Potential applications of hunters' knowledge for the conservation of pangolins in Vietnam.

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Abstract

Pangolins are one of the most valuable and widely traded taxon in the Southeast Asian illegal wildlife trade, yet little is known of their ecology and they are rarely reported in biodiversity surveys. This study mapped the range of the pangolins *Manis pentadactyla* and *Manis javanica* in Vietnam from field reports, and demonstrated that data of their distribution derives largely from the knowledge of local people. Semi-structured interviews with hunters revealed species differences and inter-site variability in the methods used to catch pangolins, and suggest that ecological differences between the species confer a higher hunting threat on populations of *M. pentadactyla*. The illegal trade in pangolins continues to form a profitable enterprise for those able to locate and catch them in the wild.

Introduction

The wildlife trade represents a key threat to global biodiversity (Bennett et al. 2002). Plants and animals are sold or exchanged as food, traditional medicine, trophies, decorations, pets, religious objects and zoo exhibits (Bennett & Rao 2002; Broad et al. 2003; Anon 2005a). In the early 1990s, the wildlife trade (excluding fisheries and timber) was valued at US $15bn per year (IIED & TRAFFIC 2002; Broad et al. 2003). More than 50% of the trade is believed to be illegal, constituting one of the most lucrative kinds of trans-national criminality (Nooren & Claridge 2001; Warchol 2004).

Intense hunting to supply the illegal wildlife trade has severely depleted the biodiversity of Asian tropical forests (Bennett et al. 2002; Fa et al. 2002). Although people have hunted mammals in these habitats for at least 40,000 years, regional declines in most species have occurred largely within the last 50 years (Corlett 2007). As the value of wildlife in markets has escalated with increasing demand and decreasing supply, hunting purely for trade is eclipsing hunting primarily for subsistence (Roberton et al. 2004; Sterling et al. 2006).

Over the past two decades, Vietnam has become an important link in the international wildlife trade network, acting as a conduit for exports from other Southeast Asian countries, such as Lao PDR and Cambodia, to international markets in Asia, Europe and America (Compton & Le 1998; Roberton & Bell in prep.). Increased market access through improved transport and communications infrastructure has prompted the development in Vietnam of an extensive illegal industry (Bell et al. 2004). Vietnam is consequently a critical country for wildlife conservation in Southeast Asia. With a population density of 256 people per square km (UN 2006), a rapidly expanding economy and strong hunting tradition, the country's natural resources are under increasingly high pressure (Sterling et al. 2006). Mammal populations have been severely depleted, being targeted primarily for the wild meat industry and for

traditional medicine (Roberton & Bell in prep.). The mammals considered at greatest risk as a result of over-hunting for the wildlife trade include primates, bears, cats, civets, Asian elephant, wild cattle, deer and pangolins (Roberton et al. 2004; Anon 2005b). Many target species have been reduced to such low levels that traders now acquire wildlife products from further afield, even outside the region. For example, the two species of pangolin indigenous to Vietnam, *Manis pentadactyla* and *Manis javanica*, are both widely believed to be experiencing rapid population declines and most pangolins confiscated in Vietnam recently have been in shipments from other countries in Southeast Asia (CEPF 2005).

Pangolins (order: Pholidota; *Manis* spp.) are insectivorous mammals confined to the Afrotropical and Indomalayan regions (Corbet & Hill 1992). With the recent proposal that the Palawan pangolin *M. culionensis* should be regarded as distinct from the Sunda pangolin *M. javanica*, the genus is now considered to comprise eight extant species (Gaubert & Antunes 2005; Table 1). Pangolins are largely nocturnal and have adapted to a highly specialized diet of ants and termites (Lekagul & McNeely 1988). They possess powerful foreclaws for digging at the base of termite mounds and to break open ants' nests, and use their long tongues to harvest the insects (Nowak 1999). Some species, including *M. pentadactyla*, are thought to be mainly terrestrial, living in ground burrows, whilst others, including *M. javanica*, are more arboreal, climbing proficiently with prehensile tails (Allen 1938; IUCN in prep.). As a defence against natural predators such as tigers, pangolins roll themselves into tight balls, protected by their thick scales (Nowak 1999). This defence is inadequate protection against human aggressors, however, and pangolin populations have suffered heavily from anthropogenic persecution for several decades (Baltzer et al. 2001; IUCN in prep.).

Table 1. Pangolin species and their IUCN Red List status.

Continent	*Species*		*IUCN Red List status*
	English name	*Scientific name*	
Africa	Giant pangolin	*M. gigantea*	LR/lc
	Cape pangolin	*M. temminckii*	LR/nt
	Long-tailed pangolin	*M. tetradactyla*	LR/lc
	Tree pangolin	*M. tricuspis*	LR/lc
Asia	Indian pangolin	*M. crassicaudata*	LR/nt*
	Palawan pangolin	*M. culionensis*	N/A**
	Sunda pangolin	*M. javanica*	LR/nt*
	Chinese pangolin	*M. pentadactyla*	LR/nt*

* GMA proposed upgrade to EN ** not yet assessed

With the exception of *M. culionensis*, all Asiatic pangolin species are classified as 'Lower Risk: near threatened' by the IUCN (2006) and appear in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, with a zero annual export quota for wild caught individuals or those traded for commercial purposes (CITES 2007). Despite this protection, pangolins are traded widely, being highly valued for both their meat, which is considered a delicacy, and for their scales, which are used for traditional medicine (Duckworth et al. 1999; Baltzer et al. 2001; Ellis 2005). Additional pressure results from the large-scale and rapid loss of their forest habitat (CEPF 2005). Consequently, pangolins are considered by many as amongst the most threatened species of mammal in Asia (Davies 2005), and a recent IUCN/SSC Global Mammal Assessment (GMA) workshop has proposed to upgrade the three near-threatened species to endangered (IUCN in prep.).

To assess a species' conservation needs, it is critical to understand its distribution and population status in the wild. Insufficient data are available on pangolin populations to enable such an assessment to be conducted. The captive behaviour and husbandry of *M. pentadactyla* is well documented (Heath & Vanderlip 1988; Chen et al. 2005), as is the ecology of the African species *M. temminckii* (Jacobsen et al. 1991; Richer et al. 1997; Swart et al. 1999). However, only a limited number of studies have examined wild populations of Asiatic species (e.g. Wu et al. 2003; Lim & Ng 2007). One of the major impediments to studying wild pangolins is the difficulty in locating them. In many areas where biodiversity surveys have been conducted no pangolins are recorded, even when substantial work is carried out by night (Duckworth et al. 1999). The suitability of social surveys as a mechanism for aiding pangolin conservation has been recently explored (Phallika & Sopheak, in prep.), and the potential for radio-tracking wild-caught pangolins to monitor home-range size and habitat utilisation has also been demonstrated (Heath & Coulson 1997a & 1997b; Lim & Ng 2007). These studies have been conducted in areas with uniquely high pangolin densities, however, and there remains a need to develop field detection and monitoring methodologies applicable to areas with heavily depleted populations.

This study examined the hypothesis that the Asiatic pangolins *M. pentadactyla* and *M. javanica* are rarely recorded in biodiversity studies and that standard ecological monitoring techniques are not well suited to the detection and surveying of pangolin populations. Since hunters apparently continue to extract large numbers of pangolins annually, local people were questioned about the methodologies that they use to locate and catch *Manis* species in Vietnam. A greater understanding of hunting practices may guide future studies of wild pangolin ecology and provide direction for the development of a field detection methodology for *M. pentadactyla* and *M. javanica*, as well as furthering our understanding of the harvesting and illegal trade of these species.

Methods

Systematic review of museum holdings and biodiversity surveys

Field reports of *Manis pentadactyla* and *Manis javanica* were systematically collected from literature reports of conservation non-governmental organisations (NGOs) currently working in Vietnam (including Fauna & Flora International, Birdlife Indochina, WWF Vietnam Programme and the International Union for the Conservation of Nature). Records were also sourced from museum holdings (including the Vietnam National University in Hanoi, the Institute of Ecology and Biological Resources in Hanoi, the American Museum of Natural History in New York, the Museum Nationale d'Histoire Naturelle in Paris, Raffles Museum in Singapore, the Natural History Museum in London and the online Global Biodiversity Information Facility database), from published literature and from reliable, unpublished observations. The study was based in Vietnam but records were collated from all Southeast Asian countries.

All available field records were compiled into a database using the following categories: species, location of record (name of province, district, commune and protected area), geographic coordinates, type of record (observation, camera trap, tracks, specimen, interview or literature review) and survey date. Altitude (metres) and forest/habitat type were recorded when available. Field records from observations by reliable observers, photo-traps, tracks and signs (which are considered easily identifiable for *Manis* species) and specimens found in the field were classed as 'confirmed records', whilst interview reports, specimens in hunters' homes and confiscated animals were classed as 'unconfirmed reports'. All methods employed by a particular survey were recorded, whether successful in recording pangolin presence or not.

Details of camera-trap surveys were sourced from NGOs and individuals working in the region, and compiled into a database with categories of survey effort, total number of photographs taken and the number of photographs of pangolins.

