Chapter 5

Animal abundances across state and community forests of Jaintia Hills

Introduction

A large number of vertebrate species are at the greatest risk today primarily because of deforestation (Geist & Lambin, 2002), poaching and local hunting (Wright & Duber, 2001; Wright, 2003). Local hunting is one of the main drivers of biodiversity loss in tropical forests (Milner-Gulland & Bennett, 2003) and in synergy with other disturbances such as logging and habitat loss can have disastrous impacts on species conservation (Laurance & Useche, 2009). Prolonged local hunting pressures, even at seemingly low intensities, can trigger species extinction rates (Corlett, 2007) rendering even undisturbed, primary forest habitats ‘empty’ (Redford, 1992; Bodmer et al., 1997).

Arboreal terrestrial herbivores and frugivores are among the most preferred species by hunters due to which their numbers have severely come down (Emmons, 1989). Their expatriation also adversely affects critical ecological processes such as seed predation, dispersal and pollination. Hunting therefore can seriously alter plant community structure and diversity by hampering animal mediated seed predation and its dispersal, thereby affecting plant recruitment and associated ecological processes (Dirzo & Miranda, 1991; Dirzo, 2001; Wright & Duber, 2001).

To buffer forests from such threats, Protected Areas (PAs), were formed to maintain habitats and conserve biodiversity. Because of the limited spatial extent of the PAs (Chape et al., 2005), large areas rich in biodiversity exists beyond the realm of any formal protection or any conservation program. Many of these areas are under the direct or de facto control of the communities and in many cases they have developed local rules and policies to govern the use and exploitation of the forest resources based on their traditional knowledge (Berkes, 2009). Lately, such areas have come under the aegis of community based conservation (CBCs) approaches (Kothari, 2006). Such efforts, however, have been scattered and limited to small isolated patches (Pathak et al., 2009) (refer to Chapter 2) whose capability to conserve wildlife and tackle the complex threats resulting out of a globalised economy is not
well understood (Shahabuddin & Rao, 2010). Additionally, between the PAs and the CBCs lies a vast ‘grey area’ which includes large forest tracts which remains often under the *de facto* control of the forest dependent communities (refer to Chapter 2). In many cases, such use-rights have been constitutionally recognised by various governments across the globe and can range from open to semi-open to restricted (Berkes, 2007; Tiwari *et al.*, 2013).

The local communities of Meghalaya, have been using and managing community forests under locally instituted rules since time immemorial (Tiwari *et al.*, 1998) but today due to rapidly shifting cultural and traditional values, such local hunting practices might not be sustainable anymore (Mohrmen & Goswami, 2013). Though such forests are governed by small forest dependent communities that have political autonomy over the forests they often lack adequate institutional safeguards which has resulted in the unsustainable use of forests by developmental agencies both from inside (elite appropriation of common resources) and outside interests in the state’s resources (Karlsson, 2011; Mukhim, 2014, 2015) Given the lack of conservation attention to these areas and the fact that they are highly vulnerable to developmental pressures, it is important to evaluate the state of biodiversity, particularly of animal abundances across such ‘grey’ community forests (Shahabuddin & Rao, 2010; Persha *et al.*, 2011).

Informed by the previous chapters, the central aim of this chapter is to estimate species abundance of terrestrial vertebrates including large birds and mammals across the gradients of hunting which was higher in the community forests (CF) and relatively lower in the state reserve forests (RF). The specific objectives are 1. To estimate the relative encounter rates of vertebrates across the CF and RF and across functional groups. 2. To estimate the occurrence and abundance of the hunted and preferred species across RF and CF. 3. To examine the relationship of the animal abundances with hunting intensity and preference across RF and CF.

**Materials and Methods**

**Study Area**

The field work for this study was carried out across a state forest (Narpuh Reserve Forest, henceforth reserve) and a community forest (elaka forests of Narpuh, henceforth *elaka*) located in the south-east corner of Meghalaya in the East Jaintia Hills district. Both the reserve and the *elaka* are part of the same contiguous ecological and environmental landscape
located across an altitudinal range of 20-800 meters above sea level along the southern escarpments of the Meghalaya plateau characterised by steep slopes. The natural vegetation in these forests comprises of broadleaved evergreen and semi-evergreen forests and the average annual rainfall is about 5000-8000 mm. The mean maximum and minimum temperature ranges from 23 to 26° C and 2 to 17°C respectively.

