Project Update: June 2010

Arunachal Pradesh in North-east India is part of the Himalaya Biodiversity Hotspot. The middle-elevation forests of Arunachal Pradesh have the highest bird species diversity in the whole world (Kissling *et al.* 2009). In addition to the diversity of its floral and faunal elements, the state also harbours a great diversity of human communities. The state has 26 different tribes who have their own distinct language, culture, and tradition. Most of the state has hilly terrain and subsistence agriculture by jhum or shifting cultivation is the mainstay of local communities. Hunting historically has been one of the important pastimes of most of the tribes of the state. In addition to being a valuable source of protein, many animal parts form important components of the local culture and traditions. Some animal parts are believed to have important medicinal properties. Selling wild meat is an important source of revenue for few, in a state where other avenues of financial income are limited. In many aspects, the lifestyles of the tribes in Arunachal Pradesh are similar to other communities in South-east Asia.

Hunting has detrimental impacts on wildlife populations. Several studies across the globe have examined impacts of hunting on wildlife. Areas under the influence of hunting can be much wider than one can imagine. Forests within 10-15 km of a road or river have been shown to be vulnerable to hunters (Robinson & Bennett, 2000). To have a core zone of 100 km^2 of hunting-free area, forests would have to extend more than 1300 km^2 (Kinnaird & O'Brien, 2007). Robinson & Bennett (2000) estimate that a typical tropical forest ecosystem may support subsistence hunting if human population density does not exceed one person/km^2. In most areas of tropical Asia, there are very few areas, which span 1300 km^2 of uninhabited contiguous forests and most areas have higher human population densities than one person/km^2.

One of the important groups of wild animals, which local communities hunt in Arunachal Pradesh, is hornbills. The most preferred species is the great hornbill *Buceros bicornis* followed by the rufous-necked hornbill *Aceros nipalensis* and the wreathed hornbill *Rhyticeros undulatus*. The two other smaller species are occasionally hunted. Local tribes, especially the Nishis, use the upper beak and casque of the great hornbill to adorn their cane caps. Wanchos, Tangsas and the Noctes use the great hornbill tail feathers in their traditional headdresses. Many communities also believe that hornbill fat has medicinal properties. Some tribes often display the heads of hornbills as trophies in their houses. Most hunting of hornbills is with rifles, muzzle-loaders and sometimes crossbows to hunt hornbills. They also use innovative techniques like bamboo traps and gum of *Ficus* trees to capture hornbills. There are also other communities in the state, which do not specifically use hornbill body parts but hunt hornbills incidentally for their meat. It is relatively easy to hunt hornbills as the local hunters have intimate knowledge of the food plants of hornbills and they focus their efforts at fruiting trees where hornbills tend to congregate. Though several tribes have taboos for hunting hornbills during the breeding season, hornbills are also occasionally hunted during the breeding season when climbers raid nests or bring down nesting trees to kill the incarcerated female and chicks.

A previous survey in eastern Arunachal Pradesh pointed out that the two large hornbill species the great hornbill and the rufous-necked hornbill were relatively rare and that the great hornbill had gone locally extinct from a few areas (Datta, 2002). It also pointed out that the unprotected Reserve and Community Forests (Unclassed State Forests) had much lower encounter rates of hornbills as compared to protected areas like the Namdapha National Park. In this study, I conducted a rapid survey across the state to investigate the differences in hornbill encounter rates and key habitat structure variables across the three different administrative regimes: protected areas, reserve forests and the community forests. Protected areas are on paper supposed to be inviolate areas, wherein extraction of resources (except for

subsistence in cases of wildlife sanctuaries) and hunting of animals is prohibited. Field staff are appointed specifically to enforce the stringent wildlife protection laws of the country. Reserve forests, on the other hand, are supposed to have some consumptive value, where regulated extraction of wood is allowed, but hunting is not allowed. The community on the other hand has rights over the community forests, although they are technically under the Forest Department and classified as Unclassed State Forest. However, for all practical purposes, the communities have de facto ownership of the land and can control/regulate the use of resources according to customary laws. On paper, even in CFs, hunting of any scheduled animal species unless it is declared, as vermin is not allowed. However, in Arunachal Pradesh, hunting has strong cultural values and it is more open as compared to other states in peninsular India. Enforcement of law is therefore difficult. In addition, community forests do not have forest protection staff to ensure enforcement of wildlife protection laws. Therefore, I expected differences in the hornbill abundances across the three different forest categories because of differential logging and hunting pressures.

I had forest structure and hornbill abundance data based on a study completed in 1996 before the logging ban (Datta 1998). I revisited three of those sites, two of which are in the reserve forests and one in a protected area. I expected the forests to show a recovery after 12 years because of the logging ban. I have compared the differences in forest structure across the three sites over the 12 years.