1. Distribution map

GIS layers of protected areas and political boundaries (province, district and commune) for Vietnam were obtained from the Vietnamese Forest Inventory and Planning Institute. Both confirmed records and unconfirmed reports for each species were incorporated into a GIS layer using ArcMap (Ver. 9.1). Data points were omitted from the analysis if the location was not recorded more accurately than at a provincial level or if the location could not be found. The majority of reports lacked precise map coordinates so location was plotted at a central point within the area identified (e.g. at commune or protected area level).

2. Survey effort

Annual biodiversity survey effort was measured as the number of surveys which primarily or secondarily assessed the diversity of mammals within an area of mapped *Manis* distribution within a particular year. It would have been preferable to take into account the number of survey hours invested by each study in different habitats, but this information was rarely available and was never characterised with respect to how time was divided between alternative survey activities. The two species were considered collectively, since a large number of records reported '*Manis* spp.' rather than identifying an individual to species level. Survey effort was plotted against year, with the date of the survey defined as the end of the field work period. If this date were not provided, the publication date of the survey was used instead. Surveys from 2005 and 2006 were excluded from the analysis since the delay in publications becoming available means that these years had a very low apparent survey effort (mean lag time from end of survey to publication = 9 months, $N = 90$; therefore 2 years is a conservative estimate to allow publications to become available in NGO libraries).

3. Survey Assessment

Field surveys were identified which listed all methodologies employed to assess the biodiversity of a particular site. All surveys that recorded the presence of one or more *Manis* species, and which reported the method used to do so, were used to assess the relative success of alternative biodiversity monitoring methodologies. These methods included standard ecological methods (line-transects and field sightings, records of tracks and signs, camera-traps) and secondary data methods (interviews with hunters, specimens found in villagers' homes). Many surveys did not differentiate between line transects conducted in daylight hours and those that used a spotlight at night and so all field sightings (whether diurnal or nocturnal) were grouped together.

Chi-square (χ^2) analyses were used to test for associations between alternative survey methods and their success in recording pangolin presence. Surveys which failed to record *Manis* presence by any method were excluded even if the study area was located within the known range of one or both species, to avoid inferring an apparent failure of the survey to record pangolins when they may not have been present in the actual study site. Surveys that recorded *Manis* presence but did not state the method used, or that recorded *Manis* presence from a literature review, were also excluded from the analysis since it was likely that this would result in a replication of records. Since identification to species level was not necessarily reliable, the genus, which is unmistakable, was considered collectively. Despite this, considerable variance undoubtedly existed in survey robustness and reliability, with teams investing varying degrees of experience and effort, and seasonal effects may have additionally influenced the likelihood of detection.

Hunter Interviews

Study Areas

Interviews were conducted with hunters living in villages around protected areas in northern and central Vietnam, between April and June 2007. Three study sites were sampled, with interviews conducted around Cuc Phuong National Park (20.14° - 20.24°N and 105.29° - 105.44°E), the contiguous area comprising Ke Go Nature Reserve (18.00° - 18.15°N and 105.83° - 106.12°E) and Khe Net State Forest Enterprise (also a proposed Nature Reserve) (18.02°N and 105.58°E), and Song Thanh Nature Reserve (15.13° - 15.41°N and 107.21° - 107.50°E; Fig. 1). Cuc Phuong National Park (CPNP) is dominated by limestone forest (max. elevation 636m), whilst Khe Go Nature Reserve and Khe Net (KGKN) are lowland evergreen forest areas (max. elevation 400m) and Song Thanh Nature Reserve (STNR) is an evergreen forest (max. elevation >1000m) (BirdLife Indochina 2007). All three sites are within the published range of one or both species of pangolin. Recent IUCN maps from the Global Mammal Assessment suggest that CPNP is within the range of just *M. pentadactyla*, that STNR is within the range of just *M. javanica* and that KGKN is within the range of both species (IUCN in prep.). Selection of these sites therefore offered the opportunity to examine hunting practices in areas in which each species lived independently, and in one area where they were believed to co-exist.

Interviews

Pangolin hunters living in the proximity of the three sites in Vietnam were questioned about their knowledge of pangolin ecology, historic and contemporary pangolin hunting practices, and the characteristics of the trade in pangolins. Potential interviewees were identified on the basis of their reputation as hunters knowledgeable about pangolins. Initial recommendations came from Commune and Village leaders, with a subsequent respondent-driven sampling method (Salganik & Heckathorn 2004), as previous interviewees inferred or

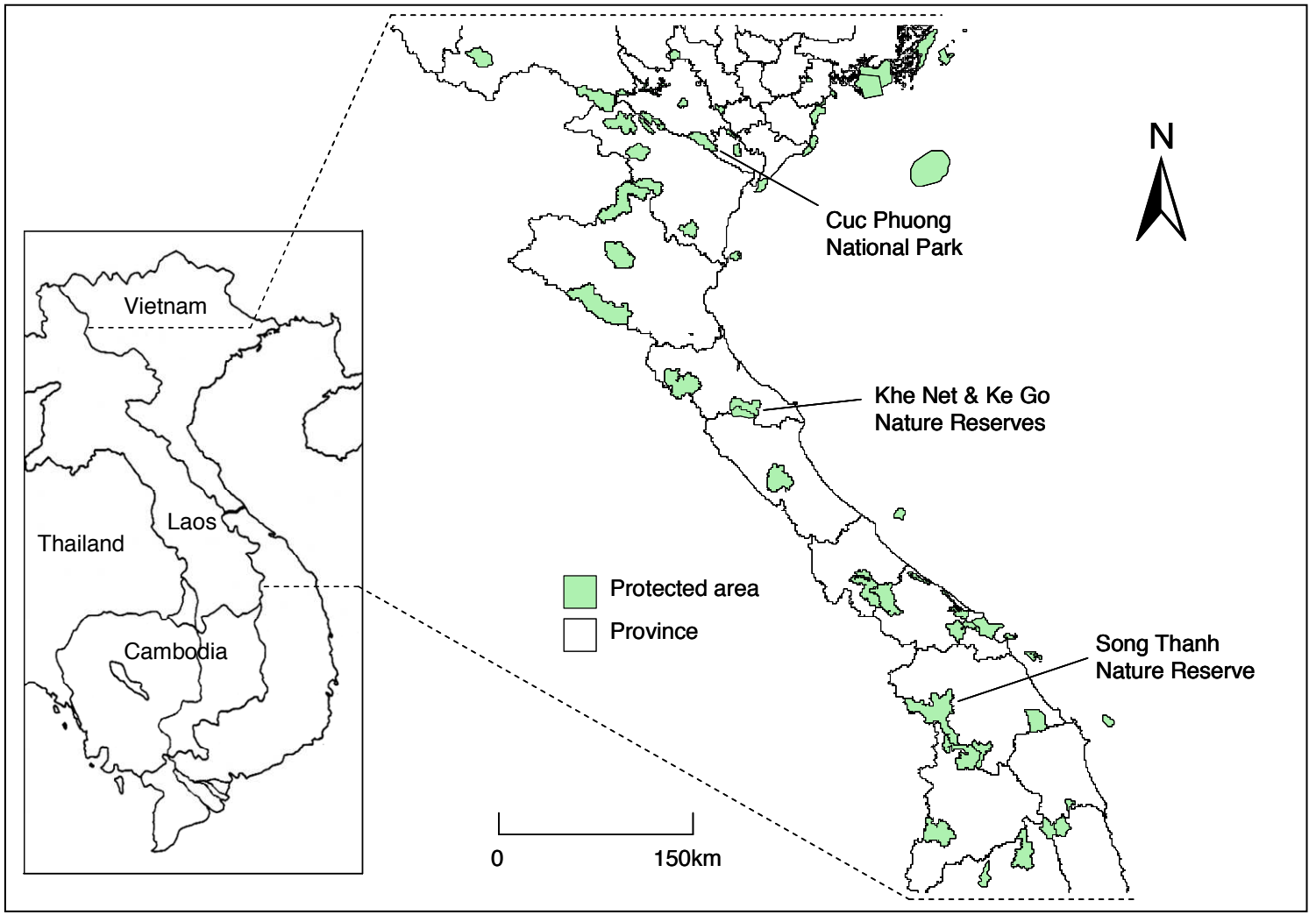

Figure 1. Location of study sites for semi-structured interviews with pangolin hunters in Vietnam.

named experienced pangolin hunters in neighbouring villages or communes. Interviewees were selected according to their availability and their willingness to participate in an informal interview with researchers. Since it is illegal to hunt in protected areas or to trade a pangolin without a permit, the issues discussed were extremely sensitive and complete random sampling within the hunter population was not possible. This selection method was a feasible means of accessing the population and a realistic surrogate given the restrictions of time and the sensitive nature of the study topic.