In the reserve, the dense forests characterised by moist tropical evergreen forests namely type 1B/C3 Cachar tropical evergreen forests (Champion & Seth, 1968) comprise 74.28% (126.79 km²) of the total area of 170.69 km² and is concentrated in the north and north-eastern part of the reserve. In the elaka, the dense forests comprise 63.25 km² (27.5%) of the total area. The largest patches of dense forests are found in the Lum Myrli, Sonaraja and Sonapyrdi area.

On its south-eastern part, Narpuh reserve forest is contiguous with Barail Wildlife Sanctuary of Assam. According to the management plan of the Narpuh and Saipung reserves, these forests were once rich in wildlife with large ungulates like gaur (Bos gaurus), sambar (Cervus unicolor), wild-buffalo (Bubalis arnee), serow (Capricornis thar) muntjac (Muntiacus muntjak) along with five species of primates and large carnivores like tiger, leopard and clouded leopard (Anonymous, 1995). Elephants too were reported to be common. Earlier, the forests near Umrangshu in North Cachar Hills (NC Hills) of Assam bordering the north-eastern part of Jaintia Hills connected Narpuh and Saipung RF to Lumding forests, Langting, Mupa and Khrungming reserve forests of Karbi and North Cachar Hills, and used to be an important wildlife corridor, particularly for the elephants. However, the construction of the Kopili hydro-electric project, commissioned in 1976, and the associated developmental activities permanently blocked this important corridor. Since then elephants hasn’t been reported from Jaintia Hills (Anonymous, 1995).

Issue of gun licenses to almost all the households around Narpuh RF to prevent crop-depredation also increased the hunting activity and resulted in the reduction of wildlife (Anonymous, 1995). Gupta et al. (2005) highlighted Narpuh and Saipung forests as one of the last remaining and highly threatened habitats of the endangered hoolock gibbon (Hoolock hoolock) in Meghalaya. Detailed inventory of mammals are missing from this area while a bird survey carried by a team which included me, revealed 98 species of birds across 45 families (unpublished report to the Department of Forest & Environment, Meghalaya). The
area is also exceptionally rich in terms of butterfly diversity and during the field study I have recorded 371 species across 5 families (unpublished data).

**Study Design**

This study was carried out in the forested areas of both reserve and *elaka*. The area for sampling was based on the hunting gradient developed in the previous chapter (see Figure 5.1 below).

![Study area map showing the distribution of trails used for animal survey across Narpuh reserve and elaka forests.](image)

**Figure 5.1:** Study area map showing the distribution of trails used for animal survey across Narpuh reserve and *elaka* forests.

Hunting intensity varied from low to medium in the reserve and medium to high in *elaka* (Chapter 4). There were no low hunted sites in *elaka* and no high hunted sites present in the reserve. I used trails in these hunted sites for estimating vertebrate abundance in both the reserve and the *elaka* forests. Because of lack of adequate sites to compare across gradients, I pooled the gradient into *elaka* and reserve for further analysis.

**Habitat similarity across the hunted sites**

Variability in the forest vegetation across the landscape can influence mammal species diversity and abundance (Johns, 1992). Therefore, it is important to assess the similarity of vegetation since variability such as fragmentation and habitat loss can drive the loss of
species richness and abundance (Wright & Muller-Landau, 2006). Normalized Differential Vegetation Index (NDVI) is a good surrogate for quantifying forest vegetation variability and therefore can provide clues into their variations across sites in a landscape (Krishnaswamy et al., 2009).

To compare the vegetation characteristic of all the sites across the state and the reserve forest, I used the Normalized Differential Vegetation Index (NDVI), one of the most reliable remotely sensed vegetation indices which is also one of the best surrogates for the measure of vegetation cover type and green biomass (Bawa et al., 2002). The following algorithm was used to derive the NDVI values:

$$NDVI = \frac{C2 - C1}{C2 + C1},$$

where C2 and C1 are near infra-red and visible red channels.

NDVI values of forest vegetation usually occur in the range 0.1 to 0.7 (Krishnaswamy et al., 2009). I used Landsat OLI data (dated Feb 19, 2014) for deriving the NDVI values for all 17 trails. For each trail mean NDVI values were derived for ten equidistant points placed all along the trail from start to end. The mean of those points were used to derive the NDVI value for a trail and ultimately to determine the vegetation status of the sites across the state and community forests.

