Wild Ungulate Distribution in the Naban River Watershed National Nature Reserve, Southwest China

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Abstract

Southeast Asia´s tropical forests harbour a unique diversity of wildlife but species and numbers are rapidly declining under current land use. To improve conservation strategies in these biodiversity hotspots, knowledge of animal species present and their distribution is crucial. We wanted to identify the ungulate community composition and distribution of a 'Man and Biosphere' reserve, the Naban River Watershed National Nature Reserve (NRWNNR), Yunnan, Southwest China. Using camera traps, transects, and spoor-plots we identified wild ungulate species and corresponding habitat properties. We compared two study sites of different protection status – the buffer and experimental zones – on an overall transect length of 32 km and analysed relationships between wildlife activity, forest vegetation structure, and human disturbance. We documented six ungulate species, all of which occurred in the buffer zone while only three species were found in the experimental zone. Wild boar sign density was about 10 times higher in the buffer than in the experimental zone. Overall wildlife sign density increased with distance away from human settlements and closer to the core zone. Hence, human disturbance strongly influenced wild ungulate abundance but the NRWNNR was found to host a diverse ungulate community, considering its small size and compared to other conservation areas in the region. The combination of various methods proved to be successful in identifying and locating forest wildlife. The NRWNNR, particularly the more strongly protected zones, could greatly contribute to future ecotourism activities in Yunnan if a strict preservation of buffer and core zones can be maintained.

Key words: *gaur, protection zones, tropical forest, Xishuangbanna, wildlife*

1. Introduction

Wildlife in the Asian tropics is under severe pressure, particularly in continental Southeast Asia with its high human population density and intensive rural activities (Li et al., 2007). For example, serious declines both in range size and numbers were observed for two charismatic ungulates, the gaur (*Bos gaurus*) and serow (*Capricornis* spec.; Sodhi et al., 2004). Habitat loss due to land transformation for agriculture and large scale industrial projects such as dams are often the cause for these declines but also hunting for highly priced bushmeat and medicinal products is increasingly depleting wildlife populations (Li et al., 2007; Sodhi et al., 2010). The extant forest areas in Southeast Asia are declining drastically in size and have become increasingly isolated (Brooks et al., 1999; Pattanvibool and Dearden, 2002). Even where the habitat is still intact – in protected areas – the phenomenon of 'empty forests' can be observed, i.e., forests with hardly any signs of animal life (Corlett, 2007). Although this is a well-known phenomenon, detailed data about the current situation of wildlife populations in such protected areas are scarce.

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We, therefore, conducted a baseline survey in the Naban River Watershed National Nature Reserve (NRWNNR) in the Dai autonomous prefecture of Xishuangbanna, Yunnan, Southwest China. As a reserve organized according to the ‘Man and Biosphere’ reserve concept (Barrett and Arcese, 1995) it combines zones of varying protection status and represents a mosaic of the major vegetation types described for Xishuangbanna (Yunnan Environmental Protection Bureau, 2006). Here, a high plant biodiversity (Ghorbani et al., 2012) and some outstanding wildlife species of critical conservation status can be found, i.e., a population of gaur belonging to the subspecies *B. gaurus readei* (Heinen and Srikosamatara, 1993). Besides few observational records, little systematic knowledge about the reserve’s current wildlife diversity is available. However, baseline data are urgently needed due to the rapid loss of forest habitats in the buffer and experimental zones and because of the expansion of monocultures, particularly rubber *Hevea brasiliensis* plantations (Li et al., 2007).

The aim of this study was to assess the presence and distribution of wildlife, especially ungulates, in areas of different protection status within the NRWNNR and relate wildlife locations to human disturbance. The wildlife species composition was compared with similar conservation areas in the region to estimate the relative importance of the NRWNNR for conservation of Xishuangbanna’s wild ungulates.

