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Chapter 3.2.

NEW FRONTIERS

3.2. TRANSFERENCE OF SEEDLINGS AND ALOCTONE YOUNG INDIVIDUALS AS ECOLOGICAL RESTORATION METHODOLOGY

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Introduction

Many theoretical and methodological aspects of the ecological restoration have been exhaustively discussed in the last two decades (Parker, 1997; Ehrenfeld, 2000; Davis and Slobodkin, 2004; Ruiz-Jaén and Aide 2004; Young et al., 2005). One of the important points of this discussion is the richness of native species employed in ecological restoration programs (Palmer et al., 1997; Rodrigues and Gandolfi 2004; Lamb et al., 2005). It seems an agreement, however, that more than just concerning with the richness of species employed in restoration processes; it is also important guaranteeing diversity capable to reestablish the ecological processes and the functioning of the degraded system. When the objective is the ecosystem functioning restoration, the action should not be focused on individual species, but rather on the fact that the functional groups must be represented in the pool of species used (Palmer et al., 1997; Cavalheiro et al., 2002).

However, it is very important stressing that most reforestations processes performed with native species already implanted do not fulfill the minimum richness and initial diversity criteria for the reestablishment of the ecological processes and the structural elements of a forest, even those performed in regions with high diversity of the remaining natural formations. Data obtained from the monitoring of restored areas in the state of São Paulo, southeastern Brazil, show that approximately 35 forest species are planted, almost always the same species in the entire state (approximately 248 thousand km^2), regardless the environmental characteristics of the restored site and the regional flora and the fact that two thirds of these species are found at the initial stages of the secondary succession makes this situation even worse (Barbosa et al., 2003). Thus, the sustainability of restored forests, especially those within highly fragmented landscapes is impaired in function of the non-reestablishment of the natural regeneration dynamics, among other factors, due to the low number of species used in this implantation (Souza and Batista, 2004).

One of the main causes for the low diversity in restoration plantings is the absence of many native species in forest seedlings production seedbeds (Barbosa et al., 2003) as a result of difficulties found to obtain native seeds with high diversity and the absence of specific technology for the production of seedlings of many native species (Silva et al., 2003; Zamith and Scarano, 2004). The great interspecific variability, the presence of diversified dormancy mechanisms (Vázques-Yanes and Orozco-Segovia, 1993), the high predation indexes (Zamith and Scarano, 2004) and the limited knowledge on the phenology and physiology of a significant part of the shrub and tree tropical plants are barriers that make the production of seedlings of native species difficult.

Unlike the low biological diversity frequently found in ecological restorations, the several types of tropical forests are characterized by the high diversity of vegetal species distributed into several forms of life including trees and shrubs (Gentry 1992), which correspond to the plants regularly used in ecological restoration programs.

Still interesting is the fact that, with a few exceptions, shrubs and trees of tropical forests present type-III survival curves, which are characterized by high mortality rates and a significantly higher number of individuals at the initial stages of life (Fenner 1987). Thus, the community of seedlings and young individuals of the tropical forest many times presents a higher number of shrub and tree species (*e.g.* Hubbell et al., 1999, Oliveira et al., 2001) that belong not only to the group of species of the late ecological succession, which germinate under the canopy and which seedlings and young individuals may be established and remain under the forest shade for many years forming a bank of seedlings (Swaine and Whitmore, 1988; Whitmore, 1989), but also to the group of early plant succession, which are mainly found next to edges and/or gaps of the forest fragments (Martins and Rodrigues, 2002; Grombone-Guaratini and Rodrigues, 2002).

These processes are not restricted to the remaining natural formations. Similarly, monospecific commercial forest plantings, which have become a component more and more important in tropical landscapes, may catalyze or facilitate the forest succession by presenting regeneration of native forest species in the understory, especially when forest fragments remain in the landscape and when the forest management is less intensive (Parrotta et al., 1997). For *Eucalyptus* spp. stands, several studies are in agreement with this idea (*e.g.* Tabarelli et al., 1993; Silva Júnior et al., 1994; Durigan et al., 1997; Geldenhuys 1997; Parrotta, 1999; Saporetti Junior et al., 2003; Yirdaw and Luukkanen, 2003; Lemenih and Teketay, 2005; Carneiro and Rodrigues, 2006 - chapter 3.1. of this book).

This short review presents two distinct and opposite conditions. One of them, potentially rich and diverse in species and vegetal forms of life (community of seedlings and young individuals in tropical natural formations and the neighboring commercial forest plantings) and another frequently characterized by low diversity of species and vegetal forms of life (restoration plantings and native species seedlings production seedbeds). However, investigative scientific works aimed at the possibility of the utilization of the community of seedlings and young individuals from native forest formations or commercial forest plantings as source of propagules for the production of seedlings and as strategy to use the regional biodiversity in the ecological restoration of degraded areas are still scarce and aimed at one or a few native species only (*e.g.* Auer and Graça, 1995; Nemer et al., 2002).

Thus, two case studies in the Atlantic Forest region, southeastern Brazil were performed in this work. In both cases, the community of native shrub and tree seedlings and young individuals from forest remnants and/or eucalyptus commercial stands (*Eucalyptus* sp.) was surveyed and later transferred to seedling production seedbeds to be used in forest restoration projects. Based on the richness values of species, density and diversity of ecological groups and on the survival rate of individuals transplanted to the seedbed, aspects concerning the transference potential of seedlings and young individuals as a technique to produce native species seedlings and to increase the diversity in forest seedbeds aimed at the restoration of degraded areas will be discussed.

Material and Methods

Study Areas

The case studies were independently conducted as follows: one study was conducted in the county of Ribeirão Grande (Area 1) and another in the county of Bofete (Area 2), approximately 150 km away from each other. These counties are located at the state of São Paulo, southeastern Brazil (Figure 1) that include the *latu sensu* Atlantic Forest, one of the largest Brazilian biomes and one of the most threatened in the world (SOS Mata Atlântica Foundation and INPE, 2002).

Figure 1. Location of the study areas in counties of Ribeirão Grande (Area 1) and Bofete (Area 2), state of São Paulo (SP), Southeastern Brazil.

In Area 1 (24º09' - 24º10'S and 48º18' - 48º21'W), the study was performed in secondary vegetation remnants, with several stages of ecological succession as a result of occupation in variable periods for agricultural exploitation and selective extraction of wood, heart of palm (*Euterpe edulis*) and fern tree (*Dicksonia sellowiana*). The Seasonal Semideciduous Forest is the vegetation type of highest influence in the area, however, due to the proximity to the Atlantic Coast, altitude (800 – 1000 m) and to the wet mild climate with no dry season ("Cfb" according to the Koeppen climate classification), there are no elements from the Ombrophilous Dense Forest in the local flora (Veloso 1992). This area belongs to a mining company, which with authorization from the lawful environmental agencies, will cut down the vegetation in order to exploit metalimestone and clay aimed at cement production.

Area 2 (23º00' - 23º05'S and 48º11' - 48º16'W), also inserted in the Seasonal Semideciduous Forest domain presents "Cfa" climate according to the Koeppen climate classification, yearly pluviometric precipitation of 1400 mm, about 600 m of altitude and belongs to a rural ownership aimed at the commercial *Eucalyptus* sp exploitation. However, besides the commercial forest plantings, there are native vegetation remnants in the area, especially near streams. Thus, the study was conducted in secondary vegetation remnants of approximately 150 ha, which includes since interfluvial areas, with no fluvial influence up to riverside regions with almost everlasting seasonal influence (Swampy Floret) and in the understory of commercial eucalyptus planted areas (*Eucalyptus* sp.).

Sampling of the Community of Seedlings and Young Individuals

In Area 1, the sampling of the community of seedlings and young individuals of shrub and tree species with individuals with up to 60 cm was performed in two distinct periods, July and December 2002, respectively corresponding to winter and summer seasons of the site studied. In each period, 50 parcels of 2x2m (200 m^2 in summer and 200 m_2 in winter) were randomly placed.

In Area 2, 20 parcels of 4x4m (360 m^2) were asymmetrically placed in the forest remnant and 87 parcels of 2x2m (348 m^2) were placed in eucalyptus plantings, with samples respectively collected in April/May 2003 and in June 2003. The maximum height for the inclusion of shrub and tree individuals was of 30 cm.

It is worth emphasizing that in the eucalyptus commercial plantations, the sampling was performed in 19-31-year-old planted areas with exploitation purposes. However, all the selected planted areas have, at least in their surrounding areas, contact with remaining forest fragments, being apart from them only by circulation wagon trails. In each studied eucalyptus planted area, a 35 m-wide zone was delimited from the edge that represents the contact with the native forest fragment. Only in this zone of variable length and according to the extension of the contact edge of each planted area with the forest remnant, the sampling of the community of seedlings was performed (sampling universe).