Methods

Survey

I conducted a rapid survey across 20 sites in Arunachal Pradesh (see Fig.1). The sites were spread across eight protected areas (PA), six reserve forests (RF) and six community forests (CF) in the state (see Table 1). Laying straight line transects in these hilly tracts is next to impossible because of the steep slopes. At every site, existing trails were therefore walked at least twice except at Abango and Konnu where bad weather and logistical difficulties did not allow replication of the trail walks. These trails are foot trails used by locals and are seldom wide enough to allow to people to walk side by side. These trails were walked in the early mornings and evenings. Numbers and species of hornbills seen in each of the trails were recorded along with perpendicular distance to the trail. I had a total effort of 658.7 km (PA = 300.5, RF = 284.9, CF & VFR = 73.3). Calls of the birds were also used to confirm presence of a species at a site. At each site, I did point-centered quarters to estimate tree density and total basal area per hectare for each of the sites. The points were spaced 100 m apart. From the point, distance of the nearest tree (of trees with GBH ≥ 30 cm) in each quarter was recorded. In addition, we also measured the GBH and tree height (with an optical range finder). At each point, I also recorded canopy cover using a canopy densiometer. I conducted at least two key informant interviews at each of the site. All the key informants were active hunters. The interviews helped obtain information on species hunted, reasons for hunting hornbills and hunting taboos. They were also asked about the presence of different species of hornbills. At sites where a hornbill species was not detected by the local hunter for a considerable amount of time, they were asked whether hornbills were seen in the last five and ten years respectively. Apart from this, information was also gathered from informal discussions with other local people.

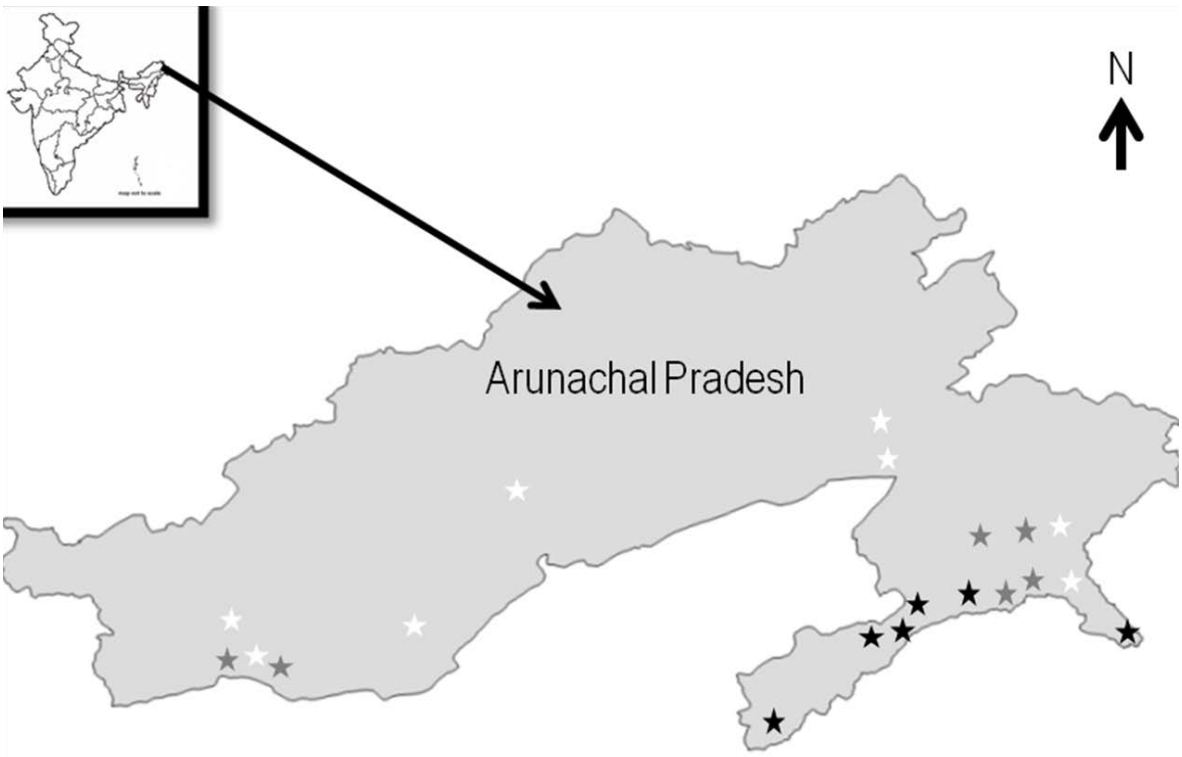

Figure 1. Map **s**howing the 20 sites which were sampled across the state. The white star indicates the protected areas, the grey star indicates the reserve forests and the black star indicates the community forests.

Change in forest structure at three sites in western Arunachal Pradesh after 12 years

In Pakke Wildlife Sanctuary and Papum and Doimara RF, I revisited some of the sites which were sampled in 1996 (Datta, 1998) to determine changes in vegetation structure and in hornbill abundance after 12 years (see Fig. 2). I expected a recovery in these sites particularly the reserve forests as logging was banned in the state during this duration.

In 1996, six trails (three in unlogged forests, one in 20-25 year old logged forest and two in semi-disturbed forest) were walked in Pakke Wildlife Sanctuary and four trails (one in plantation in Papum RF and three in recently logged forest in Doimara RF (see Datta (1998) for detailed description). In 2008, five of the 10 original trails were walked; one in the old logged forest (now > 30-35 years since logging) in Pakke Wildlife Sanctuary, one in the plantation and three in logged forest (now 12 years since logging) in RF. Currently, the plantation site (Papum RF) is highly degraded due to severe extraction pressures from nearby villages. The old logged forest inside the Pakke Wildlife Sanctuary has greater levels of protection from the Forest Department staff. Logging operations were carried out in the Doimara RF until 1996. Since then, no legal logging has occurred in the area. However, there has been illegal extraction of timber, fuel wood, cane and hunting.