I used the Mann-Whitney U test for equal median to compare the NDVI derived vegetation characteristics across the state and the community forests.

**Vertebrate abundances**

*Encounter rate survey for mammals and terrestrial birds*

In the Jaintia Hills landscape, owing to a long history of hunting by the local communities (Gurdon, 1914; Tynsong et al., 2012a; Tynsong et al., 2012b), the animals occur at low abundances and are extremely shy and elusive. Animals which otherwise are known to be tolerant to human presence such as primates and ungulates were also very shy and elusive and thus direct sightings of animals were very few. Camera traps were tried but due to frequent sabotage and low budget of the project, it was abandoned. Therefore indirect signs supplemented with direct sightings were used to arrive at relative measures of animal abundances.

Trails at each site were surveyed for animals during the day between 600 to 1000 hours and 1400 to 1800 hours. Detections were based on direct sightings, calls or indirect signs viz.
tracks, scat/dung dropping, body parts (quill, hair, and feather) and claw marks. After recording each observation, the signs were obliterated to avoid recounting. For species that could not be identified from indirect signs we considered them at the genus or family level. Species recorded outside the sampling periods were noted but not included in the analysis. All surveys except 4 were carried out by three observers: I was accompanied by a local field guide and an experienced hunter who was an expert in recording animal sightings and sign. For the other four a different but nevertheless experienced animal tracker accompanied the survey. A minimum distance of 400 m was maintained between trails at a site and 3 km across sites to ensure spatial independence of samples (Urquiza-Haas et al., 2011).

The trail was geo referenced using a GPS and the track option mode (Garmin GPS) was used to estimate the distance covered. A total of 17 trails were sampled between Nov 2012 and March 2013 resulting in a total effort of 312.76 km mean trail length of 4.43 km.

I calculated the encounter rates (ER) as no. of independent animal signs/sightings per km and it was used as a surrogate to compare species abundance across forests. For each trail, encounter rate was calculated as n/l, where n=sum of all independent encounters along the trail and l=total length of the trail. The ERs were expressed as animals/km. ER was calculated separately for species and sites. Data was tested for normality and appropriate statistics was employed.

RESULTS

Vegetation characteristic across reserve and elaka

Since all my analyses were conducted at the level of the reserve and the elaka, I compared the mean NDVI values of each trail across the reserve and the elaka to assess the vegetation similarity. To test the null hypothesis that there is no difference in the mean NDVI values across the categories of management, a t-test for equality of means was carried out. The test value (t= .248, p = 0.805) indicated that the null hypothesis be retained and it may be concluded that there were no differences in the vegetation across the sampled sites (refer to fig 5.2 below).
Vertebrate abundances

A total of 20 animal species which included eighteen mammals and two terrestrial birds, were encountered during the survey. The species of birds and mammals encountered, their scientific name, IUCN status, functional groupings based on feeding habits and habitat preferences, hunting intensity and hunting preference as per the previous chapter, is provided in Appendix 5.1.

Encounter rates (ER) varied greatly across sites. Civet spp. (Viverridae), otters (Mustilidae) squirrels (Sciuridae), rhesus macaque (Macaca mulatta), wild pigs (Sus scrofa) and muntjac (Muntiacus muntjak) occurred across all sites; bear sp. (Ursidae), hoolock gibbons (Hoolock hoolock) and capped langurs (Trachypithecus pileatus) were recorded from three sites while leopard (Panthera pardus), probably the largest carnivore occurring in the landscape, was recorded from a single site. During the approximate 2 years stay in the area, I did not find any other evidence of the leopard in the landscape.
Vertebrate abundances across categories of management

Based on the distribution of hunting intensity across the categories of management, I predicted that animal abundances would be higher in the reserve than in the elaka. To test this, I compared the mean ERs across all species between the reserve and the elaka. The mean ER of the reserve with 0.91 animals/km (+SE 0.13), was higher than that of the elaka, 0.35 animals/km (+SE 0.04) (Mann Whitney U= p=0.000).

