Assessing the impact of rainforest fragmentation on mammalian and avian frugivores

Preliminary Field Report March – June 2013

Introduction

The principal global threat to biodiversity is habitat loss and fragmentation. In the tropical forests of Borneo, the largest, most rigorous experiment ever implemented on habitat loss and fragmentation is currently underway. This is a region of extreme biological, agricultural and conservation interest. For my doctoral dissertation, I will explicitly test the effects of land clearing on mammalian and avian frugivore communities and the critical ecosystem process of frugivory and seed dispersal. In a preliminary study conducted in June-July 2012, I assessed field conditions, surveyed for fruiting trees and frugivores and explored the feasibility for conducting intensive camera trapping studies for frugivores at the site of the Stability of Altered Forest Ecosystems (SAFE) Project in Sabah, Malaysian Borneo. In my first full field season from March-June 2013, I carried out intensive surveys to locate and tag animal dispersed fruiting plants across the gradient of future fragmentation at the SAFE project site and at the control site in the Maliau Basin. I also camera-trapped and directly observed trees in fruit to "capture" the terrestrial and arboreal frugivore community at each fruiting tree. This project represents a unique opportunity to gather data on the impact of habitat fragmentation on a critical ecological process mediated by endangered large vertebrates, in a large-scale experimental design.

Objectives

The Stability of Altered Forest Ecosystems (SAFE) Project, located in Sabah, Malaysian Borneo is the world's largest ecological experiment designed to understand how industrial-scale logging, forest fragmentation and deforestation modify the functioning of tropical rainforests, impair their ability to deliver ecosystem services and reduce their capacity to support the diversity of life. For my doctoral dissertation, I will explicitly test the effects of land clearing on mammalian and avian frugivore communities and the critical ecosystem process of frugivory and seed dispersal.
The overall objectives of my doctoral dissertation are to:

1. To assess the impact of habitat fragmentation on the ecosystem service of frugivory & seed dispersal by studying variations in interactions between fruiting trees and vertebrate frugivores in the large-scale experimental set-up of the Stability of Altered Forest Ecosystems (SAFE) Project.
2. To compare the results at the SAFE site to those at the old growth control site in the Maliau Basin.

Fieldwork done during February-June 2013

The SAFE Project (Fig. 1) encompasses a gradient of forest modification including old growth forest, contiguous twice-logged forest, experimentally fragmented twice-logged forest embedded in oil palm matrix as well as contiguous oil palm plantation. The experimental site, when logging has been completed, will comprise six blocks (A-F), each with seven fragments ranging from 1-100 ha in area. Sampling locations within the fragments and control sites are arranged hierarchically from 1st to 4th order with the increasing distance between sampling locations of the same order making it amenable to the study of ecological phenomena at different scales.

I sampled the 1, 10 and 100ha fragments in Blocks A, B, D, E and F. These blocks were chosen in order to study fruiting plants and frugivore communities in two blocks with relatively good forest cover (B and

F) in comparison to two blocks with relatively poor forest cover (A, D and E). In each 1ha fragment, I set up belt transects to estimate the abundance of animal-dispersed fruiting trees. Each belt transect was 112m in length (to completely cover the diameter of the fragment) and 5m wide on each side (10m total width). This design was replicated in an identical manner in the 10ha and 100ha fragments. Thus each block had a total of 16 belt transects. During March-June 2013, I systematically surveyed for animal dispersed fruiting trees in each transect. Each animal-dispersed fruiting tree on the belt transect, having a diameter at breast height (DBH) >20cm, was marked with an aluminum tag. I measured the DBH of each tree, its height, flowering and fruiting status (phenology), and also geo-referenced each tree with a Gamin GPS. Each transect was surveyed on three different occasions to record any changes in phenology during the abovementioned period. A similar design was also used in the Maliau Basin in OG1 and OG2 sites, which have never been logged and therefore, can be considered as undisturbed old-growth forests.