In both areas, all sampled individuals were measured for height and identified according to the APG II classification system (APG, 2003). Except for the forest remnant in Area 2, where only part of the individuals were transplanted to seedbeds, in the other areas, all sampled individuals were removed and transferred into the seedbed for seedling production.

The sampled species were also classified as pioneers (including pioneers/early secondary) and non-pioneers (late secondary/climax). To do so, the classifications proposed by Ferretti et al. (1995), Gandolfi et al. (1995) and Ivanauskas et al. (2002) were researched. Species not included in categories above, as typically adapted to swampy areas, or even species with no available data in literature were classified as "non-characterized". When the research to different works presented distinct results for the same species, the ecological group in which the species appeared the most was considered.

Collection and Transference of Seedlings and Young Individuals into the Seedbed

Seedlings and young individuals were extracted from the land with the aid of a gardening shovel. Later, the land was manually and carefully removed from roots until complete clearance in order to avoid damages to the root system and/or possible associated structures (Figure 2).

Figure 2. Illustrative sequence of the transference of seedlings and young individuals to the seedling production seedbed: (A) collection of the regenerating individual in the understory of the studied areas; (B) immediate conditioning into recipient containing water; (C) transplantation to plastic sacks; (D) transplanted seedlings in seedbed of Area 2, Bofete, São Paulo, Brazil.

Shortly after removal, regenerating individuals were grouped as parcels, placed into recipients containing water and kept in this condition until transplantation, which was performed not later than 36 hours after in seedbeds next to the collection site of seedlings and young individuals.

In the transplantation process, the collected regenerating individuals were placed into polyethylene black sacks (10x15 cm) and kept under 40% of shade in Area 1 and 50% in Area 2 (Figure 2). A compound containing two parts of soil and one part of pie filter (byproduct obtained from sugar cane mill) was used as substrate for Area 1 and for Area 2, the Plantmax Florestal Estaca substrate, based on processed and enriched vegetal shells and turfs as well as expanded vermiculite were used.

During the transplantation of the regenerating individuals into the polyethylene sack, roots were carefully handled in order to avoid roots to be folded or in air bubbles formed in the substrate. Roots excessively large or twisted, fact common in individuals obtained from natural regeneration, were cut when larger than the transplantation recipient, thus allowing the proper accommodation of plants. At the transplantation moment, the cut of 50% of the surface of each leaf of the regenerating individuals was also performed in order to facilitate the visualization of new leaves. In both seedbeds, the transplanted individuals from each parcel were randomly arranged.

The cultural treatments performed were the same as those regularly used in the seedling production, in other words, overhead irrigation two times a day and manual control of weeds. In seedbed of Area 1, full liquid manures were monthly performed (macro and micronutrients) from day 30 until the end of evaluations

In transplanted seedling from Area 1, no cover fertilizations were performed.

Analysis of Data

Community of Seedlings and Shrub Individuals

For each area, both in forest remnants and eucalyptus plantings, the number of individuals, species and families, the absolute frequency, the estimated density of seedlings per hectare were obtained with the respective confidence interval values ($\alpha = 0.05$) and the proportion of individuals in each ecological group (pioneers, non-pioneers and non-characterized). For Area1, it was also obtained the number of exclusive species in each sampling season and the individuals sampled in each sampling season was compared through the Chi-Squared test with Yates correction (G.L.=1).

In relation to the size classification, sampled individuals were allocated into three height categories, arbitrarily established. For Area 1, plants were classified into class I (up to 20 cm), class II (from 21 to 40 cm) and class III (from 41 to 60 cm). For Area 2, class I (up to 10 cm), class II (from 11 to 20 cm) and class III (from 21 to 30 cm). Through the Chi-Squared test, it was verified if the number of individuals in each class was different of an equitable distribution between height classes in both areas.

Behavior of Transplanted Individuals in the Seedbed

For each study area, the general survival rates were independently obtained (for Area 1, the survival rate was obtained in relation to the sampling season and for the forest remnant in Area 2, the general survival rate was obtained with or without *Protium spruceanum)* in relation to specie and ecological group. Data of each area were independently analyzed not only due to the fact that areas were different but also because transplantations were performed in different seasons. The removal of *Protium spruceanum* individuals for the attainment of the general survival rates of forest remnants of Area 2 was due to the fact that this species corresponds to over than 50% of seedlings found in this area, thus influencing results and in some cases impairing their interpretation. It is worth stressing that many species were represented by only a few individuals (n<20); in this case, the results obtained for species must be carefully interpreted, and those obtained for the community of regenerating individuals must be emphasized.

The final evaluation of the survival rate in seedbeds was performed six and nine months after transplantation for Area 1 and Area 2, respectively. Live individuals that had issued leaves after transplantation were considered as survivors.

Individuals considered as visually not dead but that had not issued or were destitute of leaves at the moment of the last evaluation were considered as dead individuals. The proportions of survivor and dead individuals in relation to the ecological group (pioneers and no-pioneers) were compared through the Chi-Squared test with Yates correction (G.L.=1).

In order to perform a more careful analysis in relation to the survival rate in the different sizes of seedlings, individuals transplanted into the seedbed were classified into height classes, unlike procedure described in item 2.3.1.. Thus, the general survival rates were obtained in each height class (for forest remnant in Area 2 with or without *Protium spruceanum*) and ecological group (only for the group of plants from Area 2). The proportion of survivor and dead individuals in each height class was compared for the general data and for the different ecological groups in each area and for *Protium spruceanum* in case of seedlings obtained from the forest remnant of Area 2. For that, the Chi-Squared test with Yates correction (G.L.=1) and the Bonferroni correction for multiple comparisons were used to compare classes two-by-two. In the case of frequencies below five, the Chi-Squared test was replaced by the Fisher Exact test.

Results and Discussion

General Aspects of the Community of Seedlings and Young Individuals

In Area 1 (Ribeirão Grande) 774 regenerating individuals belonging to 48 species and 27 families were sampled in July (winter) and 758 belonging to 43 species and 19 families were sampled in December (summer) (Table 1). Overall, 1532 individuals belonging to 63 shrub and tree native species distributed into 28 families were surveyed. Still for Area 1, estimated density values of individuals per hectare were 38700 (± 12394) in July (winter) and 37900 (± 7945) in December (summer) (Table 2).

In eucalyptus plantings of Area 2 (Bofete), 280 individuals belonging to 42 shrub and tree native species and to 24 families were sampled (Table 3), with estimated density of 8046 (± 2295) individuals per hectare.

On the other hand, in the forest remnant of Area 2 (Bofete), 6136 individuals belonging to 119 species and 41 families were surveyed (Table 4). The estimated density per hectare was of 191688 (± 85536) individuals. These richness values corresponding to the regenerating individuals were higher not only in relation to the other studied areas but also in relation to other studies involving the survey of communities of seedlings in tropical forest of the region (Oliveira et al., 2001). However, such comparisons must be carefully interpreted because these are distinct areas with distinct disturbance situations, with different sampling intensities and with distinct seedlings and young individuals definition criteria.

In Area 1, no significant differences in relation to the number of individuals sampled in each season were observed ($\chi^2 = 0.29$; p=0.59). However, from the 63 species found, 20 (31.8%) were exclusive to the sampling of July (winter) and 17 (26.9%) were exclusive to the sampling of December (summer); in other words, 58.7% of species occurred only in one sampling season. From the 10 species of highest density in Area 1, only three, *Ocotea dispersa*, *Mollinedia widgrenii* and *Cupania vernalis* were common to both seedlings and shrub individuals sampling seasons. Therefore, there is a remarkable seasonality in the germination and establishment of individuals from different species (Lieberman 1996), fact caused by the existence of phenological standards of fruits maturation and seeds dispersion, among other factors.

In Area 2 (Bofete), *Protium spruceanum* stood out, which represents 56.7% of the total sampled individuals in the forest remnant. Considered as peculiar species non-exclusive of swamp forests (Ivanauskas et al., 1997), *Protium spruceanum* presented agglomerates in this study, especially in parcels located in areas with lower land humidity, where the sampled individuals were almost exclusively of its species (Figure 3). Possibly, the sampling season was coincident with the post-germination period of *Protium spruceanum* seedlings, in an outstanding seed production year. Indeed, many species and/or tropical shrub individuals present supra-annual reproductive characteristics with the production of cohorts (numerous) in intervals above one year (De Steven 1994, Lieberman 1996; Connell and Green, 2000).