![Box and whiskers plot showing the encounter rates (ER) across categories of management elaka (CF) and reserve (RF). Open dots outside the upper whiskers indicate the outliers exceeding 1.5 times the inter-quartile range on the upper side. Mann-Whitney U=255, p=.000](image)

**Figure 5.3:** Box and whiskers plot showing the encounter rates (ER) across categories of management *elaka* (CF) and reserve (RF). Open dots outside the upper whiskers indicate the outliers exceeding 1.5 times the inter-quartile range on the upper side. Mann-Whitney U=255, p=.000

Similarly, I examined the difference in the mean ERs at the individual species level across the categories of the management, i.e elaka and reserve.
Table 5.1: Mann-Whitney values for the mean ER and species across elaka and reserve. In the column p, ** - significant at the 0.01 level (2-tailed), * - significant at the 0.05 level (2-tailed).

<table>
<thead>
<tr>
<th>Mammals</th>
<th>Scientific name</th>
<th>Family</th>
<th>Mann-Whitney values</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serow</td>
<td>Capricornis thar</td>
<td>Bovidae</td>
<td>503.5</td>
<td>0.138</td>
</tr>
<tr>
<td>Capped langur</td>
<td>Trachypithecus pileatus</td>
<td>Cercopithecidae</td>
<td>560</td>
<td>0.535</td>
</tr>
<tr>
<td>Rhesus macaque</td>
<td>Macaca mulatta</td>
<td>Cercopithecidae</td>
<td>542.5</td>
<td>0.436</td>
</tr>
<tr>
<td>Indian muntjac</td>
<td>Muntiacus muntjak</td>
<td>Cervidae</td>
<td>457</td>
<td>0.021*</td>
</tr>
<tr>
<td>Cat sp.</td>
<td></td>
<td>Felidae</td>
<td>527</td>
<td>0.167</td>
</tr>
<tr>
<td>Leopard</td>
<td>Panthera pardus</td>
<td>Felidae</td>
<td>561</td>
<td>0.317</td>
</tr>
<tr>
<td>Crab eating mongoose</td>
<td>Herpestes urva</td>
<td>Herpestidae</td>
<td>515</td>
<td>0.167</td>
</tr>
<tr>
<td>Hoolock gibbon</td>
<td>Hoolock hoolock</td>
<td>Hylobatidae</td>
<td>510</td>
<td>0.041*</td>
</tr>
<tr>
<td>Crestless porcupine</td>
<td>Hystrix indica</td>
<td>Hystricidae</td>
<td>560</td>
<td>0.535</td>
</tr>
<tr>
<td>Porcupine sp.</td>
<td>Hystrix sp</td>
<td>Hystricidae</td>
<td>576</td>
<td>0.952</td>
</tr>
<tr>
<td>Chinese pangolin</td>
<td>Manis pentadactyla</td>
<td>Manidae</td>
<td>510</td>
<td>0.041*</td>
</tr>
<tr>
<td>Otter sp.</td>
<td></td>
<td>Mustilidae</td>
<td>526.5</td>
<td>0.342</td>
</tr>
<tr>
<td>Khalij pheasant</td>
<td>Lophura leucomelanos</td>
<td>Phasianidae</td>
<td>546</td>
<td>0.425</td>
</tr>
<tr>
<td>Red junglefowl</td>
<td>Gallus gallus</td>
<td>Phasianidae</td>
<td>577</td>
<td>0.976</td>
</tr>
<tr>
<td>Hoary bellied squirrel</td>
<td>Callosciurus pygerythrus</td>
<td>Sciuridae</td>
<td>553</td>
<td>0.664</td>
</tr>
<tr>
<td>Malayan giant squirrel</td>
<td>Ratufa bicolor</td>
<td>Sciuridae</td>
<td>509.5</td>
<td>0.088</td>
</tr>
<tr>
<td>Squirrel sp.</td>
<td></td>
<td>Sciuridae</td>
<td>555</td>
<td>0.632</td>
</tr>
<tr>
<td>Wild pig</td>
<td>Sus scrofa</td>
<td>Suidae</td>
<td>556</td>
<td>0.694</td>
</tr>
<tr>
<td>Bear sp.</td>
<td></td>
<td>Ursidae</td>
<td>493</td>
<td>0.021*</td>
</tr>
<tr>
<td>Civet sp.</td>
<td></td>
<td>Viverridae</td>
<td>554</td>
<td>0.685</td>
</tr>
</tbody>
</table>

Except bear sp., Chinese pangolin, hoolock gibbon and Indian muntjac, the difference in the ERs of the rest of the species were not significantly different across the reserve and the elaka (Table 5.1).