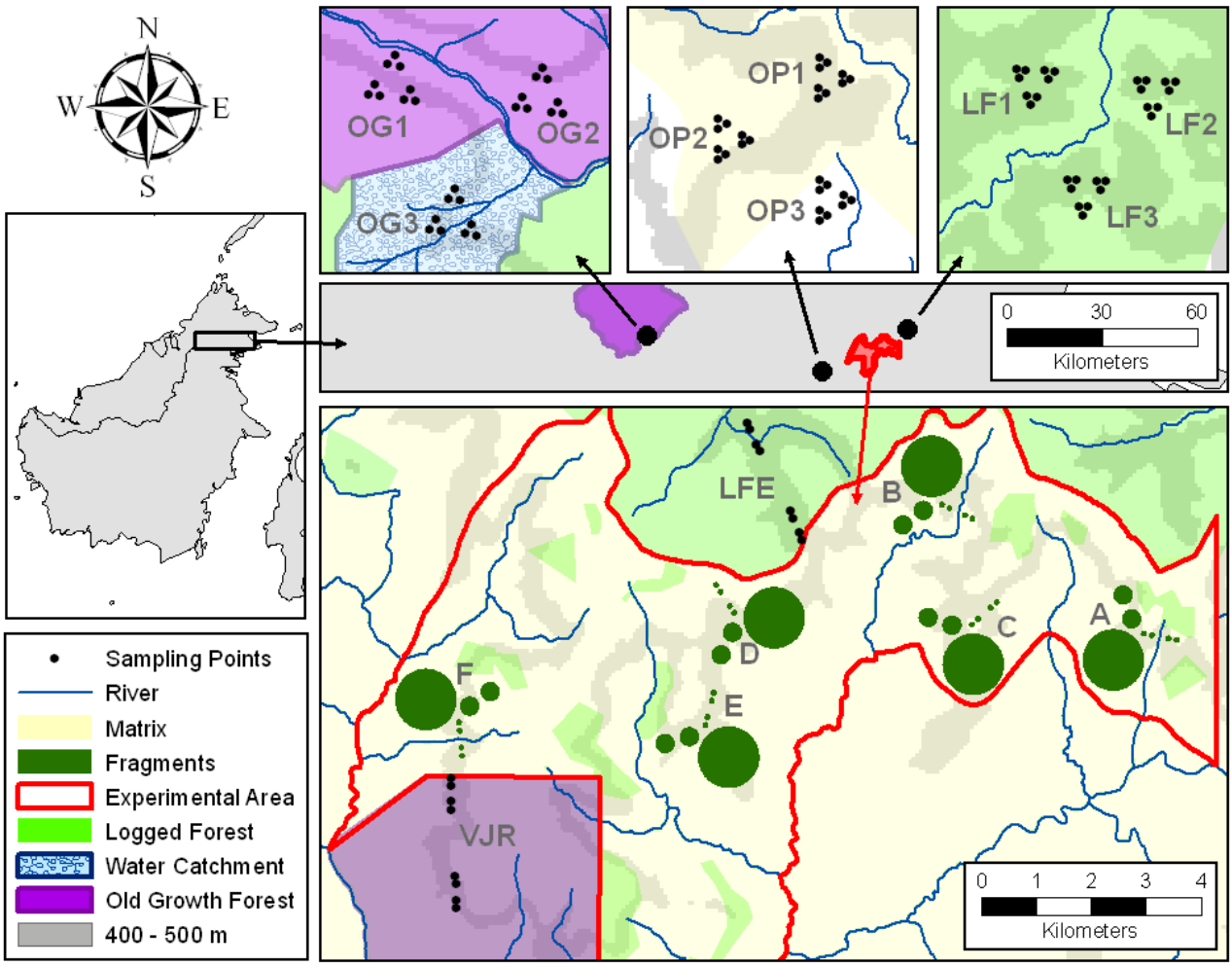

Fig. 1. *The Stability of Altered Forest Ecosystems (SAFE) Project in Sabah, Malaysian Borneo. Map showing experimental site (Blocks A-F) and control sites in primary forest (OG), oil palm (OP) and logged forest (LF)*