Interviews were conducted with a total of 84 hunters (34 around CPNP, 24 around KGKN and 26 around STNR) in 41 villages. Interviews were conducted by a two-person team, on occasion accompanied by a member of the local community, and lasted between 35 and 170 minutes (mean = 90 minutes, $N = 84$). Questions and answers were translated from and into English and Vietnamese by one of the research team members. Interviews were semi-structured, each following a similar pattern within the guidance of an interview framework (Huntington 2000), but precise questions were not pre-determined so that the conversation was able to flow and interesting lines of discussion could be pursued (Bernard 2000). Open questioning was employed wherever possible, to avoid leading the interviewee into an answer. All dialogue (including uncertain or negative answers) was recorded in notebooks by one of the interviewers, and uncertainties were clarified between team members as soon as possible after the interview.

4. Species presence, status & ecology

It was frequently not possible to obtain a response to every question from all interviewees, since interviews varied highly in content, length and interviewee attitude and knowledge. There were also often an unlimited number of possible responses to a given question. Response frequencies are therefore presented in the results as percentages in the format x% (y/z), where y is the number of interviewees that gave a particular response and z is the total

number of interviewees that were asked the question, including those that gave an alternative answer or were unable to provide an answer.

5. Hunting practices

It was possible to infer from each interview the relative extent to which an individual hunter used a particular hunting method, and to categorise each method according to whether that hunter had used it predominantly, frequently, rarely or never to catch pangolins. Log-linear analyses were used to test for differences in hunting method use between species and between study sites. Fisher's exact test was used to test 2 x 2 contingency associations.

6. Trade

A one-way independent ANOVA was used to test for differences in the date that hunters reported beginning to sell pangolins to commercial traders from outside the village rather than selling or trading them for local consumption. A general linear model was used to test for a change in the reported price of pangolin per kg since 1990, with respondent and study site initially included as fixed factors. Reported values were adjusted to 1990 prices to account for annual inflation rates, which were conservatively taken to be 10% from 1990-1997 (UNICEF 2007) and 4% from 1997-2007, except 1998 which was 9.2% (US Department of State 2007).

Results

A total of 196 field records of *Manis pentadactyla* and *Manis javanica* were compiled from biodiversity surveys, with an additional 357 records collated from museum holdings.

1. Distribution map

The plot of *M. pentadactyla* and *M. javanica* field records indicates that the two species have largely separate geographic distributions within Vietnam, with a clear latitudinal distinction (Fig. 2). Confirmed records were limited in number for both species (see Appendix 1), but those of *M. pentadactyla* were from the northern provinces whilst those of *M. javanica* were from the southern provinces. There was a region of overlap of the two species in the central provinces between Da Nang and Ha Tinh (most southerly confirmed record of *M. pentadactyla* = 16.0°N; most northerly confirmed record of *M. javanica* = 18.5°N). Unconfirmed records showed the same trend although were less distinctly separated.

2. Survey effort

Annual biodiversity survey effort significantly increased during the period 1989 to 2004 (r = 0.67, p = 0.005), as did the number of confirmed records per survey of the species *M. pentadactyla* and *M. javanica* (Fig. 3).

3. Survey Assessment

A minority of records (17%, 34/196) of the two species were confirmed records from standard ecological survey techniques (i.e. line transects, detection of tracks and signs and camera-trapping). Most were unconfirmed reports (83%, 162/196) from methods that drew upon the knowledge of local people (i.e. interviews and examining specimens in hunters' houses). There was a significant association between the different methods used and the relative frequency with which they recorded pangolin presence, with interviews being the most successful method ($\chi^2 = 75.35$, df = 4, $p < 0.001$; Fig. 4).

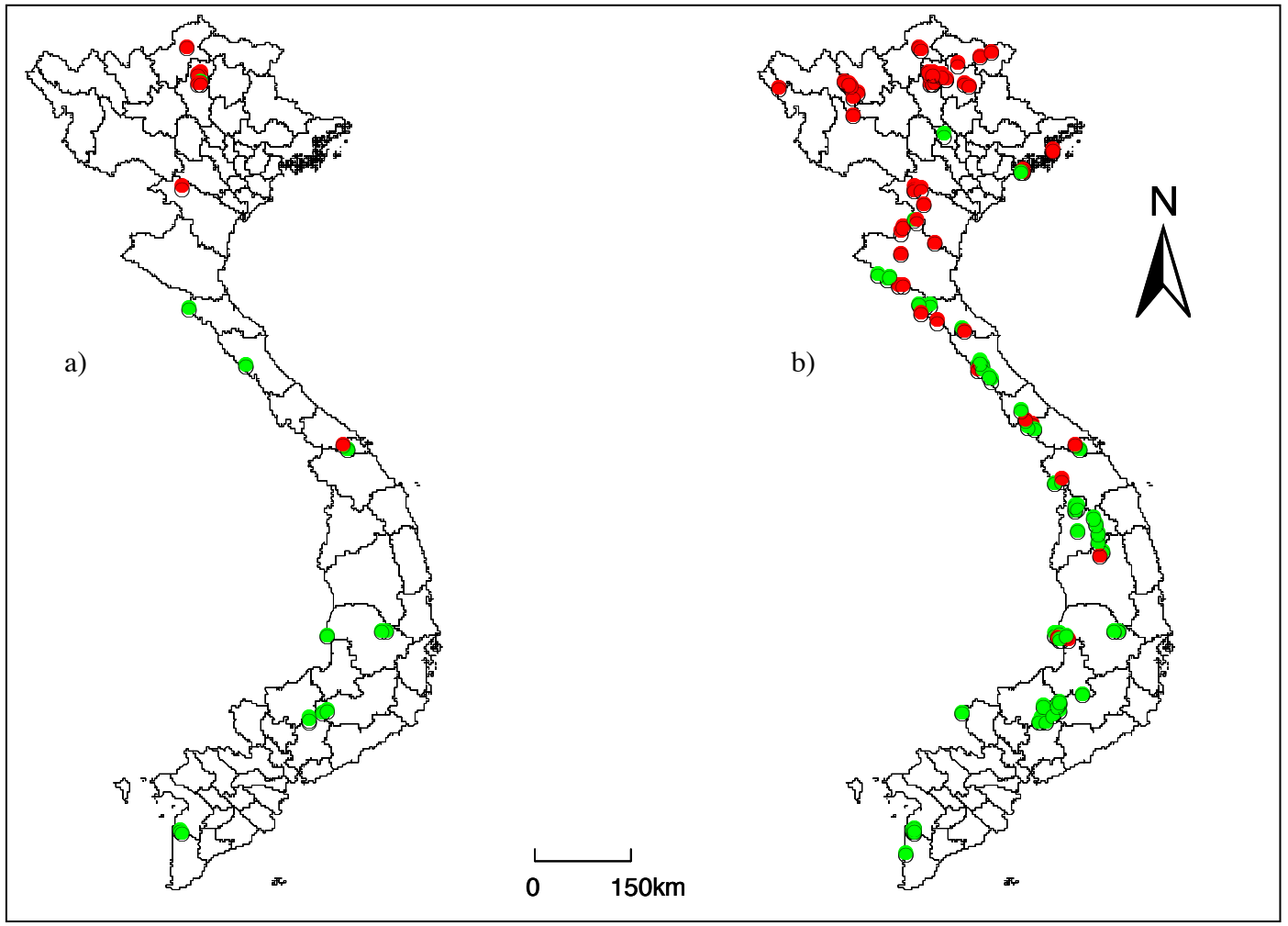

Figure 2. Plots of (a) confirmed field records and (b) all field records of M. pentadactyla *(red dots) and* M. javanica *(green dots) in Vietnam.*

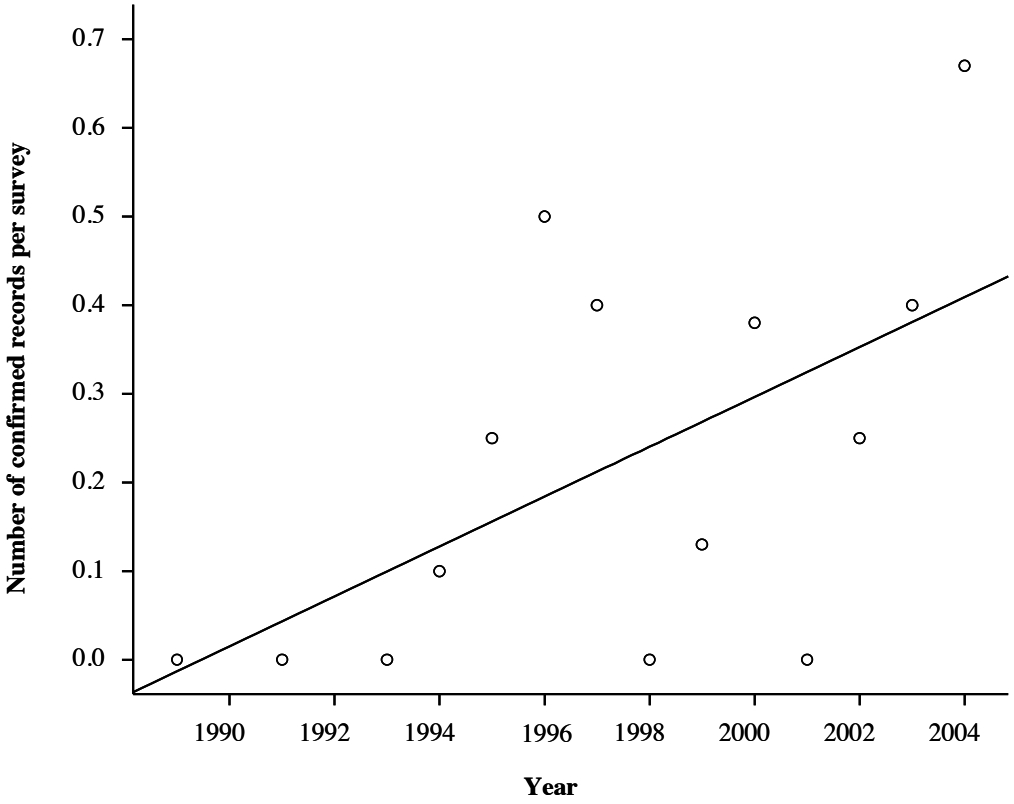

Figure 3. Number of confirmed field records of M. pentadactyla *or* M. javanica *per biodiversity survey between 1989 and 2004 (r = 0.58, p = 0.03, N = 14).*

