	**66.4%**	9.2%

Table 7.3 Results for GLM investigating predictors of self-reported hunting behaviour with lowest AIC value. Predictors significant at P<0.05 are highlighted in bold.

Variables	Std. Estimate	Std. Error	z value	P value
(Intercept)	0.0000	0.23756	4.712	<0.00001
Age	**-0.2189**	**0.01008**	**-2.617**	**0.00997**
Gender	-0.1172	0.07916	-1.433	0.15434
Hunting is an enjoyable activity	-0.1612	0.01503	-1.806	0.07328
People around you support hunting	**-0.1896**	**0.02964**	**-2.145**	**0.03387**
Capacity to hunt	-0.1459	0.09836	-1.753	0.08210

Although hunting was reported as uncommon, seven out of 169 interviewees (4.1%) specifically reported having hunted either pangolins or peacock-pheasants since 2010. Five interviewees reported pangolin hunting incidents that occurred during 2014 or 2015 outside or within Jianfengling and Yinggeling reserves. For example, one interviewee from a village outside Jianfengling Reserve described how he had heard of a villager in an adjacent village catching and eating a pangolin that was found in cropland. Hunting of peacock-pheasants was described by one interviewee near Jianfengling reserve as "frequent" and "occurring every year". Another interviewee said that he often went to Nanle Mountain inside Yinggeling Reserve to hunt peacock-pheasants and other birds because he thought that this area was not protected. Hunting of other species was also reported without prompting during interviews, and several captive wild animals and hunting gear (snap traps and cage traps) were observed in villages during fieldwork, providing evidence of ongoing local hunting activities (Figure 7.2). Three interviewees also mentioned the "turtle rush", a period of intensive local collecting of the golden coin turtle (*Cuora trifasciata*), a species highly valued in the pet trade.

Figure 7.2 Captive wild animals and hunting gears observed in villages during fieldwork. (a) Black-breasted leaf forest turtle (*Geoemyda spengleri*); (b) female silver pheasant (*Lophura nycthemera*); (c) Pallas's squirrel (*Callosciurus erythraeus*); (d) crested serpent eagle (*Spilornis cheela*); (e) snap traps; (f) cage traps. Photo credit: Yifu Wang

My open-ended questions asked for knowledge about the two target species. A total of 121 interviewees (71.6%) provided information about pangolins, whereas only 77 interviewees (45.6%) provided information about peacock-pheasants, representing a statistically significant difference (z-test, P<0.001). The relative amounts of different reported categories of knowledge also differed significantly between the two species (Spearman rank correlation, rho=0.0340, P=0.917) (Figure 7.3). GLM results revealed that the only predictor to be significantly correlated with whether interviewees reported pangolin information was age (N=147, SE=2.4, z=3.8, P<0.001; see Supplementary material for full results), with older interviewees more likely to report information. Conversely, three predictors were significantly correlated with whether interviewees reported peacock-pheasant information (N=147; county: Wuzhishan, SE=-1.6, z=-2.4, P<0.05; age: SE=1.2, z=2.7, P<0.01; occupation: state-enterprise employees, SE=1.7, z=2.9, P<0.01; see Supplementary material for full results), with older interviewees, interviewees not from Wuzhishan County, and interviewees working for state-owned enterprises more likely to report information.

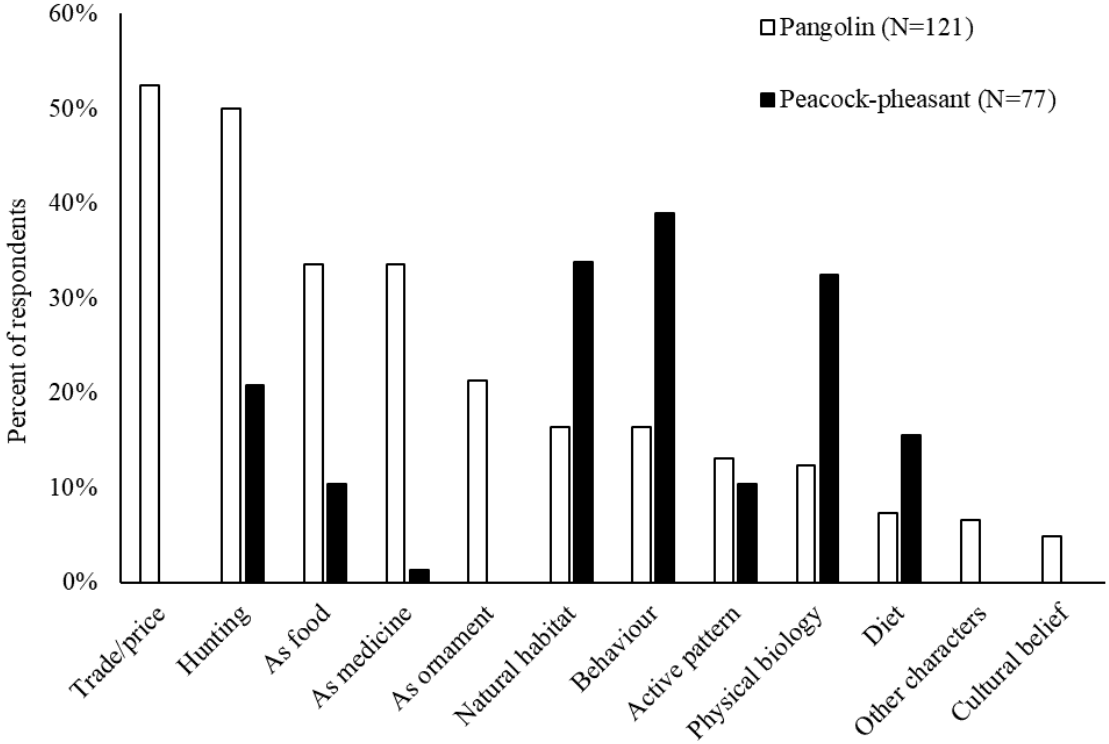

Figure 7.3 Percentage of interviewees providing different categories of knowledge about pangolins and peacock-pheasants. Note that respondents may provide knowledge on more than one category.

There was a significant difference between the number of respondents reporting exploitation-related knowledge (i.e. trade and price, hunting, consumption, use as medicine, and ornamental use) for pangolins and for peacock-pheasants (98 reports for pangolin and 20 reports for peacock-pheasants; z test, $P<0.0001$). Even non-hunters were found to be very familiar with pangolin exploitation. Indeed, these exploitation-related topics were all reported more frequently than any other categories of knowledge about pangolins, such as ecological or behavioural characteristics. The most frequently reported pangolin knowledge category was knowledge about trade and price, reported by 64 interviewees (52%). The second most frequently reported knowledge category was knowledge about hunting, reported by 61 interviewees (50%), which described hunting frequency or specific hunting techniques including looking for pangolin tracks, using dogs to track down pangolins, or smoking pangolins out of their burrows. Conversely, knowledge about peacock-pheasants focused more on behaviour (30 reports), habitat (26 reports), or physical biology (25 reports) rather than hunting (16 reports) or trade (0 reports) (Figure 7.3).

I did not collect any reports of historical hunting or trade from earlier than the 1960s. This might reflect the age limit of the interviewee sample, but might also be due to local beliefs mentioned by several interviewees (n=6), in which pangolin hunting and utilization was disapproved of in the past. Local myths regarded seeing a pangolin during the daytime as an omen representing either extreme fortune or bad luck (Katuwal, Parajuli & Sharma 2016), thus giving pangolins a more symbolic role in local culture rather than merely representing food items. This belief is apparently associated with the rarity of seeing these nocturnal animals during the daytime, combined with the reported local idea that pangolins feed on bones of the dead, also mentioned by Liu (1938).

Interviewees' extensive knowledge on hunting and trading pangolins came from changing practices during the second half of the 20th century; 49 out of 121 interviewees (>40%) provided hunting or trade information specifically from the 1960s to the 1990s, with a peak of reported hunting during the 1980s. Interviewees described

that pangolin hunting was directly supported by the Chinese government through legal commercial trade during this period, as state-owned supply and marketing cooperatives would purchase pangolin scales from locals for relatively high prices, as also reported by Wu *et al.* (2004). Hunting activity declined in the 1990s for two reasons: hunting was officially banned, and Hainan's pangolin population had reportedly declined heavily by this period. The pangolin hunting period reportedly started and ended slightly later in more remote communities (i.e., those with reduced road access). Conversely, professional hunters reported that peacock-pheasants were never a main target species in Hainan because their low body weight of around 0.5 kg per adult bird. This meant that they could not be sold for a high price. Instead, harvest of peacock-pheasants was mostly by-catch and/or for personal consumption.

These direct quotes from three interviewees illustrate the extent of hunting during the peak period and the subsequent collapse of the pangolin population:

"*A village could catch a few hundred pangolins in total in one month back in the 1980s. I caught more than 20 myself.*"

"*Hunting and government purchasing started in 1976. Around that time, a local could catch more than 30 in one month. I caught more than 20 in 1985.*"

"*Lots of villagers searched for pangolins in the mountains during the 1990s, but they found only one or two per month at that time.*"

Information provided about pangolin trade included data on historical prices of whole pangolins and pangolin scales, which show an increase in price from the 1970s, a decline in the 1990s, and a more recent further increase (Figure 7.4). Professional hunters, wild-meat dealers and consumers also confirmed to us that the recent price of a whole pangolin was 2000-3400 yuan/kg (280-490 USD/kg).

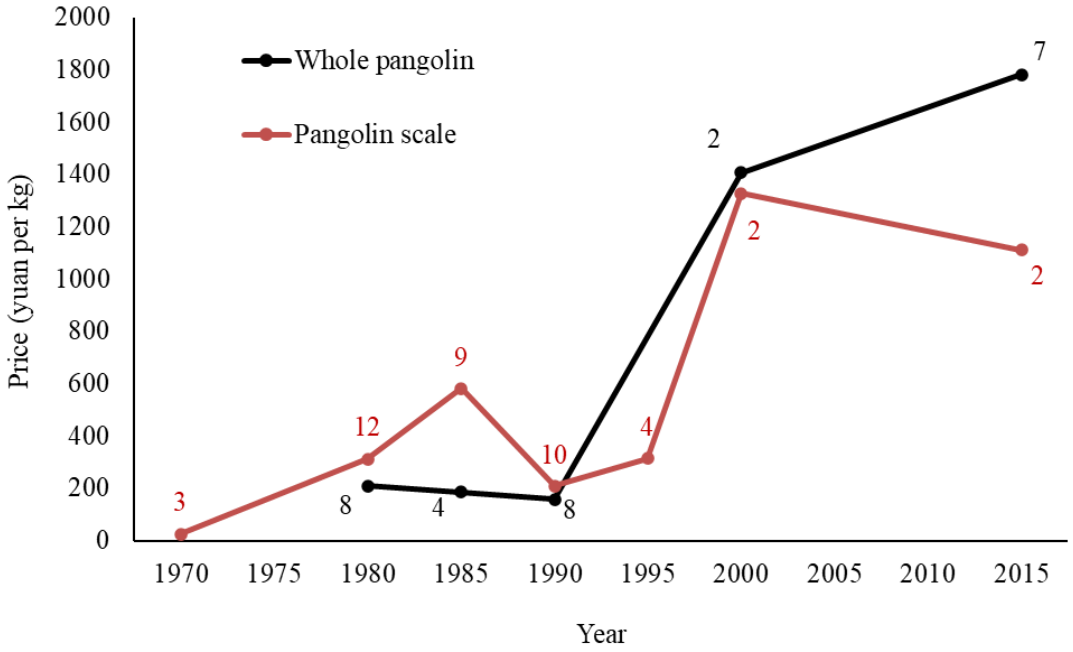

Figure 7.4 Historical price of whole pangolins (black line) or pangolin scales (red line) reported by interviewees. Data were grouped into five-year time bins, indicated on the x axis by the first year of each respective time bin. Mean reported prices are given for each time bin; numbers associated with each data point show the number of prices reported for that period.

None of the interviewed restaurant owners admitted to selling pangolin or peacock-pheasant products, but did confirm that they sold farmed wildlife species such as bamboo rats (*Rhizomys* spp.) and porcupines (*Hystrix brachyura*). These species and other wild animals from unknown sources, including passerines, squirrels and other rodents, and small carnivores, were also common in local markets, whereas pangolins and galliform birds were much rarer according to restaurant owners. This was consistent with information provided by consumers, who reported buying whole pangolins from markets that were then cooked in restaurants rather than buying dishes directly in restaurants. Both consumers and dealers reported that buying pangolins from markets took place under conditions of strong trust between buyers and sellers, with unknown buyers requiring guarantees from up to seven trusted middlemen.

The four interviewed consumers provided different reasons and scenarios for eating pangolin dishes. One consumer particularly liked the taste of pangolin meat and, since

pangolins were rare and expensive, often invited business friends and colleagues to socialize for work when pangolins were on the menu. Two consumers ate pangolin dishes at their workplaces during meals to which they were invited by other people, who ordered pangolin dishes to show respect to their guests due to the species' high price and rarity. The fourth consumer regularly enjoyed eating wild meat dishes and considered that holding a wild meat party was a way to maintain friendships and social connections. According to this consumer, pangolins were consumed for their potential health benefits but infrequently due to their high price.

7.4 Discussion

The results provide a new baseline to understand patterns, levels, and socio-cultural drivers of local hunting of pangolins and other conservation-priority species in Hainan Island, China. Unsurprisingly, direct questioning of rural interviewees provided relatively low levels of self-reported hunting, a result consistent with previous findings (Van Der Heijden *et al.* 2000; Nuno & St. John 2015). However, interviewees still provided substantial information about hunting of pangolins, peacock-pheasants and other wildlife, and local demand for wild meat. These findings indicate that Hainan's biodiversity faces continuing pressures that threaten its future. Enforcement and management agencies have made efforts to reduce regional wildlife hunting and consumption behaviours, and the results suggest that some of these behaviours (notably pangolin hunting) were more common in the past compared to today. However, observed decreases in hunting may have been driven by population declines rather than effective enforcement, and remaining illegal wildlife hunting and consumption needs to be tackled urgently. This study provides a new understanding of hunting and consumption that can contribute important insights for identifying potential solutions, and also includes crucial baselines of historical change that further aid conservation planning.