**Abundances of heavily hunted and highly preferred across the reserve and elaka**

To examine the differences of the highly hunted and highly preferred species across the categories of management, the encountered species were initially ranked according to relative harvest index (RHI) and relative preference index (RPI) (see table 5.3 below). The mean ERs of top 5 ranked species based on RHI (rank 14-22) and RPI (rank 15-23) were compared across the reserve and the elaka.
Figure 5.4: Box and whiskers plots of encounter rates of highly hunted and highly preferred species across reserve and *elaka*. *<0.01 for Mann-Whitney U test conducted for equal medians.

The ER for the highly hunted and the highly preferred species across the two categories of management are shown in Fig. 5.4. The ER of heavily hunted species across the reserve and the *elaka* was significant (U=5.5, p=.001) while the highly preferred species was not so (U=20.0, p=.058). Since the highly preferred species were either not encountered at all or encountered very sparsely across both the reserve and *elaka*, it probably indicates that the hunting pressures on the preferred species is similar across the management categories.

On the other hand, since hunting is more widespread in the *elaka* forests (see Chapter 4), the significant difference in the ERs of the highly hunted species across the reserve and the *elaka* probably indicates the severe negative impact of hunting on the animal abundances in the highly hunted sites over time.
**Hunting and functional groups**

Since arboreal and terrestrial frugivores and herbivores were among the most hunted species, I compared their abundances across the highly hunted *elaka* and less hunted reserve. Table 5.2 below shows that the abundances of omnivores and carnivores (dominated by the highly adaptable crab-eating mongoose and aquatic otters), are not significantly different among the *elaka* (highly hunted) and the reserve (low hunted). Whereas frugivorous (squirrels, civets and monkeys) and herbivores (ungulates) which faces the highest hunting pressures and are highly preferred by the local hunters occur at significantly lower abundances in the *elaka*.

**Table 5.2: Abundances of functional groups across reserve (Narpuh reserve forest) and *elaka* (*elaka* forest). Significant p values of Mann Whitney U test for equal medians are highlighted.**

<table>
<thead>
<tr>
<th>Functional groups</th>
<th><em>Elaka</em></th>
<th>Reserve</th>
<th>Mann Whitney p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SE</td>
<td>Mean</td>
</tr>
<tr>
<td>Carnivore</td>
<td>0.07</td>
<td>0.02</td>
<td>0.17</td>
</tr>
<tr>
<td>Frugivore</td>
<td>0.13</td>
<td>0.02</td>
<td>0.39</td>
</tr>
<tr>
<td>Herbivore</td>
<td>0.08</td>
<td>0.02</td>
<td>0.17</td>
</tr>
<tr>
<td>Omnivore</td>
<td>0.08</td>
<td>0.02</td>
<td>0.15</td>
</tr>
</tbody>
</table>

**Relationship between encounter rates, relative harvest index (RHI) and relative preference index (RPI)**

To examine the relationship of animal abundances with hunting intensity (based on RHI) and hunting preferences (based on RPI) across the *elaka* than reserve, I ranked the preferred species based on the relative preference index calculated in the previous chapter. See Table 5.3 below.
Table 5.3: Relative harvest index (RHI) and relative preference index (RPI) of the animal species ranked from most preferred (23) to least preferred (5). Harvest ranks range from 22 (most harvested) to 4 (least harvested). The species highlighted in bold indicates that they were not encountered during the survey.