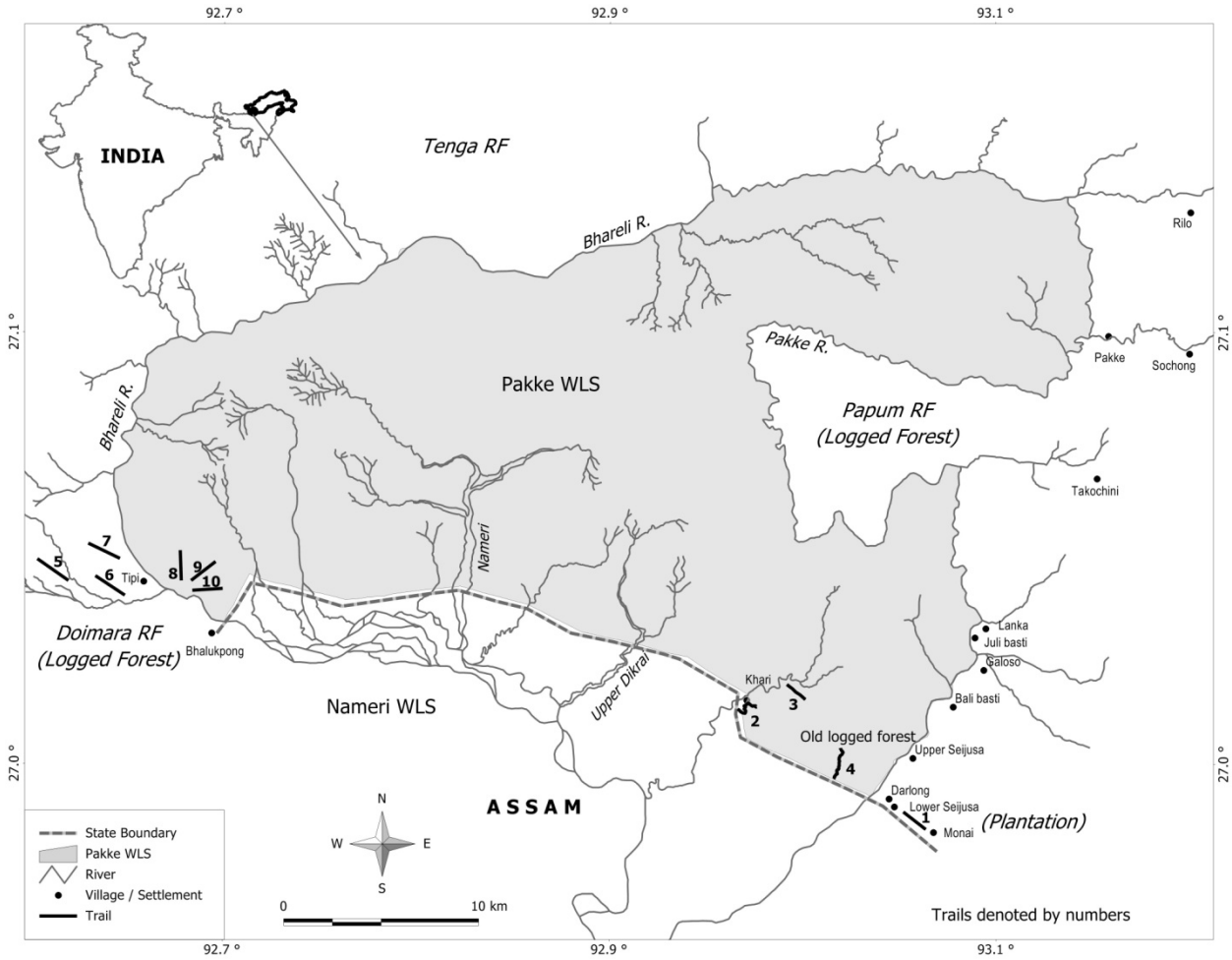

Figure 2. Map showing location of trails in Pakke Wildlife Sanctuary, Doimara and Papum Reserve Forests, western Arunachal Pradesh. In 2008, vegetation sampling and trail walks were carried out only in old logged forest in Pakke WS, plantation in Papum RF and logged forest in Doimara RF.

Table 1. Details of the sites visited during the rapid sampling in the state. The sites marked with ***** were subsequently intensively sampled between November 2008 and April 2009 (for details see Chapter 1).