Results from Season 1

The primary objective during Season 1 in 2013 was to locate animal-dispersed fruiting trees along transects overlaid on the SAFE project sampling points. A total of 633 animal dispersed fruiting trees were tagged in these belt transects (Fig. 2). A comparison of frequency distributions of fruiting trees at old growth sites in the Maliau Basin and in twice-logged sites at SAFE reveals that *Macaranga* is the dominant species in both sites. However, the distribution of *Macaranga* is patchy in Maliau as this species occurs only in treefall gaps created by landslides (Fig. 3a). On the other hand, logging has opened up the forest at SAFE and allowed *Macaranga* to dominate across the entire sampling site (Fig. 3b). It is clear that other animal-dispersed fruiting trees are extremely rare in Dipterocarp-dominated Bornean rainforests. These patterns in Borneo conform to those found in the Brazilian Amazon, where the majority of animal-dispersed fruiting trees are very rare and patchily distributed.

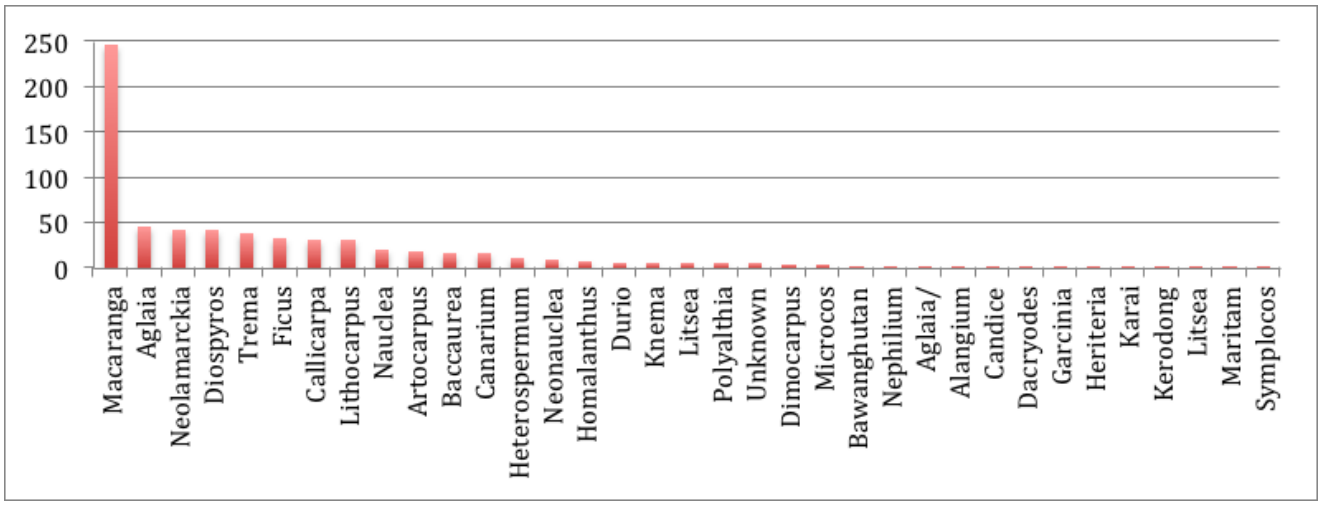

Fig. 2. *Frequency distribution of animal-dispersed fruiting trees across old growth (Maliau) and twice-logged (SAFE-Kalabakan) forest sites. The dominance of Macaranga is clearly visible while the majority of the animal-dispersed fruiting trees in Bornean forests are rare.*