<table>
<thead>
<tr>
<th>Animals</th>
<th>Scientific name</th>
<th>Family</th>
<th>RHI</th>
<th>RPI</th>
<th>Rank RHI</th>
<th>Rank RPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat sp.</td>
<td>Felidae</td>
<td>0 0</td>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoolock gibbon</td>
<td>Hoolock hoolock</td>
<td>Hylobatidae</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Leopard</td>
<td>Panthera pardus</td>
<td>Felidae</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Otter sp.</td>
<td>Mustilidae</td>
<td>0 0</td>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crestless porcupine</td>
<td>Hystrix indica</td>
<td>Hystricidae</td>
<td>0.06</td>
<td>0</td>
<td>14</td>
<td>5</td>
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<tr>
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<td>Herpestes urva</td>
<td>Herpestidae</td>
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<td>0</td>
<td>16</td>
<td>5</td>
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<tr>
<td>Malayan giant squirrel</td>
<td>Ratufa bicolor</td>
<td>Sciuridae</td>
<td>0.12</td>
<td>0</td>
<td>18.5</td>
<td>5</td>
</tr>
<tr>
<td>Hoary bellied squirrel</td>
<td>Callosciurus pygerythrus</td>
<td>Sciuridae</td>
<td>0.12</td>
<td>0</td>
<td>22</td>
<td>5</td>
</tr>
<tr>
<td>Squirrel sp.</td>
<td>Sciuridae</td>
<td>0.12</td>
<td>0</td>
<td>22</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Porcupine sp.</td>
<td>Hystrix sp</td>
<td>Hystricidae</td>
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<td>0.03</td>
<td>8</td>
<td>12</td>
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<td>Rhesus macaque</td>
<td>Macaca mulatta</td>
<td>Cercopithecidae</td>
<td>0.03</td>
<td>0.03</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Civet sp.</td>
<td>Viverridae</td>
<td>0.12</td>
<td>0.03</td>
<td>18.5</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Khalij pheasant</td>
<td>Lophura leucomelanos</td>
<td>Phasianidae</td>
<td>0.12</td>
<td>0.03</td>
<td>18.5</td>
<td>12</td>
</tr>
<tr>
<td>Red junglefowl</td>
<td>Gallus gallus</td>
<td>Phasianidae</td>
<td>0.12</td>
<td>0.03</td>
<td>18.5</td>
<td>12</td>
</tr>
<tr>
<td>Bear sp.</td>
<td>Ursidae</td>
<td>0 0.04</td>
<td>4</td>
<td>15</td>
<td></td>
<td></td>
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<tr>
<td>Capped langur</td>
<td>Trachypithecus pileatus</td>
<td>Cercopithecidae</td>
<td>0.02</td>
<td>0.05</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Binturong</td>
<td>Arctictis binturong</td>
<td>Viverridae</td>
<td>0.02</td>
<td>0.05</td>
<td>10</td>
<td>18</td>
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<td>Muntiacus muntjak</td>
<td>Cervidae</td>
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<td>0.05</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>Serow</td>
<td>Capricornis thar</td>
<td>Bovidae</td>
<td>0.11</td>
<td>0.05</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>Wild pig</td>
<td>Sus scrofa</td>
<td>Suidae</td>
<td>0.12</td>
<td>0.05</td>
<td>22</td>
<td>18</td>
</tr>
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<td>Gaur</td>
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<td>Bovidae</td>
<td>0</td>
<td>0.12</td>
<td>4</td>
<td>21</td>
</tr>
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<td>Cervidae</td>
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<td>0.13</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>Chinese pangolin</td>
<td>Manis pentadactyla</td>
<td>Manidae</td>
<td>0.03</td>
<td>0.33</td>
<td>12</td>
<td>23</td>
</tr>
</tbody>
</table>
I conducted Spearman’s rank correlations to test the relationship between the RPI and RHI with ER of the reserve and *elaka* and the associations are exhibited through the scatter plots with the correlation coefficient values and the p values.

Both the ERs of reserve and the *elaka* shows a positive correlation with the RHI and a negative with the RPI indicating that the species with high abundances shows higher RHI whereas the species with high preference occur in lower abundances. Except relationship between ER of the *elaka* and RPI, all other associations are strongly correlated (see Figs 5.2-5.5). Correlations were also carried out after discarding the outlier data points but the relationship remained significant. Hence the outliers too were included in the scatter.

![Scatter plot showing relationship between ER of *elaka* (CFer) and the relative preference index (RPI), Spearman correlation coefficient=-0.377, p=.076](image)

**Figure 5.5:** Scatter plot showing relationship between ER of *elaka* (CFer) and the relative preference index (RPI), Spearman correlation coefficient=-0.377, p=.076
Figure 5.6: Scatter plot showing relationship between ER of *elaka* (CFer) and the relative harvest index (RHI), Spearman correlation coefficient = 0.674, p = .000

Figure 5.7: Scatter plot showing relationship between ER of reserve (RFer) and the relative preference index (RPI), Spearman correlation coefficient = -0.533, p = .009
Figure 5.8: Scatter plot showing relationship between ER of reserve (RFeR) and the relative harvest index (RHI), Spearman correlation coefficient = 0.433, p = 0.039

Hunting and local extinctions

To test the hypothesis that preferred species are more prone to local extinction than non-preferred, I calculated the difference in encounter rate between reserve and elaka for each species and correlated the difference (+ or -) against (1) RPI and (2) RHI presented in the Table below.