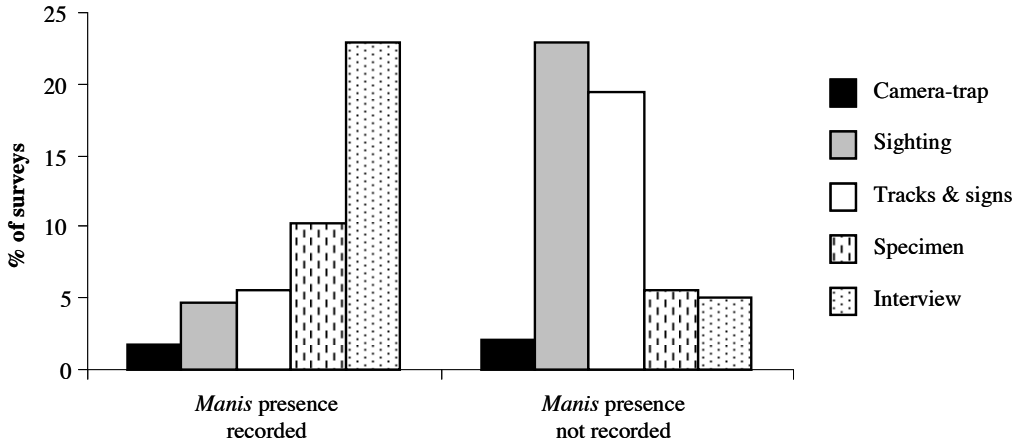

Figure 4. Relative success of alternative biodiversity survey methodologies at recording Manis *presence.*

Of the 34 records obtained from ecological survey methods, there was a significant association between the method used and the species recorded ($\chi^2 = 18.68$, df = 2, $p < 0.001$). *M. pentadactyla* were recorded significantly more frequently from signs of their presence, whilst *M. javanica* were recorded significantly more frequently from sightings and camera-trap records (Fig. 5).

Camera-trap data from surveys within the range of one or both *Manis* species illustrate the extent to which pangolins are recorded by this method (Table 2). Four of the 12 surveys reviewed recorded photographs of pangolins, with a total of eight photographs resulting from more than 14,000 trap nights and 2,600 animal photographs. The current cost of a wildlife camera-trap is a minimum of $150 for a film unit and $800 for a digital unit (Forestry Suppliers 2007). Each camera costs an additional $16 per use in film and accessories, plus labour expenses (Small Carnivore Project, unpub. data).

4. Species presence, status & ecology

Interviewees were all males, aged between 22 and 70 (mean age = 46, $N = 84$). All had caught a pangolin on at least one occasion, though most had many years of experience.

All hunters interviewed in the CPNP area (31/31) reported that only one species of pangolin is found in the National Park, with all respondents (11/11) identifying from photographs the species present as being *M. pentadactyla*. Interviewees asked about confiscated *M. javanica* being released into CPNP had mostly heard of this occurring (83%, 5/6), but none had seen any and two respondents believed that most released animals had quickly died.

All hunters interviewed in the KGKN area (24/24) reported that two different species of pangolin occur in the area. They identified *M. pentadactyla* as one of these species, referring to it as the "buffalo pangolin" (83%, 20/24) or "black pangolin" (17%, 4/24). They identified *M. javanica* as the other species, but often referred to it as two distinct 'types' (50%, 12/24).

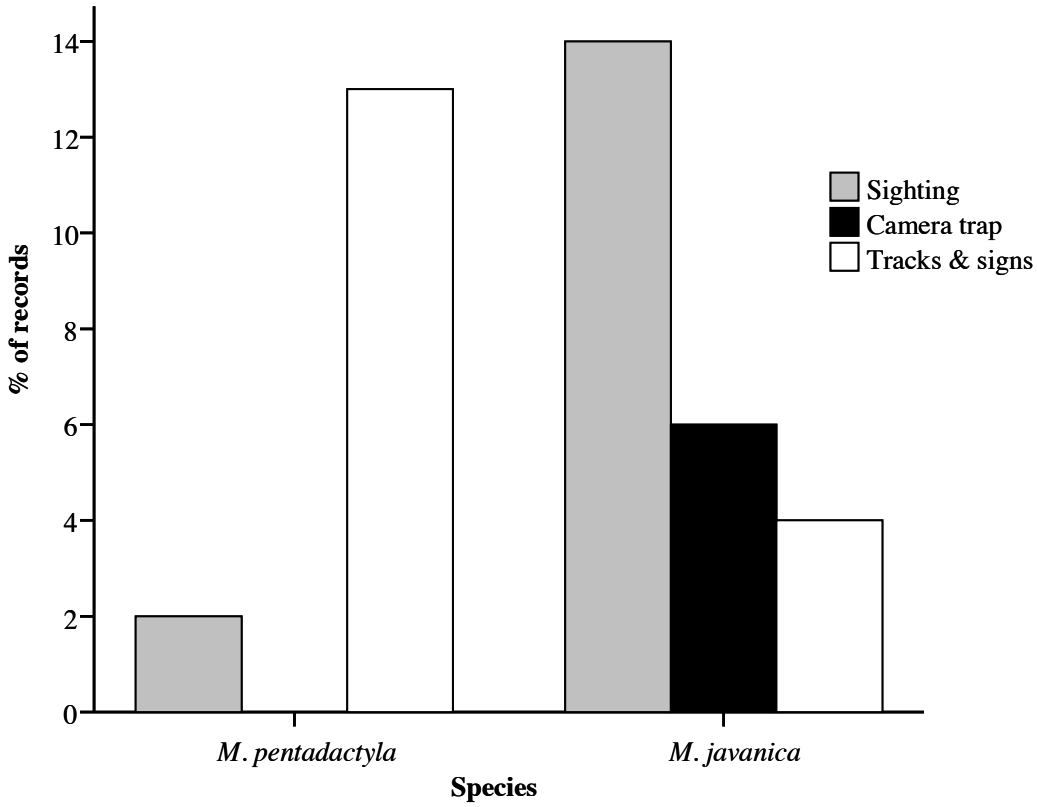

Figure 5. Relative success of different ecological survey methods in recording M. pentadactyla *and* M. javanica *presence*.

Table 2. Camera-trap effort and photos of pangolins in protected areas in Southeast Asia.

Source	*Survey dates*	*Country*	*Survey Area*	*No. trap hours*	*No. trap nights*	*No. photos of all species*	*No. photos of pangolins*	*Pangolin species (if stated)*
Walston et al. 2001	Apr-May 2000	Cambodia	Mondulkiri province	-	558	98	0	-
Kong & Tan 2002	Feb-Aug 2000	Cambodia	Kirirom National Park	-	646	Not stated	0	-
Neath & Setha 2001	Jan-Mar 2000	Cambodia	Bokor National Park	-	1242	349	4	-
Emmett & Olsson 2005	Mar 2001 - Apr 2004	Cambodia	Central Cardamom Mountains	-	5735	937	2	javanica
Lynam et al. 2006	2001 - 2002	Thailand	Khao Yai National Park	-	Not stated	Not stated	1	-
Timmins & Cuong 1999	May 1999	Vietnam	Huong Son Annamite Forest	1868	-	39	1	javanica
Le 2004	Oct 2003 - Feb 2004	Vietnam	Pu Luong Nature Reserve	-	800	37	0	-
SCP unpub. data	Oct 2006 - Jan 2007	Vietnam	Khe Net proposed NR	-	901	843	0	-
S. Swan pers. comm.	Not stated	Vietnam	Hoang Lien-Van Ban Nature Reserve	-	1126	172	0	-
S. Swan pers. comm.	Not stated	Vietnam	Mu Cang Chai Conservation Area	-	981	73	0	-
S. Swan pers. comm.	Not stated	Vietnam	Muong La Protective Forest	-	2274	129	0	-
SFNC 2001	Not stated	Vietnam	Pu Mat Nature Reserve	-	18 months	Not stated	0	-
			Totals		**> 14 600**	**> 2 600**	**8**	

These two types were most commonly called the “rice pangolin” (83%, 20/24) and “cow pangolin” (67%, 8/12).

