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Comparison of Species Composition between Regeneration Plots Planted in 1995 and 1996 in the Rincón de la Vieja-Cacao Biological Corridor

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Abstract

The purpose of the Rincón-Cacao biological corridor is to connect the two isolated tropical forest regions of Volcán Rincón de la Vieja and Volcán Cacao. Our study compared the density of woody species and overall species richness in the 1995 island plots after twenty-four months of growth and in the ten hectare region after six months of growth. Using the data from David Morales' 1996 study, we were able to check the progress of the 1995 islands after six and twenty-four months.

We expected a decrease in the number of herbaceous species in the 1995 islands after twenty-four months of growth due to shading. Results showed, however, that the number of herbaceous species actually increased. We also anticipated an increase in both the number of bird and bat dispersed woody species and individuals in the 1995 islands after twenty-four months time. This hypothesis was not supported because the number of bird and bat dispersed woody individuals decreased and the number of species remained constant. Finally, we hypothesized that the density of woody species and overall species richness, with respect to dispersal method, would be different in the 1995 islands than in the 1996 ten hectare region when compared after six months of growth. We found that there was a much greater number of species at the 1996 ten hectare region. However, we were not able to make any conclusions on the density of woody species because of a lack of background data

Key Words: species richness, biological corridor, dispersal methods, restoration, forest regeneration, forest fragmentation, tropical dry forest

Introduction

We (a UC EAP field problem group) investigated the progress of the recently initiated forest restoration project of abandoned pastures located between the tropical forest regions of Volcán Rincón de la Vieja and Volcán Cacao. The project's main goal is to convert the abandoned pasture consisting of *Hyparrhenia rufa* (African Star Grass) into a corridor between these two tropical forest patches, which will hopefully allow for

increased biodiversity as more species will be able to survive in the larger area of continuous forest. In other words, the corridor project seeks to reverse some of the detrimental effects of forest fragmentation that has limited the number of species living in this tropical dry forest region. (Morales, 1996)

In 1995, David Morales and the Costa Rican Ministry of Environment and Energy conducted primary experiments in plots of 15m radius located in pasture to determine the most effective approach for the regeneration of the forest. Some islands were burned, others plowed, and others were both burned and plowed. A group from the University of California Education Abroad Program (UC EAP) the following year measured species composition in a sample of these islands. The results indicated that burning and plowing provided the most successful method out of those tested (Monahan, et al., 1996), which spurred the decision to apply this technique to a much larger region of ten hectares in 1996.

One year later (1997), we monitored the progress of both the 1996 ten hectare experimental region and the 1995 islands. Because canopy size should have increased since the plot was last measured in 1995, we anticipate a decrease in the number of herbaceous species due to shading. We also hypothesized an increase in the number of bird or bat dispersed trees in this same plot due to the presence of trees that can attract these animals. Furthermore, as a result of the difference in area between the treatments, we expected that there would be a difference in both the density of woody species and overall species richness in comparing last year's data on the 1995 islands and the data that we obtained this year for the 1996 ten hectare region.

Methods

We formed three groups to sample four plots in each of three of the 1995 islands and 12 plots in the 1996 ten hectare region. To uniformly sample the interior with plots, we used a pattern of four 2m x 2m plots (Fig. 1). Two plots were located across from each other, two meters in from the edge of the island to account for effects from the surrounding area. The other two plots were located within the two meters of the center of the plot (Fig. 1). Four areas equivalent to the size of the 1995 islands were randomly selected in the ten hectare region. These areas were taken along a 30m transect in the area, which was representative of the average vegetation, and divided into the same "cross" pattern as the 1995 islands.

We measured the height (measured from the base of the tree to the highest meristem) and diameter (taken 1.3 meters from the base of the tree) of each woody species. If a tree leans into a plot, its seeds may fall on the ground underneath. Therefore, trees were included in the plot if the majority of the tree was within the boundaries. Each group took one sample of every herbaceous species found in the plots for later identification to compare the difference between treatment results.