2. Methodology

2.1 Study site

We conducted the wildlife and habitat survey in the Naban River Watershed National Nature Reserve (NRWNNR), Xishuangbanna Dai Autonomous Prefecture, Yunnan Province, Southwest China during the dry season from October to December 2010 (Figure 1). Xishuangbanna (21°08’ – 22°36’ north and 99°56’ – 101°50’ east) represents a transitional zone between the tropical climate of Southeast Asia and the subtropical climate of East Asia, characterized by a typical monsoon climate (Zhu et al., 2006) with an annual precipitation of 1200 – 1900 mm and average annual temperatures of 15 – 22°C . Its flora and fauna has, thus, both tropical and temperate elements (Cao and Zhang, 1997), creating a biodiversity hotspot. Thirty-six percent of China’s birds and 21% of its mammals were documented for Xishuangbanna (Cao et al., 2006), such as dhole (*Cuon alpinus*), leopard (*Panthera pardus*), gaur, Asian elephants (*Elephas maximus*) and tiger (*Panthera tigris*) (Zhang et al., 2006; Lynam, 2010). The NRWNNR is composed of three zones encompassing different protection status: 1) the ‘core zone’, in which any kind of disturbance and human activity is forbidden, 2) the ‘buffer zone’ where limited agricultural and collecting activities are allowed, and 3) the ‘experimental zone’ comprising agriculture, collecting of natural resources and other extracting activities.

To compare the wildlife abundance across different protection zones, we chose the area around Guomenshan ranger station (GM, buffer zone) and around XiaoNuoYou station (XN, experimental zone; Figure 1). The surveyed area at GM covered about 9 km^2 and an altitude of 723 – 1599 masl in the north of the reserve. Its topography was dominated by a mountain ridge stretching in east-western direction parallel to the Mekong river. The GM area was completely covered by forest and contained few human activities such as footpaths, roads, logging, and livestock-tending activities. In the eastern part, close to the border of the core zone, a settlement existed from 1969 – 1982 but was abandoned thereafter (Li, pers. comm.). During winter 2010, the reserve management initiated the construction of a broad footpath and a mineral lick to maintain camera traps for documenting wildlife at GM. In the north-western site of the reserve, XN was located on an altitude range of 1440 – 2024 masl, covering about 12 km^2.

The study area was part of the experimental zone and was covered with forest except for a few agricultural fields and patchily distributed meadows. Intensive non-timber-forest-product collecting was documented here (Ghorbani et al., 2012). The reserve administration has conducted prescribed understory vegetation burning on the ridges of XN to reduce the prevalent fire risk during the dry season.

2.2 Data collection

We assessed wildlife activity using a combination of various methods. We located six north-south walking transects, orthogonal to the mountain ridge (Gray and Phan, 2011; Steinmetz et al., 2008), parallel to each other at a distance of 500 m. At GM, transects were 2 km long, at XN they were 2 – 5.3 km long, in accordance with the forest extension. Total transect length was 11.6 km and 20.4 km at GM and XN, respectively. At GM, we walked transects twice to assess animal activity while at XN, we walked transects only once due to time and feasibility constraints. We conducted wildlife species and habitat assessments during diurnal (direct and indirect) observations in Nov / Dec 2010 and camera trapping data additionally provided information on nocturnal wildlife activity.