Generally, the community of seedlings in all environments evaluated was characterized by presenting high spatial heterogeneity both in relation to the density of individuals (high confidence interval values estimated for one hectare) and in relation to the species composition. In the forest remnant of Area 2, for example, 33 species (27.7%) were grouped into only one parcel and only 15 species (12.6%) occurred in more than 50% of parcels. In eucalyptus plantings of Area 2, 16 species (38.1%) occurred in only one parcel and none of them occurred in more than 25% of parcels. For Area 1, 11 and 9 species represented by only one individual (10 species, considering both seasons altogether) were sampled in July and December, respectively.

Among regenerating individuals sampled in the forest remnants of Area 1 (Ribeirão Grande) and 2 (Bofete), a prevalence of non-pioneer species was observed (68.3% in Area 1 and 45.4% in Area 2), what was expected due to the fact that non-pioneer species germinate under the forest canopy and remain under the forest shade in the seedlings bank condition for many years until spaces or limiting resources become available (Swaine and Whitmore, 1988; Whitmore 1989; Lieberman, 1996). However, pioneer species composed 31.7% of the total species of Area 1 and 27.7% of Area 2 (non-characterized species corresponded to 26.9% of the total species). For the number of individuals, non-characterized species prevailed in the forest remnant of Area 2, with 66.11% of the total individuals, value considered as high due to the high density of *Protium spruceanum*, followed by non-pioneer species (19.7%) and pioneer species (13.6%).

Figure 3. Seedlings and young individuals of *Protium spruceanum* in sampling parcel in the Seasonal Semideciduous Forest of Area 2, Bofete, São Paulo, Brazil.

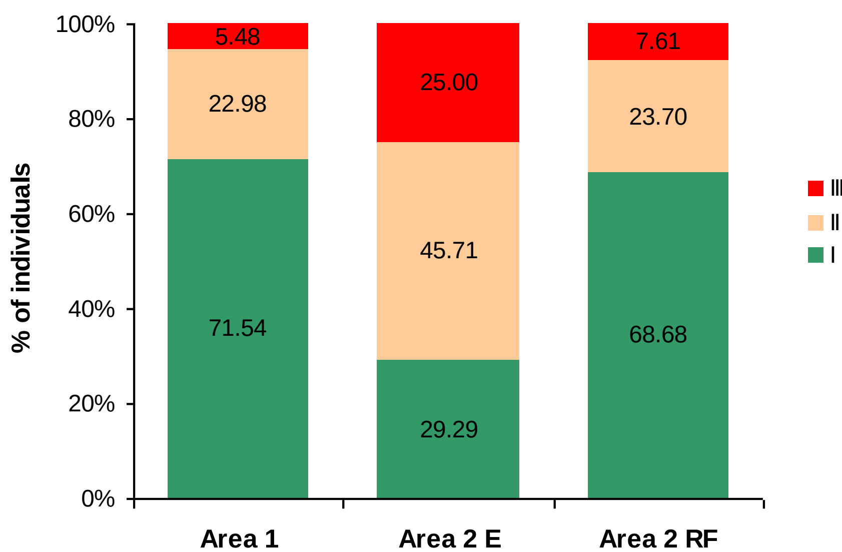


Figure 4. Distribution of individuals into height classes in each sampling environment where Area 2E: eucalyptus plantings, Area 2 FR: Forest remnant, class I: up to 20 cm for Area 1 and up to 10 cm for the other areas; class II: from 21 to 40 cm for Area 1 and from 11 to 20 cm for the other areas; class III: from 41 to 60 cm for Area 1 and from 21 to 30 cm for the other areas. In all environments, the proportion of individuals between height classes was significantly different through the Chi-Squared test (Area1 χ^2 =1615.1; $p < 0.0001$; Area2 E: χ^2=20.08; $p < 0.001$; Area2 FR: χ^2 =3687.4; $p < 0.0001$).

For eucalyptus stands of Area 2, pioneer species presented both the highest number of species (50%) and individuals (42.1%) as a result of the fact that its understory is more illuminated when compared to forest formations and also of interventions for the forest management of planted areas.

Both communities of forest remnants regenerating individuals (Areas 1 and 2) presented a significantly higher number of individuals in class I, which corresponds to the class presenting the lowest height among individuals. This fact was expected, once shrub and tree species are usually characterized by a higher number of individuals and higher mortality rates during the initial phases of life, with decrease observed as plants grow older (Fenner, 1987). However, the eucalyptus area was an exception, presenting a number significantly higher of individuals in height class II (11-20 cm) (Figure 4). Possibly, in eucalyptus planted areas, the arrival of propagules and/or the germination of seeds in the land under canopies does not occur uniformly or with the same intensity and frequency along time.

Table 1. Species sampled in the community of shrub and tree seedlings and young individuals of forest remnants (Area 1) and their respective survival rates when transferred into the seedbed, Ribeirão Grande, São Paulo, Brazil.

Family	Specie	EG	N1	N2	TN	P	AD	S(%)
Annonaceae	*Rollinia sylvatica* (A St.-Hil) Martius	NP	5	2	7	6	105	71.4
Apocynaceae	*Aspidosperma parvifolium* A.DC.	NP	1	0	1	1	1	100.0
Aquifoliaceae	*Ilex* cf. *taubertiana* Loes	NP	2	0	2	1	2	50.0
Arecaceae	*Euterpe edulis* Mart.	NP	0	1	1	1	50	0.0
	Geonoma brevispatha Barb. Rodr.*	NP	26	5	31	16	276	45.2
Boraginaceae	*Cordia ecalyculata* Vell.	P	2	0	2	2	2	100.0
Celastraceae	*Maytenus robusta* Reissek	NP	15	16	31	17	815	58.1
Elaeocarpaceae	*Sloanea monosperma* Vell.*	NP	1	0	1	1	1	100.0
Erythroxylaceae	*Erythroxylon* sp.	NP	11	34	45	23	1711	75.6
Euphorbiaceae	*Alchornea triplinervia* (Spreng.) Müll. Arg.	P	0	1	1	1	50	100.0
	Croton floribundus Spreng.	P	0	10	10	3	500	50.0
	Croton lindenianus A. Rich.*	P	1	0	1	1	1	0.0
	Sebastiania serrata (Baill.ex Müll. Arg.)*	NP	42	0	42	16	42	50.0
Fab.-caesalpinioideae	*Copaifera langsdorffii* Desf.	NP	11	0	11	8	11	18.2
	Copaifera trapezifolia Hayne*	NP	0	7	7	6	350	57.1
	Senna multijuga (Rich.) H.S. Irwin	P	9	143	152	31	7159	73.0
Fab.-cercidae	*Bauhinia forficata* Link	P	1	0	1	1	1	100.0
Fab.-mimosoideae	*Inga sessilis* (Vell.) Mart.	NP	0	4	4	4	200	100.0
	Piptadenia gonoacantha (Mart.) J.F. Macbr.	NP	1	0	1	1	1	100.0
	Piptadenia paniculata Benth.	P	18	1	19	8	68	42.1
Fab.-papilionoideae	*Dalbergia frutescens* (Vell.) Britton.*	NC	43	17	60	28	893	76.7
	Erithrina falcata Benth.	P	0	1	1	1	50	100.0
	Machaerium scleroxylum Allemão	NP	0	1	1	1	50	100.0
	Machaerium stipitatum (DC.) Vogel	P	2	0	2	1	2	50.0
	Zollernia ilicifolia (Brongn.) Vogel*	NP	0	20	20	7	1000	85.0
Lauraceae	*Endlicheria paniculata* (Spreng.) J.F. Marcbr.*	NP	4	15	19	10	754	57.9
	Nectandra leucantha Griseb.*	NP	15	22	37	19	1115	48.6

Table 1. Species sampled in the community of shrub and tree seedlings and young individuals of forest remnants (Area 1) and their respective survival rates when transferred into the seedbed, Ribeirão Grande, São Paulo, Brazil (Continued)

