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Primary tree species diversity in secondary fallow forests of Laos

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ABSTRACT

The area of primary forest is decreasing throughout the tropical world and being replaced by secondary forests. Many policy makers regard these secondary forests as being unworthy of protection since they are too degraded to have any commercial or conservation value. Because of this many are now being cleared for alternative land uses. But there are a variety of types of secondary forest differing in the extent to which they have been disturbed, the frequency at which this has taken place and, because of their position in the landscape, in their capacity to be recolonized from species from intact primary forests. This means that some secondary forests may not be as degraded as is supposed and many may have the capacity to recover if protected from further disturbances. This study reports on a comparison between remnant forest, and frequently and infrequently disturbed secondary forests in Lao PDR. The frequently disturbed forest had been cleared for shifting cultivation 3–5 times in the past 30 years while the infrequently disturbed sites had been cleared only once. The study found comparatively small differences in the occurrence of primary forest species in these two types of secondary forest and that they still contained a large proportion of primary forest tree species despite the disturbance history. This apparent resilience may be due to the capacity of many species to resprout after disturbances and their ability to recolonize across the present agricultural matrix.

1. Introduction

As the area of tropical primary forests decline throughout the tropics, secondary forests are expanding dramatically, and in many countries now exceed the total area covered by primary forest (FAO, 2005). In fact there may be very few tropical forests that are not impacted by humans in some way (Wright, 2010). Understanding the functional and successional dynamics of these secondary forests is important in terms of their management for timber, ecological services, biodiversity conservation, and non timber forest products (Guariguata and Ostertag, 2001).

Secondary forests are largely understudied (FAO, 2005), and the role they can play in the conservation of biodiversity remains poorly understood (Chazdon et al., 2009). There are differing opinions regarding the conservation value of these expanding secondary forests, and how large a role they will play in offsetting expected rates of biodiversity loss due to rapid deforestation. (Brook et al., 2006; Veddeler et al., 2005; Wright and Muller-Landau, 2006; Laurance, 2007; Dent and Wright, 2009).

These differing opinions can partially be explained by various understandings of the term 'secondary forest'. This term often groups together regenerating forests on the following spectrums:

- highly disturbed to only slightly disturbed forest,
- forests contiguous with intact forest to isolated patches,
- forests containing species with high regenerative potential to less resilient forest communities and
- recently disturbed forests to forests that have been regenerating for extended periods.

Some studies suggest that diversity of many taxa is significantly less in secondary forests (e.g. birds, dung beetles and possums; Peh et al. , 2005; Laurance, 2007; Gardner et al., 2008). Others indicate that high levels of species diversity can persist through disturbance or re-establish at a site after disturbance (e.g. woody plant species and beetles; Guariguata and Ostertag, 2001; Nichols et al., 2007). Understanding the potential trajectory of a secondary forest community can provide some indication of the future biodiversity value of the regenerating forest. Forest recovery and the accumulation of biodiversity in a particular secondary forest will depend on a number of factors including: land-use history, ongoing disturbances, and physical landscape context such as distance to primary forest (Mesquita et al., 2001; Chazdon, 2003).

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Seasonally Dry Tropical Forests (SDTFs) are considered one of the most threatened major terrestrial ecosystems on earth (Janzen, 1988; Mooney et al., 1995) and in southeast Asia, which has the highest relative deforestation rates of any major tropical region, this type of forest is particularly vulnerable (Khurana and Singh, 2001; Achard et al., 2002). This study focused on SDTFs in Lao PDR (Laos) that have been subject to slash-and-burn agricultural practices of varying intensity. These regenerating forests are particularly important in the context of Laos, as slash-and-burn agriculture is still practised over large areas, despite ongoing attempts to eradicate the practice (Messerli et al., 2009). Further, the resulting secondary forests provide a range of forest products and services to rural people, for example, bamboo shoots, forest vegetables, wildlife, and rattan (Foppes and Khetpanh, 1997).

The primary aim of this study was to compare the composition of primary tree species in secondary forests of different disturbance intensity (clearance occurrences), with nearby relatively undisturbed forest in Laos. The juvenile cohort of tree species individuals was chosen for the basis of analyses as the composition of this cohort most likely predicts the future composition of the maturing forest. Pioneer species were excluded from the analysis. Diversity indices between remnant and fallow forest communities were compared, and compositional analysis to further investigate differences between primary and secondary forests was conducted.