No.	Name	Status	Administrative control	Duration	Effort (km)
1	Abango	WLS	Mehao WLS	Jan 2008	5
2	Konnu	CF	USF (Khonsa FD)	Jan 2008	1
3	Hukanjuri	VFR	Deomali FD	Feb 2008	5
4	Soha	CF	Deomali FD	Feb 2008	7
5	Mopaya	VFR	Deomali FD	Feb 2008	8
6	Miao	RF	Jairampur FD	Feb 2008; Nov 2008–Apr 2009	54
7	Manmao	CF	USF (Jairampur FD)	Feb 2008; Nov 2008–Apr 2009	31.5
8	Glao	WLS	Kamlang WLS	Feb 2008	31
9	Mehao lake	WLS	Mehao WLS	Feb 2008	16
10	Turung	RF	Namsai FD	Mar 2008; Jan–Apr 2009	37
11	Tengapani	RF	Namsai FD	Mar 2008; Jan–Apr 2009	134
12	Hornbill	NP	Namdapha NP	Mar 2008; Jan–Apr 2009	194

13	Tale	WLS	Tale WLS	Mar 2008	30
14	Jotte	WLS	Itanagar WLS	Apr 2008	12
15	Monai	RF	Khellong FD	Apr 2008	8.5
16	Seijusa	WLS	Pakke WLS	Apr 2008	6
17	Tipi	RF	Khellong FD	Apr 2008	17.4
18	Sessni	WLS	Eagle Nest WLS	Apr 2008	6.5
19	Rima	RF	Jairampur FD	Nov 2008–Apr 2009	34
20	Yakhulo	CF	Vijaynagar USF	Jan–Apr 2009	20.8

Results

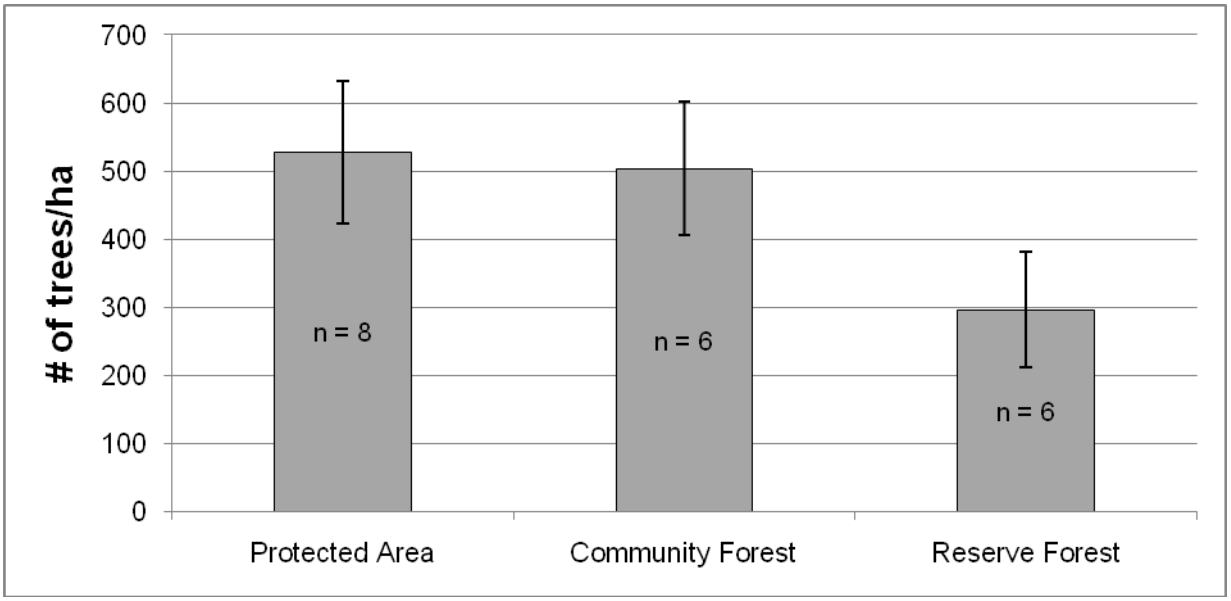

Figure 3. Tree density per hectare in protected areas, community forests and in the reserve forests.

Protected areas had the highest tree density while the reserve forests had the least density of trees (Fig. 3). Analysis of Variance (ANOVA), however, did not show significant differences amongst the three administrative regimes (F = 1.9446; df = 18, p = 0.1801). One of the potential reasons for lack of significant differences across the three categories is large within group variances in the three categories. The tree densities in protected areas ranged from 364 – 1130 trees per ha, in community forests from 154 – 730 trees per ha and in reserve forests from 73 – 506 trees per ha.

Total basal area per hectare was highest in protected areas and least in reserve forests (Fig. 4). However, ANOVA failed to detect significant differences in total basal area across the three administrative regimes (F = 1.174; df = 18, p = 0.1995). However, when total basal area per hectare between protected areas and reserve forests was compared, there was a significant difference between the two treatments. Protected areas had higher total basal area per hectare as compared to reserve forests (F = 5.6982; df = 12; p = 0.03432).