Almost all hunters interviewed in the STNR area reported just one species, *M. javanica* (96%, 25/26), but also distinguished two types, referring to them most commonly as the “large pangolin” (88%, 14/16) and “small pangolin” (87%, 13/15).

Hunters reported that populations of both species of pangolin have been reduced (95%, 93/98) and all respondents believe that this is predominantly a consequence of hunting pressure (55/55). However, some hunters in CPNP also attributed the decline to forest loss (27%, 6/28). All respondents in KGKN, which incorporates the range of both *Manis* species, believed that there are fewer *M. pentadactyla* remaining in the forests than there are *M. javanica* (20/20), with many believing that *M. pentadactyla* are now locally extinct (38%, 9/24).

All respondents in the CPNP and KGKN areas thought that *M. pentadactyla* sleep mainly in soil burrows (53/53) and that their diet mainly constitutes either solely termites (78%, 45/58) or ants and termites (18%, 10/55). None of the hunters questioned believed that *M. pentadactyla* climbs regularly, stating that the species never climbs (79%, 37/47), rarely climbs (13%, 6/47) or only climbs one or two metres from the ground (8%, 4/47). This contrasted with hunters questioned about *M. javanica*, who all stated that the species regularly climbs (50/50). *M. javanica* were reported to sleep predominantly in hollow trees (94%, 47/50) or in holes beneath the tree trunk (74%, 37/50) and to feed mainly on ants and termites (61%, 30/49), solely on termites (22%, 11/49) or solely on ants (16%, 8/49).

5. Hunting practices

A number of alternative means of catching pangolins were described by hunters in the three study sites. The following six methods were the most commonly reported.

i) Dogs

Many hunters currently or previously used dogs to hunt pangolins, the majority of whom reported that they would take their dog to the forest primarily in the daytime (93%, 41/44). Most stated that their dog was capable of following the scent of a pangolin to its resting place (86%, 43/50), though some said that it could only smell the pangolin actually in a tree hole or burrow (12%, 6/50). The majority of respondents stated that they would catch more pangolins with a dog in the rainy season (66%, 19/29), but many said that they could take the dog at any time of year (28%, 8/29). Dogs were generally reported not to specialise in pangolins (78%, 25/32) but to be used to additionally hunt other species including turtles, wild pigs and muntjac.

ii) Tracking

Hunters reported a range of alternative field signs which would indicate a pangolin's recent presence in an area and which may also assist them in locating the animal (Table 3). In particular, many respondents in all three areas claimed to be able to both recognise and to estimate the approximate age of a pangolin burrow based upon certain burrow characteristics and signs that enable them to do so (Table 4). All hunters that were asked whether there was a more favourable season for tracking pangolins reported that the rainy season was the easiest time of year to find both species (30/30).

Hunters in all areas stated that *M. pentadactyla* found in burrows were usually captured by digging them out of the burrow (90%, 46/51), or by setting a trap or net and waiting for the animal to emerge (10%, 5/51). *M. javanica* that are found by dogs are usually captured by cutting down the tree in which they are resting (98%, 45/46).

Table 3. Field signs used to infer the recent activity of *M. pentadactyla* and *M. javanica* by hunters living around CPNP and STNR (information given by hunters in KGKN is not included, since responses were confused by the presence of both species).

Species	*Field sign*	*Number of hunters that reported seeing sign*	*Notes*
M. pentadactyla		34	total no. of interviewees in CPNP that have found *M. pentadactyla* by tracking
	Diggings (from eating)	24	
	Spoor	17	of which 11 stated that the only see spoor at the entrance to burrows
	Soil*	16	of which 7 state that it is difficult to use this sign to locate pangolins
	Faeces	6	all of which stated that faeces are only found in or at a burrow
	Claw marks (on tree)	1	
M. javanica		19	total no. of interviewees in STNR that have found *M. javanica* by tracking
	Diggings (from eating)	10	
	Spoor	2	of which both stated that they see them only occasionally
	Soil*	11	
	Faeces	0	
	Claw marks (on tree)	12	of which 6 stated that they can distinguish recent marks, most commonly from the presence of sap

* refers to soil clinging to the pangolin's body that brushes off onto vegetation and trees as it walks after digging

Table 4. Signs used by hunters in CPNP, KGKN and STNR to identify and estimate the age of pangolin burrows.

	Sign	*No. hunters that reported sign*	*% of hunters*
Identifying burrows	Number of hunters that can identify a pangolin burrow	58	
	Distinctly round shape of entrance	31	53
	Distinctly different to other species' burrows	20	34
	Spoor or claw marks at burrow entrance	9	16
	Scale marks visible at burrow entrance	5	9
Ageing burrows	Number of hunters that can estimate the age of a pangolin burrow	47	
	Freshness of soil at entrance	33	70
	Presence of spiders webs at entrance (indicates old)	5	11
	Presence of flies at entrance (indicates new)	3	6

iii) Pangolin-specific traps

Hunters reported using traps set specifically to catch pangolins. Of those that used this method, as either a primary or secondary means of catching either species, all hunters in KGKN and STNR set snare traps (27/27), whilst the few hunters in CPNP that used traps all used metal, pressure-triggered clamp traps instead (4/4). Snare traps are made from bicycle brake cable (14/14), and equal numbers of hunters reported using 'lying' snares (horizontal traps to catch the animal's foot; 14/28) and 'standing' snares (vertical traps to catch the animal's neck, body or tail; 14/28). These are set either at burrows or entrances to tree hollows which are known to have been used by a pangolin in the past, to catch the animal when it returns (86%, 19/22) or in areas where pangolins are seen to have been feeding (14%, 3/22).

iv) Non-selective traps

Hunters also reported using traps opportunistically placed in the forest. Of those that used this method, as either a primary or secondary means of catching either species of pangolin, all of them used snare traps (44/44), with an approximately equal utilisation of lying (47%, 17/36) and standing (53%, 19/36) snares. These traps are placed in long lines in the forest (97%, 29/30) usually in conjunction with a drift fence (10/10), to guide passing animals of any species into the trap.

v) Spotlighting

Of the 38 hunters that claimed to have caught one or both *Manis* species at night using a spotlight, none were specifically searching for pangolins and most (61%, 23/38) clarified that they were primarily searching for other species, including frogs, geckos and civets. Sixty-eight per cent (21/31) of respondents said that pangolin eyes do not reflect the light from a torch and that they had either seen the body outline of the pangolin (57%, 12/21) or heard it moving (14%, 3/21).

vi) Opportunistic

Hunters reported occasionally catching pangolins whilst engaged in non-hunting activities. Individuals reported finding pangolins inside trees when cutting them down for firewood, or seeing them walk past a fire when camping in the forest or in fields close to the village.

Four methods were used predominantly to hunt pangolins and these were significantly associated with both the species and the study site. A three-way log-linear analysis of species, study site and hunting method produced a final model that retained all two-way interactions (likelihood ratio: $\chi^2 = 0.48$, df = 6, $p = 1.00$). The two species are predominantly hunted using different methods ($\chi^2 = 32.31$, df = 6, $p < 0.001$) and different methods are used to varying extents in the three study sites ($\chi^2 = 11.11$, df = 3, $p < 0.011$). Visual inspection of these associations reveal that *M. pentadactyla* are primarily located by tracking in CPNP, that both species are predominantly hunted using dogs in KGKN and that *M. javanica* are mainly caught by hunters setting traps (both pangolin-specific and non-selective) in STNR (Fig. 6). There were also significant associations between the study site and methods used frequently, (log-linear analysis: $\chi^2 = 22.66$, df = 10, $p = 0.012$), and between species and methods used rarely ($\chi^2 = 17.62$, df = 5, $p = 0.003$).

The use of hunting dogs to catch pangolins has declined and significantly more hunters reported that they previously hunted with a dog than do now (previously: 55% (46/84), now: 19% (16/84); Fisher's exact test, $p < 0.001$). The predominant reasons cited for this decline were, in CPNP, the risk of being caught by rangers (4/5); in KGKN, the difficulty in training dogs when there are few pangolins or experienced dogs to learn from (9/15); and in STNR the risk of dogs being injured in snare traps (5/12).