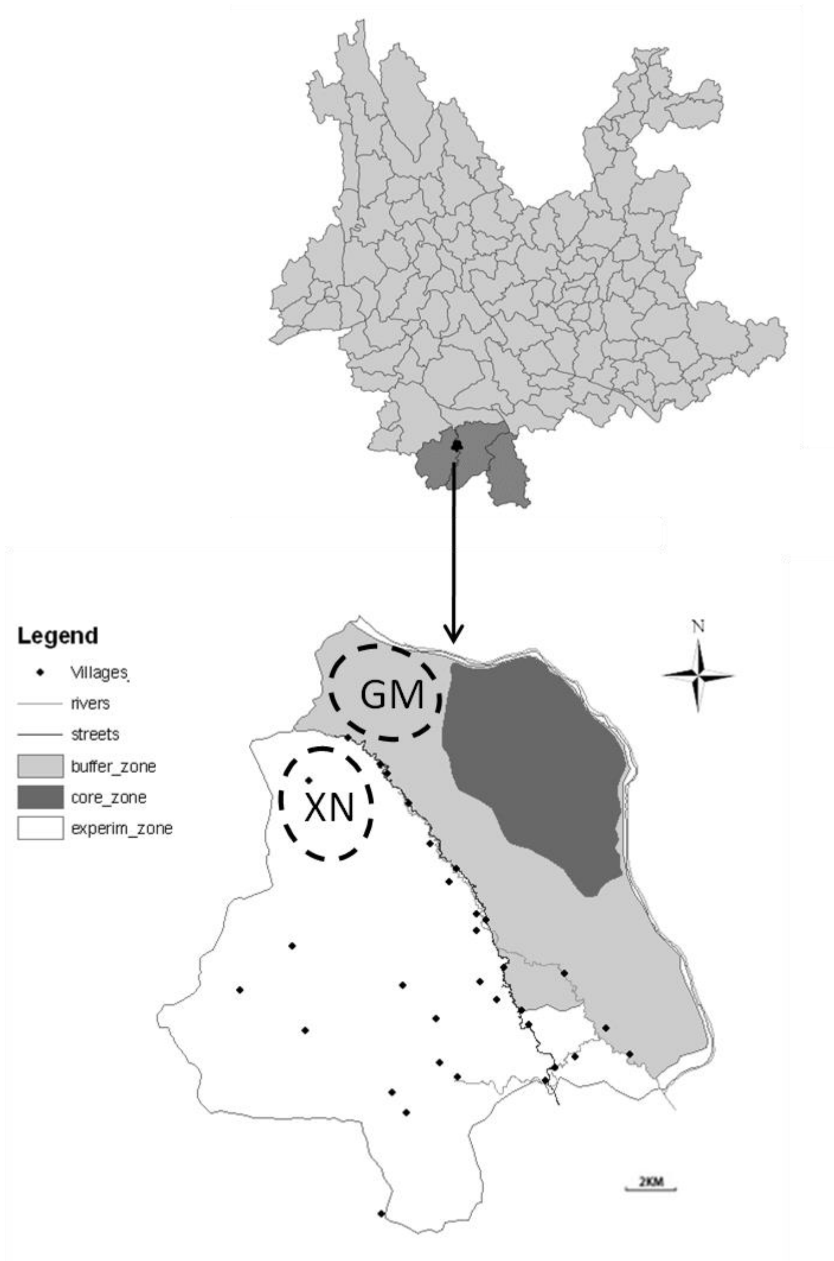

Figure 1: Map of the Naban River Watershed Nature Reserve (NRWNNR) showing the different protection zones (experimental, buffer, and core zone), villages (black circles), rivers (gray lines) and the location of our two study sites (dashed circles), i.e., Guomenshan (GM) and XiaoNuoYou (XN).

During transect walks we documented all identifiable signs of wildlife, mainly hoof prints and dung. We identified signs with the help of rangers and local guides. We attributed different-sized hoof prints, parallel tracks as well as resting grounds next to each other as belonging to different individuals per species (particularly if these species were reported to be single-living) but could not associate up-rooting activity of wild boar, for instance, with only one individual and, hence, recorded these activities as one event at a time. We covered a strip of 2 m along each side of the transect line. At GM, domesticated water buffalos (*Bubalus arnee*) roamed the forest but despite their similar body size to gaur hoof prints of both could easily be discriminated.

At GM we established 60 spoor plots of 1 m x 4 m every 200 m along the transects. Spoor plots were cleared from litter and raked to detect the number of animals crossing the plot within a known time span until the next inspection (Grainger et al., 2005). However, due to generally low animal numbers we reported only few signs on the spoor plots and sampling effort, i.e., re-visiting all plots was time-consuming, so no spoor plots were established at XN. We measured the distance between sign locations and the core zone / the next village on a map.

Along transects, at 200 m intervals, we established quadrates of 1 m x 1 m each for vegetation surveys, i.e., 64 plots at GM and 22 plots at XN. At each plot we recorded the slope, visually estimated understory vegetation cover to the nearest 5% (Kent and Coker, 1994) and its average height. For each location we recorded the distance to the nearest tree in all four compass directions as well as the tree trunk diameter at breast height (DBH); we calculated corresponding tree densities (no of trees ha^{-1}) using the point-centred-quarter method (Mitchell, 2007).

We also installed two Reconyx HC600 HyperFire camera traps at areas of expected high wildlife activity such as trails, water holes and foraging places. Camera traps were left at each location between 2 and 10 days before we shifted them to another place. Additional direct observations and photographs were recorded together with the location of any wildlife spotted in the area.