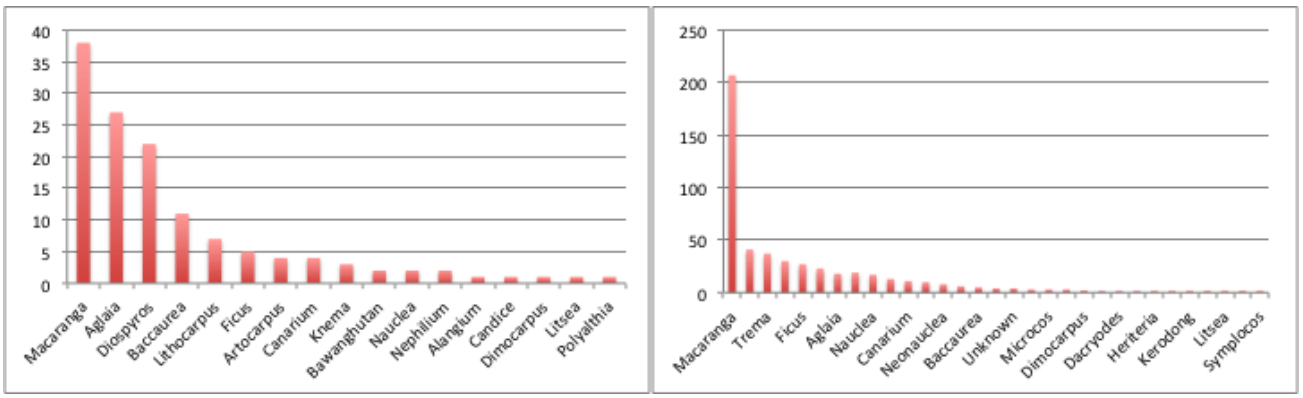

Fig. 3 a, b. *Frequency distribution of animal-dispersed fruiting trees in old growth (Maliau) forest site (Fig. 3a - left). Although Macaranga appears to be dominant in Maliau, most Macaranga occurs patchily in treefall and landslide gaps in old growth forest. Logging clearly encourages the dominance of Macaranga as can be seen at the SAFE project site (Fig. 3b - right).*