2. Methods

2.1. Site description

Forest tree surveys were conducted at the National University of Laos (NUOL), Faculty of Forestry Training and Model Forest (TMF) in Sangthong District, Vientiane prefecture, Laos (approximately 18°16′25″N, 102°10′31″E). These surveys were conducted from January to June 2006 and February to April 2007. The condition of natural resources and degree of forest degradation in the TMF are considered representative of large areas throughout Laos (NUOL/GTZ, 2000). Local economic and development conditions are also comparable with many regions of the country where rural poverty presents challenges to improving land-use management. The regional climate is influenced by the Asian monsoon with distinct wet (May to October) and dry (November to April) seasons and average rainfall of approximately 1750 mm per year (Suzuki et al., 2008). Low rainfall and high temperatures of 40 °C in the dry season leads to plant water deficits (Kennavong et al., 2003).

2.2. Forest communities surveyed

The three forest community types sampled as part of this study were:

- Remnant Forest (RF). These sites were used as reference sites to compare to the secondary forest communities. While most forests in the region have been subjected to some anthropogenic disturbance in the past, the sites chosen for this study had not been clear felled. Large trees (i.e. larger than 75 cm diameter at breast height (DBH)) were present, indicating the forest had remained largely intact for an extended period.
- Fallow Forest (low use) (FL). Fallow forests of age between 7 and 10 years post clearing were chosen which had been slashed, burned and cultivated only once in the past 30 years. These areas had been used for one rotation of dry land glutinous rice before being abandoned and subjected to no maintenance (other than non-timber forest products harvesting).
- Fallow Forests (high use) (FH). These fallow forests were also aged between 7 and 10 years post clearing but had been slashed, burned and cultivated between 3 and 5 times in the past 30 years.

All of these forest sites were located within a matrix of different land uses, with many patches of secondary forest being under 1 ha in size. All fallow forests were within 600 m of relatively undisturbed forest. These relatively undisturbed remnant forest sites were variable in terms of their size, and connectivity with larger tracts of remnant forest.

2.3. Assessing tree species juveniles

Juveniles of primary forest tree species were the subject of all surveys. Pioneer tree species, and all other vascular plants including shrubs were excluded. The juvenile cohort was defined for this study as established individuals greater than 1 m in height, but less than 10 cm DBH.

Laos, one of the most botanically understudied countries in Southeast Asia, is believed to contain up to 11,000 species of flowering plants and it is likely there are many species at risk that are as yet unidentified (Prance et al., 2000; WWF, 2008). While this makes research particularly interesting, it also presents challenges for species identification. Consistent local field guides are lacking, which makes it difficult to identify juvenile material. In this context the approach to species identification was as follows:

Species were sampled and given a Lao name by a local village expert, which was then transliterated by an academic staff member from the Faculty of Forestry of NUOL. Species were further identified using local texts and published descriptions, and by comparing specimens with samples in regional herbaria (NUOL Forestry Faculty Herbarium, Chang Mai University Herbarium Thailand, and the Thailand Forest Herbarium in Bangkok). A number of published resources applicable to the region were also used (Nguyen et al., 1996; Gardner et al., 2000; Callaghan, 2003). Specimens were identified to species level, if possible, and were included in the analysis if they could be identified as Recognisable Taxonomic Units (RTUs: Mayfield et al., 2005). During the sampling process, when it became obvious that one Lao name had been used for more than one species, these species were excluded (6.9% of stems surveyed). Pioneer species were also excluded using indigenous knowledge, and by comparing species lists with those found in primary forest transects (2.7% of stems excluded in this way). Species known to be native to local primary forest but not found during remnant forest sampling were included. For example, *Afzelia xylocarpa* was not observed during remnant forest sampling but was included, because the local forest expert indicated that its absence in remnant forest was due to exhaustive logging, and that it was in fact a primary forest species. Species for which less than three individuals were encountered in all plots were also excluded, as defining these as distinct species, or RTUs, was deemed to be potentially problematic due to the issues with identification described above. This particular technique was accepted in the context of this study, but should be taken into consideration when interpreting the results.

2.4. Sampling design

The sampling design included three nested levels of organisation in which a transect was the basic unit. The three hierarchical levels of sampling were as follows: level 1, forest community type (3 types: RF, FL, FH); level 2, sampling sites (6 sites per forest community type); level 3, transects (3 transects per sampling site). Transects were systematically located throughout available forest sites in the study area. A total of 54 40-metre long transects were sampled using a variable area sampling design (Sheil et al., 2003). Each transect was divided into eight cells extending away from the central transect until the fifth individual of the target class (see Section 2.3) was located. For a complete description of the method