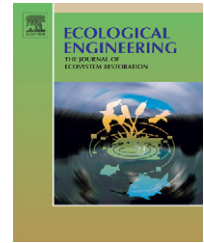


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# A rapid assessment approach on soil seed banks of Atlantic forest sites with different disturbance history in Rio de Janeiro, Brazil

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## ABSTRACT

This study represents a rapid assessment approach on the composition of soil seed banks in the Atlantic rainforest in Brazil and therefore marks a tool for the fast estimation of one important aspect of the regeneration ability of forest sites with different disturbance histories.

The project was carried out in a private reserve in the state of Rio de Janeiro, where research plots were established in three different forest sites: in continuous forest where selective logging took place, in forest regrowth after complete cutdown about 60 years ago and in a forest fragment. Additionally data from another forest remnant in this region were added to compare especially the results concerning the influence of fragmentation processes on soil seed bank structure.

With remarkably less sampling effort compared to germination experiments the sieving method is resulting in a fast gain of information on this particular topic which still is comparable to already published results.

Every investigation site in our study differs considerably in soil seed bank composition concerning their disturbance history. Furthermore coherences between canopy structure and the density of small-sized seeds in the soil, as well as edge effects within the forest fragments were observed. We recognised a higher amount of small seeds under more open canopy conditions in general and discovered trends of higher species richness near the forest boundary in the forest fragments.

This rapid assessment approach might be an easy to handle tool and a practical alternative to more extensive germination experiments for upcoming investigations on the regeneration capability in highly fragmented and disturbed landscapes like the Atlantic rainforest.

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## 1. Introduction

Soil seed banks are the last natural regeneration source in isolated and highly fragmented areas. Today about 7% of the Atlantic forests original extent still remains (Morellato and Haddad, 2000; Galindo-Leal and de Gusmão Câmara, 2003;

Tabarelli et al., 2005; INPE/Mata Atlântica, 2008). It is often restricted to steep hill slopes or heavily fragmented forest areas of varying size and intensity of isolation (Ranta et al., 1998; Oliveira-Filho and Fontes, 2000). Over 99% of the 100,000 forest fragments in Rio de Janeiro State are smaller than 500 ha (Tabarelli and Peres, 2002). There are multiple causes

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of anthropogenic forest degeneration and therefore different impacts on the ecosystem functioning. Forest types with different disturbance history and forest fragments are heterogeneous habitats and continuously changing in structure and varying in species composition (e.g. Williams-Linera et al., 1998; Laurance et al., 2002; Galindo-Leal, 2003). On behalf of evaluation of the current status of certain areas and for implications for conservation actions, a fast estimation of regeneration potential will be indispensable. Up to 85% of the re-establishment of plants after disturbances is based on soil seed banks (Baider et al., 2001) and there still is a lack of information about potentials and dynamics of soil seed banks in the Neotropics, including structural aspects like seed size and distribution in the soil. A fast approach on the influence of disturbance history and edge effects on those aspects would provide valuable information, especially for a large-scale disturbed and highly fragmented area under ongoing threat like the Mata Atlântica. Furthermore there are changes in forest structure and its response to seasonal rainfalls (Sattler et al., 2007) and the aftermath on regeneration-relevant aspects like soil seed bank structure still lacks knowledge. The majority of published results on this topic are predicated on soil seed bank estimations obtained by germination experiments. (e.g. Garwood, 1989; Rico-Gray and García-Franco, 1992; Dalling et al., 1997; Martins and Engel, 2007). This study wants to contrast the results of this conservative and extensive method with the outcome of an easy to handle rapid assessment approach with focus on the influence of different disturbance histories, especially fragmentation processes, on soil seed bank structure.

## 2. Methods

### 2.1. Study area

The study was conducted in June 2007 within the Atlantic rainforest (Mata Atlântica) at the private reserve “Reserva Ecológica de Guapiaçu” (REGUA – 22°25'53" S, 42°45'20" W) in the state of Rio de Janeiro, Brazil. The 5500 ha reserve is located about 100 km in northeast direction from the city of Rio de Janeiro and covers an altitudinal gradient from 30 to 2200 m asl.