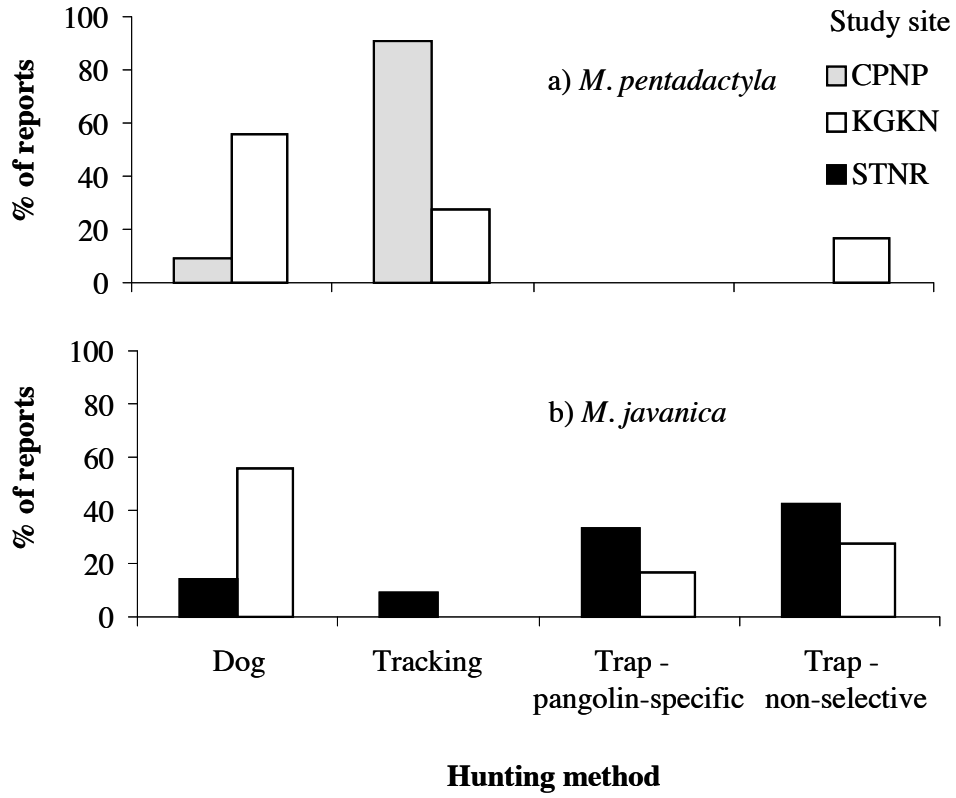

Figure 6. Frequency of reports of methods used as the predominant means to hunt (a) M. pentadactyla *and (b)* M. javanica *in the three study sites.*

All respondents living in the KGKN area, who have had opportunity to hunt both *Manis* species, stated that *M. pentadactyla* are easier to hunt than *M. javanica* (22/22), both by tracking (17/17) and with dogs (17/17). They explained that this is because *M. pentadactyla* burrows are easier for a hunter to see (76%, 17/22) and because it is more difficult for a dog to follow the scent of *M. javanica*, which is partially arboreal (76%, 17/22). All explanations of this apparent distinction in the ease of hunting alluded to the more terrestrial behaviour of *M. pentadactyla* and the more arboreal behaviour of *M. javanica* (31/31).

6. Trade

Both species of pangolin are hunted solely for the wildlife trade, with 99% of respondents (80/81) stating that all pangolins caught are now sold to traders. However, hunters reported that captured pangolins had formerly been consumed locally (93%, 78/84), being used primarily for their meat (94%, 79/84). This switch from subsistence hunting to commercial trade occurred significantly later in STNR (mean year = 1995, $N = 18$) than either CPNP or KGKN (mean year CPNP = 1990, $N = 24$; KGKN = 1989, $N = 16$; Fig. 7).

The price paid to hunters per kilogram of pangolin has increased at a rate more rapid than annual inflation since the commercial trade in the species began (Fig. 8). Of those interviewees asked, all stated that the price is not stable but tends to fluctuate throughout the year (8/8), and that pangolins that have an injury are less valuable (28/28). Injured pangolins are reportedly reduced from a mean minimum of 16% of their value ($N = 9$), to a mean maximum of 39% ($N = 25$). Most hunters questioned stated that they received a lower price per kg for a larger pangolin than for a smaller one (87%, 20/23), all agreeing that pangolins over 5kg are less valuable (mean maximum weight for optimal price = 4.4kg, mean minimum = 0.7kg, $N = 20$).

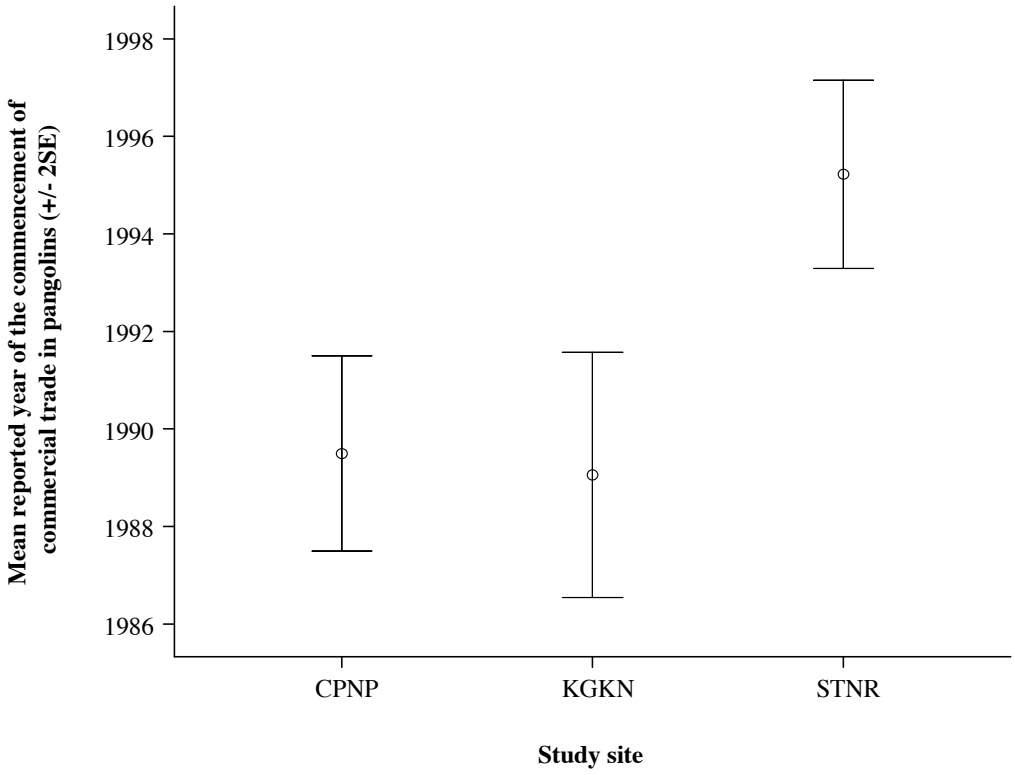

Figure 7. Mean reported year in which the commercial trade in M. pentadactyla *and* M. javanica *began in the three study sites of CPNP, KNNR and STNR (one-way independent ANOVA,* $F_{2,55} = 9.82, p < 0.001$*).*

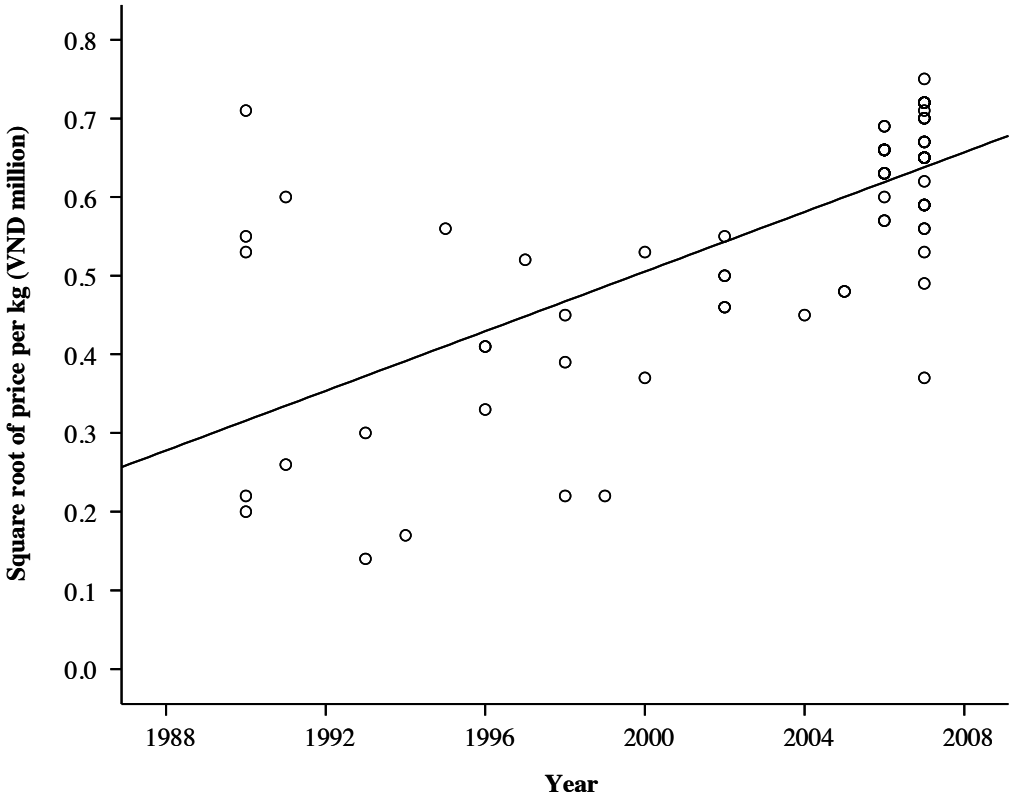

Figure 8. Price trend for commercial sales of pangolin in Vietnam (sqrtprice = 37.38 + (0.019.year), $F_{1,91} = 88.08$, $R^2 = 0.49$, $p < 0.001$). Values adjusted to 1990 prices to account for inflation rates.