Family	Specie	EG	N1	N2	TN	P	AD	S(%)
	*Nectandra megapotamica (*Spreng.) Mez.	P	3	6	9	4	303	88.9
	Ocotea corymbosa (Meisn.) Mez.*	P	124	1	125	9	174	33.6
	Ocotea dispersa (Nees) Mez*	NP	70	51	121	34	2620	66.9
	Ocotea sp1	NP	0	4	4	4	200	50.0
Loganiaceae	*Strychnos brasiliensis* (Spreng.) Mart.*	NP	11	25	36	16	1261	91.7
Melastomataceae	*Miconia* sp1	P	0	4	4	1	200	25.0
	Miconia sp2	P	3	5	8	5	253	0.0
	Tibouchina pulchra (Cham.) Cogn.	P	7	0	7	3	7	14.3
Meliaceae	*Cabralea canjerana* (Vell.) Mart.	NP	1	0	1	1	1	100.0
	Cedrela fissilis Vell.	NP	2	1	3	3	52	66.7
	Trichilia pallida Sw.*	P	0	3	3	3	150	66.7
	Trichilia sp.	NP	1	5	6	6	251	66.7
Monimiaceae	*Mollinedia widgrenii* A. DC.*	NP	15	46	61	37	2315	86.9
Moraceae	*Sorocea bonplandii* (Baill.) W.C. Burger, Lanj. & Wess. Boer*	NP	17	19	36	20	967	52.8
Myrsinaceae	*Rapanea ferruginea* (Ruiz & Pav.) Mez	P	4	22	26	18	1104	80.8
	Rapanea guianensis Aubl.	P	0	1	1	1	50	100.0
	Rapanea umbellata (Mart.) Mez	P	7	4	11	7	207	72.7
Myrtaceae	*Campomanesia guaviroba* (DC.) Kiaersk*	NP	3	8	11	3	403	90.9
	Eugenia pluriflora DC.*	NP	5	0	5	3	5	0.0
	Eugenia sp1	NP	0	11	11	2	550	72.7
	Gomidesia sp1	NP	1	2	3	3	101	66.7
	Gomidesia sp2	NP	2	0	2	2	2	0.0
	Myrcia fallax (Rich.) DC.	P	28	29	57	24	1478	59.6
	Myrtaceae sp1	NP	0	90	90	27	4500	64.4
	Myrtaceae sp2	NP	6	0	6	2	6	16.7
	Psidium cattleianum Sabine	NP	1	1	2	2	51	100.0
Nyctaginaceae	*Guapira opposita* (Vell.) Reitz	NP	0	7	7	4	350	85.7
Rosaceae	*Prunus myrtifolia* (L.) Urb.	NP	111	14	125	27	811	34.4
Rutaceae	*Esenbeckia grandiflora* Mart.	NP	5	0	5	5	5	40.0
	Zanthoxylun rhoifolium Lam.	P	4	0	4	3	4	50.0
Sapindaceae	*Alophyllus edulis* (A.St.-Hil., Cambess. & A. Juss.) Radlk.	P	6	14	20	13	706	90.0
	Cupania vernalis Camb.	NP	98	69	167	37	3548	32.3
	Matayba guianensis Aubl.*	NP	25	16	41	28	825	31.7
Solanaceae	*Solanum argenteum* Dunal*	NP	1	0	1	1	1	100.0
Styracaceae	*Styrax acuminatus* Pohl.*	NP	2	0	2	2	2	0.0
Vochysiaceae	*Vochysia tucanorum* Mart.*	P	1	0	1	1	1	0.0

EG: Ecological group (NC: non-characterized, NP: non-pioneer, P: pioneer), N1: number of individuals sampled in July; N2: number of individuals sampled in December; TN: total number of individuals sampled; P: number of parcels in which the species was sampled; AD: absolute density (number of individuals. ha^{-1}), S(%): survival rate in seedbeds.* species not found in the 30 main seedbeds of native species from the state of São Paulo, Brazil (Barbosa et al., 2003).

Table 2. Summary of the structure and diversity general parameters of the community of seedlings in both study areas

Parameters	Area 1			Area 2	
	July (winter)	December (summer)	Total	Forest Remnant	Eucalyptus Plantings
Number of individuals	774	758	1532	6134	280
Density[1] (N of ind.ha^{-1})	38700 (±12394)	37900 (±7945)	-	191688 (± 85536)	8046 (± 2295)
Number of species	48	43	63	118	42
Number of families	27	19	28	41	24
Number of exclusive species	20	17	28[2]	-	-

[1] Estimation with the respective values of the confidence interval between parentheses (α = 0.05).
[2] Number of species common to both seasons.

Table 3. Species sampled in the community of shrub and tree seedlings and young individuals of eucalyptus understory (Area 2) and their respective survival rates when transferred into the seedbed, Bofete, São Paulo, Brazil.

Family	Specie	EG	N	NP	AD	S(%)
Anacardiaceae	*Tapirira guianensis* Aubl.	P	2	2	57	100.0
Annonaceae	*Xylopia brasiliensis* Spreng.*	P	1	1	29	-
Apocynaceae	*Tabernaemontana hystrix* Steud.	P	47	19	1351	89.4
Arecaceae	*Euterpe edulis* Mart.	NP	1	1	29	100.0
Asteraceae	*Vernonia* sp	P	1	1	29	100.0
Celastraceae	*Maytenus salicifolia* Reissek*	NP	3	3	86	66.7
Clusiaceae	*Calophyllum brasiliense* Cambess.	NC	4	3	115	25.0
Combretaceae	*Terminalia triflora* (Griseb.) Lillo	P	1	1	29	100.0
Euphorbiaceae	*Actinostemon communis* (Müll. Arg.) Pax*	NP	4	1	115	100.0
	Alchornea triplinervia (Spreng.) Müll. Arg.	P	2	2	57	100.0
	Croton floribundus Spreng.	P	9	5	259	100.0
	Maprounea guianensis Aubl.*	P	4	3	115	75.0
	Pera glabrata (Schott) Poepp. ex Baill.	NP	7	7	201	85.7
Fab.-caesalpinoideae	*Copaifera langsdorffii* Desf.	NP	1	1	29	100.0
	Senna pendula (Humb. & Bonpl. ex Willd.) H.S. Irwin & Barneby	P	1	1	29	100.0
Fab.-mimosoideae	*Inga vera* Willd.	P	1	1	29	-
	Piptadenia gonoacantha (Mart.) J.F. Macbr.	P	2	2	57	50.0
Fab.-papilionoideae	*Andira fraxinifolia* Benth.	P	2	2	57	50.0
	Machaerium nyctitans (Vell.) Benth.	P	1	1	29	-
Lauraceae	*Ocotea velutina* (Nees) Rohwer	NC	10	5	287	80.0
Melastomataceae	*Tibouchina sellowiana* Cogn.*	NC	1	1	29	100.0
Meliaceae	*Trichilia catigua* A. Juss.*	NP	1	1	29	100.0
	Trichilia pallida Sw.*	P	5	2	144	100.0
Myrsinaceae	*Rapanea* cf. *umbellata* (Mart.) Mez	P	5	4	144	60.0
	Rapanea ferruginea (Ruiz & Pav.) Mez	P	1	1	29	100.0
Myrtaceae	*Eugenia ligustrina* (Sw.) Willd.*	NP	1	1	29	100.0
	Eugenia pluriflora DC.*	NP	1	1	29	100.0
	Myrcia fallax (Rich.) DC.	P	10	7	287	80.0
	Myrcia guianensis (Aubl.) DC.*	NP	3	3	86	100.0

Table 3. Species sampled in the community of shrub and tree seedlings and young individuals of eucalyptus understory (Area 2) and their respective survival rates when transferred into the seedbed, Bofete, São Paulo, Brazil (Continued)

Family	Specie	EG	N	NP	AD	S(%)
	Siphoneugenia aff. *widgreniana* O. Berg.	NP	1	1	29	100.0
Rosaceae	*Prunus myrtifolia* (L.) Urb.	P	11	1	316	81.8
Rubiaceae	*Palicourea marcgravii* A.St.-Hil.*	NC	55	16	1580	30.9
	Psychotria vellosiana Benth.*	NP	19	13	546	21.1
Rutaceae	*Esenbeckia febrifuga* (A.St.-Hil.) A. Juss. ex Mart.*	NP	1	1	29	100.0
Salicaceae	*Casearia sylvestris* Sw.	P	3	3	86	100.0
Sapindaceae	*Cupania tenuivalvis* Radlk.*	NP	12	9	345	58.3
	Matayba elaeagnoides Radlk.	P	4	3	115	50.0
Siparunaceae	*Siparuna guianensis* Aubl.*	NP	34	14	977	79.4
Solanaceae	*Cestrum* cf. *sendtnerianum* Mart.	P	5	2	144	100.0
Not-identified	Indet E01	NC	1	1	29	-
	Indet E02	NC	1	1	29	100.0
	Indet E03	NC	1	1	29	-

Legend: EG: Ecological group (NC: non-characterized, NP: non-pioneer, P: pioneer), N: number of individuals; NP: number of parcels in which the species was sampled; AD: absolute density (number of individuals. ha^{-1}), S(%): survival rate in seedbeds.* species not found in the 30 main seedbeds of native species from the state of São Paulo, Brazil (Barbosa et al., 2003).