Mean annual temperature for this region is about 23 °C with a mean annual rainfall of about 2560 mm, and there is a hot and rainy season from October to March and a cooler and dry season from April to September (Kurtz and de Araújo, 2000). Vegetation can be classified as dense ombrophilous forest (Veloso et al., 1991) and is typical for the lower and medium elevations of the coastal mountain range (Morellato and Haddad, 2000; Oliveira-Filho and Fontes, 2000).

Research plots were established in three different forest sites: in continuous forest where selective logging took place until late 1970s, in forest regrowth after complete cutdown about 60 years ago (N. Locke, pers. comm.) and in a 100-ha forest fragment. The forest fragment is surrounded by agricultural landscape and smaller forest remnants. It is located in about 750 m distance from continuous forest and was separated at least 25 years ago (N. Locke, pers. comm.).

Additionally data from another forest fragment was used, which was investigated in 2005. This 65 ha forest remnant

is located at 22°16'42" S, 42°51'40" W, nearby the village of Vargem Grande about 45 km to the north from REGUA and surrounded by intensively used agricultural landscape and smaller forest remnants. The closest continuous forest (Parque Nacional da Serra dos Órgãos) is situated about 25 km to the southeast.

### 2.2. Sample design

A 100 × 100 m (1 ha) research plot was set up at every investigation site and a 10 × 10 m grid of marked points was established within each plot. To quantify the seed bank, soil samples of 500 cm<sup>3</sup> were taken in two depths, 0–5 cm and 5–10 cm. The litter layer was removed from the soil surface. Sample effort was set to 8 samples chosen randomly from the grid points in each continuous forest site and doubled to 16 samples at the forest fragments, whereas respectively 4 samples were taken at four different distances from the edge (at 5 m, 35 m, 65 m, 165 m).

Each soil sample was dried in a gas oven at 85 °C for 2 h and homogenized. A volume of randomly chosen 100 cm<sup>3</sup> of each sample was sieved in a Keck-Sand-Shaker™ for 3 min equipped with three sieve elements with different mesh sizes (23 OPN – 0.5 mm; 30 OPN – 1.2 mm; 46 OPN – 2.3 mm). Thereby the samples became divided into three size fractions (large > 2.3 mm > medium > 1.2 mm > small > 0.5 mm). The left-over smaller than 0.5 mm was discarded. Each fraction was examined using a binocular microscope and all intact seeds were counted and classified to morphospecies, whereas they were accounted separately between the sites in REGUA and the fragment at Vargem Grande because of the spatial and temporal differences in sampling.

To evaluate the canopy openness as an important factor for general forest structure, hemispherical photography was used. This is an approved tool for such assessments (Fassnacht et al., 1994; Trichon et al., 1998; Jonckheere et al., 2004). I used a Nikon™ Coolpix 4500 digital camera with a Nikon™ FC-E8 fisheye lens mounted on a tripod. Pictures were taken at a height of 1.30 m at every grid point in each plot. In the forest fragments additional pictures were taken at the sample points in 165 m distance from the edge. Resolution of the images was set to 2272 × 1704 pixels. The methodology was only used under overcast conditions to avoid dazzling and reduce reflections to optimize the results.

### 2.3. Data analysis

To analyze and compare the morphospecies composition between all sites at REGUA a Jaccard-cluster-analysis (group average link) was used. Because of spatial and temporal differences in sampling, the data from the fragment at Vargem Grande was hard to fit in and therefore were excluded from this analysis.

Two-way ANOVAs with Student–Newman–Keuls multiple comparison procedures were used to analyze the effects of different sites and sample depths on the total number of seeds and species in the soil seed bank. Three-way ANOVAs with Student–Newman–Keuls multiple comparison procedure were additionally executed to test for effects of different sites, sample depths and distance from the forest edge at the fragments

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