2.3 Data analysis

Pearson-correlations tested for relationships between animal sign density and vegetation structure (i.e., understory cover, height, tree density) as well as distance to the next village / core zone. The 4 m strip width of the transects was used for calculating relative wildlife sign density (Buckland et al., 2001). Data were tested for normality and, if needed, transformed accordingly (Zar, 1999). Student's t-tests compared wildlife sign density for GM and XN as well as the former settlement region versus GM. One-way ANOVA tests compared wildlife sign densities across the fixed environmental factors tree density, understory height and cover and DBH. The level of significance for our tests was $\alpha < 0.05$.

3. Results

3.1 Vegetation structure

The two study sites differed in their frequency of disturbance as indicated by signs of local people (number of paths, selective logging, collection activities, livestock herding) but not in their vegetation and environmental characteristics (Table 1). The mean tree breast height diameter (DBH), i.e., overall tree age and size, was twice as large at GM compared to that of XN. Understory vegetation cover showed large variations, particularly in XN, where it was dense in small valleys and gorges while cover was much lower on top of hills and ridges. This variation was seemingly the result of prescribed burning of the understory vegetation on the drier ridges while some open areas around XN, strongly overgrown by *Girardinia diversifolia*, were intensively used as pasture for domestic water buffalos.

Table 1: Means (±SD) and statistical values of student's t-tests comparing different parameters of forest structure across study sites. GM = Guomenshan (buffer zone), XN = XiaoNuoYou (experimental zone), DBH = tree diameter at breast height (1.3 m above ground).

	GM	XN	*t*	*P*
Tree density (trees ha^{-1})	2113 (± 1562)	1960 (± 2113)	- 0.365	0.716
Understory height (cm)	65 (± 44)	62 (± 34)	- 0.305	0.761
Understory cover (%)	36 (± 24)	32 (± 25)	- 0.716	0.476
DBH (cm)	11 (± 10)	22 (± 15)	3.204	0.003
Elevation (masl)	1203 (± 155)	1725 (± 137)		
No. of plots	64	22		

3.2 Ungulate species documented

In the NRWNNR, we documented six wild ungulate species belonging to three different families (Table 2): gaur (*Bos gaurus*), sambar (*Rusa unicolor*), red muntjac (*Muntiacus muntjac*), wild boar (*Sus scrofa),* Chinese goral (*Naemorhedus griseus*) and Chinese serow (*Capricornis milneedwardsi*). The recorded signs were mostly hoof prints and dung and, in case of wild boar, signs of up-rooting activity. We documented most of the species using both by indirect and direct observations. Pictures were taken of gaur and Chinese goral. The documentation of the Chinese serow was based on only two weak hoof print signs only, identified by a local guide, and, therefore, the presence of this species should be taken with care and was not regarded in most analyses (Table 2).

In total, we found 228 signs of the six ungulate species combined on all transects; at GM (buffer zone), almost twice as many than at XN (experimental zone; Table 3). Two species, sambar and Chinese goral, were only recorded at GM, where we also documented 67 sign events of the wild boar. The number of gaur signs, which was together with wild boar and muntjac found at both sites, was by 25% higher at GM compared to XN; wild boar signs were even four times more frequent in GM than in XN (Table 3). Muntjac was the only species that occurred more frequently at XN compared to GM. The overall relative wildlife sign density was with 54 signs ha^{-1} more than three times higher at GM than at XN with 16 signs ha^{-1} (t = 3.59, p = 0.006, n = 11); wild boar sign densities were seven times greater at GM than at XN (t = 5.22, p = 0.001, n = 11) while other species did not differ significantly (Table 3). We found 16% of muntjac signs directly on trails, in contrast to signs of other species. A high proportion of signs was created by only one individual, e.g. in 48% of gaur, 80% of muntjac and 74% of sambar signs. On the other hand, 62% of the signs of wild boar were up-rooting signs, making it impossible to distinguish between one individual spending a longer time there or a group of animals. The latter signs were counted as one event and represented a zone of high activity, often close to trees providing fruits or nuts.