Results

Six months after the 1995 treatment was initiated 7 woody species and 11 herbaceous species were recorded (Monahan, et. al. 1996). We identified 10 woody species and 29 herbaceous species in the 1995 treatment plots. There were 13 woody species and 45 herbaceous species censused in the 1996 plot.

We classified each woody plant that we encountered in a treatment (Table 1) Using the Jaccard Similarity Index we compared the composition of trees between the 1995 island plots and the 1996 ten hectare region both after 6 months of growth, and between the 1995 island plots after six months of growth and the 1995 after twenty-four months of growth. (Jaccard's coefficient: $CC= C/ (S_1+S_2-C)$, where S represents the total number of species in all plots of a treatment and C the number of species in common between the two treatments. Species similarity is measured on a scale of zero to one with zero being no similarity between the treatments.) Using this indicator we found that between the 1995 treatments (at six and twenty-four months) CC = 0.42 and between the 1995 at six months and the 1996 at six months CC = 0.33.

The number of bird and bat dispersed woody species in the 1995 treatment was the same at six months and twenty-four months, but the number of individual woody plants was lower after twenty-four months of growth than after six months (Tables 1,2,3) There was a greater number of woody individuals dispersed by wind after twenty-four months of growth (Table 2). After twenty-four months there were fewer wind dispersed species than after six months of growth (Table 4). The results showed a high number of naturally dispersed species relative to the planted stakes in all of the treatments (Table 2).

When comparing the 1995 island treatment to the 1996 ten hectare region both after six months of growth, the number of species of woody plants dispersed by wind was greater in the islands, but the ten hectare region had more bird and bat dispersed species than in the islands (Table 5). The number of individual woody plants dispersed by wind was greater in the island plots than in the ten hectare region (Table 3). This was not the case for the number of individuals dispersed by birds and bats (Table 3). There were 25

woody wind dispersed individuals in the 1995 islands, and one individual wind dispersed plant in the 1996 ten hectare region. The number of bird and bat dispersed individuals in the 1995 islands after six months of growth was 34, and the number of bird and bat dispersed individuals in the 1996 ten hectare region was 19 (Table 3).

The number of large herbivore dispersed individuals was greatest in the 1995 island plots after twenty-four months of growth (Table 2).

Discussion

Because this project was designed as a management study (with only one island treatment and one ten hectare plot) rather than a scientific experiment, we lacked the replicates needed to obtain significant statistical results. A better design for future regeneration experiments would include replicates of each treatment and detailed regeneration data from the first year of treatment onward.

The increase in the number of both woody and herbaceous species found in the islands from 1995 to 1996 suggests that as succession occurs, the number and diversity of species increases (Table 1,6). This contradicts our hypothesis that herbaceous individuals will decrease over time. This could be due to a longer exposure time to wind and animal dispersed seeds. The high species richness of the ten hectare region just six months after treatment suggests better seed dispersal and less competition with grass in a ten hectare area than isolated islands. The 1995 treatments (at six and twenty-four months) may reflect a higher community similarity than the 1995 and 1996 treatments (each at six months) due to similar seed dispersion patterns and competition with grass within the islands and differences in area, soil, land contour, and distance from forest

The decrease in the number of bird and bat dispersed woody individuals in the 1995 treatment (from six to twenty-four months), and the constant species number, could be the result of intraspecific competition between larger individual trees (Table 2). This finding does not support our hypothesis that the number of species and individuals of bird and bat dispersed woody plants will increase over time. A more relevant variable could be biomass or percent canopy coverage.

Our hypothesis regarding community change with respect to dispersal method between treatment areas is not supported because the number of bird and bat dispersed species is not contingent upon treatment size. The high number of herbivore dispersed individuals in the 1995 island plots after twenty-four months of growth is due to an unusually large cluster of Guazuma trees found in a single plot (Table 2).

We encountered a number of problems when collecting our data. The first of which was the difficulty in obtaining samples of all the herbaceous species and keeping those samples in order. A second problem was that we only counted those woody individuals that were of 130 cm or higher when obtaining the density of woody species. On the other hand our reference data had included trees of all sizes (Morales, 1996). This causes a discrepancy in the contingency tests that we ran which included number of individuals in the 1995 islands after six months of growth.