Hainan's rich biodiversity has constituted an important resource for local communities for millennia. Even pre-modern regional human interactions with many vertebrate

species were unsustainable on Hainan, leading to numerous prehistoric and historical extinctions (Turvey *et al.* 2019), and escalating natural resource use has placed increasing pressure on regional biodiversity (Chau *et al.* 2001; Gong *et al.* 2006; Xu *et al.* 2017). However, although historical accounts indicate that pangolins have been exploited for food and medicine on Hainan since at least the early 20th century (Allen 1938; Liu 1938), data from this study suggest that local myths reduced hunting for consumption, thus keeping hunting pressure relatively low and stable until the Chinese government promoted a nation-wide state-run commercial trade of pangolins from the 1960s (Wu *et al.* 2004). This is also supported indirectly by the heavy pangolin harvests reported in the 1960s-1980s followed by the sudden decrease in offtake in the 1990s. If hunting pressure had been high before the mid-20th century, local pangolin populations may not have been sufficiently abundant to support such a high harvest load, and the subsequent decline in harvests would also not have been so drastic. This pattern of recent historical change in hunting intensity of pangolins contrasts with peacock-pheasants, which appear to have been hunted more than pangolins in the past because there were no cultural taboos restricting such behaviour. Conversely, peacock-pheasants did not experience an increase in hunting pressure driven by changes in state policy.

Cultural taboos play an important role in regulating a wide range of local behaviours and support sustainable interactions with biodiversity across many cultures and social-ecological systems (Colding & Folke 2001; Wadley & Colfer 2004). However, as demonstrated by the increased acceptability of hunting pangolins in Hainan, such taboos can be eroded easily by rapid societal change or outweighed by monetary incentives, and are often hard to restore following their disruption (Golden & Comaroff 2015; Katuwal, Parajuli & Sharma 2016). State-encouraged hunting during past decades has also changed the nature of specific human-wildlife interactions and has driven severe population declines and extirpations in other Chinese species, such as tigers (*Panthera tigris*) (Coggins 2003; Kang *et al.* 2010).

Patterns of pangolin knowledge, hunting and consumption across Hainan are therefore very different compared to local awareness and interactions with peacock-pheasants as a result of this official policy change. Whereas increased knowledge about both species was positively associated with interviewee age in the analyses, fewer interviewees had knowledge about peacock-pheasants, and knowledge about this species also showed geographic variation and was greater among state-enterprise employees, a category that consists mainly of reserve workers. These results suggest that although peacock-pheasants are known to be hunted (Liang & Zhang 2011), they have been less of a priority target compared to pangolins, which do not show any variation in knowledge across the entire survey area or across all demographic sectors of the interviewee sample. In addition, interviewees did not provide much information about peacock-pheasant trade as there was little wider demand for this species. However, it was noted that even though peacock-pheasants might face lower intentional hunting pressure comparing to pangolins, hunting of this species still needs conservation attention due to a lack of knowledge of sustainable off-take thresholds, their probable low population size, and potentially high by-catch rates (e.g., from snares) as suggested by interview data. As one of the most threatened galliforms in China, this species is also at potential risk of becoming valued due to its rarity, a main driver of consumption of luxury wildlife dishes (Sandalj, Treydte & Ziegler 2016; Shairp *et al.* 2016; Cardeñosa 2019).

From a historical perspective, hunting first became formally regulated in China in 1989 when the first wildlife protection law was enacted, and hunting of pangolins, peacock-pheasants, and many other wildlife species was banned through their listing as Protected Animals (SFA of China 1989). Hunting in general is also prohibited within the seven protected areas included in the survey, which were established from the 1970s to the 2000s (Ministry of Ecology and Environment of China 2012). The rapid change in government policy did not lead to a sudden end in hunting or trade of wildlife products, and the results show that the price of pangolin products increased substantially during the 1990s. This economic change might reflect not only pangolin population decline, but also the shift from a controlled price to a market price where supply capacity would have a greater impact on economic value (Gale 1955; Courchamp *et al.* 2006).

This study also shows that shifts in attitudes towards hunting and consuming wildlife are still ongoing. Although the majority of interviewees reported negative attitudes towards hunting, many still enjoyed hunting. These results suggest either that levels of subsistence or economic hunting were underreported in this study, or that recreational hunting remains popular (Phelps, Biggs & Webb 2016). Indeed, enjoyment and recreational value are major drivers of local hunting in many other parts of rural China (Chang *et al.* 2019). Recreational use of wildlife also showed up in the wild meat consumer survey in which wild meat parties with friends was mentioned as a frequent and important social event. It is also notable that hunting is often framed as a solitary activity in contrast to wild meat parties, and so needs to be addressed separately from recreational consumption of wild meat.

Furthermore, several responses in my study demonstrate that understanding of current conservation regulations is incomplete. For example, some hunting activities were not considered to constitute "hunting" by interviewees. One example is the "turtle rush", that overharvested golden coin turtles and many other reptile species (Gong *et al.* 2006; Gaillard *et al.* 2017). Several interviewees were also unclear about which areas were protected, or appeared unconcerned about openly discussing hunting protected species outside reserve boundaries as if protected animals were only protected in reserves. These observations might suggest the lack of using appropriate language when communicating with locals and highlight potential future directions.

There were some unavoidable limitations in the study design. Illegal behaviours such as hunting are likely to be sensitive to direct questioning. Specialist interview techniques have been developed to attempt to overcome this problem (Hinsley *et al.* 2019; Jones *et al.* 2020), but restrictions such as sample size, design and analytical complexity, and time constraints prohibited application of these techniques in this study. Although some previous studies have obtained valuable results about sensitive behaviours through the use of direct questioning techniques (Kroutil *et al.* 2010), I assume that some interviewees are likely to under-report personal hunting behaviours, while over-reporting is much less likely. However, 10% of the interviewee sample

admitted to recent hunting or to being potential hunters. This is not a low percentage given the known pressures from hunting that face many highly threatened species in Hainan (Gong *et al.* 2006; Liang, Cai & Yang 2013; Xu *et al.* 2017). This figure can be treated as a minimum estimate, and probably underestimates the real number of hunters in this study. I also note that the use of snowball sampling rather than random sampling might conceivably have led to preferential selection of interviewees who were more likely to discuss hunting and hunting-related knowledge, thus making it difficult to infer wider levels of hunting across rural Hainan from the data. However, overall, the findings suggest that there is a continuing and urgent need to tackle hunting as a threat to biodiversity in Hainan.

Other points highlighted in my results might be helpful for tackling ongoing hunting pressure in Hainan. Firstly, self-reported hunters tended to believe that people around them supported hunting. However, the results also indicate that most interviewees held negative attitudes towards hunting. I acknowledge that some interviewees might have misreported their true opinions on hunting during interviews. However, conservation mitigations could focus on this reported difference between perceived and actual social norms to encourage desired behaviour change, a well-studied concept that has been applied in many areas beyond wildlife conservation (Zhang, Cowling & Tang 2010; McDonald, Fielding & Louis 2014). Secondly, I suggest that the terminology associated with hunting, and regulations associated with hunting and protected areas, need further clarification through improved local educational activities to reduce misunderstanding and the perpetuation of unwanted behaviours. Lessons should be learned from this historical policy change and how it failed to convey these terminologies clearly, to avoid similar loopholes in future.

Consumption of wild animal products has also been impacted by the rapid changes in hunting policy. Such changes can lead to different social norms related to consuming different species. The change in patterns of pangolin exploitation revealed in this study contrasts with that of peacock-pheasants. As a result, strategies to change wildlife consumption behaviour in Hainan should not focus solely on the conservation status or

threats of species of concern, but also on the social associations that these species provide to consumers, whether it is recreational uses or health benefits. Appropriate conservation mitigations should thus include encouraging suitable substitutes, and helping to establish new social norms (Clarke, Milner-Gulland & Bjørndal 2007; Drury 2009a).

My study highlighted that conservation interventions should build upon the understanding that current patterns of wildlife exploitation, and that consumption could merely be a legacy of past policy changes and shifting social norms. Due to the current COVID-19 pandemic, regulations on trading and consuming wild animal products have now become much tighter in China (National People's Congress of China 2020a). The corresponding policy change means that species traditionally common in trade, such as bamboo rats and porcupines, can no longer be traded. A new social norm needs to be established. Indeed, the fieldwork for this study was conducted before the COVID-19 outbreak, providing a baseline for future studies on the impact of these new policy shifts on local hunting and wildlife consumption behaviours. On the other hand, ongoing hunting practices in rural areas of Hainan and other parts of China require extra management attention, as human interactions with threatened wildlife species might pose threats not only to biodiversity but also to public health. Various bans on hunting and consuming wild animals have been established since 1989 and intensively recently to cope with the COVID-19 pandemic. However, changing public behaviours by implementing bans is just the first step (Ribeiro *et al.* 2020; Zhu & Zhu 2020). Establishing and accepting such new social norms and adhering to desired behaviours is the final goal, and understanding the history of how social norms have changed can provide valuable insights for current management.

Chapter 8 Insights for pangolin conservation and beyond

8.1 Introduction

Chapter 1 of this thesis outlined the reasons for conserving biodiversity and summarised the major threats that have contributed to the sixth mass extinction (Markku 1997; Ceballos *et al.* 2015). Illegal wildlife trade is an important cause of population decline among many species (Díaz *et al.* 2019). These include eight species of pangolins, which are the focus of this study (Nijman 2010; Challender, Harrop & MacMillan 2015a; IUCN 2020; Sas-Rolfes *et al.* 2019). Large seizures of pangolin products have been taken from illegal international trade routes. The legal and illegal trade started more than 10 years ago, and pangolins have since attracted attention among conservationists (Challender & Waterman 2017; Heinrich *et al.* 2017).

Pangolins have recently achieved totemic status among conservationists as the newest flagship species attracting public attention alongside bears, pandas, and tigers. However, pangolins are unusual, almost unique, among the traditional lists of charismatic species, since they do not have any characteristics that are normally associated with charismatic species or flagship species, such as forward-facing eyes or soft fur (Home *et al.* 2009; Smith *et al.* 2012). This has heightened the need to look beyond physical appearance when identifying charismatic species (Bowen-Jones & Entwistle 2002; Skibins, Dunstan & Pahlow 2017). The process of how pangolins have successfully upgraded their importance profile is interesting. The results might help guide fundraising and educational programmes for un-typically charismatic but endangered species. The conservation of pangolins is also important in their own right. Although pangolin related ecology and biology requires further study, other aspects including cultural relationships with locals, medicinal values, and economic values provide strong reasons for pangolin conservation (Walsh 2007; Liu *et al.* 2016; Boakye 2018). These connections and values are not only evident in China but are also found across other range states (Mahmood *et al.* 2013; Katuwal *et al.* 2015; Soewu & Sodeinde 2015).

Effective conservation requires evidence-based interventions (French *et al.* 2012). Results from this study revealed that illegal trade in pangolins and their products is much more complex than simply just the extraction of a natural resource or a threat to a biological taxon. Holistic understanding from social, cultural, economic, and political aspects of pangolin trade is required to identify key problems and suggest potential solutions which will be described later in this chapter (Challender, Harrop & MacMillan 2015b). Moreover, some experience from this study can also be generalized to advise for conservation in a wider context and for species other than pangolins. The following sections will discuss these points in more detail.

8.2 Pangolin conservation interventions needed in China

Pangolin conservationists in China are faced with numerous problems if they are to save pangolins from the brink of extinction. These problems can be divided into five detail aspects:

- Continuous hunting pressure on remaining pangolin populations in China
- Inadequate active law enforcement on illegal trade both online and offline
- Non-transparent and shambolic management of legal trade and farming
- Lack of awareness and participation from key stakeholders
- Lack of understanding of both biology and ecology aspect and social science aspect of pangolin trade

If the motivations to collaborate, and the necessary funding and resources were of no concern, what would be the ideal interventions to conserve pangolins in mainland China? To answer this question requires a look back to the theoretical framework that guided this research and considering the key links identified by MRA (Figure 8.1). In general, insights from this research aim to guide more effective behaviour change interventions and law enforcement. Thus, the ideal strategies will be discussed from these two perspectives. Also, since the demand for pangolin products varies with product types, whether medicines, food, or ornaments, interventions should address different demand types accordingly.

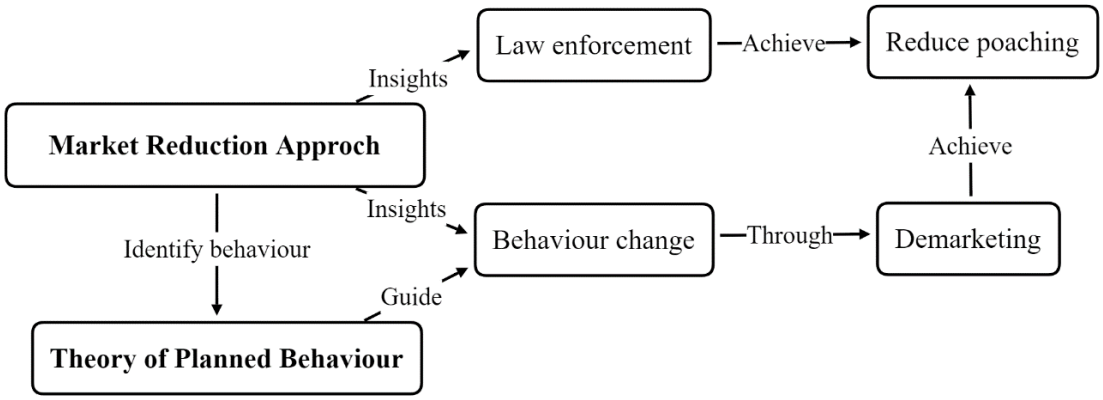

Figure 8.1 Theoretical framework used by this study (see also Chapter 2).

Results from this study showed that pangolin hunting still persists in some areas of China. Thus, nature reserves (NRs) should strengthen their regulations and eliminate illegal hunting activities, at least within NRs, together with help from law enforcement agencies. On the other hand, areas outside NRs should not be neglected. Education and awareness-raising programmes might be needed to highlight the concepts of protected animals and illegal hunting regardless of NR boundaries. Interventions to eliminate hunting should also involve consideration of substitute behaviour and income sources. The functional role of hunting for local people could be diverse and requires an in-depth understanding. This also means to incorporate local communities into the decision-making process to achieve more effective interventions.