3.3 Ungulate species distribution

Due to low sample size at XN, we analysed only the wild ungulate species distribution at GM. The number of wildlife signs could not significantly be explained by forest vegetation structure. A slight tendency of higher abundance of wild boar, gaur, and muntjac signs at areas of lower understory height was visible ($F_{2,61}$ = 2.56, P = 0.086). Most animals further tended to avoid areas of < 40% and > 80% understory cover ($F_{4,59}$ = 1.51, P = 0.21). Tree density and stem DBH did not significantly influence animal numbers ($F_{3,60}$ = 1.17, P = 0.328 and $F_{3,63}$ = 0.29, P = 0.835, respectively).

Table 2. List of documented wild ungulate species at the Naban River Watershed National Nature Reserve (NRWNNR) and their respective kind of evidence (PS = personal sighting, PH = photograph, S = sign). Additionally, the overall number of records and documentations of these species in the NRWNNR and their documentation across other reserves of Southeast Asia are shown.

Family	**Scientific name**	**Common name**	**Evidence**	**No of records in NRWNNR**	**Documented in other areas**	**Literature**
Suidae	*Sus scrofa*	Wild boar	PS, S	82	Laos, Thailand, Vietnam, Cambodia	Timmins 1997, Duckworth 1998, Pattanavibool and Dearden 2002, Polet and Ling 2004, Kitamura *et al.* 2010, Gray and Phan 2011
Cervidae	*Muntiacus muntjac*	Red muntjac	PS, S	56	Laos, Thailand, Vietnam, Cambodia	Timmins 1997, Duckworth 1998, Pattanavibool and Dearden 2002, Polet and Ling 2004, Kitamura et al. 2010, Gray and Phan 2012
	Rusa unicolor	Sambar	S	13	Laos, Thailand, Vietnam	Timmins 1997, Duckworth 1998, Pattanavibool and Dearden 2002, Polet and Ling 2004
Bovidae	*Bos gaurus*	Gaur	PS, S, PH	75	Laos, Vietnam, Cambodia	Timmins 1997, Duckworth 1998, Polet and Ling 2004, Gray and Phan 2014
	Capricornis milneedwardsii	Chinese serow	S	2	Laos, Thailand	Timmins 1997, Duckworth 1998, Pattanavibool and Dearden 2002, Kitamura et al. 2010
	Naemorhedus griseus	Chinese goral	PS, S, PH	1	Thailand	Pattanavibool and Dearden 2002

Table 3. Number of signs and relative sign density (number of signs ha^{-1}) of different wild ungulate species for both study sites GM = Guomenshan (buffer zone) and XN = XiaoNuoYou (experimental zone). Chinese goral was not included in statistical analyses due to low sample size.

	Number of signs		Sign density		*t*	*P*
	GM	XN	GM	XN		
Gaur	43	32	8.7	4.2	1.335	0.233
Chinese serow	2	-	28.9	3.7	5.224	0.001
Red muntjac	24	32	10.2	8	0.538	0.604
Sambar	13	-	5	-		
Wild boar	67	15	0.8	-		
Overall	149	79	53.6	15.9	3.593	0.006

The number of signs per plot did not significantly differ but tended to increase with growing distance away from the next village (Figure 2a); the average distance of all signs per plot to the next village was with 2.3 km significantly larger at the buffer zone GM compared to 1.8 km at the experimental zone XN (t = 6.21,

$P < 0.001$, $n = 224$). Further, the average distance of muntjac signs to the next village at GM was with 2.6 km almost twice as high than that of XN (1.4 km; $t = 5.53$, $P < 0.001$, $n = 51$). The same pattern was visible for gaur with a distance of 2.1 km at GM versus 1.5 km in XN ($t = 4.152$, $P < 0.001$, $n = 75$) while no trend was found for wild boar ($t = -0.816$, $p = 0.417$, $n = 79$).