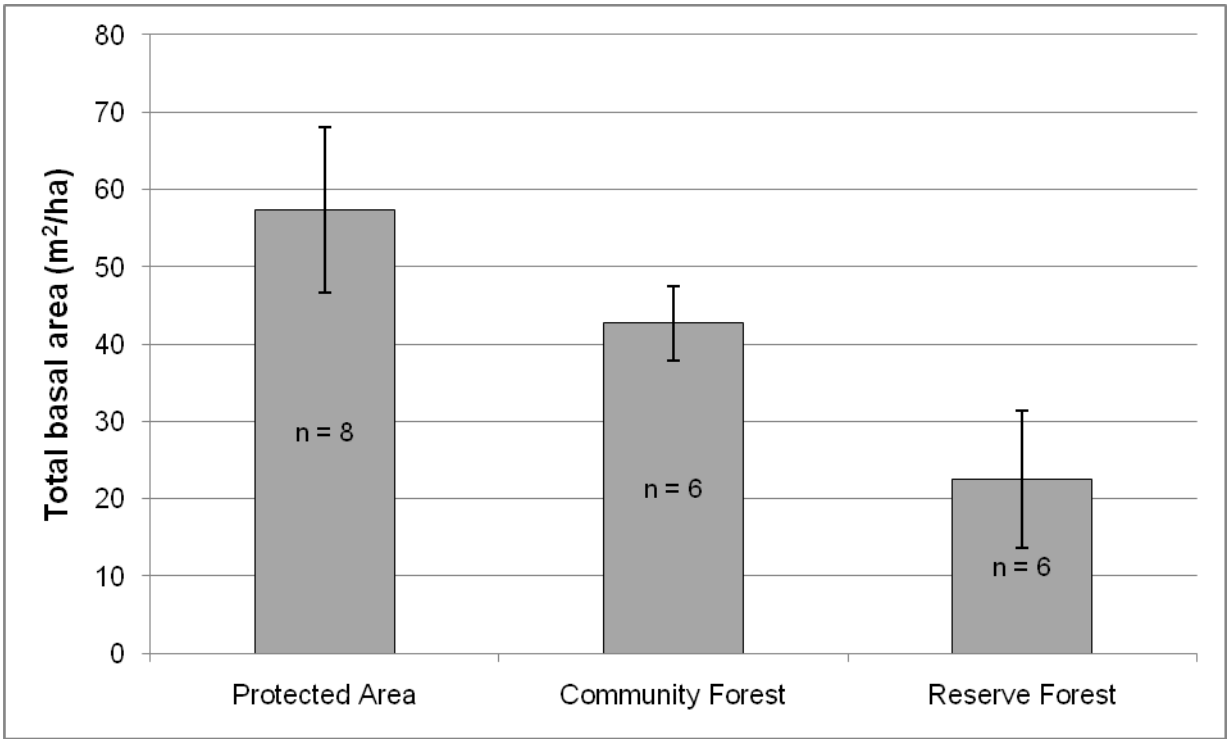

Figure 4. Total basal area/ha in the protected areas, community forests and in the reserve forests.

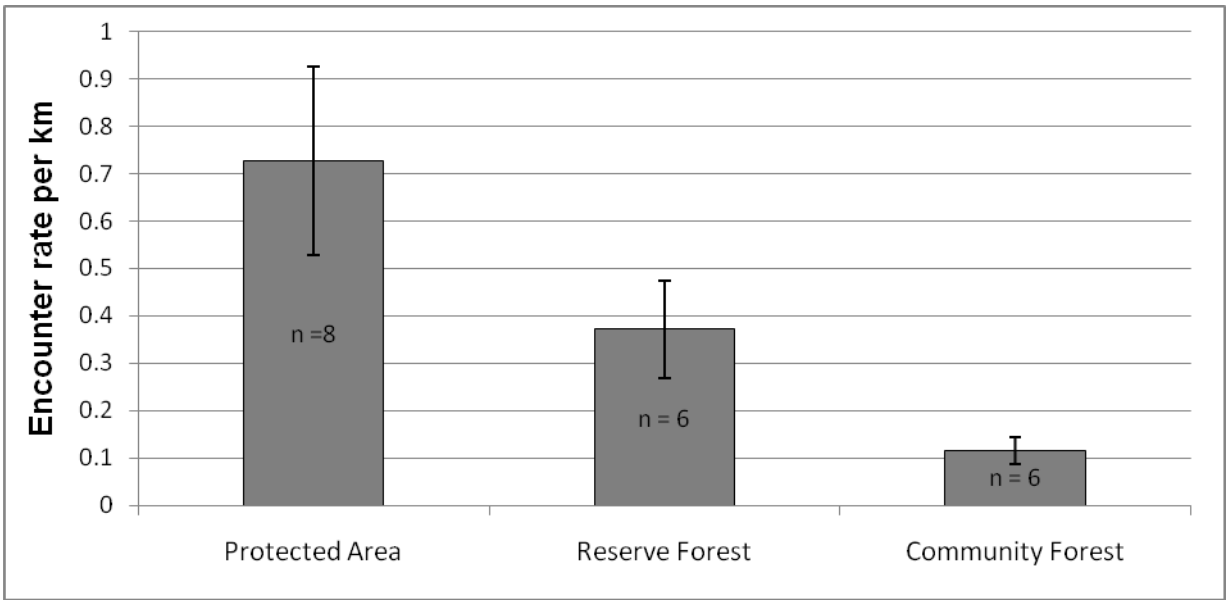

Figure 5. Overall hornbill (all five species) encounter rate per km (± SE) across the three administrative regimes.