The demand for pangolin products from traditional Chinese medicine (TCM) was discussed in detail in Chapter 5 and 6. These findings suggest that three types of interventions might be needed to effectively reduce demand on pangolin medicines. Firstly, trade participants and consumers should learn about the legality of pangolin medicine, so that they can identify illegal products and illegal sources, such as stickers, permitted hospitals, lack of farmed products, and so on. Secondly, realizing the widespread occurrence of illegal products and the health risks associated with counterfeit or fake pangolin medicines might provide a strong enough motive for the TCM sector to participate in combating illegal pangolin medicine. Their willingness to contribute might also mean that demand reduction through using sustainable substitutes is feasible. Since the development and expansion of the TCM industry in China is an inevitable trend in the near future, the demand for pangolin products is also likely to increase. However, the currently limited capacity to supply pangolin products means

substitutes are going to be more common and more necessary. Thirdly, demand on pangolin products for health benefits, not medicines or not prescribed TCM, could be addressed with help from TCM sectors. As a trusted source of information for healthcare advice, people holding misbeliefs on the potential health benefits from pangolin scale/meat/blood might change their behaviours and perceptions (Si, Song & Gao 2013).

From the law enforcement perspective, strengthening active law enforcement is necessary to tackle the widespread illegal trade in pangolin scale. Undercover inspection of pharmaceutical shops and wholesale markets would be a useful start. Online TCM markets and ornament markets also require more enforcement and monitoring. The current situation lacks law enforcement, and this might also be due to the blurred accountability between different law enforcement departments on the regulation of different aspects of pangolin trade (see Chapter 3). Therefore, providing clearer accountability for each department involved might help to ensure overall enforcement effectiveness (Bennett 2009). Passive enforcement could be helped by the above-mentioned public education interventions which enable the public to identify and report illegal pangolin products.

At the same time, the legal pangolin scale market also needs to be addressed. More transparent and evidence-based management is required for the current pangolin scale stockpiles. Transparent management can help TCM practitioners to see the necessity of choosing sustainable substitutes instead of pangolin scales. Publicizing information also enables public and other sectors to contribute to passive law enforcement as mentioned above. More research to quantify national level demand on pangolin scale medicine is needed to help design the necessary management strategies. Little information is available on this aspect and this study has provided the first piece of information, yet a nationwide assessment is needed.

Results from the pangolin meat market showed that the motivations for consuming pangolin meat varied substantially. Thus, no single message is available to effectively change all aspects of consumer behaviour on Chinese pangolins. However, some of the main motivations deserve more attention than others. Firstly, the demand due to

perceived health benefits could be addressed with help from TCM communities as discussed above. Secondly, pangolin as a luxury dish could be addressed alongside other wildlife products with similar functions, such as bear paws and Chinese Bahabas. The illegal and expensive nature of these products also represents the potential association with corruption and other illegal behaviours. Since anti-corruption has been mainstreamed and emphasized in mainland China, highlighting the association of luxury wildlife dishes with corruption might achieve some positive changes in behaviour. The “pangolin prince” scandal played out in February 2017 and attracted wide media attention partly because corrupt behaviour was involved in which forestry officials were found to have invited a businessman, mocked as the pangolin prince by media, to eat pangolin dishes. Thus, the link had already been pointed out and recognized to some extent. There are also successful demand reduction examples in mainland China through linking with anti-corruption, including the reduction in consuming shark fin due to government austerity measures (Quah 2015; Jeffreys 2016).

Active law enforcement measures directed towards participants of pangolin meat trade still need to be strengthened. However, results have shown that traders were highly cautious about their trading behaviours, and so were difficult to apprehend. Nevertheless, results also reveal that traders and hunters are often closely connected closely to share information about available prey (see Chapter 6). Thus, once information about one trader/hunter becomes available, tracking down the social network should help in taking down an illegal trade network. This is also how the local forestry administration tracked down the major criminal case, using the information provided by "Penguin Love Earth" reporting platform as mentioned previously (Call for Action 2019). Again, this involved passive law enforcement with help from public reporting. Thus, public education programmes on the legality of pangolin products are very important.

Pangolin focused research is desperately needed from several perspectives which are key for effective conservation. The need to embrace social science aspects has been addressed in previous sections, particularly on the market demand and trade regulation. Equally, biological and ecological aspects need to be strengthened as well. For example, data on pangolin population and distribution have largely been missing for all pangolin

species including Chinese pangolin (Challender & Waterman 2017). More recently, research has assessed available monitoring methods that could be used for different species of pangolin (Ingram, Willcox & Challender 2019; Willcox *et al.* 2019). Range countries and researchers should adopt appropriate methods to update their pangolin population data. Lack of such data could reduce the interest and motivation from other sectors in conservation if conservation interventions cannot be backed up with solid numbers. The unsustainable nature of illegal trade and poaching is also only based on logical assumptions.

Overall, the interventions or recommendations proposed above address the pangolin conservation problems summarized above through voluntary and compulsory behaviour changes among various trade participants. Continuous research is also required to provide both incentives and tools for pangolin conservation. Experience from successful interventions could be helpful after considering local adaptation (Jenks, Vaughan & Butler 2010; Pearson *et al.* 2014). Studies also demonstrate the importance of having combined strategies to achieve desired outcomes (Truong, Dang & Hall 2016; Salazar, Mills & Veríssimo 2019). More importantly, the design of each intervention requires careful consideration with evidence and theory to achieve the expected outcome. Evidence-based and theory-informed interventions are rare, but one example is the "Chi" campaign launched by TRAFFIC in Vietnam (Offord-Woolley 2017). A specific functional demand on rhino horn products was identified, the symbolic use of rhino horn to show off wealth or power in this case, based on preceding social science research. The message, channel to distribute message, behaviour change theory, and evaluation of outcomes and other important aspects were well considered from the design stage (Olmedo, Sharif & Milner-Gulland 2018). The rigorous consideration of the campaign from the design stage is the basis for ensuring future success.

Effective interventions also require participation from key stakeholders. The holistic approach taken by this study helped to identify important stakeholders for pangolin conservation in China (Table 8.1). When targeting the five problems identified above, relevant stakeholders should be included into the discussion to ensure different voices are heard and to maximize effectiveness. One example in practice is the "Penguin Loves Earth" illegal wildlife trade online reporting platform, a collaborative project between

a technology company, conservation NGOs, and government enforcement agencies. This online platform allows public to report potential illegal wildlife trade they observed either online or in real-life and the information would be filtered by wildlife trade experts in conservation NGOs. Useful information is then directed to relevant forestry administrations to help with law enforcement. Through this mechanism, the platform helped Hunan Forest Administration to crack a major criminal case involved more than 129 criminals, seized 216 individual pangolins, and 66kg of pangolin scales in 2017 (Call for Action 2019). Such collaboration is a great example when trying to strengthening law enforcement by involving more relevant stakeholders such as public and NGOs.

Table 8.1 Relevant stakeholders in pangolin trade and conservation.

Types of stakeholders	Name or example
Government department and enforcement agencies	Customs; Forestry Police; Forestry Administration; National Medical Products Administration; Administration of TCM; Administration of Market Regulation
Conservation organization	Conservation NGOs; IGOs; nature reserves; etc. e.g. TRAFFIC, CITES
Researchers and research institutes	Scientists who study pangolin or pangolin conservation
Education agencies/news or social media	TCM universities/colleges/training centres; nature education programs; news or social media such as Weibo and The Paper
TCM communities/NGOs	Chinese Society of Traditional Chinese Medicine, China Association of Chinese Medicine etc.
TCM industries and hospitals	Pharmaceutical companies; pharmaceutical shops (including online platforms and wholesale markets); certified hospitals
Businesses or platforms potentially selling pangolin products	Taobao (an online shopping platform); Wenwantianxia (a collector's forum)
Pangolin farms and rescue centers	Research Base for Pangolin Domestication and Breeding from South China Normal University (Hua *et al.* 2015)
Public or consumers	Consumers as key stakeholders in pangolin trade

The above-mentioned problems are all important to tackle for pangolin conservation in China. However, the real-life situation is often that applications are limited by available resources, so selection of projects and prioritization of interventions are needed (Wilson *et al.* 2006). MRA could again prove useful at this point to identify priority targets. According to MRA, conservation resources should be focussed on disrupting key stakeholders or links that are essential to maintain the trade and also relatively easier to change comparing to other targets in order to maximize the effectiveness. One way to identify "easier to change" targets could be through comparing existing conservation efforts. Important targets previously received little conservation attention could be

future priorities for the potential high return.

Results from this study showed that certain key stakeholder groups were particularly more neglected and less involved in conservation compared to others. This was reflected through the different levels of knowledge about pangolin trade regulation (henceforward knowledge levels) known by stakeholders. Since this study covered most of the stakeholder groups involved in the pangolin trade, a holistic comparison of knowledge levels was one possible approach. The reported legality of the different pangolin products was used as the indicator for knowledge levels, i.e. whether participants in trade knew the legality relating to their trading and consuming behaviours, and if they knew the severity of the potential consequences of illegal conducts. "Allele" participants, such as medicine and food consumers should, in theory, have similar levels of knowledge as they play similar roles in the trading chain (Zhang, Hua & Sun 2008; Oxford Economics 2018). Results from this study showed that opportunistic local hunters, end TCM market traders and consumers, and wild meat consumers have lower knowledge levels compared to their allele counterparts (Figure 8.2). This suggests that there is still space for more interventions to improve their involvement in pangolin conservation. In particular, TCM end sellers and consumers showed even less knowledge of legality, which should be prioritized as low hanging fruits.

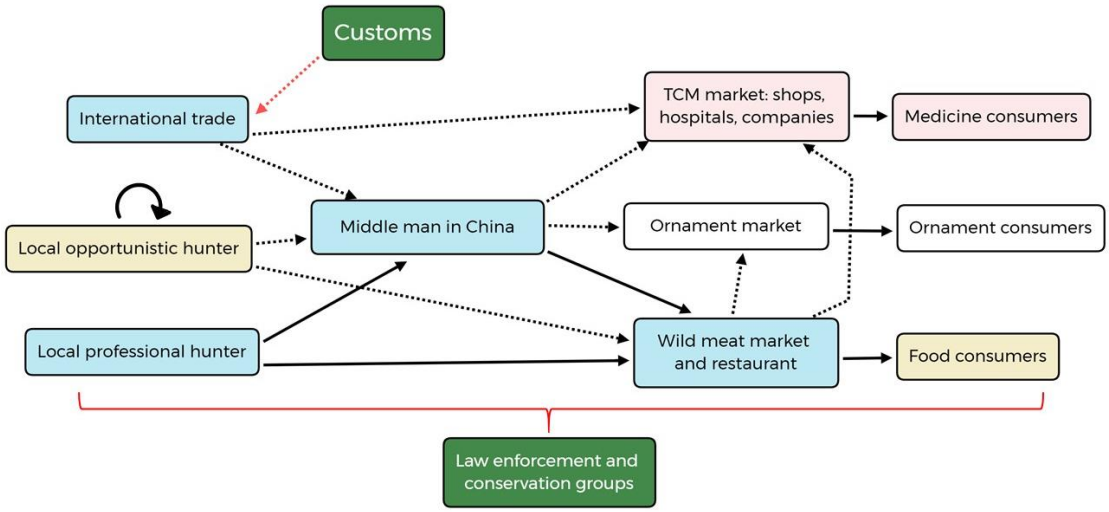

Figure 8.2 Simplified pangolin trading chain in China. Colour codes: blue colour means participants are fully aware of the illegality and the potential consequences if caught; yellow colour means they understand the illegality but do not think the illegal conduct is severe or think they won't get caught; red colour means that participants are not very

aware of the illegality, nor do they know the potential consequence; white colour means no data from this study.

Chapter 5 showed that awareness of legality rather than pangolin conservation status was the most influential factor contributing to supportiveness among trade participants, even if their actual knowledge of legality is poor. Thus, targeted education programs and public awareness campaigns focussing on trade-related regulations are proposed as means for behaviour change. With MRA highlighting the importance of targeting neglected key stakeholders, careful considerations on the design and planning of the above proposed interventions should involve key stakeholders whose voice and knowledge are vital for the successful application. The next section will discuss conservation related to TCM trade beyond pangolins since the problems discussed above also echoed with issues faced by other species as well.

8.3 Highlighting TCM related conservation

Preparing for submission

Traditional Chinese Medicine (TCM) has been an important part of Chinese culture for thousands of years, and has co-evolved alongside many of China's national development initiatives (Chen & Xie 1999). Today, TCM is an indispensable part of China's healthcare system and is practiced in parallel with Western medicine (Hesketh & Zhu 1997). For example, TCM-specialized hospitals and clinics in China treated 0.962 billion patients in 2016, with medical services provided through TCM treatments accounting for 15.8% of the total national medical services provided that year (Tang, Liu & Ma 2008; National Health and Family Planning Commission of the PRC 2017). TCM use is not limited to China, but is also practiced in a wide range of international markets where Chinese communities have settled, including Japan, southeast Asia, USA, Canada, and many European countries (Lin *et al.* 2018). As a healing system, TCM targets illness and provides guidance on lifestyle and exercise. Herbal medicines are commonly used, but acupuncture, massage, diet recommendations, and animal-based medicines are also used, sometimes in a combination (Tang, Liu & Ma 2008).

Animal-based products make up only a small proportion of commonly-used TCM ingredients. However, the use of products from a series of threatened and charismatic species, such as pangolins and bears, has attracted considerable conservation and

animal welfare concerns. Studies have also increasingly highlighted the potential impact on biodiversity from the rapid development of TCM (Still 2003; Chi *et al.* 2017; Esmail *et al.* 2020; Hinsley *et al.* 2020). Biodiversity threatened by TCM includes both species native to China, and also species in other geographic regions that are impacted by international trade, associated with the incorporation or substitution of non-native species such as African pangolins into TCM (Challender & Hywood 2012). The Chinese government has put forward various strategies to promote further development of TCM, both within China and also on the wider international stage through policies such as the Belt and Road Initiative (State Council 2009; State Administration of TCM & NDRC 2016; State Council 2016). In particular, the Law of the People's Republic of China on Traditional Chinese Medicine came into effect in 2017, and marked stronger national legislative support to promote and develop TCM services. Article 1 of Chapter 1 specifies the purpose of this law as "inheriting and carrying forward traditional Chinese medicine, guaranteeing and promoting the development of the traditional Chinese medicine undertaking, and protecting the health of the people". TCM has also been used as part of the treatment for COVID-19 within China during the current pandemic, further promoting its reputation and development (Chen & Chen 2020; Wan *et al.* 2020).