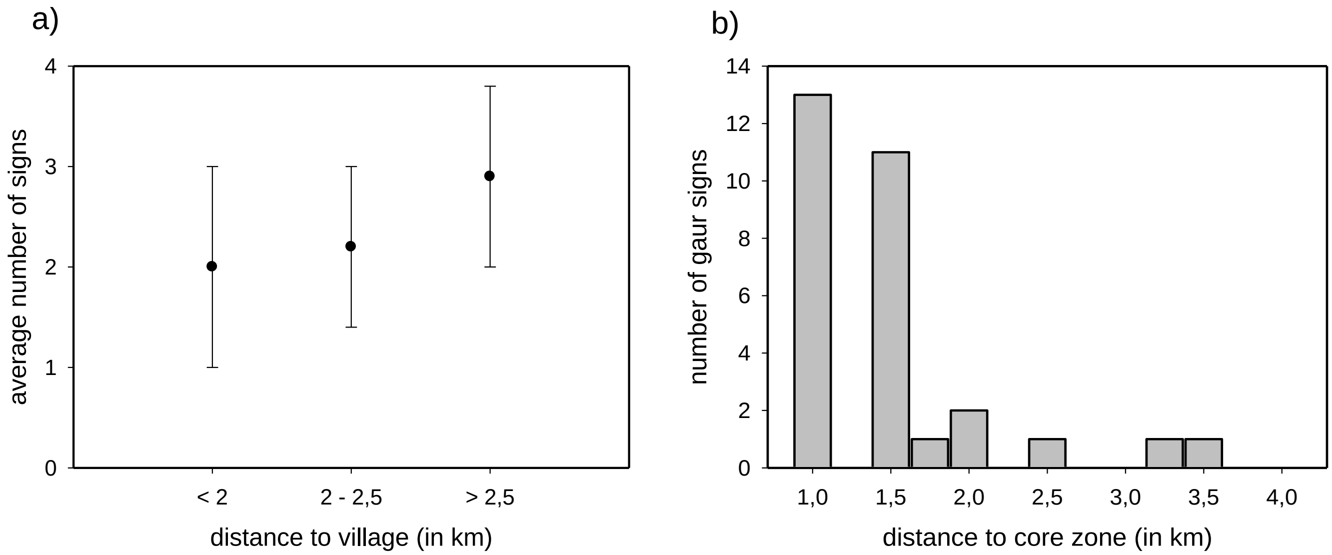

Figure 2: a) Average number (±SE) of all animals signs against increasing distance to the next village (in km). b) Number of gaur signs with increasing distance to the core zone (in km), recorded at Guomenshan (overall mean = 1.57, standard deviation = 0.69, n = 30).

Wild boar and muntjac signs were not influenced by the distance to the core zone while 99% of sambar signs were located within a distance of less than 1.7 km away and 83% of gaur signs were found within a distance of less than 2 km (43% in < 1 km) away from the core zone (Figure 2b). Despite no difference in vegetation structure to the rest of GM, wildlife sign density at the former settlement was about 15 signs ha^{-1} higher, significantly so for gaur ($t = 2.39$, $P = 0.02$, $n = 62$) and sambar ($t = -2.92$, $P = 0.012$, $n = 13$). Relative density of muntjac signs was similar, only the relative density of wild boar signs was higher at GM (Figure 3). Only 13% of wild boar but 37% of gaur and 62% of sambar signs were found here.

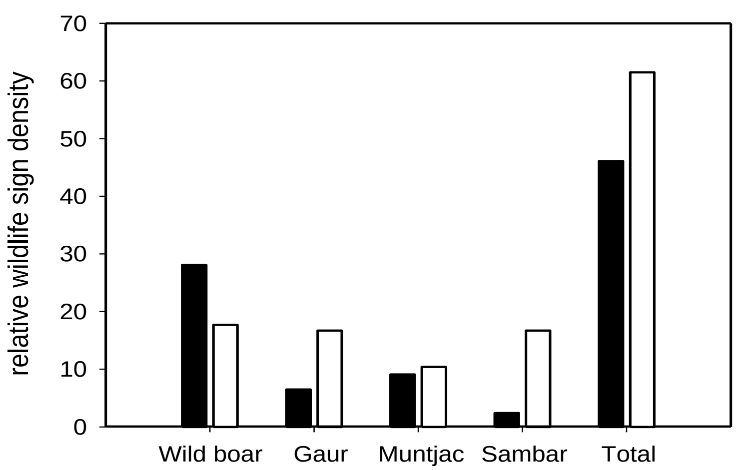

Figure 3: Relative wildlife sign density (number of signs ha-1) recorded on transects at the former settlement area (white bars, n = 12) and the remaining area of Guomenshan (black bars, n = 52).

Direct observations were generally difficult due to dense vegetation. Sightings of gaur and Chinese goral took place in the buffer zone while we directly observed muntjac in the experimental zone only (Figure 4). On several occasions, domestic water buffalos passed the camera traps. The camera placed at the experimental zone XN recorded three muntjacs, a female and two males, distinguishable by their antlers (Figure 4).