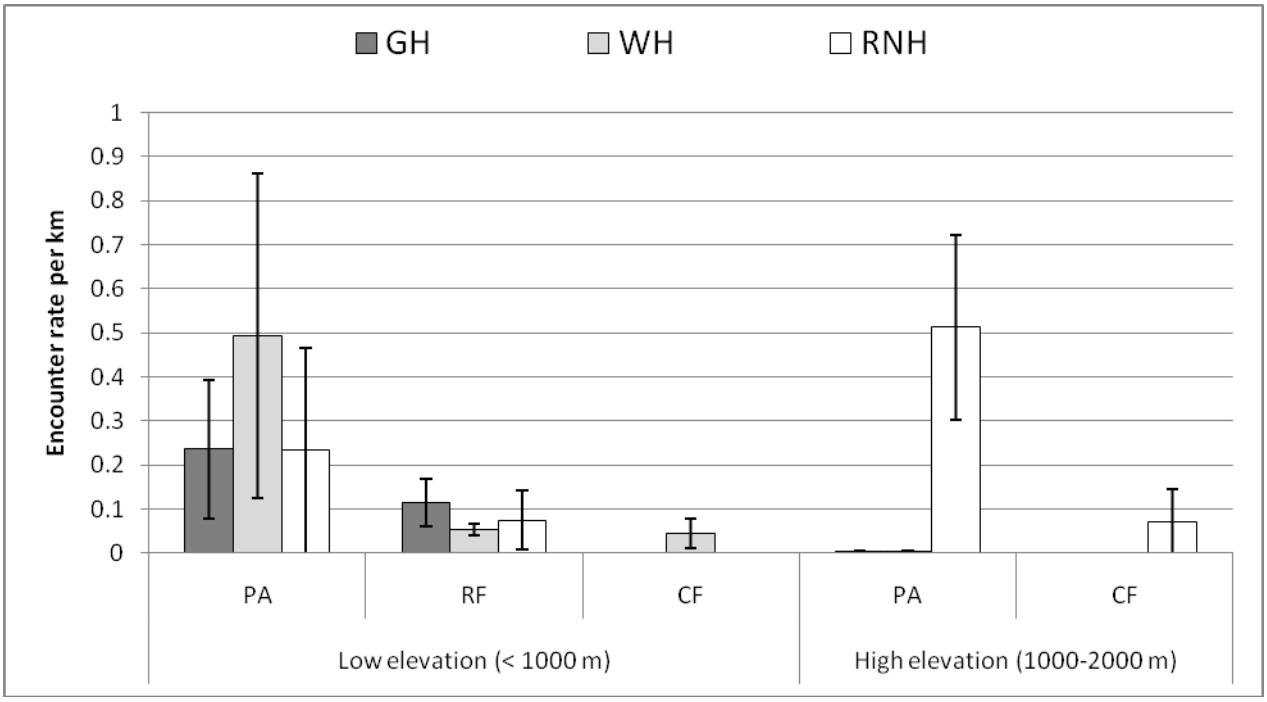

Figure 6. Encounter rates per km (± SE) of three large species of hornbills in low elevation and high elevation forest across the three administrative regimes. I have not yet sampled any reserve forests in the high elevations. PA - protected area, RF - reserve forest, CF - community forest. GH - great hornbill, WH - wreathed hornbill, RNH - rufous-necked hornbill.

The protected areas had higher encounter rates of all hornbills (pooled) as compared to reserve forests and community forests (Fig. 5). Though reserve forests had lower tree density and basal area than community forests, they fared much better in overall encounter rates of hornbills.

Hornbills show differences in their distributions along the elevation gradient. Therefore, I divided the sites into low elevation sites (< 1000 m) and high elevation sites. Protected areas had higher encounter rates of all the three large-bodied hornbills, great hornbill, wreathed hornbill and rufous-necked hornbill (Fig. 6). Great hornbill was not detected in the any of the community forests (n = 4). Wreathed hornbill was the only species detected in the low elevation (< 1000 m) community forests.

In at least one site, the local hunters had not detected four of the five species of hornbills in the last 5 years. In at least five sites, key informants had not detected the great hornbill in the last 5 years (Table 2). Local tribes had not seen the rufous-necked hornbills in the last 5 years at two sites (Table 2). Even the small-bodied species like the Oriental pied hornbill and the brown hornbill had gone locally extinct from two and one sites respectively (Table 2). The only species, which has been detected in all the sites, was the wreathed hornbill (Table 2).

Table 2. Number of sites which can be potentially occupied by hornbills (based on elevation distributions), sites at which the species was detected, sites at which species is present (based on local information) but was not detected and sites where the species has not been detected in the last 5 years.

Species	Potential sites	Detected	Present but not detected	Possibly locally extinct
Great hornbill	15	5	5	5
Rufous-necked hornbill	10	7	1	2
Wreathed hornbill	16	10	6	0
Brown hornbill	11	6	4	1
Oriental pied hornbill	11	2	7	2

Change in forest structure at three sites in western Arunachal Pradesh after 12 years

There were significant differences in tree density in all the three sites after 12 years (Table 3). The declining trend was consistent across the three sites. There was 74%, 53% and 34% reduction in the tree density in the plantation, logged forests and the old logged forests from 1996. However, larger trees with GBH ≥ 150 cm declined only in the plantation and the logged forest sites. Trees with GBH ≥ 200 cm decreased significantly in only logged forests. While basal area showed a significant decline in the logged forests after 12 years, tree height and mean GBH of trees remained similar over the 12 years in logged forests. The density of trees with larger GBH (≥ 150 cm) remained similar over the 12 years in the old logged forest. The plantation had extremely low densities of trees with GBH ≥ 200 cm even in 1996. There was a decline in the mean GBH, tree height and basal area in the plantation over the 12 years.

Table 3. Structural vegetation characteristics of the three sites in 2008. Sample sizes (number of plots) for each of the parameters estimated are given in parentheses. Kruskal-Wallis One-Way ANOVA results are shown.