For next year's group we advise increasing the size and number of plots to obtain better density and species richness counts, as well as permanently marking these plots to compare them over the years. We also recommend ignoring herbaceous and focusing on woody individuals, thus giving more accurate information regarding succession patterns and allowing for increased sampling area.

We can conclude that forest regeneration is very difficult to plan and manipulate artificially. The results strongly support that succession depends on natural dispersion (wind, birds, and bats), with planted trees having much lower success rates. Recommendations for next year's treatment include 1) reduce or eliminate the planting of seeds and stakes (they don't survive and the stakes are costly), 2)plant only the nursery tree species that survived, 3)transplant grown 2 meter trees pulled from the forest and treated with rooting hormone. The latter may act as nuclear trees that attract birds and mammals and encourage seed dispersal (Janzen, 1988).

Work Cited

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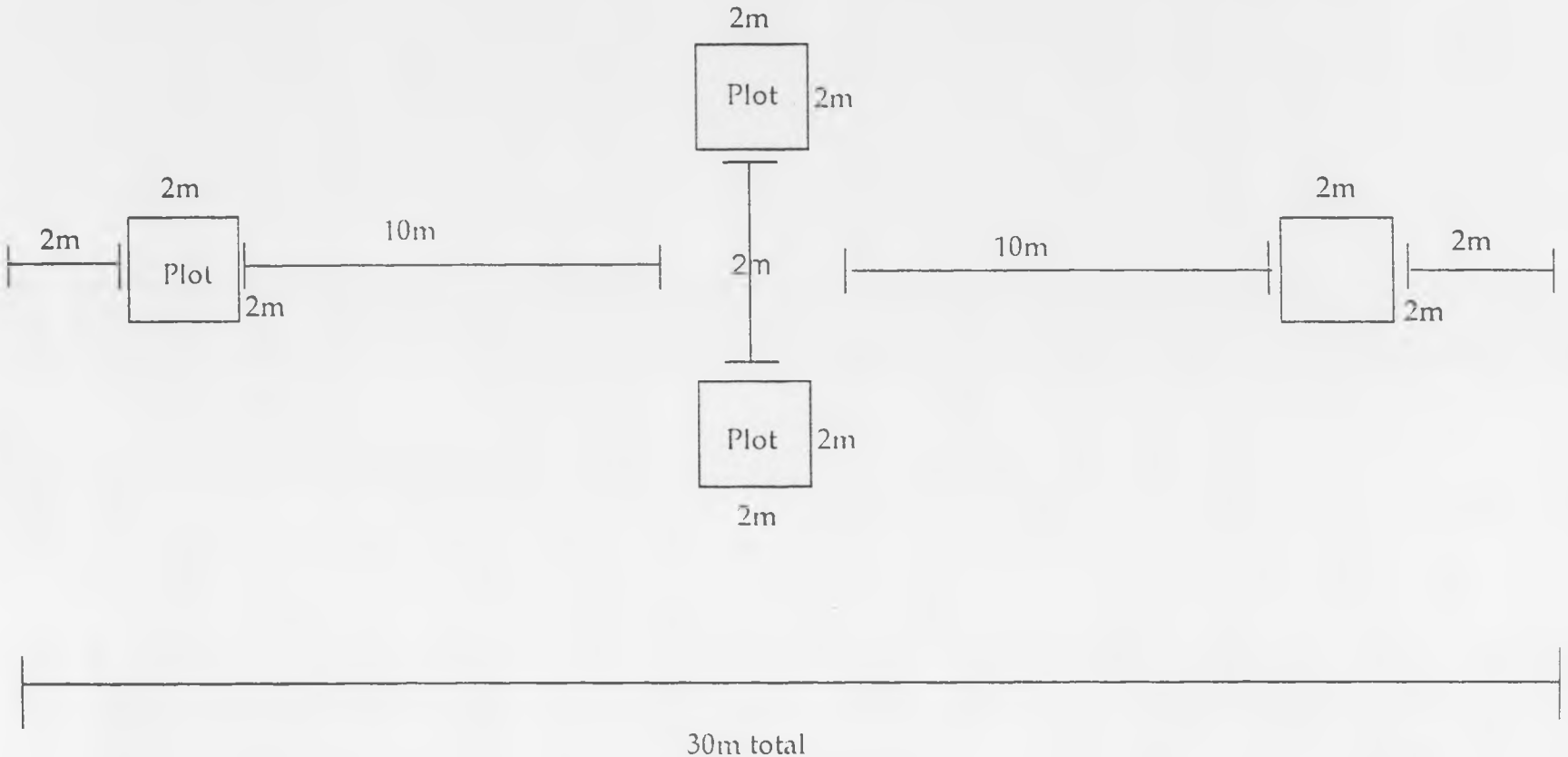
Figure 1*: Sampling design for 1997 in both the three 1995 islands and the 1996 10 hectare plot