Table 4. Species sampled in the community of shrub and tree seedlings and young individuals of forest remnants (Area 2) and their respective survival rates when transferred into the seedbed, Bofete, São Paulo, Brazil

Family	Specie	EG	Community			Seedbeds	
			N	NP	AD	N	S(%)
Anacardiaceae	*Astronium graveolens* Jacq.	P	1	1	31.2	-	-
	Tapirira guianensis Aubl.	P	77	16	2406.3	50	82.0
Annonaceae	*Guatteria nigrescens* Mart.*	NP	2	1	62.5	3	100.0
Apocynaceae	*Aspidosperma subincanum* Mart.*	NP	2	2	62.5	2	100.0
	Tabernaemontana hystrix Steud.	NC	1	1	31.2	57	86.0
Arecaceae	*Euterpe edulis* Mart.	P	19	5	593.8	17	58.8
	Geonoma brevispatha Barb. Rodr.*	NP	8	3	250.0	4	75.0
	Syagrus romanzoffiana (Cham.) Glassman	NP	5	2	156.3	20	90.0
Asteraceae	*Gochnatia polymorpha* (Less.) Cabrera	NC	19	7	593.8	4	100.0
Boraginaceae	*Cordia sellowiana* Cham.	P	5	3	156.3	5	100.0
Burseraceae	*Protium spruceanum* (Benth.) Engl.*	P	3482	12	108812.5	898	58.4
Celastraceae	*Maytenus aquifolia* Mart.*	NP	2	1	62.5	1	100.0
	Maytenus salicifolia Reissek*	NP	238	12	7437.5	142	64.1
Chloranthaceae	*Hedyosmum brasiliense* Miq.*	NC	6	2	187.5	-	-
Clusiaceae	*Calophyllum brasiliense* Cambess.	NC	17	5	531.3	6	33.3
Combretaceae	*Terminalia triflora* (Griseb.) Lillo	NC	69	14	2156.3	25	44.0
Ebenaceae	*Diospyros inconstans* Jacq.	NC	2	2	62.5	1	100.0
Elaeocarpaceae	*Sloanea monosperma* Vell.*	NP	15	6	468.7	1	100.0
Erythroxlaceae	*Erythroxylum cuneifolium* (Mart.) O.E. Schulz*	NP	7	2	218.7	5	100.0
Euphorbiaceae	*Actinostemon communis* (Müll. Arg.) Pax*	NP	33	7	1031.3	14	100.0

Table 4. Species sampled in the community of shrub and tree seedlings and young individuals of forest remnants (Area 2) and their respective survival rates when transferred into the seedbed, Bofete, São Paulo, Brazil (Continued)

Family	Specie	EG	Community			Seedbeds	
			N	NP	AD	N	S(%)
	Alchornea triplinervia (Spreng.) Müll. Arg.	P	6	4	187.5	4	50.0
	Croton floribundus Spreng.	P	132	7	4125.0	55	90.9
	Maprounea guianensis Aubl.*	P	13	3	406.2	6	50.0
	Pera glabrata (Schott) Poepp. ex Baill.	NP	17	8	531.3	9	88.9
	Sebastiania commersoniana (Baill.) L.B. & Downs	NC	10	4	312.5	12	91.7
Fab.-caesalpinioideae	*Copaifera langsdorffii* Desf.	NP	41	13	1281.3	23	21.7
Fab.-cercidae	*Bauhinia longifolia* D. Dietr.	NC	10	2	312.5	10	80.0
Fab.-mimosoideae	*Albizia polycephala* (Benth.) Killip ex Record	NC	1	1	31.2	1	100.0
	Calliandra tweediei Benth.	P	2	1	62.5	1	100.0
	Inga marginata Willd.	P	1	1	31.2	1	0.0
	Inga vera Willd.	P	53	12	1656.2	29	82.8
	Piptadenia gonoacantha (Mart.) J.F. Macbr.	NP	9	3	281.3	5	60.0
Fab.-papilionoideae	*Andira fraxinifolia* Benth.	P	9	3	281.3	3	33.3
	Centrolobium tomentosum Guillemin ex Benth.	P	13	3	406.2	9	88.9
	Dalbergia frutescens (Vell.) Britton*	NC	75	7	2343.8	64	95.3
	Lonchocarpus cultratus (Vell.) AMG. Azevedo & HC. Lima	P	4	2	125.0	4	75.0
	Machaerium aculeatum Raddi	P	27	5	843.7	15	100.0
	Machaerium brasiliense Vogel	P	7	4	218.7	6	100.0
	Machaerium stipitatum (DC.) vogel	P	7	3	218.7	7	100.0
Lacistemaceae	*Lacistema hasslerianum* Chodat	NP	11	5	343.7	10	100.0
Lauraceae	*Aniba firmula* (Nees & C. Mart.) Mez*	NP	3	2	93.7	-	-
	Endlicheria paniculata (Spreng.) J.F. Macbr.*	NP	9	4	281.3	1	100.0
	Nectandra cf. *grandiflora* Nees & C. Mart. ex Nees	NC	23	9	718.7	22	77.3
	Nectandra oppositifolia Nees & Mart.	NP	1	1	31.2	-	-
	Ocotea cf. *velutina* (Nees) Rohwer	NP	22	9	687.5	19	78.9
	Ocotea corymbosa (Meisn.) Mez*	P	16	7	500.0	2	100.0
	Persea pyrifolia (D. Don) Spreng.	NP	1	1	31.2	1	100.0
Lythraceae	*Lafoensia pacari* A.St.-Hil.	P	1	1	31.2	1	100.0
Melastomataceae	*Leandra scabra* DC.*	NC	7	1	250.0	7	57.1
	Leandra sp.	NC	1	1	31.2	1	100.0
	Miconia ligustroides (DC.) Naudin*	P	1	1	31.2	7	57.1
	Ossaea sp.	NC	1	1	31.2	-	-
	Tibouchina sellowiana Cogn.*	NC	7	4	218.7	4	100.0
Meliaceae	*Cedrela fissilis* Vell.	NP	5	3	156.3	3	66.7
	Trichilia catigua A. Juss.*	NP	14	4	437.5	8	87.5

Table 4. Species sampled in the community of shrub and tree seedlings and young individuals of forest remnants (Area 2) and their respective survival rates when transferred into the seedbed, Bofete, São Paulo, Brazil (Continued)

Family	Specie	EG	Community			Seedbeds	
			N	NP	AD	N	S(%)
	Trichilia elegans A. Juss.*	NP	3	3	93.7	3	100.0
	Trichilia pallida Sw.*	P	47	15	1468.7	37	83.8
Monimiaceae	*Mollinedia schottiana* (Spreng.) Perkins*	NP	7	2	218.7	3	100.0
Myrsinaceae	*Rapanea* cf. *umbellata* (Mart.) Mez	P	79	18	2468.8	49	77.6
	Rapanea ferruginea (Ruiz & Pav.) Mez	P	30	10	937.5	15	80.0
Myrtaceae	*Campomanesia* cf. *xanthocarpa* O. Berg.	NP	5	4	156.3	4	100.0
	Eugenia cf. hyemalis Cambess.	NP	1	1	31.2	1	100.0
	Eugenia florida DC.	NP	1	1	31.2	1	100.0
	Eugenia ligustrina (Sw.) Willd.*	NP	212	2	6625.0	71	97.2
	Eugenia pluriflora DC.*	NP	20	3	625.0	19	94.7
	Gomidesia affinis (Cambess.) D. Legrand	NP	37	8	1156.3	26	80.8
	Myrcia breviramis (O. Berg.) D. Legrand.*	NP	5	3	156.3	-	-
	Myrcia cf. *hartwegiana* (O. Berg.) Kiaersk.	NP	5	2	156.3	5	80.0
	Myrcia fallax (Rich.) DC.	P	90	14	2812.5	66	93.9
	Myrcia guianensis (Aubl.) DC.*	NP	37	11	1156.3	17	94.1
	Myrcia multiflora (Lam.) DC.	NP	25	4	781.2	17	100.0
	Myrciaria cf. *tenella* (DC.) O. Berg.	NP	20	5	625.0	9	88.9
	Myrciaria floribunda (H. West ex Willd.) O. Berg*	NP	9	6	281.3	7	42.9
	Myrtaceae sp1	NC	1	1	31.2	-	-
	Myrtaceae sp2	NC	1	1	31.2	-	-
	Myrtaceae sp3	NC	1	1	31.2	-	-
	Myrtaceae sp4	NC	1	1	31.2	-	-
	Myrtaceae sp7	NC	3	1	93.7	-	-
	Myrtaceae sp8	NC	8	3	250.0	4	50.0
	Myrtaceae sp9	NC	1	1	31.2	1	100.0
	Siphoneugenia aff. *widgreniana* O. Berg.	NP	17	9	531.3	11	90.9
Nyctaginaceae	*Guapira hirsuta* (Choisy) Lundell	P	26	9	812.5	19	100.0
Piperaceae	*Ottonia* cf. *leptostachya* Kunth	NP	18	1	562.5	-	-
	Piper arboreum Aubl.*	NP	2	1	62.5	-	-
	Piper gaudichaudianum Kunth.*	NC	5	2	156.3	3	100.0
Polygonaceae	*Coccoloba cordata* Cham.*	NC	4	2	125.0	3	66.7
Proteaceae	*Roupala brasiliensis* Klotzsch	NP	43	5	1343.7	39	61.5
Rosaceae	*Prunus myrtifolia* (L.) Urb.	NP	15	6	468.7	7	100.0
Rubiaceae	*Amaioua intermedia* Mart.	NP	4	2	125.0	3	66.7
	Chomelia obtusa Cham. & Schltdl.*	NP	5	3	156.3	5	100.0
	Faramea montevidensis (Cham. & Schltdl.) DC.*	NP	28	3	875.0	11	27.3
	Ixora venulosa Benth.*	NP	4	2	125.0	-	-
	Palicourea marcgravii A.St.-Hil.*	NC	197	15	6156.2	86	37.2
	Posoqueria sp.	NC	2	1	62.5	-	-
	Psychotria cf. *carthagenensis* Jacq.	NP	1	1	31.2	1	100.0
	Psychotria leiocarpa Cham. & Schltdl.*	NP	3	2	93.7	3	100.0
	Psychotria sp.	NC	5	4	156.3	5	60.0