	Site	1996	2008
Tree density	**Plantation (RF)**	**284 ± 45**	**73 ± 12****
	Logged forest (RF)	**257 ± 17**	**121 ± 13****
	Old logged forest (PA)	**550 ± 34**	**364 ± 15****
Tree density (> 150 cm)	**Plantation (RF)**	**35 ± 15**	**3 ± 3****
	Logged forest (RF)	**26 ± 4**	**14 ± 4****
	Old logged forest (PA)	42 ± 6	42 ± 5
Tree density (> 200 cm)	**Plantation (RF)**	3 ± 3	0 ± 0
	Logged forest (RF)	**15 ± 3**	**2 ± 1****
	Old logged forest (PA)	14 ± 4	22 ± 5
Density of four main hornbill food species	**Logged forest (RF)**	**16 ± 3**	**2 ± 1****
	Old logged forest (PA)	53 ± 9	51 ± 13

Comparison of vegetation in old logged forest, logged forest and plantation across 12 years

There were significant differences across plantation, logged forest and old logged forest sites in overall tree density, density of trees ≥ 150 cm GBH, density of trees ≥ 200 cm GBH, density of four main non-fig hornbill food plants, tree GBH, tree height and basal area per plot (Table 4). Old logged forests inside

Pakke Wildlife Sanctuary fared better than the logged forests and the plantation in RFs. The plantation was the most degraded amongst the three sites.

Table 4. Structural change in vegetation parameters from 1996 to 2008 in the three sites. In each site, Mann-Whitney U test values that showed significant differences ($P < 0.05$) between the years are marked in bold.

	Plantation	**Logged forest**	**Old logged forest**
Tree density (per ha)	73 ± 12 (35)	121 ± 13 (57)	364 ± 15 (20) **
Tree density (> 150 cm)	3 ± 3 (35)	14 ± 4 (57)	42 ± 5 (20) **
Tree density (> 200 cm)	0 ± 0 (35)	2 ± 1 (57)	22 ± 5 (20) **
Density of 4 hornbill food plants	0 ± 0 (35)	2 ± 1 (57)	51 ± 13 (20) **
GBH (cm)	41.07 ± 4.36 (24)	77.16 ± 5.45 (46)	90.14 ± 8.23 (20) **
Tree height (m)	5.07 ± 0.34 (24)	10.99 ± 0.63 (46)	14.59 ± 0.68 (20)**
Basal area (m^2) per plot	0.03 ± 0.01 (35)	0.25 ± 0.04 (57)	2.41 ± 0.97 (20)**

Discussion

It has been suggested that most of the biodiversity is unlikely to survive without effective protection. (Myers *et al .* 2000; Bruner *et al .* 2001). Tropical parks have been found to be effective at protecting the ecosystems and their biodiversity inspite of problems like funding constraints and significant land-use pressure (Bruner *et al .* 2001). In Arunachal Pradesh, too the initial findings seem to be supporting this trend especially concerning hornbills. In Arunachal Pradesh, protected areas had the highest tree density and total basal area per hectare while the reserve forests had the least. As expected with more than 20 years of logging in most RFs, the total basal area per hectare of trees in reserve forests was significantly lower than protected areas. Logging can potentially result in loss of main food plants of hornbills or in loss of large nesting trees. Potentially, logging can have strong detrimental effects on long-term persistence of hornbills in the area. However, as per the findings presented in Chapter 1 it is evident that hunting has a stronger influence on hornbill presence in the area. My results over many sites across the state also reiterate this trend; community forests had the lowest encounter rates of hornbills, which were significantly different from protected areas and reserve forests. I failed to detect great hornbill, which the locals often target for its tail feathers or casque, or body fat in many areas across the state. In two of the community forests, the local hunters have not detected great hornbill in the last 5 years. This suggests that though community forests may offer good habitats for hornbills, yet they also face high pressures from hunting. One of the reasons for this could be proximity of these forests to the villages and there is a high probability that people access community forests more often than they do protected areas and reserve forests.

In Arunachal Pradesh, large mammals occur at extremely low densities in dense forest habitats and because in most areas they have been overhunted. In such scenarios, the focus of hunters often shifts to easily detected large birds like hornbills. Hornbills are large-bodied birds and are relatively easy to kill. Local hunters have knowledge of the important food plants of hornbills. In the non-breeding season, they often wait under fruiting trees where large flocks of hornbills congregate. Even in the best habitats with least habitat perturbations and extremely low hunting pressures, only few hornbills can be sustainably harvested in a year. This is because of the slow reproductive rate and low natural densities of hornbills. In most areas, the demand for hornbill body parts like the tail feathers and casques is high. Such demands can really push hornbills to local extinction. Local hunters had failed to detect great

hornbill in the last 5 years at five sites. Even rufous-necked Hornbill whose casque and tail feathers are used as substitutes in the absence of great hornbill casque and feathers was not detected at two sites in the last five years. It was surprising that even the small-bodied species like the Oriental pied hornbill and brown hornbill were not detected at two and one site respectively. The small-bodied species particularly the brown hornbill because of its drab coloration is often not hunted for its body parts, although some Wanchos occasionally may keep the feathers for use by children during traditional ceremonies. They are hunted occasionally for their meat. The two areas from where the Oriental pied hornbills have gone locally extinct are Abango and Jotte. In Jotte, the hunter suggested that it was a disease, which probably wiped out a large chunk of the population. He indicated that in 1 year they found large numbers of dead Oriental pied hornbills in the area. In Abango, however, the Oriental pied hornbill could have been locally wiped out because of high hunting pressures. Brown hornbill on the other hand vanished from the Upper Wancho areas, probably because of loss of forests and due to high hunting pressures exerted by the local communities.