Table 5.4: Spearman's rank correlation for the difference in the mean encounter rate between reserve and elaka (RFeR-CFeR) for each species and the relative harvest index (RHI) and relative preference index (RPI) * - Correlation is significant at the 0.05 level (2-tailed).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Correlation Coefficient</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFeR-CFeR vs RHI</td>
<td>0.176</td>
<td>0.422</td>
</tr>
<tr>
<td>RFeR-CFeR vs RPI</td>
<td>-0.510</td>
<td>0.013*</td>
</tr>
</tbody>
</table>

The correlation for the difference in the mean ER between elaka and reserve (RFeR-CFeR) is positively correlated with the RHI and negatively with the RPI. The negative relationship
between the RFe-CFe and the RPI is also statistically significant and may be an indicator that the highly preferred species might be prone to local extinctions.

**Discussion**

This study showed that the encounter-rate based animal abundances were significantly higher in the low hunted reserve compared to the high hunted *elaka*. The results supported all the hypotheses at all the pooled, species and functional group level. The abundances of both the highly preferred and highly hunted species, except pheasants, were higher in the reserve in comparison to the *elaka* indicating that both historic as well as current hunting pressures are having significant impact on the lowering of animal populations of *elakas*. The reserve, on the other hand, seemed to sustain relatively higher animal abundances owing chiefly to lower hunting pressures, in the absence of any habitat differences. Since one of the primary goals of conservation is to sustain species by reducing direct offtake pressures on them, in the case of Jaintia Hills, the state forests (Reserves) seems to be fulfilling this goal relatively better than the community forests (*elakas*).

**Animals more abundant in low hunted reserve, less in high hunted *elakas***

Most large ungulates, primates and game species like the bear in northeast India are under high hunting pressure (Hilaluddin *et al.*, 2005; Aiyadurai *et al.*, 2010) but the impacts of hunting on their abundances were not known. This study clearly demonstrates that hunting pressures might be driving animal abundances to a lower level, particularly of the preferred and hunted game species. Earlier studies in India in the Western Ghats demonstrated that the abundances of large and medium ungulates were significantly lower in the high hunted sites compared to the low hunted ones (Madhusudan & Karanth, 2002; Kumara & Singh, 2004).

A probable reason why the most hunted species were found to be lower in the *elaka* is because of prolonged harvesting of hunted species, particularly ungulates and arboreal mammals which reduces their abundance in comparison to non-hunted sites (Urquiza-Haas *et al.*, 2011). Birds, particularly the generalists like the pheasants, tend to show higher resistance to hunting pressures and tolerance to human presence (Poudyal, 2008). Moreover, smaller bodied species groups exhibit higher fecundity rates than larger bodied ones (Damuth, 1981; Robinson & Redford, 1986) and therefore they face lower risks to extinctions due to offtake.
pressures compared to large bodied animals (Johnson, 2002). That may be a likely reason why the pheasants might be showing higher abundances in the elaka.

The absence of highly preferred species like Chinese pangolin and bear from the high-hunted areas under elaka and the overall absence of large ungulates like gaur and sambar both from this survey (Table 5.1) and the recent hunting records of the local communities (see Appendix 4.1), hints towards their possible local extinction. Studies carried out in the tropics and the neo-tropics has demonstrated that sustained long term hunting pressures can drive the extinction of large-bodied ungulates (Corlett, 2007; Rentsch & Damon, 2013) which ultimately leads to the alteration of the forest ecological communities in the high hunted sites (Hill et al., 1997).

**Ecological responses to hunting**

An alteration of the mammal community might be underway in the study site with many highly preferred species being either rendered locally extinct or are confined to the more remote parts of the park. Such selective offtake has also lead to the dominance of the disturbance-resilient species such as wild pig, muntjac and civets occurring in higher abundances. Wild pig is known to be resilient to a wide range of habitat disturbance and is known to persist in a wide range of climatic condition too right from sea-level till 4000 m elevation (Choudhury, 2013). The high persistence of the omnivores like wild-pigs and adaptable carnivores like otters and crab-eating mongoose may be attributed to higher fecundity rates (Damuth, 1981) and hence possess the ability to quickly recolonize disturbed areas (Steinmetz et al., 2010). Such life-history and ecological traits make them resilient to hunting pressures (Robinson & Redford, 1986; Johnson, 2002).