The trend of growing market demand for TCM will very likely continue over the near future due to this policy support. It is therefore critical to understand the impact and sustainability of TCM on threatened or potentially threatened species. Since China is a major demand market and driving force for TCM development (State Council 2016), it is particularly important to gain a better understanding of TCM trade in China for more effective management. However, few studies have focused on this aspect to provide useful insights. To address this key information gap, this study provides an overview of current TCM-related regulations of conservation threatened species in China, and then discuss three main problems that are identified as barriers that limit the development of sustainable TCM trade related to threatened biodiversity: (i) untransparent regulations and loopholes, (ii) weak law enforcement, and (iii) lack of research and collaboration with the TCM sector.

8.3.1 Regulation overview of wildlife trade for TCM

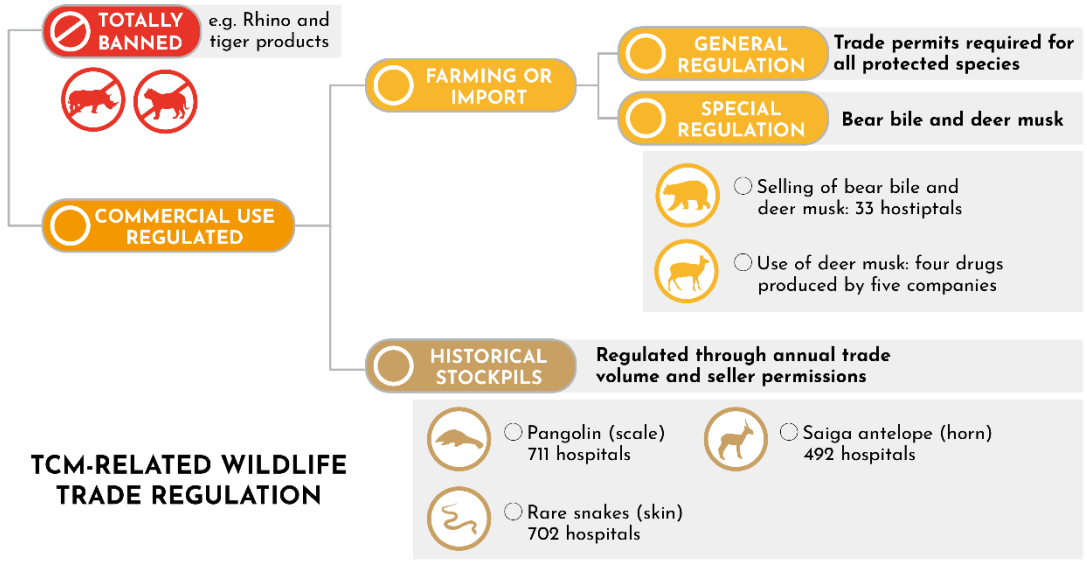

Figure 8.3 Overview of current TCM wildlife trade. *Designed by Runxi Wang*

Current regulations for threatened species used in the TCM trade within China vary according to the different contexts facing each harvested species. Only two conservation concerned species, rhino and tiger products, are completely banned from TCM trade (State Council 1993). Two other groups of wildlife and their products are allowed in China's legal TCM trade, which include some threatened species. All of these legally traded wildlife medicines should carry trade permits on the smallest trading package.

Group 1: Wildlife with legal import and established commercial farming

International imports for commercial use are allowed for some species under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) with taxa specific regulations, for example geckos, sea horses, and many plant species (CITES 2016a). Trade of legally imported wildlife products are regulated similarly with other local wildlife species products that trade permits are required. Commercial farms have been established for many species used in TCM, including Asiatic black bear (*Ursus thibetanus*), sika deer (*Cervus nippon*), musk deer (*Moschus* spp.), and various species of snakes and plants (Huang & Li 2007; Meng *et al.* 2011; Wu *et al.* 2013). Trade in these species relies on farmed products such as bear bile, deer musk and snake shed. Most Chinese animal species listed as threatened by IUCN, or that are locally rare, are nationally protected in China, with wild harvest for commercial

use strictly prohibited by the Wild Animal Protection Law (National People's Congress of China 2020). Farming of protected wildlife species in China is regulated by many laws and regulations, from the national Wildlife Protection Law to provincial-level regulations that specify conditions for farming and sources of animals etc. (National People's Congress of China 2020). Threatened or rare plant species are also protected by the Regulations of the People's Republic of China on Wild Plants Protection, and wild collection is strictly regulated, yet farming or trade related regulations are unclear (State Council of China 2017). In addition to regulations on farming that apply to all protected species, selling of bear bile and deer musk is subject to further specific regulations due to the rarity of these animals; only 33 hospitals in China can sell bear bile and deer musk medicines directly to patients (SFA of China 2008a), and use of these products in prescription drugs also requires province-level permits from the Medical Products Administration (formerly the Food and Drug Administration) that regulate the types of medicines and quantities to be used. The use of deer musk is further restricted to four drugs produced by five companies (China Food and Drug Administration 2005).

Group 2: Wildlife with historical stockpiles

Stockpiles have been established for a second group of TCM products including pangolin scale, the horn of saiga antelope (*Saiga tatarica*), and skins of rare snake species (species protected under the Wildlife Protection Law and relevant CITES Appendices) (SFA of China 2007). These durable products were accumulated in stockpiles before national regulations, the Wild Animal Protection Law, came into place in 1989. Pangolin scale in the Chinese Pharmacopoeia, the official reference for traditional medicine in China, refers to scales from the Chinese pangolin (*Manis pendatactyla*), but identification of different pangolin species from scales is challenging, meaning that in practice scales from other pangolin species are also used (Chinese Pharmacopoeial Commission 2015). Volumes of traded pangolin scales, saiga horns and snake skins are regulated by annual quotas that are decided by provincial forestry administration bodies, based upon applications made by stockpile holders on the amounts they intend to use in the coming year. The mean annual quota for pangolin scales was 26.58±1.58 tons from 2008 to 2015, and quotas for snake products were 35.43 tons in 2008 and 36.90 tons in 2009; quota amounts for other years or for saiga

horn are not publicly available (SFA of the People's Republic of China 2007; SFA of China 2008b; SFA of China 2009; SFA of China 2010; SFA of China 2011; SFA of China 2012; SFA of China 2013; SFA of China 2014). End-sellers are regulated, with only 711, 492, and 702 hospitals in China allowed to sell medicines containing pangolin scales, saiga horns, and snake products to patients, respectively (SFA of China 2008a). The ongoing COVID-19 pandemic has raised the importance of regulating wildlife trade to a national priority for many countries. At the onset of the pandemic, China quickly established new regulations restricting the national trade of wild animals for consumption or fur (Ministry of Agriculture and Rural Affairs of China 2020). However, these new regulations did not include species farmed for TCM. To reduce the risk of future outbreaks of zoonotic disease, the farming and handling of wild animals for other purposes, including TCM, also needs to be regulated.

8.3.2 Problems

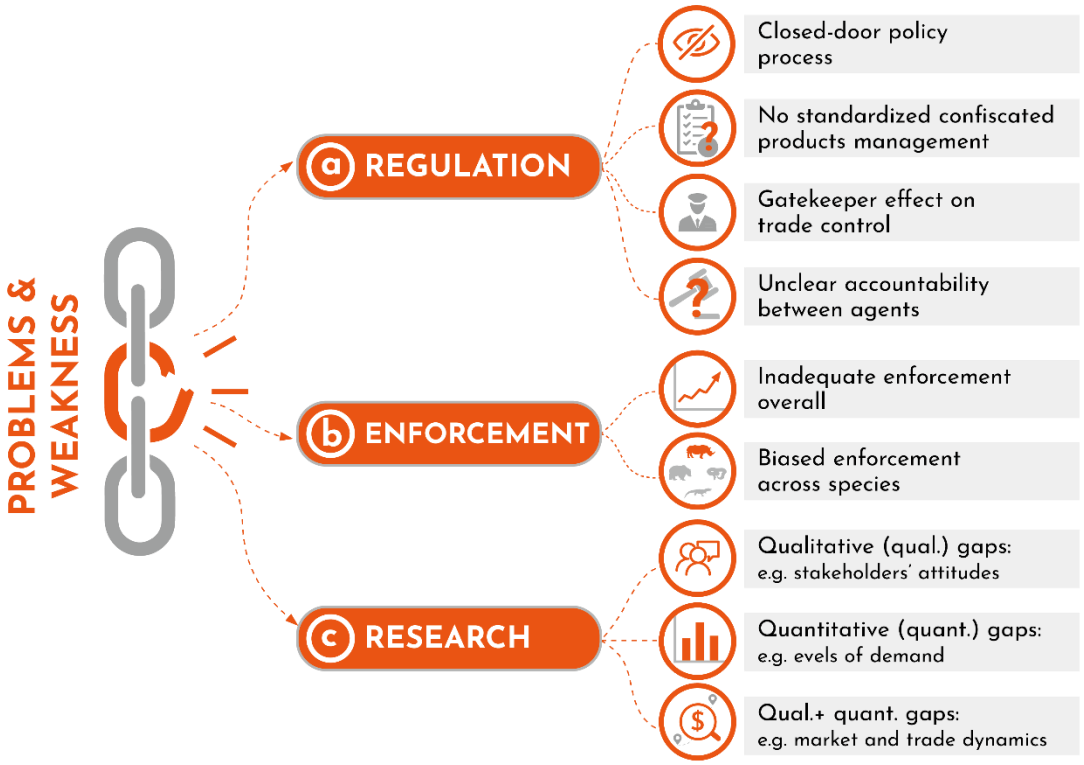

Figure 8.4 Problems with current TCM trade. *Designed by Runxi Wang*

Current TCM regulations

Although TCM trade in China is regulated by various levels of laws and regulations, untransparent information and unclear details, weak law enforcement, and a lack of

baseline research are all issues with the current regulation system. For example, most of the relevant information on the stockpile trade (including the distribution of quotas beyond the provincial level, the total amount of remaining stockpiles, and most annual quotas) is not available to public. This regulatory approach therefore means that key public stakeholder groups (e.g., scientific and conservation organisations, the general public) are excluded from the policy processes behind many key legislative decisions, including defining the volumes assigned under annual quotas, assessing the suitability of certified hospitals, and issuing permits to manufacturing companies and stockpile holders. This lack of transparency within the policy process also provides loopholes for corruption and other unlawful behaviours. A recent legal case in 2020 focused on the former head of Beijing Wildlife Protection Station, the gatekeeper responsible for validating stockpile statutes and issuing TCM trade permits for many threatened species including pangolins, saiga and bears. During a 19-year term of office, this official amassed more than 8 million RMB (~1 million USD) in bribes and a further 49 million RMB (~6.9 million USD) from uncertain but probably illegal sources (Gao 2020). Amassing these sums was made possible by the lack of clarity in the regulations for applying for permits and status certificates to use stockpiles. Regulations did not specify conditions or timelines for issuing these permits, meaning that this individual gained full control over whether to allow, reject, or defer applications. Similar problems also exist for certification of wildlife farming, where there is uncertainty over most of the requirements for obtaining farming certificates, and even over the existing number of licensed farms and animals involved in farming (Hu 2016). Lack of open access to information also prohibits the public from reporting observed illegal behaviours or supporting correct law enforcement processes.

China's current trade policy for the management of confiscated products is also unclear, offering further loopholes for corruption and unqualified products to enter the market. Internationally, CITES recommends that confiscated wild-sourced products of species listed in Appendix I should only be re-used for scientific, educational, enforcement or identification reasons, whereas confiscated Appendix II and Appendix III products can re-enter trade if no illegal trade would be involved (CITES 2016d). However, China has no national regulations to standardize management or disposal of confiscated wildlife products, which leads to different managements and allows certain gatekeepers

to have full control of confiscated products, thus enabling unlawful behaviours such as corruption. This is a particular concern for species which have legal markets within China (e.g., pangolin scales and saiga horn), as there are no national laws or regulations that prohibit confiscated products from re-entering the market, or that specify how such products can be legally traded. A record sale of pangolin scales to certified companies by the Bozhou Forestry Administration at auction in 2013 demonstrates that it is feasible for seized products to re-enter markets (Tian Cheng Auction Company 2013).

In addition to these legal loopholes, a further opportunity for corruption is in quality control of traded products. When pangolin scales were listed in the Chinese Pharmacopeia, this specifically referred to scales of the Chinese pangolin; however, species identification is rarely conducted for confiscated pangolin scales, providing an opportunity for internationally trafficked non-native pangolin species to enter the TCM market through legal routes in China (Chinese Pharmacopoeial Commission 2015; Cheng, Xing & Bonebrake 2017). For example, the Bozhou Forestry Administration auction provided no species information, and just used the general terms "pangolin scales" and "roasted fragmented pangolin scales" (Tian Cheng Auction Company 2013). This problem may not only apply to pangolin scales. Furthermore, the quality of confiscated products also requires more regulation attention in terms of health concerns, if they are used as TCM and consumed by the public.

Enforcement of TCM trade regulations

Previous studies have shown that illegal TCM trade and products are widespread across China (Li, Zhao & Bennett 2007; Yin *et al.* 2015; Xu *et al.* 2016). Despite ongoing research attention, efforts to regulate illegal TCM trade of many threatened species in China have not yet been effective. For example, the percentage of shops selling illegal pangolin scale products has not declined significantly during the past 10 years (Xu 2009; Challender *et al.* 2014; Xu *et al.* 2016). Studies on trade of pangolin scales and saiga horns also show that participants in TCM trade chains, especially end-sellers and consumers, have little clear understanding of the illegal aspects of their behaviours or the products they sell or use. Indeed, illegal TCM products are often openly displayed by vendors (Li, Zhao & Bennett 2007; Wang, Turvey & Leader-Williams 2020). This lack of awareness or concern over illegality, particularly among sellers, suggests that

current law enforcement is inadequate and needs to be strengthened for many TCM-traded species.