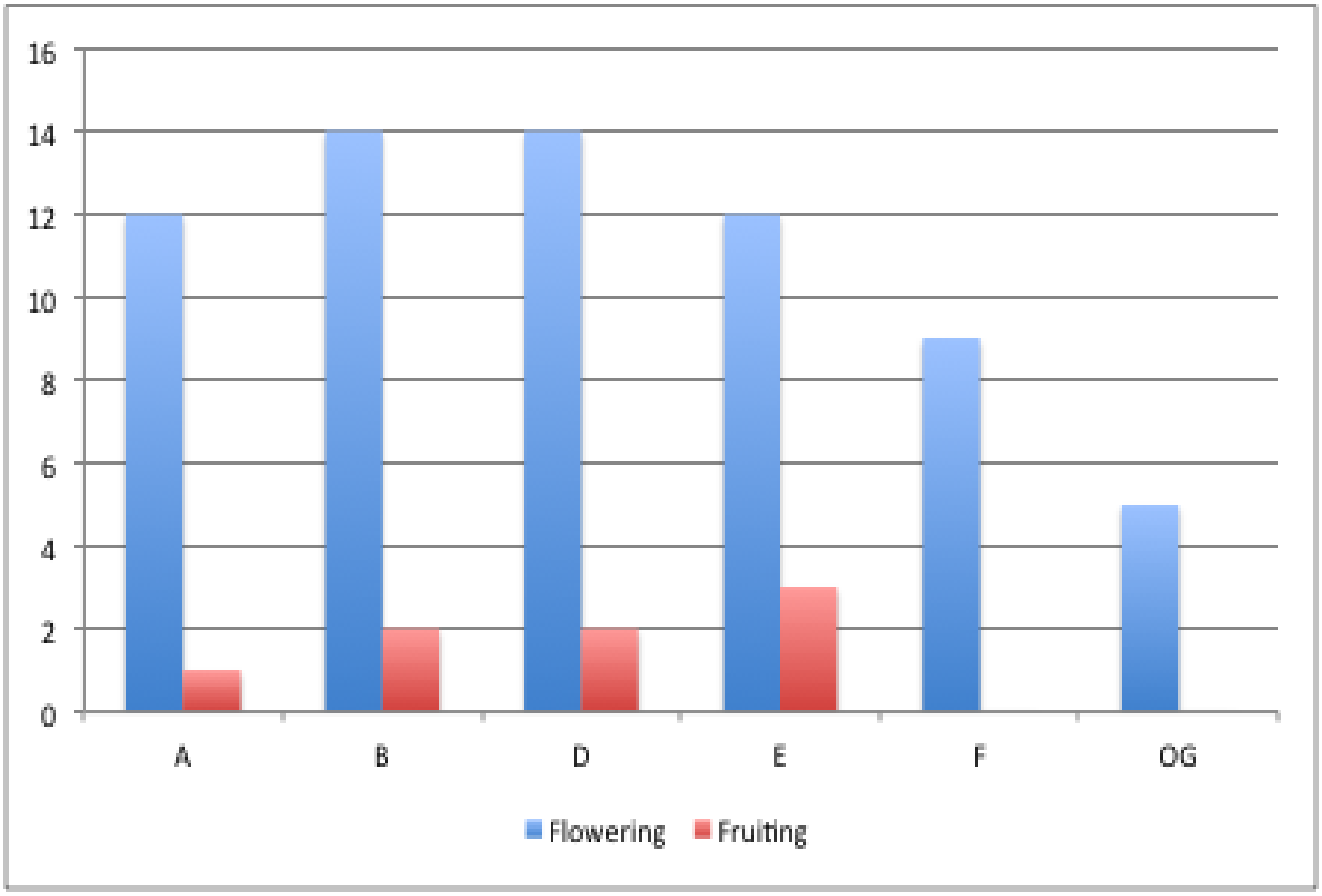

Fig. 4. *Flowering and fruiting phenology recorded at SAFE Blocks A, B, D, E and F and in Old Growth (OG) in the Maliau Basin. Fruiting was very sparse during this season and no fruiting was recorded in Maliau. 8 animal-dispersed fruiting trees fruited at SAFE. The Y Axis represent the number of flowering or fruiting events recorded.*

Fig. 4 shows flowering and fruiting phenology across old growth and twice-logged field sites from February-June 2013. Fruiting was extremely sparse during this season.

Eight of these trees came into fruit during March-June 2013. These trees were camera-trapped with covert no-glow infrared video camera traps. The trees include *Diospyros* sp., *Aglaia* sp. and *Ficus* sp. A preliminary analysis of the data from direct observation shows that bulbuls comprise the dominant arboreal frugivores (Fig. 5). Data from video camera traps has revealed species such as crested fireback pheasants, sambar, sun bears and orangutans as the dominant terrestrial frugivores feeding on fallen fruits (Fig. 6). Observations were conducted at three Ficus trees to survey the arboreal frugivore community. Observations were conducted from dawn to 10AM and all birds and mammals visiting the trees were recorded. Feeding behavior of frugivores was also recorded in whether they swallowed fruit whole or pecked at the pulp and dropped the fruit under the parent tree. In the former case, it may be argued that the probability of a seed successfully being dispersed would be higher as the disperser is moving the seed away from the parent tree. Bulbuls and crested firebacks were observed swallowing fruits whole. Observations were not conducted at the remaining 5 trees since the canopy around the trees was too dense to allow observations.