(a) (b) (c)

Figure 4: Photographic evidence of a) gaur, b) sambar, and c) muntjac in the Naban River Watershed National Nature Reserve (NRWNNR) observed between October and December 2010. Photo credit: P. Trumpf.

4. Discussion

4.1 Wildlife species abundance

Six wild ungulate species were documented in the NRWNNR, including gaur, sambar and Chinese goral, all of them ‘vulnerable’ species (IUCN, 2011) as well as the more common red muntjac, wild boar, and probably the ‘nearly threatened’ Chinese serow species (IUCN, 2011).

Comparable surveys across Southeast Asia show similar wildlife candidates representing the ungulate communities in forests of Thailand, Laos, Cambodia and Vietnam (Table 1). Wild boar and muntjac occurred in all of these regions (Table 1), documenting the rather un-specialized habitat requirements of these species (Smith and Xie, 2008). Both species were even reported to survive in highly degraded landscapes within and surrounding large cities such as Hong Kong (Pei et al., 2010). The habitat at NRWNNR seemed to suit the Chinese goral as the only other reserve they were reported at was the Om Koi Wildlife Sanctuary in Thailand (Table 1).

The higher wildlife sign numbers in the buffer zone at Guomenshan (GM) compared to the experimental zone at XiaoNuoYou (XN) was probably due to stronger human disturbance in the latter area where we also detected poachers, logging activities, shelters, hides and fireplaces on several occasions during our surveys. The building of a broad footpath from the road to the former settlement and the installation of mineral licks within the buffer zone might further enhance human activities and consequent human-wildlife encounters. In contrast, animal activity, especially gaur signs, was high within the buffer and directly adjacent to the core zone. This highlights the success of the strict protection management and the corresponding zonation scheme in the NRWNNR.

The low abundance of wild boar at the experimental zone XN was probably not due to vegetation structure as they prefer riparian vegetation and gullies (Abaigar et al., 1994; Caley, 1997), landforms that were present at both XN and GM. As the forest at XN was completely surrounded by farmland, wild boar might have been decimated by hunting. Muntjac, which can also represent serious pests in farmland (Chapman et al., 1994), showed similar sign densities at GM and XN. Muntjac generally prefer dense vegetation structures providing cover (Chapman et al., 1994; McCullough et al., 2000), which existed at both study sites, thus representing a favourable habitat (Pei et al., 2010).

Sambar and Chinese goral were only found in the buffer zone GM, which, in contrast to XN, comprised steep and rocky places, i.e., preferred habitat structures of the goral (Chaiyarat et al., 1999; Smith and Xie, 2008). Conversely, for Sambar vegetation and terrain seem to be more suitable at XN compared to GM as described by Porwal et al. (1996) and Varni et al. (2012) while nothing is known about the reaction of sambar to human disturbance. At the NRWNNR, no open or half-open patches were found in the forest, which are often described as preferred ungulate habitat in Southeast Asia (Chodhury, 2002; Eisenberg and Seidensticker, 1976; Wani et al., 2012). Sambar in India were reported to intensively utilize open landscapes (Wani et al., 2012), generally hiding during daylight in dense vegetation and foraging at night in more open habitats (Smith and Xie, 2008); hence, this species seems to locally respond to disturbance in a similar way as the red deer (*Cervus elaphus*) in Middle Europe, changing habitat from open landscapes to forests (Rethwisch et al., 2001). Similar tendencies to prefer open, agricultural landscapes such as plantations were reported for gaur and sambar in parts of India (Balakrishnan and Easa, 1986; Eisenberg and Seidensticker, 1976), which contradicts our findings. This disagreement might be due to the rather small scale and intensive agriculture in addition to poaching activities at NRWNNR and an exhaustive fragmentation of the remaining forest habitats in this region.

Only one direct observation of a gaur herd of four individuals was made during our study at GM; generally, gaur herds consist of 6 – 8 individuals (Bhumpakaphan, 1997). Gaur are rather shy and difficult to detect due to their preference of dense bushes (Honglian and Renchao, 1999). Hence, little is known about their habitat preferences, feeding ecology and population structure. Gaur numbers have rapidly declined due to hunting and habitat fragmentation (Steinmetz, 2004) and they seem to shy away from human disturbance at NRWNNR, which is expressed by their frequent occurrence directly adjacent to the core zone and their scarce occurrence close to human activity hotspots.