Law enforcement effort also varies between traded species. For example, rhino horn has been banned from trade since 1993 (State Council 1993), and recent studies have shown that practitioners, sellers and consumers are well aware of this ban and that rhino products can no longer be traded legally as TCM (Cheung *et al.* 2018). The demand for rhino horn in China has now shifted to investment and collectible value rather than medicinal purposes, differing greatly from drivers of trade for pangolin scale (Gao *et al.* 2016). This unequal awareness of existing legislation for different species might reflect different amounts of law enforcement, which could have arisen for three possible reasons. Firstly, legal markets still exist for pangolins and some other species, potentially complicating law enforcement and lowering enforcement efficiency. Secondly, charismatic species that attract more conservation attention or higher protection status could be allocated more enforcement resources (e.g., manpower, training) and conservation resources (e.g., education programmes, campaigns). Thirdly, species with longer histories of protective legislation might receive more efficient enforcement due to familiarity of law enforcers with relevant regulations; whereas rhino horn was banned in 1993, trade in many other species threatened by TCM has only been regulated since 2008. However, although these reasons might explain why enforcement effort differs between species, illegal trade should be tackled regardless of such differences or the potential co-occurrence of legal trade for some species.

A further complicating factor is that multiple administrative bodies and departments are often involved in different aspects of law enforcement relating to TCM trade, because TCM wildlife products are also traded and regulated in the wider medicine and TCM product sectors. Trade regulation thus involves the TCM Administration, the Medical Products Administration, the Forestry and Grassland Administration, and the Administration for Market Regulation. There can be benefits in having multiple departments involved with law enforcement, such as ensuring representative voices from diverse stakeholders and minority groups and thus increasing legitimacy (Sirico Jr 1980). However, multi-agency management can also cause problems such as unclear division of responsibility and difficulties for cross-agency collaboration (Freeman &

Rossi 2011). These problems can reduce overall enforcement efficiency and lead to weak law enforcement.

Research

Although international researchers have long recognized the potentially profound impact of TCM trade on wildlife conservation (Mainka & Mills 1995), very little research has still been conducted into China's TCM trade, and key basic information is still lacking. There is no complete list of species threatened by TCM demand; there are no quantitative estimates of demand or actual trade volumes available for most traded species; stakeholders' attitudes, drivers of demand, and knowledge about the trade are largely unknown; market and trade as complex and dynamic systems are also understudied (Hinsley *et al.* 2020). Without a comprehensive understanding of all of these subject areas, there remains no basis for evidence-based policy or development of conservation mitigations. This situation contrasts markedly with baselines of conservation knowledge about many other anthropogenic threats, such as habitat loss or hunting, where such factors are a routine research topic considered integral for informing management planning (Benítez-López *et al.* 2017). Although the TCM trade is regarded as globally important and in need of urgent management, research is potentially hindered by factors including language barriers, lack of transparent information, and limited available or relevant data. Ethnocentrism might pose a further barrier, whereby TCM might simply be regarded as a superstitious belief that can be tackled by "education" without the need for in-depth research. This view is reflected in many conservation campaigns, which label TCM ingredients such as rhino horn as having no medicinal value (Dang Vu & Nielsen 2020).

Moreover, most of the legal TCM wildlife trade involves certified sellers such as hospitals. However, there has been little attempt to estimate TCM demand from these legal sellers, meaning that the legal supply cannot be estimated to meet the currently sanctioned market. If demand surpasses the capacity of the legal supply, this could create space for illegal products to enter the market, and create problems for social justice on how limited resources should be distributed (Cummings 1993). In addition, there have been proposals to use substitutes as a solution for conserving species threatened by TCM, but little research has been conducted to provide evidence about

the sustainability of promoting such substitutes. The TCM market is also currently undergoing rapid expansion onto the international stage (State Administration of TCM & NDRC 2016; Lin *et al.* 2018; Hinsley *et al.* 2020), meaning that demand for TCM products is likely to increase in near future. However, a lack of background research to understand the status of species traded for TCM has made it difficult to develop regulations to address the sustainability of traded TCM products.

Further basic information is therefore essential to support effective policy and management planning for the TCM trade. Research requirements include, but are not limited to: (i) assessing sustainability of wild-sourced TCM ingredients; (ii) understanding stakeholders' attitudes and knowledge of traded species; (iii) understanding quantitative aspects of the trade, such as levels of demand, sales data and product prices; and (iv) in-depth understanding of market and trade dynamics, particularly for predicting potential impacts of new policy or management decisions such as promoting new substitutes or allowing seized products to re-enter trade. in particular, TCM related plant species should be given equal or more attention as the few animal species involved. Most of TCM ingredients are plant-based yet the sustainability of wild-sourced or farmed species are rarely investigated (Hesketh & Zhu 1997). All of the above research directions require in-depth and long-term collaboration with TCM stakeholders, including farmers, practitioners, consumers and TCM-related administrations, and multiple lines of research evidence need to be integrated to guide decision-making.

8.3.3 Recommendations for regulating legal trade in TCM

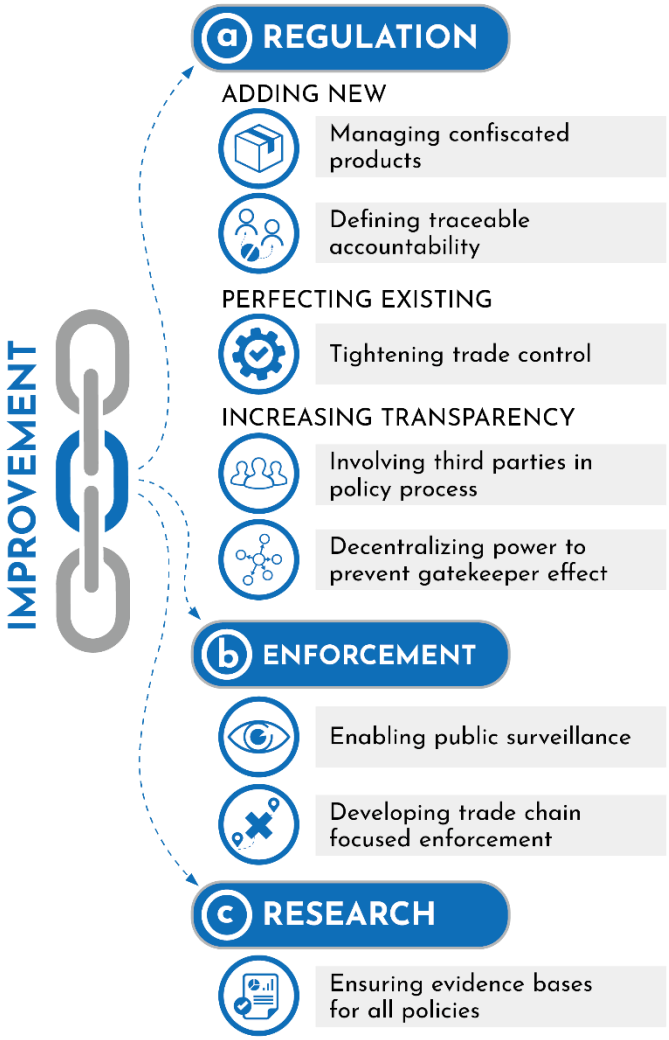

Figure 8.5 Suggesting potential improvements. *Designed by Runxi Wang*

Improvements are needed from regulation, enforcement, and research aspects for a more sustainable TCM trade. Firstly, it is essential to fill gaps in the current regulatory framework that clear regulations for how to handle confiscated products are needed. Decisions and policies over whether to dispose of seized products or to allow certain species to re-enter the trade should be evidence-based. It is particularly important to understand the potential impact of trade and international trafficking on wild populations. In terms of revising existing policies, more clearly divided accountability of law enforcement staff across multiple agencies is required. This is important for both efficient enforcement and mutual supervision to avoid gatekeeper effect. Also, more detailed and tightened trade regulations need to be established and enforced. A high level of scrutiny and a more clearly defined legal market should be applied to the trade of all threatened species used for TCM. This should be comparable to the current strict

source-to-end regulation for musk deer products, which are limited to a few patent drugs produced by five companies using farmed musk and which can only be sold in some certified hospitals. Restricting the use of TCM products from threatened species to a few drugs or symptoms might help to reduce demand to levels that can hopefully be fulfilled by legal supplies. Clear specification of permitted drugs or specific target symptoms could also help with law enforcement, as it would reduce the complexity of trade and increase the difficulty of fraud through the use of certifications or trade permits if fewer products are involved. This policy change would require participation of TCM stakeholders in deciding how best to allocate limited resources and minimize social injustice.

Transparency and publicity of TCM-related regulations and data needs to increase. Increased transparency would allow third parties such as conservation organisations and researchers to better understand the trade and provide evidence-based suggestions to improve existing policies or enforcement. Enhancing publicity of policy process also helps with decentralizing power and prevent gatekeeper effect. Moreover, increased messaging about TCM-related regulations and policy can also strengthen law enforcement by allowing the general public to contribute through reporting observed illegal trade or consciously avoiding illegal behaviours. Recent research on trade in pangolin products has demonstrated that TCM trade participants may have little understanding of relevant policies, which can lead to unintentional illegal behaviour (Wang, Turvey & Leader-Williams 2020). Key stakeholders participating in TCM trade of threatened animal products should therefore receive more targeted education about existing regulations, which could be integrated into the existing training systems for TCM doctors and practitioners.

More professional training should be provided to law enforcers on the ground to assist with this process. To account for the uneven enforcement efforts between different species, such training should not be solely species-focused, but should instead also adopt a trade chain focus. For example, law enforcers could be divided into teams responsible for monitoring and regulating different parts of the trading chain, such as TCM farms, hospitals, or wholesale markets. Training provided to different groups should thus differ according to the species involved, the types of products and

certification type, permitted quantities, and related system-specific factors. This approach can provide clear accountability of each agency without duplicating effort, and enables mutual vigilance and collaboration between different agencies when tracking up and down interconnected trading chains.

Building a greener and more sustainable TCM trade is important for both Chinese national development and global biodiversity conservation. Further research and transparent implementation of regulations relevant to both agendas are required to achieve this goal. Therefore, this study recommend that both local and international researchers must collaborate with key stakeholders in TCM communities, whose voices need to be heard the most. TCM stakeholders should also be incorporated into the policy processes behind regulating legal trade and combating illegal trade. As the TCM industry expands its coverage and size, such approaches are necessary to mitigate its negative impact on threatened biodiversity.

8.4 Conservation in China and beyond

This study focuses mainly on one taxon. However, insights and recommendations could also be applied to conserving other traded or threatened species in China or globally. In general, the following points seem worthy of future consideration.

Firstly, the application of social science disciplines to conservation needs to be greatly strengthened, particularly in China. Although several conservation research projects have used social science methods and theories, the numbers are few compared with: (i) the wide geographic range of China; (ii) the great number of species of conservation concern; (iii) the diverse cultural and social characteristics within this country; and (iv) the numbers of studies that have only used natural science approaches (Zhang, Hua & Sun 2008; Dutton, Hepburn & Macdonald 2011; Zhang & Yin 2014; Turvey *et al.* 2015; Nash, Wong & Turvey 2016; Pan *et al.* 2016; Turvey *et al.* 2017). This study highlighted the lack of social science evidence in existing conservation practices and the need for evidence-based and theory-informed interventions. Moreover, social science methods are often low cost and can cover a wide geographical range efficiently. As a result, they are recommended by other studies as the first step to identify key problems, potential

solutions, and evaluation methods (Jenks, Vaughan & Butler 2010).

Secondly, what goes together with the lack of social science evidence is the frequent failure to recognize the complexity of the problems from a broader social perspective. Strong biology and ecology themes have been emphasized in the short history of conservation science (Soulé 1985). Basic concepts used in biological science have sometimes subconsciously shaped how scientists view conservation problems. For example, it is often easier to see problems framed in the context of taxonomic divisions. Species are often the most frequently used unit in conservation science (Rojas 1992). However, the reality is often more complex beyond species level (Challender, Harrop & MacMillan 2015b). As shown in this study, pangolins were not traded with clear distinctions between species, and the public hold vastly different views on different types of pangolin products. Functions of the product, rather than taxonomic species, determined several differences in attitude. Conservationists need to recognise that the complexity of conservation problems is beyond the scale of single species or other biological units. Such recognition will help to conduct social science research in a way that provides deeper insights and more practical guidance for conservation applications.

Thirdly, this study also pinpoints the importance of adapting social science methods accordingly. A lot of researchers have criticized the "WEIRD" problems in behavioural science studies, which is that the study populations are too often "Western, Educated, Industrialized, Rich, and Democratic" people (Baumard & Sperber 2010; Henrich, Heine & Norenzayan 2010). This subset of study population obviously has nothing to do with China or the Chinese people, as is often the case in other places of conservation concern. Thus, it is critical to test local feasibility of using presumably well-established methods. The unique cultural-social background in China further adds to the importance of local adaption.

Fourthly, it is not only research methods that need to be locally adapted, but also interventions. One particular example is the uniquely important role of top-down control in China (Edward Grumbine & Xu 2011). This study has shown that understanding the legal framework in China was key in shaping public attitudes and behaviours towards pangolin products (see Chapter 4, 5, and 6) as is likely the case for

other species. In other areas, local authorities or elders might play an important role that similar to the top-down implications in China (Byers, Cunliffe & Hudak 2001; Cinner 2007). The emphasis on top-down control does not mean that bottom-up interventions should be abandoned. Instead, the online reporting platform example mentioned above relies largely on public contributions and it helped to crack down one of the largest wildlife crimes in China. Conservationists working in China should recognize such potential and address them in favour of conservation.

Fifthly, the unique cultures, value systems, and political structures need to be understood and respected at the local level. Obvious examples in China are species involved in TCM use. More broadly speaking, the utilitarian values rooted deeply within Chinese ideologies have had strong impacts on peoples' attitudes and behaviours (Zhang & Yin 2014; Wenxuan 2017). Encouraging more diverse conservation values is important but it should not be achieved in ways that undermine local perceptions and value systems (Green *et al.* 2015).

Moreover, the important role of China in conserving both its own biodiversity and globally threated species is increasingly recognized (Nijman 2010; Sutherland *et al.* 2019). However, not enough research and conservation interventions have been conducted in China to match up with this recognition (McBeath & McBeath 2006). Misunderstandings, information lags, and insufficient research or application are observed, while language, culture, policy, and other factors together contributed to these observed problems (Gao *et al.* 2016). International and cross-boundary collaboration is needed. Current policies in mainland China have provided great opportunities for biodiversity conservation research. The flagship concept of "Ecological Civilization" has been emphasized intensively by President Xi in various speeches during the past few years. With strong policy support on protecting the environment and biodiversity, it is a great opportunity for more and effective conservation work and research in China.