Discussion

This study has compiled the first range distribution maps for the pangolin species *Manis pentadactyla* and *Manis javanica* in Vietnam. The paucity of confirmed field records from standard ecological survey methods has been demonstrated, reiterating the need for a taxon-specific field detection methodology. Hunters reported that the two species of pangolin are caught using different hunting methods and that there is also inter-site variation in the method used. The threat to both species persists, but populations of *M. pentadactyla* have suffered a greater decline because it is an easier species to hunt.

Ecological Knowledge

Distribution Map

Knowledge of the distribution and population status of pangolins is needed to be able to plan effective measures for their conservation. This study has produced the most comprehensive collation to date of confirmed records and unconfirmed reports for the two species of pangolin occurring in Vietnam and has created the first distribution maps for this taxon within that country. Although data on the abundance of pangolin species were sparse, distribution mapping may help to target conservation efforts and to identify sites for field research or placement of confiscated individuals. Similar field record compilations have been made for small carnivores in Vietnam, and have guided conservation prioritisation for this taxon (Roberton et al. in prep.).

The plotted confirmed records showed a clear latitudinal distinction in the two species' ranges, with a central region of coexistence. Unconfirmed records were less distinctly separated because there was a greater likelihood of confusion between species.

The region of overlap of the two species' ranges suggests that a simple latitudinal replacement, as mapped by Corbet and Hill (1992), may be too simplistic an interpretation of pangolin distribution in Vietnam. We were unable to test the assertion by Duckworth et al. (1999) of an altitudinal separation of the species, since an inadequate number of confirmed field records contained elevation data (2 of 34) or accurate location coordinates (7 of 34). Similarly, no conclusions could be made on the habitat preferences of either species, due to the low incidence of reporting of forest type (5 of 34) or elevation in the confirmed field records. This review has therefore highlighted a need for more detailed record-keeping in biodiversity surveys, all of which should provide basic data on geographical coordinates, vegetation type and elevation for confirmed records.

Biodiversity survey effort

Biodiversity survey effort in Southeast Asia has increased in the last two decades. Vietnam implemented its "open-door" policies in the early 1990s, and since then an increased number of international organisations have been conducting surveys throughout the country. This greater survey effort has been matched by an increase in the number of confirmed records of *Manis* species per survey, which may suggest a growing proficiency of survey teams to identify pangolin presence, but more probably simply reflects better reporting of incidental mammal records.

Field records from primary data sources remain relatively scarce, however, and we demonstrated a reliance on interview reports from local communities and hunters from which to infer pangolin distribution. This supports the observation that pangolins not well covered by biodiversity surveys (Duckworth 1999) and reiterates the need to develop a specific field detection methodology for *Manis* species. The reliance on hunters' knowledge and their apparent ability to continue to extract large numbers of pangolins annually, lends support to the concept of applying the traditional ecological knowledge (TEK) and hunting experience of local people to the study and conservation of pangolins. Advocates of TEK have promoted

its use in scientific research and ecological understanding (Huntington 1998), and numerous studies have successfully used semi-structured interviews to assess the relevance of TEK to ecological research (Ramstad et al. 2007; Stave et al. 2007).

Retrospective support for the notion of tapping hunters' knowledge of pangolins additionally came from the correlation shown by this study between biologists' records of the two pangolin species and hunters' reports. Of the few field records obtained from ecological survey methods, *M. pentadactyla* were more frequently recorded from signs of their presence, whilst sightings and camera-trap records were more common for *M. javanica*. This corresponds with the differences in population status and hunting methods subsequently reported by hunters in interviews, with *M. pentadactyla* more reduced in number and more commonly found by tracking.

Hunters' knowledge

There is frequently little distinction drawn between the ecology of different pangolin species (e.g. Sterling et al. 2006), yet this study demonstrated that *M. pentadactyla* and *M. javanica* may have significantly different ecological habits, that they are predominantly hunted using different methods and that they may face differing levels of anthropogenic threat.

Distribution and ecology

Hunters' reports correlated with the mapped range distribution of the two species in the three study areas, with *M. pentadactyla* in CPNP, both species in KGKN and *M. javanica* in STNR. Awareness of local names, and of the common tendency of hunters to refer to *M. javanica* as two different 'types' of pangolin, may benefit future surveys in marginal areas of the two species' ranges. Indeed, this tendency may explain some of the unconfirmed records of *M.*

pentadactyla in the southern provinces, since an interviewer may assume that a report of two pangolin types refers to two species rather than one.

Interviewees believed the two species to be ecologically distinct, both in diet and in the extent to which they are more terrestrial or arboreal. Such data is unconfirmed and should be treated cautiously. However, these trends were reported consistently, correlate with available species accounts (IUCN in prep.) and influence the hunting methods employed for each species. This suggests that these distinctions are at very least a useful guide for future studies of pangolin ecology.

Hunting methods: i) species differences

This study identified four main methods with which hunters catch pangolins in the three study sites: using dogs, tracking, pangolin-specific traps and non-selective traps. Hunting with guns has diminished following a ban on, and confiscation of, private guns beginning in the early 1990s (Sterling et al. 2006). Other methods of catching pangolins (e.g. spotlighting) seem to be both rare and opportunistic and probably represent a relatively minor threat.

Dogs were considered by most hunters to be the most effective means by which to find pangolins, since a good hunting dog is capable of finding the scent of either species and following it to the burrow or hole in which the animal is sleeping. Dogs are used considerably less than previously, however, for practical reasons unique to each area. A decline in the use of the most efficient means of hunting pangolins perhaps has optimistic connotations for their conservation, though has probably been concurrent with an increasing intensity of alternative hunting methods.

As a terrestrial species that digs conspicuous soil burrows, *M. pentadactyla* are mainly located by identifying an area in which a pangolin has been recently active and then searching for the occupied burrow. *M. javanica,* in contrast, are mainly caught in snare traps, both pangolin-

specific and non-selective. Traps are systematically set at every hole that hunters believe to have been previously used by a pangolin and any unused holes are reportedly blocked. The practice of cutting down trees to capture pangolins is presumably also reducing the number of tree hollows available for occupancy. Since *M. javanica* is thought to depend on hollows of big trees, particularly as sites for natal dens by the females (Lim & Ng 2007), harvesting them in this manner may mean that habitat loss is acting concurrently to reduce the population.

Hunting pressure on *M. javanica* is thus evidently very high, but the comparative ease with which *M. pentadactyla* are hunted, both with dogs and by tracking, suggests that the level of threat is higher for this species. In areas where the two species co-exist, *M. pentadactyla* populations are likely to be more reduced. This suggestion is supported by the reportedly lower population of *M. pentadactyla* in KGKN, and should be a consideration when determining threat status for the two species.

Hunting methods: ii) site differences

Inter-site variability is a confounding factor, with topographic and law enforcement characteristics affecting the relative prevalence of hunting practices in the study areas. For example, CPNP's steep limestone hills may largely prohibit the widespread use of long lines of snare traps, whereas the gentler slopes of KGKN and STNR are more conducive. Similarly, the prevalence of hunting with dogs in KGKN is probably a consequence of less well enforced forest protection. An area's status as National Park (e.g. Cuc Phuong), Nature Reserve (e.g. Song Thanh) or state forest enterprise (e.g. Khe Net) is likely to affect the quality of control of illegal activities. Fear of Forest Protection Department rangers was the most commonly cited explanation for the decrease in dog use by hunters around CPNP, indicating that the extent of hunting activity may be lessened by a strong law enforcement presence, as it has elsewhere in Asia (SFNC 2003; Lee et al. 2005; Corlett 2007).

Studying pangolin ecology

Although none of the surveys reviewed specifically aimed to confirm *Manis* presence or absence from a given area, the low number of confirmed records is illustrative of the point that pangolins are largely missed by conventional biodiversity monitoring, and demand a genus-specific detection and census methodology.

Camera traps

Since their development in the early 1980s, camera traps have become an important tool for monitoring rare, cryptic species in a wide range of environments (Cutler & Swann 1999). The number of confirmed *Manis* records has been augmented by camera-trap photographs, but this remains a financially costly method and frequently provides no confirmation of pangolin presence even in areas of known occurrence. Importantly, a negative photo-trap result does not necessarily indicate the absence of a species from a study site, and photographs are too irregular be used either as a measure or as a comparison of population density. However, camera-trapping may have an application as a non-intrusive means of studying pangolin behaviour and den-use, once an individual has been found and its home-range identified (Lim & Ng 2007).

Line-transects

Tracking was reported by hunters as being used to locate both *M. pentadactyla* and *M. javanica*. The tracks and signs that indicate the presence of both species are more prevalent in the rainy season, which is also when pangolins may be more active (Allen 1938). The field sign most commonly reported as being used to indicate pangolin activity were the diggings made by both species when searching for food. Pangolin burrows were described as unmistakable for those of other species, and as having a uniquely round entrance. Rodents' holes are significantly smaller, and although porcupines also live in burrows, they use natural holes and rock crevices rather than excavating their own (Nowak 1999). Burrows, diggings and all other signs reported as useful, could be learnt and identified by field biologists, given

adequate training and experience. Track stations at burrow entrances may be used to overcome initial uncertainty in identifying pangolin burrows and to confirm that another species is not the inhabitant. With such training, teams undertaking future biodiversity surveys might more frequently record pangolin presence, particularly of *M. pentadactyla*, in areas where populations still persist.