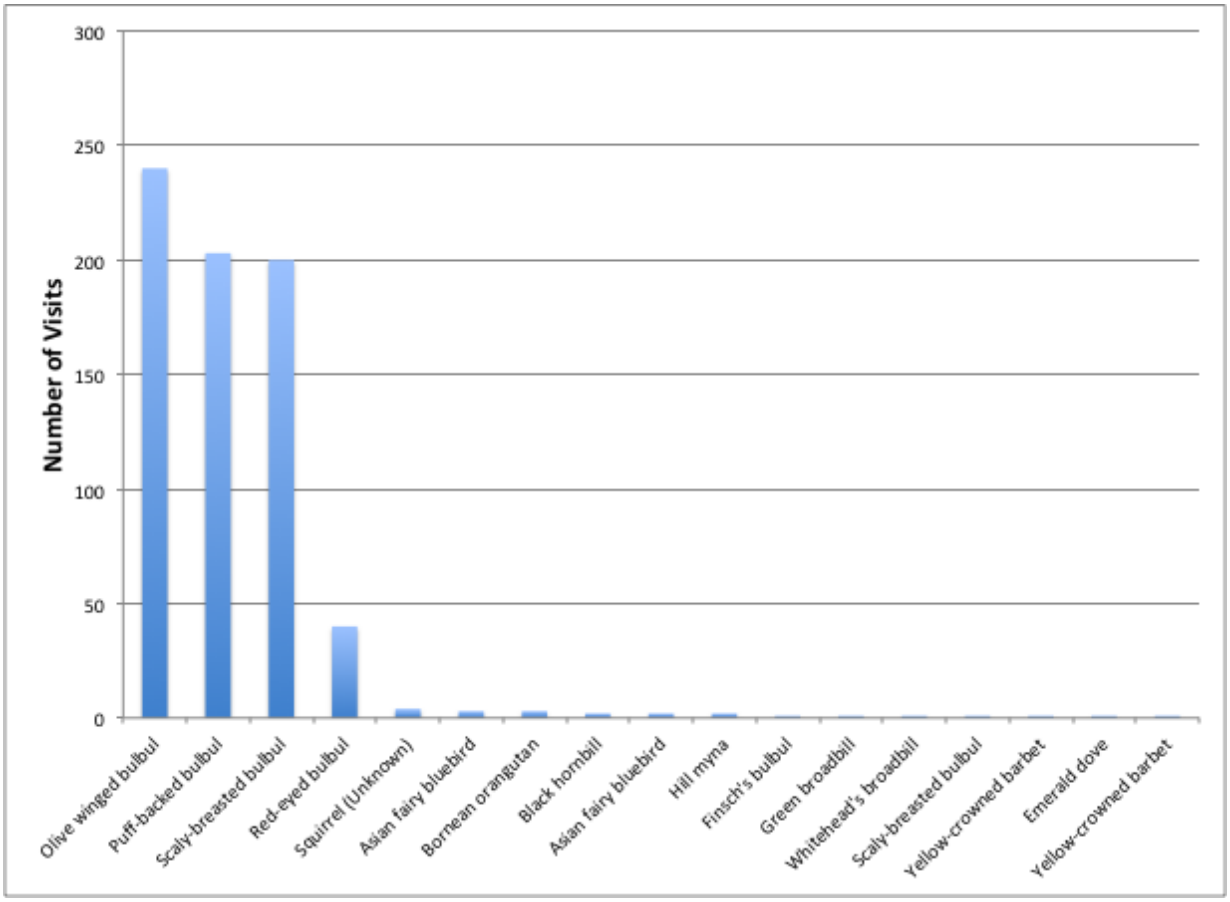

Fig. 5. *Dominant arboreal frugivores (in terms of number of visits observed) at Ficus sp. and Diospyros sp. are four species of bulbuls (Family Pycnonotidae). Bulbuls were observed swallowing Ficus fruits whole and then moving away from the fruiting tree to different microhabitats. These data are based on direct visual observations of frugivores at fruiting trees.*