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Appendix I

普通民众对于打猎的态度调查
Attitude Towards Hunting

此问卷为无记名方式仅限18岁以上成年人作答，不会在未经您许可的情况下记录或公开有关您的个人信息，希望您能诚实回答。非常感谢参与！
This is an anonymous questionnaire for adults about 18 years old. No personal information will be recorded or published without your consent. We hope you can answer these questions honestly and thanks for your participation

1. 年龄 Age [单选题] [必答题]
○ 18-24 ○ 25-29 ○ 30-34 ○ 35-39 ○ 40-44 ○ 45-49 ○ 50-54 ○ 55-59 ○ 60-64 ○ 65以上

2. 性别 Sex [单选题] [必答题]
○ 男 M ○ 女 F

3. 民族 Ethnicity [单选题] [必答题]
○ 汉 Han ○ 黎 Li ○ 苗 Miao ○ 壮 Zhuang ○ 回 Hui
○ 其他 _____

4. 您现在的长期居住地 Your current long term address [单选题] [必答题]
○ 海南省海口市 Haikou ○ 海南省三亚市 Sanya ○ 海南省琼中县Qiongzhong
○ 海南省五指山市 Wuzhishan ○ 海南省乐东黎族自治县 Ledong
○ 海南省白沙黎族自治县 Baisha ○ 海南省其他地区Other cities in Hainan
○ 其他请注明市/县 _____ others

5. 职业 occupation [单选题] [必答题]
1） 企业职员 employee of private enterprise 2） 事业单位人员 employee of state-own enterprise 3） 专业技术人员 professional 4） 公务员 civil servant 5）农民 farmers 6） 工人 worker 7） 自由职业者 freelance 8） 军人 military personnel 9） 离退休人员 retired 10） 学生 student 11） 其他 other

6. 年平均收入 Average Annual Income [单选题] [必答题]
○ 1万元以下 under 10,000 yuan ○ 1万元至5万元 10,000 to 50,000 yuan

○ 5万元至10万元 50,000 to 100,000 yuan ○ 10万元至30万元 100,000 to 300,000 yuan ○ 30万元至50万元 300,000 to 500,000 yuan ○ 50万元至100万元 500,000 to 1000,000 yuan ○ 100万元以上 above 1000,000 yuan

7. 最高学历 Education Level [单选题] [必答题]
○ 小学或以下 elementary school or below ○ 初中或高中 middle school or high school ○ 大学或专科 university or college ○ 研究生或以上 graduate degree or above

8. 您认为_____。 You think that_____[单选题] [必答题]
1）野生动物应被完全保护不应被利用 Wildlife should be completely protected without any utilization
2）以自然保护动物福利等为主一定程度上加以利用 Wildlife could be used to some extend with the priority consideration of nature conservation and animal welfare
3）以人类利益和需要为主在不枯竭的前提下充分利用 wildlife could be fully utilized (without deplete the resource) with the priority consideration of human interests and needs
4）野生动物是一种资源，人类有权随意取用 Wildlife is a type of resource and human have the right to use it in whichever way they want
5）不知道 Don’t know

9. 打猎提供给人类的好处多于坏处 hunting provides to human more benefit than harm [单选题] [必答题]
○ 完全认可 totally agree ○ 很大程度认可 largely agree ○ 好坏均等 neutral ○ 很大程度不认可 largely disagree
○ 完全不认可 totally disagree ○ 不知道 don’t know

10. 打猎带给自然环境的好处多于坏处 hunting provides to nature more benefit than harm [单选题] [必答题]
○ 完全认可 ○ 很大程度认可 ○ 好坏均等 ○ 很大程度不认可
○ 完全不认可 ○ 不知道

11. 您认为打猎是一个令人愉悦的过程吗？Do you think hunting is a joyful process [单选题] [必答题]
○ 令人愉悦的 joyful ○ 很大程度上令人愉悦的 largely joyful ○ 既不愉悦也不难过 neutral

○ 很大程度上令人难过的 largely sad ○ 令人难过的 sad ○ 不知道 don’t know

12. 您周围的人经常打猎吗? Do people around you hunt frequently [单选题] [必答题]

○ 经常打猎 frequently ○ 有时打猎 sometimes ○ 很少打猎 seldom ○ 从不打猎 never ○ 不知道 don’t know

13. 您周围的人对打猎持支持态度吗? Do people around you support hunting [单选题] [必答题]

○ 完全支持 totally support ○ 很大程度上支持 largely support ○ 既不支持也不反对 neutral

○ 很大程度上反对 largely against ○ 完全反对 totally against ○ 不知道 don’t know

14. 假如您想打猎，您个人_____? if you want to hunt, you [单选题] [必答题]

○ 有能力打猎 can hunt

○ 无打猎能力 can’t hunt

○ 其他 _____ other

提示：如果您的答案为“其他”请填写您的原因

15. 您或者您周围的人打猎是不是出于自己的意愿? Do you or people around you go to hunting under your/their own will [单选题] [必答题]

○ 完全出于自己意愿 totally under your/their own will

○ 很大程度上出于自己意愿 largely under your/their own will

○ 有时出于自己意愿有时不是 sometimes yes sometimes no

○ 很大程度上不是出于自己意愿 largely not under your/their own will

○ 完全不是出于自己意愿 totally not under your/their own will

○ 不知道 don’t know

16. 您有可能在未来的 12 个月中打猎吗? Will you likely go hunting in the future 12 month [单选题] [必答题]

○ 完全可能 possible

○ 很大程度上可能 largely possible

○ 不知道 don’t know

○ 很大程度上不可能 largely not possible
○ 完全不可能 totally impossible

17. 您在过去的两年中曾打猎过吗？Have you been hunting during the past two years? [单选题] [必答题]
○ 打过猎 _____ Yes
○ 没有打过猎 No

18. 您知道一些人们用的打猎方式吗？Do you know some hunting methods that people use?

19. 您认识下列图中的动物吗？请按您知道的回答。Do you know the animal below [单选题] [必答题]
○ 认识 _____ Yes
○ 不认识 No

20. 您认识下列图中的动物吗？请按您知道的回答。Do you know the animal below [单选题] [必答题]

○ 认识 _____ Yes

○ 不认识 No

21. 您在过去的 12 个月中见到过这些动物吗？如果见到过，什么时间、在哪里？ Have you seen these animals during the past year? If so, when and where

22. 您能估计下在您的活动范围内这些动物的数量吗？Can you estimate the number of these animals in your active area?

23. 您知道关于这些动物的任何知识吗？如食性，药用价值，行为，等等 Do you know anything about these animals? Like diet, medical use, behavior etc.

24. 您知道附近有狩猎这两种动物的情况吗？ Do you know any information about hunting of these animals?

25. 您知道捕获的动物被卖到哪里吗？Do you know where the harvest animals are sold to?

26. 您知道饭店或药店或中间人收购穿山甲或海南孔雀雉的价格吗？Do you know the price of pangolin or Hainan peacock pheasant that restaurants or pharmaceutical shops or mid-man give for?

在五指山，乐东和白沙问的附加问题：1）您记得以前捕猎穿山甲的相关信息吗：在哪里捕，谁捕猎（本地人还是外地人），大规模捕猎是什么时候开始，什么时候结束，各个时期的收购价格（整只动物或甲片价格），收购商是政府还是私人，每年或每月大概抓多少；2）有用穿山甲做药材或饰品的吗？
Additional questions asked in Wuzhishan, Ledong, Baisha: 1) what do you know about the historical pangolin hunt: where to hunt, who hunts (local or people from outside), when did hunting happen, price at difference time (whole animal or just scale), number of catch per month/year, who to sell to (government or private sector); 2) any use of pangolin as medicine or ornamentation?

普通民众对于野生动物及其制品的认识和态度调查
Attitude Towards wildlife products

此问卷为无记名方式仅限18岁以上成年人作答，不会在未经您许可的情况下记录或公开有关您的个人信息，希望您能诚实回答。非常感谢参与！
This is an anonymous questionnaire for adults about 18 years old. No personal information will be recorded or published without your consent. We hope you can answer these questions honestly and thanks

for your participation

1. 年龄 Age [单选题] [必答题]
○ 18-24 ○ 25-29 ○ 30-34 ○ 35-39 ○ 40-44 ○ 45-49 ○ 50-54 ○ 55-59 ○ 60-64 ○ 65以上

2. 性别 Sex [单选题] [必答题]
○ 男 M ○ 女 F

3. 民族 Ethnicity [单选题] [必答题]
○ 汉 Han ○ 黎 Li ○ 苗 Miao ○ 壮 Zhuang ○ 回 Hui
○ 其他 _____

4. 您现在的长期居住地 Your current long term address [单选题] [必答题]
○ 海南省海口市 Haikou ○ 海南省三亚市 Sanya ○ 海南省琼中县Qiongzhong
○ 海南省五指山市 Wuzhishan ○ 海南省乐东黎族自治县 Ledong
○ 海南省白沙黎族自治县 Baisha ○ 海南省其他地区Other cities in Hainan
○ 其他请注明市/县 _____ others

河南问卷Henan questionnaire：4. 您现在的长期居住地 Your current long term address [单选题] [必答题]
○ 河南省郑州市 Zhengzhou ○ 河南省开封市 Kaifeng
○ 其他 请注明市/县 _____ others

5. 职业 occupation [单选题] [必答题]
1） 企业职员 employee of private enterprise 2） 事业单位人员 employee of state-own enterprise 3） 专业技术人员 professional 4） 公务员 civil servant 5）农民 farmers 6） 工人 worker 7） 自由职业者 freelance 8） 军人 military personnel 9） 离退休人员 retired 10） 学生 student 11） 其他 other

6. 年平均收入 Average Annual Income [单选题] [必答题]
○ 1万元以下 under 10,000 yuan ○ 1万元至5万元 10,000 to 50,000 yuan ○ 5万元至10万元 50,000 to 100,000 yuan ○ 10万元至30万元 100,000 to 300,000 yuan ○ 30万元至50万元 300,000 to 500,000 yuan ○ 50万元至100万元 500,000 to 1000,000 yuan ○ 100万元以上 above 1000,000 yuan

7. 最高学历 Education Level [单选题] [必答题]

○ 小学或以下 elementary school or below ○ 初中或高中 middle school or high school ○ 大学或专科 university or college ○ 研究生或以上 graduate degree or above

问卷中的野生动物制品指用在**野外环境生活的动物种群**制作的产品，包括食品，装饰品，药物，等，**不包括养殖产品**。如不确定来源是否为养殖请按野生来源作答。特别注意：购买或使用野生动物制品**并非一定是违法**。是否违法取决于有关该动物的相关规定。
Wildlife products in this questionnaire refers to any products produced from animal population living in the wild, including food, medicine, or ornamentation, etc, not products made from breeding population. If unsure about the source, please regard it as wild. Note: buying/consuming wildlife products may not be illegal. The illegality depends on the regulation related to this animal species.

8. 您认为_____。 You think that_____[单选题] [必答题]
1）野生动物应被完全保护不应被利用 Wildlife should be completely protected without any utilization
2）以自然保护动物福利等为主一定程度上加以利用 Wildlife could be used to some extend with the priority consideration of nature conservation and animal welfare
3）以人类利益和需要为主在不枯竭的前提下充分利用 wildlife could be fully utilized (without deplete the resource) with the priority consideration of human interests and needs
4）野生动物是一种资源，人类有权随意取用 Wildlife is a type of resource and human have the right to use it in whichever way they want
5）不知道 Don’t know

9. 购买或使用野生动物制品提供给人类的好处多于坏处 buying/consuming wildlife products provides to human more benefit than harm [单选题] [必答题]
○ 完全认可 totally agree ○ 很大程度认可 largely agree ○ 好坏均等 neutral ○ 很大程度不认可 largely disagree
○ 完全不认可 totally disagree ○ 不知道 don’t know

10. 购买或使用野生动物制品带给自然环境的好处多于坏处 buying/consuming wildlife products provides to nature more benefit than harm [单选题] [必答题]

○ 完全认可 ○ 很大程度认可 ○ 好坏均等 ○ 很大程度不认可
○ 完全不认可 ○ 不知道

11. 您认为购买或使用野生动物制品是一个令人愉悦的过程吗？Do you think buying/consuming wildlife products is a joyful process [单选题] [必答题]

○ 令人愉悦的 joyful ○ 很大程度上令人愉悦的 largely joyful ○ 既不愉悦也不难过 neutral
○ 很大程度上令人难过的 largely sad ○ 令人难过的 sad ○ 不知道 don’t know

12. 您周围的人经常购买或使用野生动物制品吗？Do people around you buy/consume wildlife products frequently [单选题] [必答题]

○ 经常购买或使用野生动物制品 frequently ○ 有时购买或使用野生动物制品 sometimes ○ 很少购买或使用野生动物制品 seldom ○ 从不购买或使用野生动物制品 never ○ 不知道 don’t know

13. 您周围的人对购买或使用野生动物制品持支持态度吗？Do people around you support buying/consuming wildlife products [单选题] [必答题]

○ 完全支持 totally support ○ 很大程度上支持 largely support ○ 既不支持也不反对 neutral
○ 很大程度上反对 largely against ○ 完全反对 totally against ○ 不知道 don’t know

14. 假如您想购买或使用野生动物制品，您个人_____？ if you want to buy/consume wildlife products, you____ [单选题] [必答题]

○ 有途径有财力购买/使用 know where to buy/consume and have the money to do so
○ 无途径 don’t know where to buy/consume
○ 无财力 don’t have the money to buy/consume
○ 无途径也无财力 don’t know where and don’t have the money to buy/consume
○ 其他 _____ other
提示：如果您的答案为“其他”请填写您的原因

15. 您或者您周围的人购买或使用野生动物制品是不是出于自己的意愿? Do you or people around you buy/consume wildlife products under your/their own will [单选题] [必答题]

○ 完全出于自己意愿 totally under your/their own will
○ 很大程度上出于自己意愿 largely under your/their own will
○ 有时出于自己意愿有时不是 sometimes yes sometimes no
○ 很大程度上不是出于自己意愿 largely not under your/their own will
○ 完全不是出于自己意愿 totally not under your/their own will
○ 不知道 don’t know

16. 您有可能在未来的 12 个月中购买或使用野生动物制品吗？ Will you likely buy/consume wildlife products in the future 12 month [单选题] [必答题]