Population Estimation

Accurate estimation of the age of diggings and burrows could enable a surrogate measure of pangolin density to be developed, although occupant identity would again need to be certified. True measures of population size would require knowledge of the rate of burrow creation and territory size, but comparative studies need only record burrow number per unit area in different habitats or areas. Similar approaches, based on relative burrow density, have been used to compare porcupine populations (Sidique & Arshad 2004). For *Manis* species, such efforts would also be best invested in the rainy season, when pangolins may be more active and signs of their activity are more easily visible.

Sighting or capturing pangolins

Pangolins confiscated from the wildlife trade are currently often released immediately into forest areas close to the point of confiscation, which may be a long way from the place of capture or even outside of their natural range. Release at a sub-optimal location may compromise an animal's chances of survival, as a consequence of unsuitable habitat or recapture into the trade (Sterling et al. 2006). For example, confiscated *M. javanica* have been released into CPNP (S. Roberton, pers. comm.), which this study suggests is outside of their natural range. A greater understanding of *Manis* home range size and habitat utilisation will allow more informed decision-making for the placement of confiscated pangolins, and will enable post-release monitoring. Such information is best gained from direct observation of wild pangolins, for example through radio-telemetry studies.

Training or confiscating dogs able to locate pangolins thus has potential for conservationists, either as a direct means of determining population densities or as part of a capture methodology for radio-tracking wild-caught individuals. Projects in New Zealand have demonstrated the potential of using conservation dogs to locate elusive, endangered species (e.g. Robertson et al. 1999). Transferring such a method to Vietnam's forests may prove a viable way for scientists to overcome the problems of detecting pangolins, though there may be practical difficulties associated with training dogs in areas of low pangolin density, as reported by hunters in KGKN.

The only methods of pangolin capture reported not to injure the animals were those using a net placed over the entrance to a burrow or hole. These can either be pegged out on the ground, whilst the trapper waits nearby, or incorporated into a snare mechanism that is triggered when the pangolin enters the net, lifting the animal off the ground. Though rarely used by hunters, due to their relatively high expense, such nets were commonly described as the only method of catching a pangolin that is guaranteed not to injure it. At a cost of US$1.50 per net, this is an option that would be within the budget of most conservation field programs, and could be used in conjunction with trap transmitters to allow multiple traps to be set and monitored simultaneously. Other methods that may have application to catching pangolins include breakaway snares with trap transmitters (Sirtrack 2007). If these were to prove suitable for *Manis* species, then the data contained within this study could guide efficient setting of traps to maximise capture rate.

Trade

There was no significant difference in current price between the three sites, even though the commercial trade in pangolins began later in STNR than either other area. This lag was probably a consequence of the reserve's previous relative isolation, with improvements to access and infrastructure occurring only in the last decade (Quang Nam People's Committee

2005). As populations of pangolins diminish, their value to hunters is increasing at a rate greater than that of annual inflation. The large range of values reported for 2006 and 2007 (Fig. 8) is an artefact of hunters describing the last known price as 'current', regardless of the date of sale, and so recent prices are almost certainly higher than indicated (reliable reports of US$94 per kg, pers. obs.). Prices appear to be higher in Vietnam than in neighbouring countries (e.g. Cambodia: US$45 per kg, Phallika & Sopheak in prep.; Indonesia: US$17 per kg D. Martyr pers. comm.), although a regional trade study would be needed to confirm this. The lower price per kg reported for larger pangolins correlates with the observations of previous studies (Nooren & Claridge 2001) and probably reflects an attempt by traders to set an upper limit on the total price paid for a pangolin. However, a hunter may still gain several months' or a year's salary from a single animal and so it is unlikely that selling a pangolin will ever be an unprofitable enterprise (Sterling et al. 2006).

Conservation Implications

The data gathered and presented by this study should help to identify some of the measures necessary to help to conserve *Manis pentadactyla* and *Manis javanica* in Vietnam's protected areas, and provide both direction and a practical basis on which to develop methods for future studies of pangolin ecology.

1) **Recommendations for biodiversity studies**.

- The scarcity of detailed and accurate scientific recording of pangolin records is a key problem. It is recommended that, where possible, pangolin field detection and monitoring methods be integrated into general biodiversity surveys and surveys targeting other taxa.

2) **Reducing hunting pressure and prioritising conservation efforts**.

- Hunting pressure on pangolin populations in these three protected areas remains high, but the exact nature of the threat depends upon both the species and the area.

- For populations to persist, law enforcement must target and reduce the extent of the main threats, whether this is through confiscation of hunting dogs, removal of snare lines or regulating access to the forests.

- Populations of *M. pentadactyla* are at higher risk from hunting than those of *M. javanica* and are likely to be more heavily depleted. This has implications for the current GMA review of IUCN Red List status.

- As stipulated in IUCN guidelines (IUCN 2002), re-release of confiscated animals is not a viable option in areas of continued high hunting pressure. This study has identified the

major threats to pangolin populations and has mapped the natural distribution of the two species, which should facilitate future placement decisions.

3) **Adopting hunter methods for studying pangolin ecology**.

- There is huge potential for using the knowledge and experience of hunters to develop methodologies for studying these two pangolin species in the wild. It should be possible:
  - i) To use pangolin field signs such as burrows, diggings, spoor and claw marks to confirm pangolin presence in an area.
  - ii) To use burrow density and age to estimate and compare population sizes.
  - iii) To use dogs or experienced hunters to locate pangolins, and nets to catch them, for radio-tracking.

During the course of this study, we encountered a wealth of knowledge and experience amongst the interviewees. Visits into the forest with hunters demonstrated for us the potential value of recruiting experienced local people, as we quickly recorded a number of recent pangolin burrows and began to recognise their field signs.

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Appendix 1. Confirmed field records of *M. pentadactyla* and *M. javanica* in Southeast Asian countries.

Source	*Survey Year*	*Country*	*Survey Area*	*Field record information source*	*Species*
Emmett & Olsson 2005	2004	Cambodia	Central Cardamom Mountains	camera trap (2 photos)	*javanica*
Neath & Setha 2001	2000	Cambodia	Bokor National Park	camera-trap (4 photos)	*javanica*
Lynam et al 2006	2002	Thailand	Khao Yai National Park	camera trap	*javanica*
Timmins & Cuong 1999	1999	Vietnam	Huong Son Annamite Forest	camera-trap	*javanica*
Neath & Setha 2001	2000	Cambodia	Bokor National Park	sighting	*javanica*
Kong & Tan 2002	2002	Cambodia	Kirirom National Park	sighting	*javanica*
WCS 1995	1995	Lao PDR	adjacent to Nam Kading NBCA	sighting	*javanica*
Care 2004	2004	Vietnam	U Minh Thuong National Park	sighting	*javanica*
Murphy & Phan 2001	2001	Vietnam	Cat Tien National Park	sighting (2 records)	*javanica*
Le et al. 1997b	1997	Vietnam	Phong Nha-Ke Bang National Park	sighting	*javanica*
Le et al. 1997a	1997	Vietnam	Ea So	sighting (2 records)	*javanica*
Dang et al 1995	1995	Vietnam	Yok Don National Park	sighting	*javanica*
Frontier Vietnam 1994	1994	Vietnam	Ba Na Nature Reserve	sighting	*pentadactyla*
Vu et al. 2005	2005	Vietnam	Lung Day, Cao Bang province	freshly-dug burrow	*pentadactyla*
BirdLife 2004	2004	Vietnam	Yok Don National Park	freshly-dug burrow	*javanica*
Le et al. 2004	2003	Vietnam	Na Hang Nature Reserve	freshly-dug burrow (2 records)	*pentadactyla*
BirdLife 2003	2002	Vietnam	Na Hang Nature Reserve	freshly-dug burrow	*pentadactyla*
Long & Tuoc 1999	1999	Vietnam	Pu Mat Nature Reserve	freshly-dug burrow	*Manis* spp.
Round 1999	1999	Vietnam	Pu Mat Nature Reserve	freshly-dug burrow	*Manis* spp.
Walston et al. 2001	2001	Cambodia	Mondulkiri province	tracks or signs	*javanica*
WCS 1995	1995	Lao PDR	adj to Nam Kading NBCA	tracks or signs	*Manis* spp.
FFI 2006	2006	Vietnam	Khau Ca area	tracks or signs	*pentadactyla*
Dang et al 2004	2003	Vietnam	Da Teh State Forest Enterprise	tracks or signs	*javanica*
FFI 2005	2003	Vietnam	Pu Luong Nature Reserve	tracks or signs	*pentadactyla*
Frontier Vietnam 1996	1996	Vietnam	Na Hang Nature Reserve	tracks or signs (3 records)	*pentadactyla*