*Drawing not to scale

Table 2. The number of individuals in woody plants for each dispersal method of the 1995 island treatment after six and twenty-four months. From the graph the most common dispersal methods were wind and bird/bat (b/b). (b/b=bird and bat, nurs=tree from nursery, prop=propagule, and seed=trees planted from seed.)

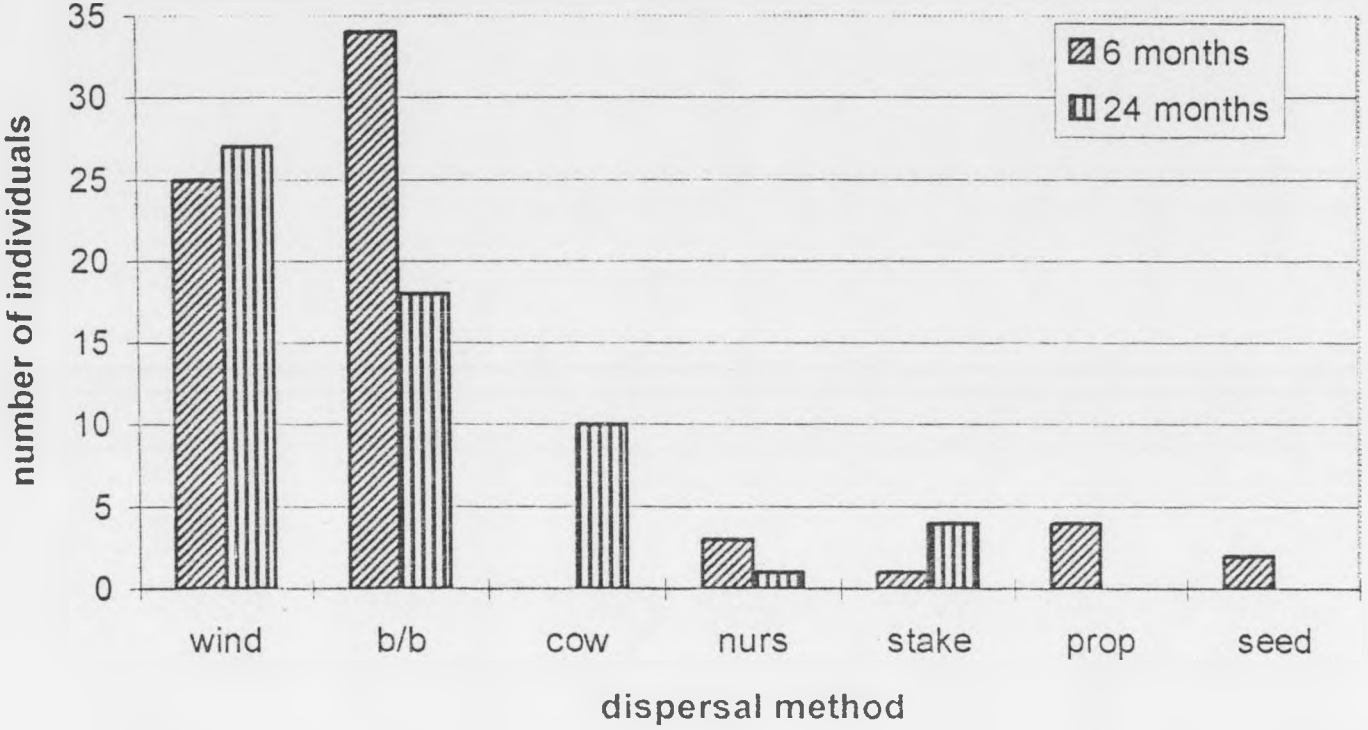


Table 3. The number of individuals in woody species versus the dispersal method for