○ 完全可能 totally possible
○ 很大程度上可能 largely possible
○ 不知道 don’t know
○ 很大程度上不可能 largely not possible
○ 完全不可能 totally impossible

17. 您在过去的两年中曾购买或使用野生动物制品吗？Have you been buying/consuming wildlife products during the past two years? [单选题] [必答题]

○ 购买或使用过_____ Yes
○ 没有购买或使用过 No

18. 您认识下列图中的动物吗？请按您知道的回答。Do you know the animal below [单选题] [必答题]

○ 犰狳（又称铠鼠）Armadillo
○ 穿山甲（又称鲮鲤）pangolin
○ 食蚁兽（又称大食蚁兽）giant anteater
○ 不认识 don’t know

19. 穿山甲在中国的种群状态是怎样的？what’s the population status of pangolin in China [单选题] [必答题]
1） 已灭绝 extinct 2） 野外已灭绝 extinct in the wild 3） 极度濒危 critically endangered 4） 濒危 endangered
5） 受威胁 threatened 6） 不受威胁 not threatened 7） 不知道 don’t know

20. 您知道有关穿山甲的知识吗？任何方面都可以 Do you know anything about pangolin? Any aspects? [填空题]
_____

21. 您是从哪些来源知道关于穿山甲的信息的？how do you know this information? [多选题]

☐ 电视节目 TV show ☐ 广播电台 video broadcast ☐ 公益广告 conservation advertisement ☐ 医院/药店 hospital/pharmaceutical shops ☐ 动物园/博物馆 zoo/museum ☐ 市场/餐馆 market/restaurant ☐ 报纸/网络新闻 online news/news paper ☐ 书籍文献 books/journals ☐ 朋友或家人 friends/family ☐ 野外见过 seen in the wild ☐ 养殖场 breeding farm
☐ 其他来源请补充 _____ other

22. 您知道关于穿山甲的药用价值吗（也叫炮山甲、甲珠）？请详细说明一些 Do you know any medical use of pangolin? Please specify[填空题]
_____

23. 您是从哪些来源知道关于穿山甲的药用价值的？How do you know the medical use of pangolin [多选题]
☐ 电视节目 TV show ☐ 广播电台 video broadcast ☐ 医院/药店 hospital/pharmaceutical shops ☐ 市场/餐馆 market/restaurants ☐ 报纸/网络新闻 online news/news paper ☐ 书籍文献 books/journals ☐ 朋友或家人 friends/family ☐ 养殖场 breeding farm
☐ 其他 _____ other

24. 市场上的穿山甲制品（包括肉制品、药品、饰品）的来源是 ？ What’s the source of pangolin products in market? [单选题] [必答题]
○ 全部来自人工养殖 all from breeding farm
○ 大部分来自人工养殖一部分来自野外 largely form breeding farm and some from wild
○ 一半来自人工养殖一半来自野外 half from breeding farm and half from wild
○ 大部分来自野外一部分来自人工养殖 largely from wild and some from breeding farm
○ 全部来自野外 all from wild
○ 不知道 don’t know

25. 关于消费穿山甲制品： 您在过去的两年中曾经 ？have you bought/consumed pangolin products as_____during the past two years [矩阵单选题] [必答题]

	购买或使用过 yes	没有购买或使用过 no	不确定 unsure

a）作为药材 as medicine	○	○	○
b）作为食材 as food	○	○	○
c）作为饰品 as ornamentation	○	○	○

26. 您支持作为_____买卖穿山甲制品吗？ do you support trading of pangolin products as _____ ?[矩阵单选题][必答题]

	支持 support	不支持 not support	不知道 not sure
a）作为药材 as medicine	○	○	○
b）作为食材 as food	○	○	○
c）作为饰品 as ornamentation	○	○	○

27. 您认为消费者为什么购买或食用穿山甲肉制品呢？ Why do you think some people would buy/consume pangolin meat? [多选题]
☐ 味道可口 good taste ☐ 保健作用 good for health ☐ 猎奇心理 curiosity ☐ 彰显财富/地位 showing off wealth and status
☐ 医疗作用 medical use ☐ 解决温饱 protein source ☐ 应酬需要 social engagement needs ☐ 其他原因，请补充 _____ other, please spercify

28. 关于穿山甲制品的合法性： about the legality of pangolin products [矩阵单选题] [必答题]

	合法 legal	不合法 illegal	不知道 don’t know
a）作为药材 as medicine	○	○	○
b）作为食材 as food	○	○	○

c）作为饰品 as ornamentation	○	○	○

29. 穿山甲受法律保护吗？ Is pangolin protected by law[单选题]［必答题］
○ 受法律保护 yes
○ 不受法律保护 no
○ 不清楚 not sure
30. 您知道多少卖野味的饭店？how many wild meat restaurants do you know?［单选题］［必答题］
○ 0
○ 1-3
○ 4-9
○ 10或以上

TCM survey questions

1）您卖穿山甲片吗？Do you have pangolin scales?
2）甲片价格多少？What's the price of pangolin scales?
3）过去 12 个月的销量如何？（总销量，月平均销量，最好销量，最低销量）How was the sale during the past 12 month? (total sale, average monthly sale, best sale, lowest sale etc.)
4）穿山甲片有什么药用价值？What medical values does pangolin scale have?
5）有药品可以替代穿山甲片吗？Are there any substitutes for pangolin scale?
6）患者购买穿山甲片主要用于什么用途？What purpose does consumer buying it for?
7）能形容一下此类顾客的特征吗？（年龄段，性别，收入等等）can you describe the consumers? Age group, gender, income etc.
8）甲片的来源是哪里？Where does the scale come from?
9）您知道什么有关甲片销售的法律法规吗？Do you know any regulations related to pangolin scales?
10）您知道有关穿山甲的任何知识吗？Do you know anything about pangolin?