Protected areas are currently the most secure places for hornbills as compared to the reserve forests and community forests. Due to complete absence of any protection mechanisms in the community forests, hornbills seem to be extremely vulnerable to hunting. In addition, in most PAs, locals are aware of the existence of a PA and are slightly wary of hunting in a PA. There are no settlements inside most PAs in Arunachal, which results in interior areas of PAs being more secure than community forests. Community forests are also regularly visited by the villagers to collect fuel wood, other non-timber forest produce like cane and bamboo, for shifting cultivation and for hunting as compared to PAs. The frequent presence of people, movement in the forests and greater opportunities for both targeted and incidental hunting would probably result in higher hunting pressures in community forests.

In reserve forests, the focus is often on logging and most people are actively engaged in logging activities and may hunt at much lower frequencies than in community forests, where villagers might visit specifically to hunt. Anecdotal observations in some of the RFs indicate that for most part of the daytime, people are engaged in logging-related activities, which gives them little opportunity to hunt. Logging operations are often intensive, fast-paced and noisy (which might scare the animals away). In Tengapani RF for instance, the labor engaged in logging occasionally hunt big game like deer in the night by sitting on machans under fruiting trees. Hunting during the daytime is more incidental than targeted. Geographic orientations of the RFs and CFs with respect to villages might also have an important bearing on the patterns observed. However, I have not looked into those aspects as of now.

Change in forest structure at three sites in western Arunachal Pradesh after 12 years

There was a clear pattern of decline in tree density (of GBH ≥ 30 cm, GBH ≥ 150 cm and GBH ≥ 200 cm) from plantation to old logged forest, despite a 12-year official ban on logging. The old logged forest in the sanctuary fared better in all vegetation parameters including the density of four main hornbill non-fig food plants (*Polyalthia simiarum*, *Dysoxylum binectariferum, Amoora wallichi* and *Chisocheton paniculatus*). We did not detect any of the four important non-fig food plants in the plantation. I also did not detect any hornbills in the plantation, which has been completely degraded. Loss of fruiting trees is known to have a negative impact on hornbills (Anggraini *et al* . 2000; Sitompul *et al* . 2004). The numbers of rhinoceros *Buceros rhinoceros* and helmeted hornbills *Rhinoplax vigil* were found to be lower than expected in disturbed forests wherein the numbers of the hornbill food plants was also depleted (Anggraini *et al .* 2000). In our study site, despite the ban on logging, the logged forests and the plantation have experienced illegal logging and fuel wood extraction in the past twelve years. Although logged forests and plantation in the RFs are under the control of the Forest Department and are supposed to be legally protected, in reality there is poor law enforcement here compared to protected

areas. Despite the inadequacies of law enforcement in many protected areas, the stronger protection status does confer better protection and meeting of conservation goals (Bruner *et al .* 2001).

The logged and the plantation (RFs) forests, which are accorded lower levels of protection than wildlife sanctuaries and national parks, appear to be more vulnerable to illegal logging. Both the RFs are close to human settlements and thus act as important sources of fuel wood and timber for house construction for local communities. The neighbouring state of Assam has undergone severe deforestation in the past two decades. The most alarming deforestation has been along the Arunachal Pradesh-Assam border in this area (Sonitpur district) where between 1994 and 2002, about 344 km^2 of forest was lost, with an annual deforestation rate of 1.38%. The rate of loss accelerated between 1999 and 2001, when 143 km^2 of forest was lost (Kushwaha & Hazarika, 2004). The loss has been highest and the most rapid in the Naduar RF which adjoins the Papum RF in Arunachal. The rapid illegal felling, clearing and encroachment has affected several RFs and even parts of PAs in Assam. This large-scale rapid deforestation has been driven mainly due to increased insurgency activities by Bodos (an ethnic group of Assam), who are demanding a separate homeland in the area. Their settlement to legitimize land ownership has been facilitated by local political patronage.

Logging is considered as one of the major drivers of deforestation across SE Asia; many studies have shown that logged forests are important for wildlife populations and should not be ignored as potential habitat for wildlife (Johns, 1996; Willott *et al .* 2000). Protected areas constitute a very small proportion of forests in most areas and logging concessions or production forests are often many times larger in area (Bennett, 2001). For example, only 7% of hornbill habitat is under the protected area network across Asia with most such areas being small in size (Kinnaird & O'Brien, 2007). This asymmetry in land use means that forests outside PAs need to be considered to ensure wildlife survival over larger landscapes, especially of wide-ranging species such as hornbills. Conservation efforts would be doomed if it remains restricted to tiny pockets of protected forests (Kinnaird & O'Brien, 2007). However, in reality, socio-economic and political factors, including poverty and insurgency in this region plays an over-riding role in determining the actual fate of forests where despite strong forest conservation laws on paper, the on-ground protection, especially in Reserved Forests, remains almost negligible.

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