Table 4. Species sampled in the community of shrub and tree seedlings and young individuals of forest remnants (Area 2) and their respective survival rates when transferred into the seedbed, Bofete, São Paulo, Brazil (Continued)

Family	Specie	EG	Community			Seedbeds	
			N	NP	AD	N	S(%)
	Psychotria vellosiana Benth.*	NP	63	13	1968.7	53	64.2
	Randia armata (Sw.) DC.*	NC	2	1	62.5	-	-
	Rubiaceae sp1	NC	5	1	156.3	5	100.0
Rutaceae	*Balfourodendron riedelianum* (Engl.) Engl.	NP	3	1	93.7	3	100.0
	Esenbeckia febrifuga (A.St.-Hil.) A. Juss. ex Mart.*	NP	49	5	1531.2	23	100.0
	Esenbeckia grandiflora Mart.	NP	6	2	187.5	5	100.0
	Pilocarpus pauciflorus A. St.-Hil.*	P	2	1	62.5	-	-
	Zanthoxylum rhoifolium Lam.	P	13	2	406.2	10	60.0
Salicaceae	*Casearia decandra* Jacq.*	NP	9	6	281.3	7	100.0
	Casearia sylvestris Sw.	P	2	2	62.5	1	100.0
Sapindaceae	*Allophylus edulis* (A.St.-Hil.. Cambess. & A. Juss.) Radlk.	P	8	4	250.0	3	100.0
	Cupania tenuivalvis Radlk.*	NP	63	13	1968.7	30	56.7
	Matayba elaeagnoides Radlk.	P	99	15	3093.7	48	68.8
Sapotaceae	*Pouteria* sp.	NC	2	1	62.5	-	-
Siparunaceae	*Siparuna cujabana* (Mart.) A. DC.*	NP	1	1	31.2	1	100.0
	Siparuna guianensis Aubl.*	NP	40	2	1250.0	12	75.0
Solanaceae	*Cestrum* cf. *sendtnerianum* Mart.	P	7	4	218.7	5	100.0
	Cestrum schlechtendalii G. Don.*	NC	4	1	125.0	4	100.0
Styxraceae	*Styrax pohli* A. DC.	NC	1	1	31.2	5	80.0
Symplocaceae	*Symplocos tenuifolia* Brand*	P	30	9	937.5	1	100.0
Violaceae	*Hybanthus atropurpureus* (A.St.-Hil.) Taub*	NP	1	1	31.2	-	-
Vochysiaceae	*Vochysia tucanorum* Mart.*	P	8	3	250.0	5	20.0
Not-identified		NC	120	19	3750.0	-	-
	Indet sp1	NC				1	100.0
	Indet sp2	NC				4	75.0
	Indet sp3	NC				1	100.0
	Indet sp4	NC				1	100.0
	Indet sp5	NC				1	100.0
	Indet sp6	NC				2	100.0
	Indet sp7	NC				1	100.0
	Indet sp8	NC				1	100.0
	Indet sp9	NC				2	0.0
	Indet sp10	NC				6	50.0
	Dead before identified	NC				27	0.0

EG: Ecological group (NC: non-characterized, NP: non-pioneer, P: pioneer), N: number of individuals; NP: number of parcels in which the species was sampled; AD: absolute density (number of individuals. ha^{-1}), S(%): survival rate in seedbeds.* species not found in the 30 main seedbeds of native species from the state of São Paulo, Brazil (Barbosa et al., 2003).

Survival Rate of Seedlings and Young Individuals in Seedbeds

The general survival rates in seedbeds for both Areas under study (Ribeirão Grande and Bofete) obtained at different seasons and sampling environments were high, except for winter for Area 1, being always above 50% (Table 5). In Area 1, the survival rate in seedbed of individuals transplanted in July (winter) was significantly lower ($\chi^2 = 117$; $p < 0.0001$) in relation to survival rate of individuals transferred in December (summer). Probably, low temperatures and the occurrence of frosts were the responsible for the lower survival rates observed in the winter. Thus, the survival success in seedbed of individuals transplanted from the forest regeneration seems to be associated to the climatic conditions of the season in which the transplantation was performed.

Table 5. Survival rate in seedbed of the different sets of seedlings analyzed

Area	Set of seedlings and young individuals	Class I		Class II		Class III		Total	
		N	S(%)	N	S(%)	N	S(%)	N	S(%)
1	July (winter)	590	44.1 [a]	146	40.4 [a]	38	28.9 [a]	774	42.6
	December (summer)	506	70.9 [a]	206	69.9 [a]	46	63.0 [a]	758	70.2
	Total	1.096	56.5 [a]	352	57.7 [a]	84	47.6 [a]	1.532	56.3
2	Eucalyptus plantings	82	47.6 [b]	128	69.5 [a]	70	84.3 [a]	280	66.8
	Forest remnant	1.275	66.6 [b]	867	73.7 [a]	282	66.3 [b]	2.424	69.0
	Forest remnant (*Protium spruceanum* not included)	547	76.1 [a]	720	78.5 [a]	259	65.6 [b]	1.526	75.4
	Protium spruceanum	728	59.5 [a]	147	50.3 [a]	23	73.9 [a]	898	58.4
	Pioneers (Forest remnant)	179	82.7 [a]	287	86.0 [a]	86	76.7 [a]	552	83.5
	Non-Pioneers (Forest remnant)	205	82.4 [a]	325	78.8 [a]	144	61.1 [b]	674	76.1
	Pioneers (Eucalyptus planting)	24	79.1 [a]	56	83.9 [a]	38	86.8 [a]	118	83.9
	Non-Pioneers (Eucalyptus plantings)	22	54.6 [a]	42	61.9 [a]	25	88.0 [a]	89	67.4

Different letters in column represent significant differences in the survival rate between height classes (Chi-Squared test, $\alpha = 0.05$).

N: number of individuals, S(%): survival rate, class I: up to 20 cm for Area 1 and up to 10 cm for the other areas, class II: from 21 to 40 cm for Area 1 and from 11 to 20 cm for the other areas, class III: from 41 to 60 cm for Area 1 and from 21 to 30 cm for the other areas

For seedlings and young individuals from eucalyptus areas, from the total of species (42), five presented mortality rate of 100%. However, all these five species were represented in the seedbed by only one individual. Otherwise, 21 species reached 100% of survival ate, however, the number of individuals in the seedbed was also low, and only one species was represented by more than five individuals (Table 3). Thus, due to the low number of individuals for many species, these data should be carefully interpreted.