Larger species (gaur and sambar) succumb to hunting pressure earlier (Peres, 2000) and tend to be extirpated first whereas smaller and more fecund species (wild pig and muntjac) can sometimes persist at reduced densities (Pattanavibool & Dearden, 2002; Tungittiplakoml & Deardenz, 2002; Jerozolimski & Peres, 2003). However, as this study shows, even the known tolerant species like the wild pig and the muntjac are occurring at much lower abundances in comparison to the sites with low-hunting pressures.

Relatively lower encounters of even highly adaptable small arboreal species such as squirrels in the elaka is noteworthy and might be indicative of the fact that the hunters might be selectively targeting these species. The most abundant squirrel in the landscape was the hoary
bellied squirrel (*Callosciurus pygerythrus*) which is well known for its tolerance to disturbance (Choudhury, 2013) as well as a pest of the areca nut (*Areca catechu*). Areca nut is a thriving plantation activity in the landscape and is one of the most important cash crops in the region (Tynsong & Tiwari, 2011). Therefore, the local communities might be targeting the squirrels, which were reported to cause damage to the areca fruits, specifically as crop-depredators.

**High preference leading to local extinctions?**

High hunting owing to high demands for wild-meat, cash and trade-demands on several species occurring in the landscape is leading to severe depletion across the landscape. Relatively, the reserves fare better in terms of animal abundance, which, from the previous Chapter 4, might be happening due to a combination of factors such as occurrence of game animals in the community forests, relatively difficult access, voluntary compliance with wildlife laws and state’s ownership over the reserve. The conditional compliance to law, that can be seen in the Narpuh reserve with respect to hunting might also be dependent on the animals that the communities chose to hunt. Since a majority of the hunting records comprised of small bodied species like squirrels, giant squirrels and relatively less preferred like wild pigs and serow, they refrain from hunting these species from the reserve probably because hunting them might not offset the costs and risks involved (Nuno *et al.*, 2013).

On the other hand, unregulated hunting combined with local demands for wild-meat leading to high-cash value, might be the driver behind low animal abundances except a few species known to be tolerant to hunting and human induced disturbances. Chinese pangolin, the highest preferred species, and Asiatic black bear (*Ursus thibetanus*)—fourth highest preferred (see table 5.3), were not encountered in the *elaka* forests whereas highly preferred species like the sambar, gaur and binturong were not recorded during the entire survey and the duration of the stay indicating that they might either be occurring in extremely low abundances or has been rendered locally extinct. Even species like squirrels, wild pig and muntjac, which are known to sustain viable populations even in the face of considerable disturbance and hunting pressures (Corlett, 2007), were found to occur in lower abundances in the community forests thereby indicating that local hunting is highly unsustainable in Jaintia Hills and local knowledge is not contributing to sustainable management of resources.
Conclusion

The encounter-rate based abundances of the animals supplements the previous Chapter 4’s findings and showed that high intensity hunting in the *elaka* have significantly lowered the large and medium vertebrate abundances while many highly preferred species might either have been locally extirpated or they might be occurring at extremely low abundances. Since occurrence of game species in the *elaka* was the highest ranked response as to why the communities preferred to hunt less in the reserve has severe implication on the future of the wildlife conservation of the whole landscape since if the current trend of rapid forest loss (Chapter 2) continues along with the high hunting intensity, it will impart high pressure on the forest resources, including wildlife of the reserve. Therefore, urgent corrective measures should be adopted to safeguard the forest resources of the *elakas*. Protecting the community forests of *elaka* is critical, not merely for the wildlife, but also critically important for the local livelihoods of the people whose culture and economy are deeply intermeshed with these forests. Given the ethnically sensitive nature of local politics and the troubled relationship that people often articulate against the state, further loss of forests would create a situation where the conflicts with the forest department will increase and jeopardise even the remaining forests and wildlife within the reserve. Therefore, it is important that the interest in community conservation shouldn’t be merely sustained on the value-judgement induced arguments of social justice and conservation ethics. Instead, a more comprehensive evaluation system of such community managed areas incorporating their capacity to maintain forest cover and conserve biodiversity and wildlife has to be formulated.
References


Emmons, L.H. (1989) Tropical rain forests: why they have so many species and how we may lose this biodiversity without cutting a single tree. *Orion*, 8, 8-14.