each of the two treatments, 1995 islands and 1996 10 hectare plot, after six months of growth. (b/b=bird and bat, nurs=tree from nursery, prop= propagule, and seed=trees planted from seed.)

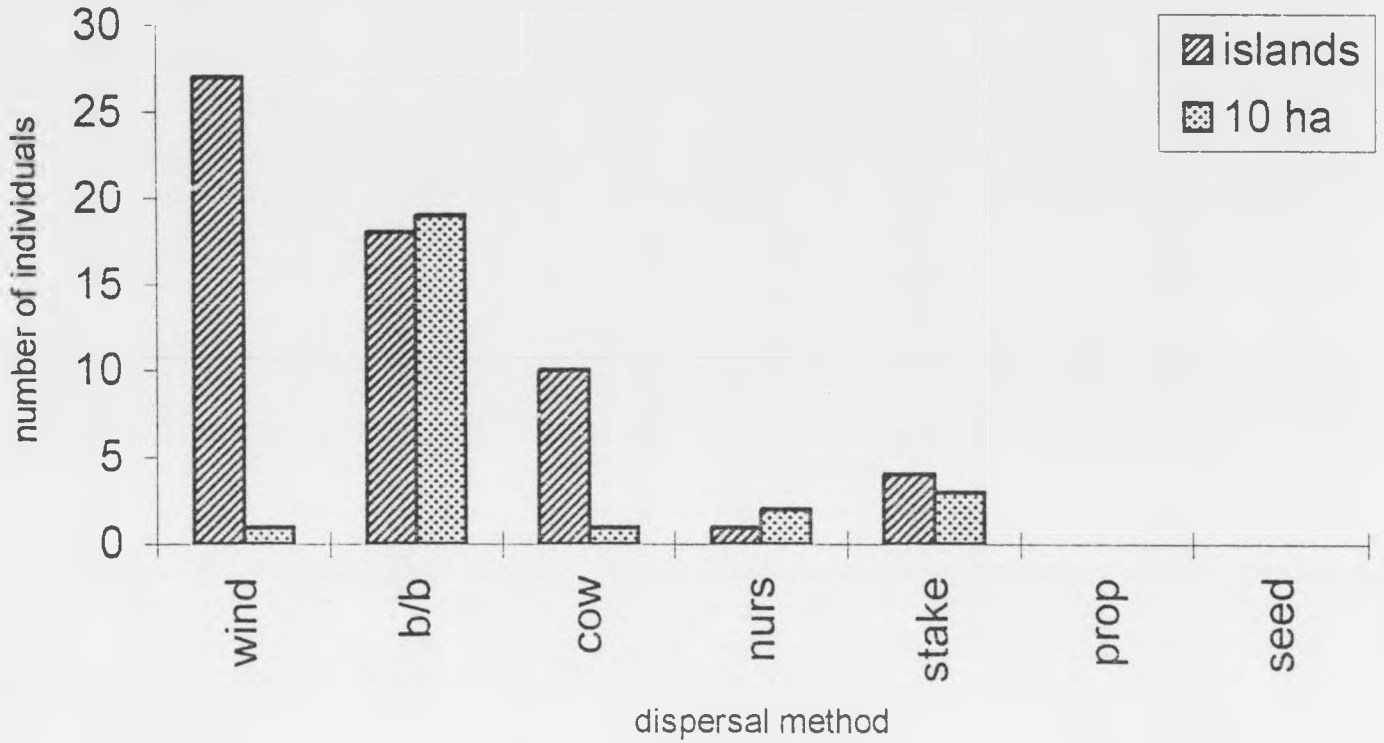


Table 4. The number of species in woody plants for each dispersal method of the 1995 island treatment after six and twenty-four months. (b/b=bird and bat, nurs=tree from nursery, prop=propagule, and seed=trees planted from seed.)