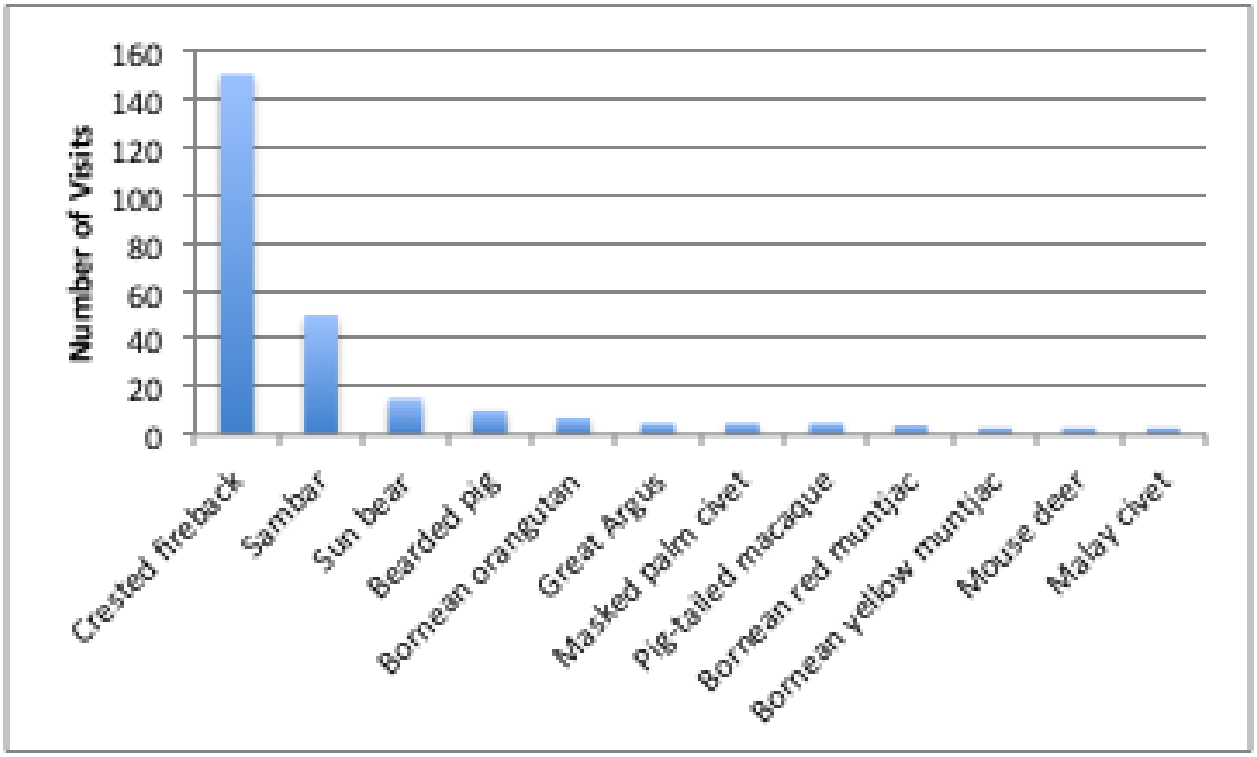

Fig. 6. *Dominant terrestrial frugivores (in terms of number of visits observed) at Ficus sp. and Diospyros sp. are crested fireback pheasant and sambar deer. These data are based on camera-trapping of fruiting trees.*

Future Directions

A mini masting was observed in the Maliau Basin during June 2013. It is expected that many more trees will come into fruit over the next field season. This will allow a comprehensive analysis of the frugivore community at fruiting trees before and after fragmentation since logging in the experimental area is now underway. To capture the auditory frugivore community (most of which are arboreal avian frugivores), I propose to use SM2 Song Meters (Wildlife Acoustics Inc., U.S.A.). These will enable a comprehensive collection of data of all frugivores that vocalize. Frugivores can be then identified using spectrogram analyses. This passive and non-invasive method of data collection is extremely efficient at collecting data on the entire auditory community since, unlike camera-traps, it does not rely on a fruiting event occurring.

Acknowledgements

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