Besides the ungulate species, five other mammal and two larger bird species were documented. Twice local guides identified paw prints of an Asian black bear (*Ursus thibetanus*) in the buffer zone. A wild cat (leopard cat (*Prionailurus bengalensis*) or marbled cat (*Pardofelis marmorata*)) was caught by the camera trap at XN as well as a striped squirrel (*Tamiops spec.)*. Near the Mekong River, a red jungle fowl cock (*Gallus gallus*) and in XN several silver pheasants (*Lophura nycthemera*) were observed as well as a group of about 10 Rhesus macaques (*Macaca mulatta*).

4.2 Current situation

In our study, wildlife sign numbers generally increased further away from villages and with closer distance to the core zone. Hence, the animals at NRWNNR seem to avoid humans, an observation that has been made in several other regions (Barnes et al., 1991; Griffiths and Van Schaik, 1993). The forest at the experimental zone XN is smaller in size, surrounded by several villages and crossed by a road, whereas the forest at the buffer zone GM borders villages and a road only at one side, which might be reflected in the animal sign numbers. Wildlife, however, can become habituated to disturbance as has been documented for ibex, red deer, reindeer (Reimers et al., 2010) and elk (Thompson and Henderson, 1998). Secondary forest growing on abandoned human settlements was shown to be preferred elephant habitat (Barnes et al., 1991) and at NRWNNR, the ungulate species present might prefer the abandoned settlement due to better forage quality, lack of human disturbance, relative openness of the vegetation or closeness to the core zone.

The increasing problem of hunting of endangered species such as gaur, monkeys and bears for traditional Chinese medicine, an eminent threat to biodiversity in the region (Mainka and Mills, 1995; Still, 2003), might also be threatening the NRWNNR in the future. Currently, the destruction of habitats through establishing rubber plantations as well as poaching are probably the most severe threats to the conservation of NRWNNR's wildlife community. Further, large parts of Xishuangbanna's forests have recently been transformed into rubber plantations, seriously affecting the region's unique biodiversity on a larger scale (Li et al., 2007; Zhang and Cao, 1995). The ungulate community of the NRWNNR is still quite intact, if not in numbers, at least in case of species richness, and has therefore a high value for conservation. A frequent exchange of wildlife subpopulations with other reserves, which can prevent genetic population bottlenecks (Amos and Balmford, 2008), is barely possible at NRWNNR due to human construction and activities. For example, the adjacent Xishuangbanna National Nature Reserve (XNNR), previously only separated from the NRWNNR by the Mekong river, which could be crossed by animals during times of low water levels in the past, is now probably out of reach for most wildlife due to the erection of a dam and the associated rise of the water body. If isolated in the NRWNNR, the local gaur population, which counts probably only about 70 heads (Cao, pers. comm.), will soon suffer inbreeding depression, which results in a loss of fitness and can lead to a rapid extinction vortex (e.g. Brook et al., 2002).

5. Conclusions

The Naban River Watershed National Nature Reserve is with about 270 km^2 a rather small conservation area and its forests are used for a number of collecting and extracting activities by humans due to its design according to the 'Man and Biosphere' guidelines. The results of this study show that the NRWNNR still hosts a unique wildlife community with an astonishing number of ungulate species. This diversity in combination with the contiguous forests in the buffer and core zone highlights the importance of the NRWNNR as protective area. Efforts should be made in connecting this small reserve to existing surrounding reserves and forests using a network of wildlife corridors. This will enable wildlife to recolonize suitable habitats and strengthen the genetic pool. The buffer zone encompassing the abandoned settlement should become part of the core zone and remain under strict protection status as has been proven successful up to now. The installation of camera traps can be a useful tool to reduce poaching. Additionally, local people could receive limited allowance to hunt in a sustainable way for their subsistence, which represented a powerful tool in other conservation areas (e.g., Elkan et al., 2006). The local community could, in turn, help to monitor wildlife and combat the commercial hunting and trade of wildlife for traditional Chinese medicine.

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