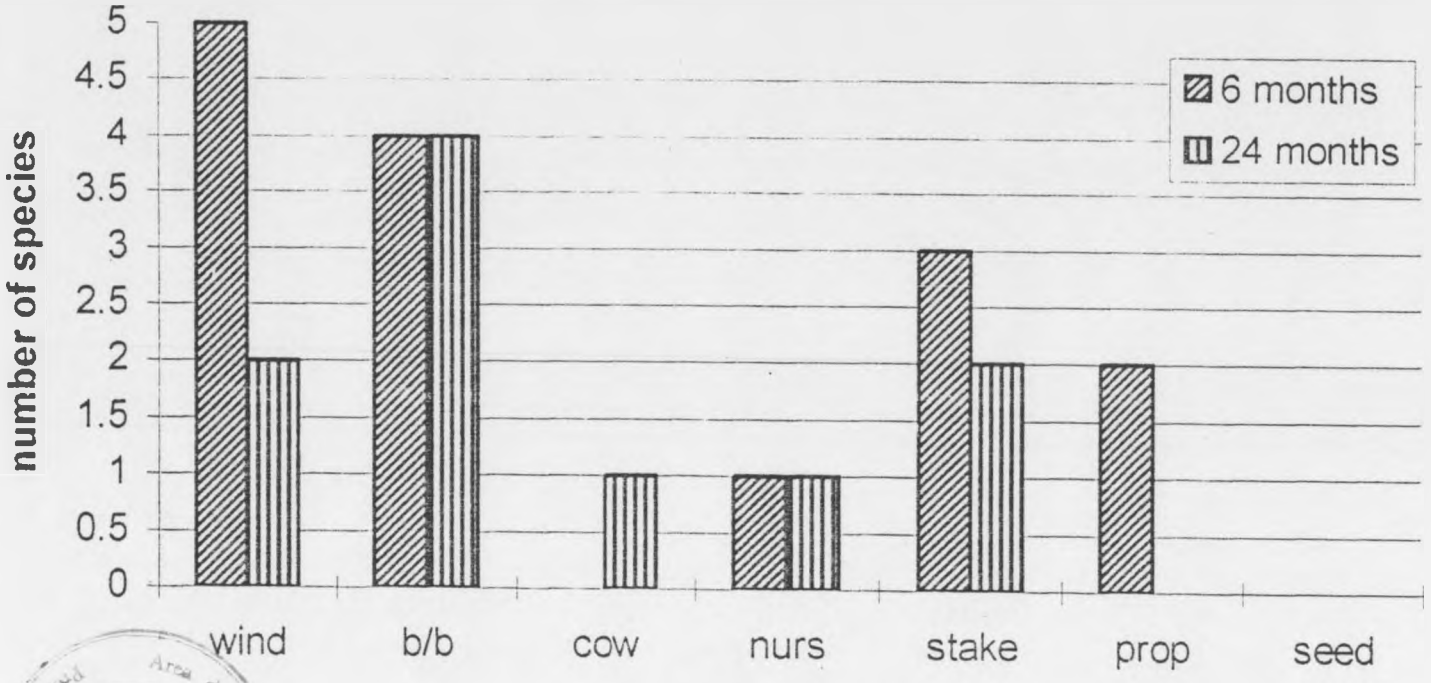
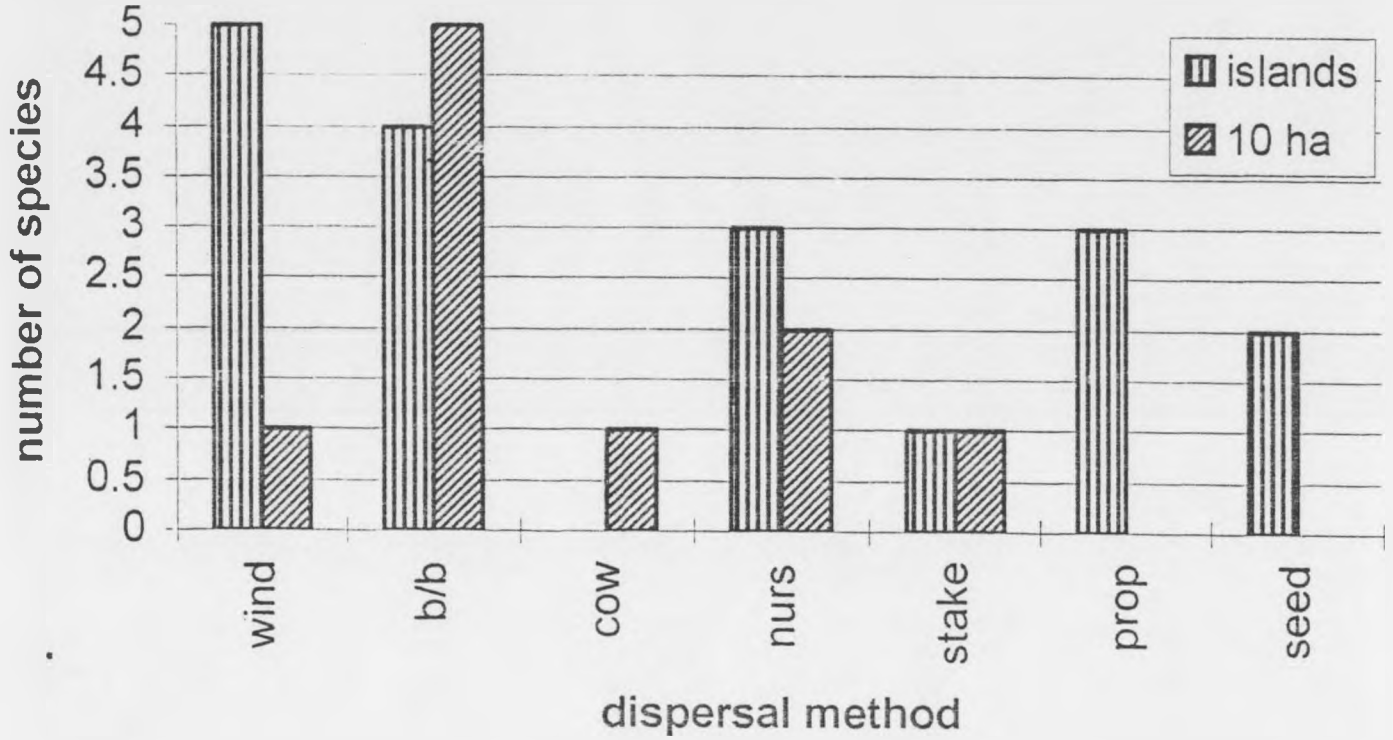