Still for seedlings and young individuals from eucalyptus areas, only eight species presented at least 10 transplanted individuals. From these, five presented survival rates above 75% (*Myrcia fallax*, *Ocotea velutina*, *Prunus myrtifolia*, *Siparuna guianensis* and *Tabernaemontana catharinensis*), one presented survival rate ranging from 50 to 75%

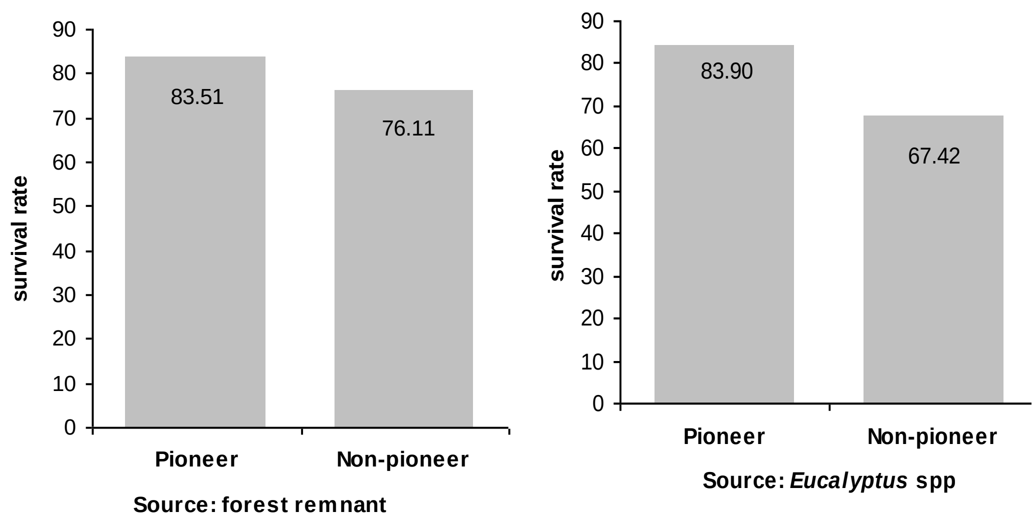
(*Cupania tenuivalvis*) and two species presented survival rates below 50% (*Palicourea marcgravii*, *Psychotria vellosiana*) (Table 3).

From parcels of the forest remnants of Area 2, 2424 regenerating individuals belonging to 110 shrub and tree species were transplanted to the seedbed. The general survival rate reached was of 69.0% (1675 individuals belonging to 107 species); however, when *Protium spruceanum* is not considered in this analysis, the survival rate increases up to 75.4%.

Out of the total species originated from the forest remnant, 52 presented 100% of survival rate in seedbed, however, 36 of them presented less than five individuals transplanted and, therefore, the results corresponding to the survival rate in seedbed must be carefully seen. Dissimilarly, only two species, *Inga marginata* (one individual) and Indet sp9 (two individuals) presented mortality rate of 100%. It is worth mentioning, however, that from the total of individuals transferred from the forest remnant to the seedbed, 27 died before being identified.

Still for plants originated from the forest remnant of Area2, from the 22 species with at least 20 individuals transferred into the seedbed, 13 (*Eugenia ligustrina*, *Myrcia fallax*, *Dalbergia frutescens*, *Tabernaemontana catharinensis*, *Croton floribundus*, *Tapirira guianensis*, *Rapanea* cf. *umbellata*, *Trichilia pallida*, *Inga vera*, *Gomidesia affinis*, *Esenbeckia febrifuga*, *Nectandra* cf. *grandiflora* and *Syagrus romanzoffiana*) presented survival rates above 75%, and among these, only *Esenbeckia febrifuga* presented survival rate of 100%. For five species (*Protium spruceanum*, *Maytenus salicifolia*, *Psychotria velloziana*, *Matayba elaeagnoides* and *Roupala brasiliensis*), the survival rate ranged from 50 to 75% and only three species (*Palicourea marcgravii*, *Securidaca* sp. and *Copaifera langsdorffii*) presented survival rates below 50% (Table 4).

In relation to individuals originated from Area 2, both in eucalyptus areas and in forest remnants, the survival rates were significantly higher when compared to pioneer species (Figure 5).



(A) (B)

Figure 5. Survival rate in seedbed in the different ecological groups of individuals obtained from two sampling environments of Area 2, Bofete, São Paulo. (A) χ^2=9.73; p=0.0018; (B) χ^2=6.84; p=0.0089.

Non-pioneer seedlings germinate and remain under the forest canopy in shady places, where luminosity is reduced, air humidity is high and temperature is mild (Swaine and Whitmore, 1988; Whitmore, 1989), reason why they undergo higher impact when transferred to the seedbed under the sunlight or with a certain degree of shading, especially because they cannot stand increases on solar radiation, temperature and humidity.

However, there are several exceptions of non-pioneer species in this work presenting high survival rate levels when transferred to the seedbed such as *Actinostemon communis*, *Esenbeckia febrifuga*, *Lacistema hasslerianum* and many others from the family Myrtaceae, so that such impacts in the transplantation do not represent hindrances in the production of non-pioneer species seedlings by means of the transference of the natural regeneration to the seedbed.

In Area 1, no significant differences in the survival rate in seedbed for the different height classes were found, both in the two sampling seasons and in the total values. For propagules originated from the eucalyptus understory, the best survival rates occurred for individuals with 11-20 cm and 21-30 cm of height, and for plants originated from the forest remnant understory, the best survival rates occurred for individuals with 11-20 cm of height (Table 5).

Still considering individuals from the forest remnant of Area 2, one observes that when species *Protium spruceanum* is removed from the analysis, the survival rate of plants become significantly higher in classes I (up to 10 cm) and II (11-20 cm) and when *Protium spruceanum* is individually analyzed, no significant differences between the proportion of survivor and dead individuals in the seedbed and between the three height classes were verified (Table 5).

The responses from species in relation to the survival rate of each height class were variable. Comparisons and extrapolations of the general survival rate results here obtained should not be applied for other areas and communities, once these variables are strongly influenced by the environmental conditions at the moment and after transference of plants and by the floristic and structural composition of the community. The results obtained exemplify the situation reported above. When *Protium spruceanum* is removed from the analysis, the set of plants obtained from the forest remnant no longer presents height class of 11-20 cm as the one presenting the highest survival rate, but the first two classes (up to 10 cm and from 11 to 20 cm) as the best for transplantation purposes.

However, when the objective is no longer the transplantation of the shrub and tree community but the transplantation of pre-established species, the survival rate results of each class must be considered in the definition of the best transplantation height. However, besides the class presenting the best transplantation height, one should observe the fact that, except for a few exceptions, shrub and tree tropical species present a number considerably higher of individuals at the initial phases of life, with decrease observed as plants grow older (Fenner 1987), also observed in classes of individuals with lower heights.

For example, *Protium spruceanum*, species with higher number of individuals in relation to the other species, presented the best survival rates for the class on individuals with height of 21-30 cm; however, although these differences were not significant, it was observed that the number of individuals within this class was far lower when compared to the other classes, so that even under lower survival rates, at the end of the evaluations, the number of survivor individuals in classes of up to 10 cm and 11-20 cm was higher than that presented by class of 21-30 cm of height. Therefore, smaller individuals would be found more easily and with more density, so that, even presenting lower survival rates, their transference would be more suitable.

Still in relation to the size of the transplanted individuals, although no significant differences were found between the survival rates in the different height classes for Area 1, the low density of plants in class III (41-60cm) in addition to the practical verification that the removal and transportation of individuals of this size require great effort make the transference of plants, except for special cases, to be recommended for lower sized individuals.

Thus, the differences in the survival rate in the transference of seedlings and young individuals to the seedbed may be explained by many factors such as the season in which the transference is performed, height of transferred individuals and mainly the floristic composition and number of individuals of each species in the set of transplanted individuals.

Use Potential of the Community of Seedlings and Aloctone Young Individuals in the Ecological Restoration

Considering values below the confidence interval, the number of plants found in the 320 m^2 of sampling area of the forest remnant of Area 2 (Bofete) would be sufficient to perform a restoration planting of a two-hectare area, considering the spacing commonly used in restoration projects in Brazil, generally 2x3m. If averages were used instead of values below the confidence interval, this value would probably be twice as high. Still considering the forest remnant of Area 2, the total number of sampled species (119) certainly fulfills the minimum floristic and functional diversity requirements of the restoration plantings, being far above values commonly used in the region (Barbosa et al., 2003; Souza and Batista, 2004).

For the other areas such as Area 1 (Ribeirão Grande) and eucalyptus stands of Area 2 (Bofete), the richness and density values remain above those found by Barbosa et al. (2003) in restoration plantings in the region; however, the total number of species sampled (63 and 42, respectively) is possibly below the number required in terms of floristic and functional diversity aimed at the perpetuation of the restores area. Thus, seedlings exclusively produced through the use of plants from this area would not be sufficient for the performance of ecological restoration projects based on high floristic and functional diversity. However, the adoption of this methodology would be an interesting complementary strategy to produce seedlings, especially when aimed at uncommon species in forest seedlings production seedbeds and hence in restoration plantings of degraded areas, or even as strategy for the enrichment of degraded forest fragments, low-diversity restoration plantings or natural regeneration areas, which usually present low vegetal diversity (Figure 6).

The use of populations of some species, especially those that, for some reason, cannot be produced through conventional methods or those with supra-annual seed production with high density of individuals in some seasons instead of the use of the community of seedlings and young individuals as a whole is perfectly justifiable. The results obtained for *Protium spruceanum*, which is not found in the main seedbeds of the state of São Paulo, Brazil (Barbosa et al., 2003), but sampled in the community of plants from the remnants of Area 2 (Bofete) with density extremely high are the most classic example.