Appendix II

R code used in this study and some glm output results

```
#SEM of behaviour data
library(lavaan)
library(lavaanPlot)
library(semPlot)
attach(Hainantree)
modelhainan = '
Intention =~ Attitude + Norms + Control + q16 + past.bhv
Attitude =~ q9 + q10 + q11 + q8
Norms =~ q12 + q13
Behaviour =~ Intention + past.bhv + q14
Control =~ q15 + q14

Attitude ~~ Norms
Attitude ~~ Control
Norms ~~ Control
'
fithainan = sem(modelhainan, data = Hainantree, std.lv = TRUE)
summary(fithainan, standardized = TRUE)
summary(fithainan, fit.measures = T)
inspect(fithainan,"cov.lv")
semPaths(fithainan, "std",label.cex=1.8, layout = "tree2",
        curvePivot = T, thresholds = T, edge.label.cex = 1.5,font= 6)

fitMeasures(fithainan, 'all')
fitMeasures(fithainan, c("GFI","agfi","NFI","nnfi","cfi", "rmsea", "srmr"))

attach(Henantree)
modelhenan = '
Intention =~ Attitude + Norms + Control + q16 + past.bhv
Attitude =~ q9 + q10 + q11 + q8
Norms =~ q12 + q13
Behaviour =~ Intention + past.bhv + q14
Control =~ q15 + q14

Attitude ~~ Norms
Attitude ~~ Control
Norms ~~ Control
'

fithenan = sem(modelhenan, data = Henantree, std.lv = TRUE)
summary(fithenan, standardized = TRUE)
summary(fithenan, fit.measures = T)
inspect(fithenan,"cov.lv")
semPaths(fithenan, "std",label.cex=1.8, layout = "tree2",
        curvePivot = T, thresholds = T, edge.label.cex = 1.5,font= 6)
fitMeasures(fithenan, 'all')
fitMeasures(fithenan, c("GFI","agfi","NFI","nnfi","cfi", "rmsea", "srmr"))
```

```
#Hainantree
attach(Hainantree_alp)
Hainantree2=rpart(Hainantree_alp$use~q1+q2+q3+q5+q6+q7+q8+q9+q10+q11+q12
+q13+q14+q15+q30,
                  data=Hainantree_alp, method = "class")
rpart.plot(Hainantree2, extra = 108, box.palette=list("Greens","Reds"), cex = 0.6
)
printcp(Hainantree2)
summary(Hainantree2)
plotcp(Hainantree2)

pruneHainantree2 = prune(Hainantree2,cp=0.012)
plotcp(pruneHainantree2)

prp(pruneHainantree2,extra = 108, box.palette=list("Greens","Reds"),
   cex=1,family="A",font =2, fallen.leaves= T, space = 0.0,
   branch = 1)
predhaiann= predict(pruneHainantree2, type = "class")
table(predhaiann,Hainantree_alp$use)


#PCA analysis for wild animal consumers
> summary(henanpca)
Importance of components:
                          PC1    PC2     PC3     PC4     PC5
Standard deviation     1.6441 1.3130 1.18956 1.11232 1.06895
Proportion of Variance 0.1689 0.1078 0.08844 0.07733 0.07142
Cumulative Proportion  0.1689 0.2767 0.36514 0.44247 0.51388
                           PC6     PC7     PC8     PC9   PC10
Standard deviation     1.01282 0.96936 0.93759 0.89490 0.8699
Proportion of Variance 0.06411 0.05873 0.05494 0.05005 0.0473
Cumulative Proportion  0.57800 0.63673 0.69167 0.74172 0.7890
                          PC11    PC12    PC13    PC14    PC15
Standard deviation     0.83687 0.79822 0.78220 0.71427 0.70682
Proportion of Variance 0.04377 0.03982 0.03824 0.03189 0.03122
Cumulative Proportion  0.83279 0.87261 0.91085 0.94274 0.97396
                          PC16
Standard deviation     0.64544
Proportion of Variance 0.02604
Cumulative Proportion  1.00000
> summary(hainanpca)
Importance of components:
                          PC1    PC2     PC3     PC4     PC5
Standard deviation     1.8225 1.4186 1.14507 1.03208 1.02577
Proportion of Variance 0.2076 0.1258 0.08195 0.06657 0.06576
Cumulative Proportion  0.2076 0.3334 0.41533 0.48191 0.54767
                           PC6    PC7     PC8    PC9    PC10
Standard deviation     0.95505 0.9295 0.89158 0.8791 0.84429
```

```
Proportion of Variance 0.05701 0.0540 0.04968 0.0483 0.04455
Cumulative Proportion  0.60468 0.6587 0.70836 0.7567 0.80122
                       PC11    PC12    PC13    PC14    PC15
Standard deviation     0.79331 0.76760 0.75351 0.70590 0.68835
Proportion of Variance 0.03933 0.03683 0.03549 0.03114 0.02961
Cumulative Proportion  0.84055 0.87738 0.91287 0.94401 0.97362
                       PC16
Standard deviation     0.64964
Proportion of Variance 0.02638
Cumulative Proportion  1.00000

# demographic variable and wild animal consumer glm
> henandemoglm=glm(Henantree_num_demo$use~., data = Henantree_num_demo)
> summary(henandemoglm)

Call:
glm(formula = Henantree_num_demo$use ~ ., data = Henantree_num_demo)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.16068  -0.09547  -0.07266  -0.05139   0.97425

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.086708   0.067858   1.278    0.202
q1          -0.002275   0.003767  -0.604    0.546
q2          -0.014480   0.015598  -0.928    0.353
q3           0.010061   0.009309   1.081    0.280
q4          -0.027156   0.016978  -1.599    0.110
q5          -0.002994   0.002304  -1.300    0.194
q6           0.007072   0.006880   1.028    0.304
q7           0.014225   0.015667   0.908    0.364

(Dispersion parameter for gaussian family taken to be 0.07078726)

    Null deviance: 86.763  on 1220  degrees of freedom
Residual deviance: 85.865  on 1213  degrees of freedom
AIC: 241.72

Number of Fisher Scoring iterations: 2

> step.henandemo=stepAIC(henandemoglm,direction = "both",
+                        trace = FALSE)
> summary(step.henandemo)

Call:
glm(formula = Henantree_num_demo$use ~ q4 + q5, data = Henantree_num_demo)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
```

```
-0.10205  -0.09844  -0.06954  -0.05955   0.96934

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.140935   0.024461   5.762 1.05e-08 ***
q4          -0.035276   0.015947  -2.212   0.0271 *
q5          -0.003611   0.002161  -1.671   0.0950 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 0.07076684)

    Null deviance: 86.763  on 1220  degrees of freedom
Residual deviance: 86.194  on 1218  degrees of freedom
AIC: 236.39

Number of Fisher Scoring iterations: 2

> lm.beta(step.henandemo)

Call:
glm(formula = Henantree_num_demo$use ~ q4 + q5, data = Henantree_num_demo)

Standardized Coefficients::
(Intercept)          q4          q5
  0.0         -0.06324230 -0.04777425

#TPB variables and wildlife product consumer glm
> henantpbglm=glm(Henantree_num_TPB$use~., data = Henantree_num_TPB)
> summary(henantpbglm)

Call:
glm(formula = Henantree_num_TPB$use ~ ., data = Henantree_num_TPB)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.43961  -0.11141  -0.04976   0.01472   1.05828

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.384981   0.055143   6.982 4.80e-12 ***
q8           0.027395   0.010200   2.686 0.007332 **
q9          -0.012470   0.007696  -1.620 0.105414
q10          -0.011705   0.008472  -1.382 0.167336
q11          -0.021367   0.008197  -2.607 0.009254 **
q12          -0.036275   0.009311  -3.896 0.000103 ***
q13          -0.014093   0.007744  -1.820 0.069013 .
q14           0.150337   0.026505   5.672 1.76e-08 ***
q15          -0.008073   0.004777  -1.690 0.091310 .
q30           0.021059   0.009752   2.159 0.031016 *
```

```
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 0.06183821)

    Null deviance: 86.763  on 1220  degrees of freedom
Residual deviance: 74.886  on 1211  degrees of freedom
AIC: 78.678

Number of Fisher Scoring iterations: 2

> step.henantpb=stepAIC(henantpbglm,direction = "both",
+                       trace = FALSE)

> lm.beta(step.henantpb)

Call:
glm(formula = Henantree_num_TPB$use ~ q8 + q9 + q11 + q12 + q13 +
    q14 + q15 + q30, data = Henantree_num_TPB)

Standardized Coefficients::
(Intercept)          q8          q9         q11         q12
 0.00000000  0.07520614 -0.07819338 -0.08472268 -0.12482839
        q13         q14         q15         q30
-0.05670946  0.15910711 -0.05182913  0.06092156


#demographic variable and pangolin consumption behaviour glm

attach(henandemo)
fit.henandemo = glm(henandemo$use~.,data= henandemo)
summary(fit.henandemo)


attach(hainandemo)
fit.hainandemo = glm(hainandemo$use~.,data= hainandemo)
summary(fit.hainandemo)

> fit.hainandemo = glm(hainandemo$use~.,data= hainandemo)
> summary(fit.hainandemo)

Call:
glm(formula = hainandemo$use ~ ., data = hainandemo)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-0.26331  -0.11253  -0.08941  -0.06998   0.95439

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
```

```
(Intercept)  0.178635   0.072643   2.459   0.0141 *
q1          -0.001181   0.005247  -0.225   0.8220
q2          -0.016091   0.019801  -0.813   0.4166
q3          -0.013547   0.012773  -1.061   0.2892
q4          -0.003870   0.006111  -0.633   0.5267
q5          -0.001347   0.003170  -0.425   0.6709
q6           0.022749   0.009439   2.410   0.0161 *
q7          -0.022176   0.016726  -1.326   0.1852
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 0.0882555)

    Null deviance: 83.867  on 946  degrees of freedom
Residual deviance: 82.872  on 939  degrees of freedom
AIC: 398.57

Number of Fisher Scoring iterations: 2

> hainandemo.step=stepAIC(fit.hainandemo,direction = "both",
+                 trace = FALSE)
> summary(hainandemo.step)

Call:
glm(formula = hainandemo$use ~ q6, data = hainandemo)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-0.21814  -0.10141  -0.07806  -0.07806   0.92194

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.054717   0.018463   2.964  0.00312 **
q6          0.023347   0.008453   2.762  0.00586 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 0.0880374)

    Null deviance: 83.867  on 946  degrees of freedom
Residual deviance: 83.195  on 945  degrees of freedom
AIC: 390.26

Number of Fisher Scoring iterations: 2

> lm.beta(hainandemo.step)

Call:
glm(formula = hainandemo$use ~ q6, data = hainandemo)
```

```
Standardized Coefficients::
(Intercept)          q6
 0.00000000  0.08948723

> summary(fit.henandemo)

Call:
glm(formula = henandemo$use ~ ., data = henandemo)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.15155  -0.08726  -0.06916  -0.04694   0.98788

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.078120   0.065042  -1.201   0.2300
q1           0.002968   0.003611   0.822   0.4113
q2           0.027075   0.014951   1.811   0.0704 .
q3           0.006614   0.008923   0.741   0.4587
q4          -0.007655   0.016273  -0.470   0.6382
q5          -0.003057   0.002208  -1.384   0.1665
q6           0.006866   0.006594   1.041   0.2980
q7           0.030897   0.015017   2.057   0.0399 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 0.06503273)

    Null deviance: 79.943  on 1220  degrees of freedom
Residual deviance: 78.885  on 1213  degrees of freedom
AIC: 138.19

Number of Fisher Scoring iterations: 2
> henandemo.step=stepAIC(fit.henandemo,direction = "both",
+                        trace = FALSE)
> summary(henandemo.step)

Call:
glm(formula = henandemo$use ~ q2 + q6 + q7, data = henandemo)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.15281  -0.08689  -0.06954  -0.04832   0.99524

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.09859    0.05199  -1.896   0.0582 .
q2           0.02739    0.01494   1.834   0.0669 .
q6           0.01118    0.00609   1.835   0.0667 .
q7           0.03239    0.01473   2.199   0.0281 *
```

```
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 0.06502486)

    Null deviance: 79.943  on 1220  degrees of freedom
Residual deviance: 79.135  on 1217  degrees of freedom
AIC: 134.07

Number of Fisher Scoring iterations: 2

> library(lm.beta)
> lm.beta(henandemo.step)

Call:
glm(formula = henandemo$use ~ q2 + q6 + q7, data = henandemo)

Standardized Coefficients::
(Intercept)          q2          q6          q7
 0.00000000  0.05272677  0.05377807  0.06404509

#pangolin consumer in Hainan glm using knowledge and attitude variables

> fit.hainanall = glm(Hainan_pconsumer_0601$use~.,data= Hainan_pconsumer_0601,
family = "binomial")
> summary(fit.hainanall)

Call:
glm(formula = Hainan_pconsumer_0601$use ~ ., family = "binomial",
    data = Hainan_pconsumer_0601)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.9067  -0.4181  -0.2659  -0.1779   3.2791

Coefficients:
                  Estimate Std. Error z value Pr(>|z|)
(Intercept)        2.97118    1.09737   2.708 0.006778 **
q8                 0.03530    0.11991   0.294 0.768482
q9                -0.19592    0.10529  -1.861 0.062773 .
q10                0.12549    0.10726   1.170 0.242054
q11               -0.22508    0.11638  -1.934 0.053116 .
q12               -0.31133    0.14471  -2.151 0.031442 *
q13               -0.29087    0.11500  -2.529 0.011427 *
q14               -0.16392    0.10432  -1.571 0.116095
q15                0.06619    0.08046   0.823 0.410695
q19               -0.02321    0.07793  -0.298 0.765860
q20_eco           -1.47292    0.85393  -1.725 0.084552 .
q20_med           -1.55100    0.86890  -1.785 0.074259 .
q20_pop           -1.62391    0.83141  -1.953 0.050797 .
```

```
q20_cul              -15.70882  649.21855  -0.024 0.980696
q20_tra               -2.69292    1.29819  -2.074 0.038045 *
q20_foo               -1.13207    0.81361  -1.391 0.164102
q20_orna              -2.41055    1.60705  -1.500 0.133619
q20_don               -2.17416    0.84942  -2.560 0.010480 *
q21_TV                -0.93011    0.27055  -3.438 0.000586 ***
q21_boardcast          0.67049    0.34680   1.933 0.053194 .
q21_campaignad         0.15397    0.35245   0.437 0.662214
`q21_hosp/pharm`       0.71884    0.34868   2.062 0.039243 *
`q21_zoo/museum`      -0.27209    0.42316  -0.643 0.520224
`q21_market/restaurant`  0.68290  0.42189   1.619 0.105518
`q21_online/papernews`  -0.79244  0.35622  -2.225 0.026111 *
`q21_books/journals`    0.19325    0.30956   0.624 0.532444
`q21_friends/family`    0.21960    0.31170   0.705 0.481105
q21_wild               0.68635    0.37866   1.813 0.069894 .
q21_farm               1.17428    0.47669   2.463 0.013763 *
q21_other             -0.46114    0.91010  -0.507 0.612367
q30                   0.32399    0.14695   2.205 0.027472 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 608.20  on 946  degrees of freedom
Residual deviance: 469.32  on 916  degrees of freedom
AIC: 531.32

Number of Fisher Scoring iterations: 14

> hainanall.step=stepAIC(fit.hainanall,direction = "both",
+                        trace = FALSE)
> summary(hainanall.step)

Call:
glm(formula = Hainan_pconsumer_0601$use ~ q9 + q11 + q12 + q13 +
    q20_tra + q20_don + q21_TV + q21_boardcast + `q21_hosp/pharm` +
    `q21_market/restaurant` + `q21_online/papernews` + q21_wild +
    q21_farm + q30, family = "binomial", data = Hainan_pconsumer_0601)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.6818  -0.4228  -0.2816  -0.1926   3.2117

Coefficients:
                  Estimate Std. Error z value Pr(>|z|)
(Intercept)         1.1841     0.5919   2.000 0.045462 *
q9                 -0.1575     0.0953  -1.653 0.098322 .
q11                -0.2025     0.1082  -1.872 0.061213 .
q12                -0.2833     0.1329  -2.132 0.033011 *
q13                -0.2751     0.1080  -2.548 0.010837 *
```

```
q20_tra                -2.0312     1.1178  -1.817 0.069184 .
q20_don                -0.4871     0.2980  -1.635 0.102132
q21_TV                 -0.9299     0.2583  -3.600 0.000318 ***
q21_boardcast           0.6258     0.3194   1.959 0.050094 .
`q21_hosp/pharm`        0.8033     0.3285   2.445 0.014465 *
`q21_market/restaurant` 0.6905     0.4086   1.690 0.091051 .
`q21_online/papernews`  -0.6761     0.3373  -2.004 0.045020 *
q21_wild                0.5519     0.3579   1.542 0.123065
q21_farm                1.0106     0.4471   2.261 0.023786 *
q30                     0.3086     0.1396   2.211 0.027066 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 608.20  on 946  degrees of freedom
Residual deviance: 482.51  on 932  degrees of freedom
AIC: 512.51

Number of Fisher Scoring iterations: 6

> lm.beta(hainanall.step)

Call:
glm(formula = Hainan_pconsumer_0601$use ~ q9 + q11 + q12 + q13 +
    q20_tra + q20_don + q21_TV + q21_boardcast + `q21_hosp/pharm` +
    `q21_market/restaurant` + `q21_online/papernews` +
    q21_wild + q21_farm + q30, family = "binomial", data = Hainan_pconsumer_0601)

Standardized Coefficients::
          (Intercept)                    q9
            0.0000000            -0.7689631
                  q11                   q12
           -0.8477501            -0.9958826
                  q13                q20_tra
           -1.2294418            -0.9814055
              q20_don                 q21_TV
           -0.6502517            -1.5215468
        q21_boardcast        `q21_hosp/pharm`
            0.7879309             0.7915908
`q21_market/restaurant`  `q21_online/papernews`
            0.5563326            -0.9486514
             q21_wild              q21_farm
            0.5157505             0.6664706
                  q30
            0.7936113

> fit.henanall = glm(Henan_pconsumer_0601$use~.,data= Henan_pconsumer_0601,
family = "binomial")
> summary(fit.henanall)
```

```
Call:
glm(formula = Henan_pconsumer_0601$use ~ ., family = "binomial",
    data = Henan_pconsumer_0601)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.2944  -0.3775  -0.2839  -0.2084   2.9304

Coefficients:
                                Estimate Std. Error z value Pr(>|z|)
(Intercept)                     -2.232821   1.418296  -1.574 0.115419
q8                              -0.053487   0.178055  -0.300 0.763876
q9                              -0.090588   0.121159  -0.748 0.454653
q10                              0.090232   0.141548   0.637 0.523823
q11                              0.008922   0.135170   0.066 0.947372
q12                             -0.178737   0.152152  -1.175 0.240104
q13                             -0.155973   0.129533  -1.204 0.228545
q14                             -0.135679   0.102767  -1.320 0.186749
q15                              0.040622   0.080582   0.504 0.614184
q19                             -0.027523   0.082164  -0.335 0.737639
q20_eco                         -1.582278   1.151036  -1.375 0.169238
q20_med                          1.805321   0.998803   1.807 0.070687 .
q20_pop                         -0.488655   1.125578  -0.434 0.664189
q20_cul                          0.818203   1.161546   0.704 0.481178
q20_tra                          0.886019   0.974361   0.909 0.363174
q20_foo                         -0.834038   1.214570  -0.687 0.492275
q20_don                          1.046062   1.014249   1.031 0.302369
q21_TV                          -0.590964   0.253879  -2.328 0.019926 *
q21_boardcast                    0.056364   0.445691   0.126 0.899364
q21_campaignad                  -0.345955   0.377215  -0.917 0.359075
`q21_hosp/pharm`                 1.155141   0.297141   3.888 0.000101 ***
`q21_zoo/museum`                -0.036958   0.337335  -0.110 0.912758
`q21_market/restaurant` -1.120207   0.827166  -1.354 0.175650
`q21_online/papernews`  -0.128480   0.285406  -0.450 0.652590
`q21_books/journals`    -0.471098   0.292856  -1.609 0.107696
`q21_friends/family`     0.204452   0.377701   0.541 0.588295
q21_wild                 1.479991   0.756146   1.957 0.050314 .
q21_farm                 1.481160   0.941146   1.574 0.115538
q21_other               -0.216753   0.788051  -0.275 0.783278
q30                      0.273881   0.144200   1.899 0.057523 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 622.12  on 1220  degrees of freedom
Residual deviance: 530.85  on 1191  degrees of freedom
AIC: 590.85
```

```
Number of Fisher Scoring iterations: 7

> henanall.step=stepAIC(fit.henanall,direction = "both",
+                       trace = FALSE)
> summary(henanall.step)

Call:
glm(formula = Henan_pconsumer_0601$use ~ q13 + q14 + q20_eco +
    q20_med + q21_TV + `q21_hosp/pharm` + `q21_books/journals` +
    q21_wild + q30, family = "binomial", data = Henan_pconsumer_0601)

Deviance Residuals:
   Min      1Q  Median      3Q     Max
-1.1802  -0.3766  -0.2909  -0.2279   2.8740

Coefficients:
                  Estimate Std. Error z value Pr(>|z|)
(Intercept)        -1.68518    0.60833  -2.770  0.00560 **
q13                -0.18461    0.11243  -1.642  0.10060
q14                -0.15591    0.09548  -1.633  0.10249
q20_eco            -2.12954    1.01963  -2.089  0.03675 *
q20_med             0.86687    0.27146   3.193  0.00141 **
q21_TV             -0.61378    0.23891  -2.569  0.01020 *
`q21_hosp/pharm`    1.13661    0.27852   4.081 4.49e-05 ***
`q21_books/journals` -0.50205    0.27972  -1.795  0.07269 .
q21_wild            1.40814    0.65451   2.151  0.03144 *
q30                 0.26258    0.13893   1.890  0.05876 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

   Null deviance: 622.12  on 1220  degrees of freedom
Residual deviance: 541.78  on 1211  degrees of freedom
AIC: 561.78

Number of Fisher Scoring iterations: 7

> library(lm.beta)
> lm.beta(henanall.step)

Call:
glm(formula = Henan_pconsumer_0601$use ~ q13 + q14 + q20_eco +
    q20_med + q21_TV + `q21_hosp/pharm` + `q21_books/journals` +
    q21_wild + q30, family = "binomial", data = Henan_pconsumer_0601)

Standardized Coefficients::
      (Intercept)               q13               q14
        0.0000000        -0.7631037        -0.7104907
          q20_eco            q20_med             q21_TV
```

-2.3925519 1.2687464 -1.1355360
`q21_hosp/pharm` `q21_books/journals` q21_wild
1.5263104 -0.8857133 0.6258245
q30
0.7752380