Table 5. The number of species in woody plants for each dispersal method in the two different treatments, 1995 islands and 1996 10 hectare plot, after six months of growth. (b/b=bird and bat, nurs=tree from nursery, prop=propagule, and seed=trees planted from seed.)



Tree Type	95 at 6 months	95 at 24 months	96 at 6 months	Dispersal
Erythrina	0	4	0	planted
Hampea	X	17	1	natural
Trema	X	3	3	natural
Papaveraceae	X	4	8	natural
Solanum A	0	5	2	natural
Solanum woody	X	4	6	natural
Solanum B	0	0	2	natural
Ochroma	X	10	0	natural
Cecropia	0	1	1	natural
Sida	0	2	7	natural
Guazuma	0	10	0	natural
Glyrcidia	0	0	4	planted
Conostegia	X	0	1	natural
Psidium	0	0	1	natural
Enterolobium cyclocarpu	0	0	1	planted
Pachira aguatica	0	0	1	planted
Euphorbiaceae	X	0	0	natural
Total species	7	10	13	
Total number	N/A	60	38	

Table 1. Collection of woody species found at each site for each treatment. An "X" indicates presence in the "95 at 6 months" data, where as a number indicates the numbers of individuals of each species that were of at least breast height in the "95 at 24 months" and "96 at 6 months" data sets.