The great spatial heterogeneity of the regeneration and not only of individuals and the main species demonstrates that the high richness and diversity values are conditioned to a wide and disperse sampling throughout the area. In practical terms, this indicates that the better distributed and the higher is the area at the moment the field individuals are collected, the higher the number of species obtained will be. However, it is important stressing that this recommendation should take into consideration the size of the remaining forest fragments. Thus, the collection of seedlings and young individuals is recommended in short distances of large remaining forest areas, and the collection in long distances of small forest areas is restricted.

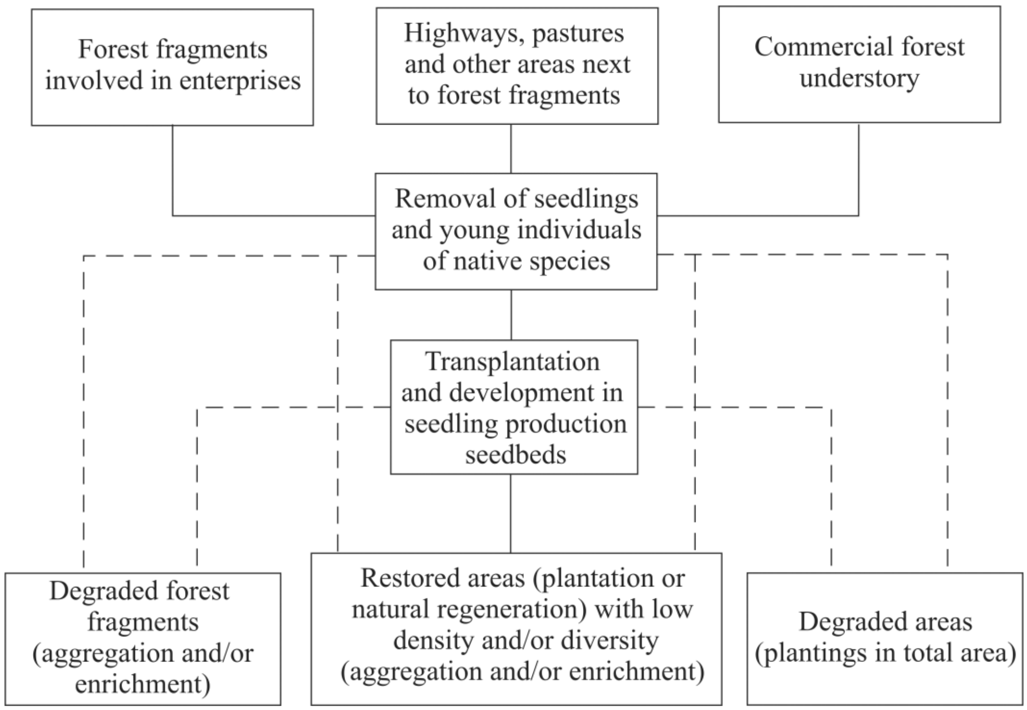


Figure 6. Organization chart demonstrating the possibilities of obtaining and using seedlings and young individuals in the restoration of ecosystems.

It is also worth stressing that considering the recruitment seasonality, the floristic richness of the regenerating individuals community (seedlings and young individuals) is higher when the community is transplanted to the seedbed in more than one season. Even in seasons in which plants present lower survival rate in the seedbed (in the case of this study, winter), the transplantation is interesting, once many species are only found in the community of seedlings and young individuals in some seasons (Lieberman, 1996; Santos and Válio, 2002).

At the end of the evaluations in seedbeds, seedlings of 56 shrub and tree species were found in Area 1 (Ribeirão Grande), 40 obtained in July and 39 in December and 113 species in Area 2 (Bofete), 107 from the forest remnant and 37 from eucalyptus stands and although the best survival rate results in seedbed had been reached with pioneer species which are species with more availability in seedbeds and the most used in reforestation processes aimed at the ecological restoration (Barbosa et al., 2003), the majority of non-pioneer species also presented satisfactory survival rates.

The comparison of the results obtained in this work with the survey of the native seedlings production in the state of São Paulo (Barbosa et al., 2003) also reveals that many transplanted species are not even found in the 30 main seedbeds of the state. Considering only species that at the end of the evaluation period of this study presented at least 10 survivor individuals in the seedbed, the eucalyptus area contains two species not mentioned in the survey performed by Barbosa et al. (2003). By means of transplantation of the natural regeneration of forest remnants and also considering only species with at least 10 survivor individuals in the seedbed, it was possible producing seedlings of 12 shrub and tree species not found in seedbeds analyzed by Barbosa et al. (2003) in each area.

Thus, the verification that by means of the controlled removal of the natural regeneration, it is possible producing seedlings of a large number of species usually not found in forest seedbeds and certainly absent in the restoration plantings of degraded areas, evidences the potential of this technique in the recovery of the regional biodiversity, being passible of application and recommended for many situations in the restoration process of degraded ecosystems (Figure 6).

Many transplanted species of the native shrub and tree community are not found in seedbeds probably in function of the short-term availability, production seasonality, low quantity or difficulties found in the collection of seeds or even due to the lack of knowledge on their dormancy physiological mechanisms and on technologies employed in the germination of seed. In these cases, the transference of the regenerating individuals to the seedbed would be a simple and perfectly feasible alternative that would eliminate difficult and hard-to-perform stages, sometimes expensive and unknown for many species such as processing, storage and pre-germinative treatment of the seeds.

Therefore, one considers that the methodology employed for the production of seeds of native species is effective and applicable as complementary technique in relation to conventional ones, always aimed at the increase on the floristic and functional diversity of forest seedling production seedbeds and hence of ecological restoration plantings.

Final Considerations and Future Perspectives

The transference of seedlings and young individuals for the production of seedlings and later restoration of neighbor degraded areas belonging to the same vegetal formation as areas from where seedlings and young individuals were removed may contribute significantly for ecological restoration regional programs not only due to the possibility of using a high diversity of regional species, but also due to the use of populations genetically adapted to the local environmental conditions.

The community of seedlings and young individuals from the forest remnants studied presented high richness of species and density of individuals and are representative of species from the different forest succession ecological groups. Thus, the community of seedlings demonstrated great potential to be used as source of aloctone seedlings in ecological restoration projects aimed at the recovery of the vegetal diversity.

However, it is important emphasizing that the present study did not evaluate the impacts that the removal and transference of regenerating individuals into seedbeds may cause in the regeneration dynamics of the community and in the genetic structure of the regenerating populations. Therefore, further studies should be conducted in order to evaluate these impacts and to generate parameters to regulate this activity for it to be sustainable. Thus, for natural areas, in principle such methodology would be perfectly accepted only for areas irreversibly deforested with the authorization from environmental licensing agencies such as areas flooded for the generation of energy, construction and maintenance of highways, mining, etc., being in these cases, an important measurement to soften the impacts generated.

Although the diversity values are lower in relation to those of the forest remnants, the community of seedlings from forest plantings also presented potential to be used in forest restorations, especially when the methodology employed is aimed at species presenting high density in regeneration under plantings or at those uncommon in seedbeds and/or ecological restoration plantings. Moreover, in function of being agricultural production areas widely distributed through several regions of the world and frequently not protected by the environmental legislation, the transplantation of regenerating individuals in these environments becomes more and more interesting, once unlike natural areas, this procedure may be applied with no restriction in relation to impacts on the natural regeneration of the area.

Although the data presented are regional, the results obtained from evaluations of the community of seedlings and young individuals in other tropical formations (Hubbell, 1999; Oliveira et al., 2001; Benitez Malvido and Lemus-Albor, 2005) and the understory of monospecific forest plantings of other regions (Tabarelli et al., 1993; Silva Júnior et al., 1994; Durigan et al., 1997; Yirdaw and Luukkanen, 2003) have demonstrated to be similar in relation to the richness and density of native species so that this technique could be generally recommended as a native species seedling production technique and as source of aloctone propagules for ecological restorations, once recommendations for natural areas are followed.

However, it is worth mentioning that since this topic has not been widely applied to the restoration of ecosystems, new researches must be performed both in the forest studied and in other forest formations and areas with the objective of evaluating the potential of seedlings as source of propagules for the restoration process and the effects of the removal of seedlings on the natural regeneration of natural areas and to search for techniques that allow achieving higher survival rates in seedbeds or even the direct transference of seedlings and young individuals to areas to be restored. Experiments involving the transference of lianas, epiphytes and herbaceous species, forms of life also abundant and not less important for the dynamics of tropical forests (Gentry and Dodson 1987; Galeano et al., 1998) but not widely used in ecological restorations are also applicable and must be object of study in future researches.

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