Fellowship report

ITTO Fellowship funds research on forest management impacts in Costa Rica

by
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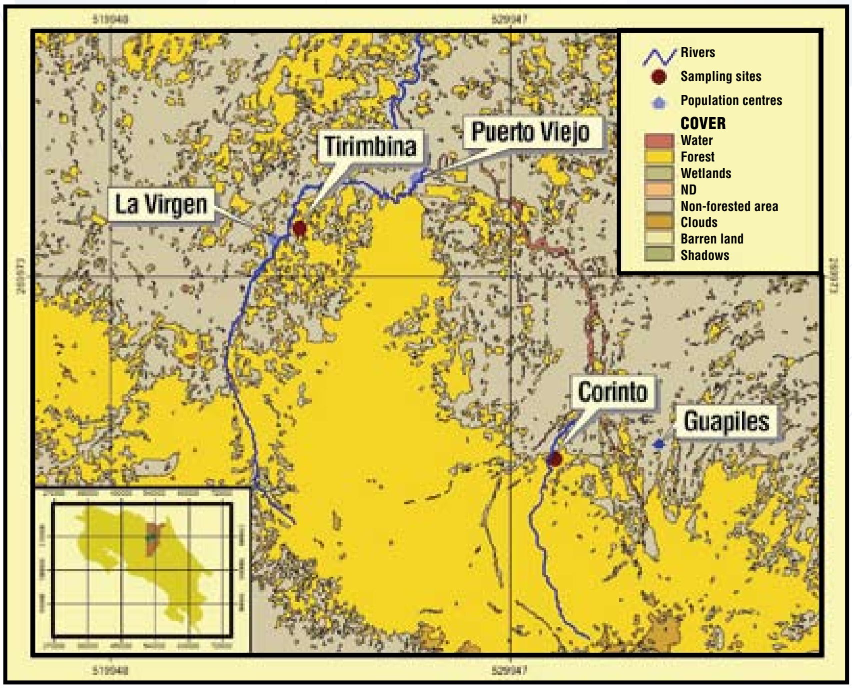
At present, it is widely recognized that ecosystem processes are influenced by functional traits and their interactions (Tilman *et al.* 1997), with functional diversity affecting resource dynamics in the short term and ecosystem stability in the long term (Díaz and Cabido 2001). Functional diversity is the type, range and relative abundance of functional traits present in a given community, which may be affected by man-induced changes in disturbance regimes (Díaz *et al.* 2007).

Plant functional types (PFTs) are a measure of functional diversity (Díaz and Cabido 2001) and are defined as sets of species showing similar responses to environmental conditions and having similar effects on the ecosystem (Díaz and Cabido 1997, Lavorel *et al.* 1998, Lavorel and Garnier 2002). Thus, PFTs bridge the gap between plant physiology and community and ecosystem processes (Díaz and Cabido 1997, Lavorel *et al.* 2007), making it possible to narrow down the high diversity of species into a limited number of groups showing similar responses to specific factors, compare flora species and communities with few taxonomic similarities, and, most importantly, understand the interactions between biodiversity, abiotic factors and ecosystem processes (Díaz *et al.* 2002).

The functional analyses linked to long-term dynamics data on tree species (recruitment, mortality, growth) conducted during this research work are presented as a significant step forward in the understanding of the ecological behaviour of tropical forests and, particularly, in the understanding of tree community responses to disturbance. The objective of this research was to identify the functional types of tree species in two very moist tropical forests in the north-eastern region of Costa Rica and assess their response to varying intensities of disturbance caused by forest management activities.

Plot locations

Figure 1: Moist tropical forest sites in La Tirimbina and Corinto forests, north-eastern Costa Rica



Study areas

The forests in the areas under study belong to the Central American Atlantic Moist Forest Eco-region and are classified as vulnerable and outstanding areas at the bio-regional level (Dinerstein *et al.* 1995). The study areas are specifically located in the Tirimbina Rain Forest Center and in the Los Laureles de Corinto Demonstration and Research Area. Both areas are defined as 'very moist tropical forests' according to Holdridge's life zone classification system, with altitudes ranging from 160 to 350 m.a.s.l., annual rainfalls of 3800 to 4000 mm, and temperatures ranging from 23.5 to 24.5 °C (Finegan and Camacho 1999).

Each of the sites comprises nine 180m x 180m plots; at the center of each site there is a one-hectare (100m x 100m) permanent sample plot (PSP) with a 40-meter wide buffer strip. Three forestry treatments were conducted for each site with three replicates each (Finegan and Camacho 1999).

Methodology

The data used in this study were derived from 13–16 years of measurement of individuals with DBH ≥ 10 cm in 13 one-hectare permanent sample plots (PSP) located in selectively logged forests. Through a review of secondary information, five functional traits were identified for each of the 317 registered species, including three reproductive traits (dispersion type, pollination agent and sexual system) and one vegetative trait (adult tree height), while the absolute growth rate was determined through the analysis of PSP data. Using functional traits, conglomerate analyses were conducted to identify PFTs. Forests were classified into three levels (control, low and high) of disturbance, which was defined in terms of the percentage of basal area reduction caused by forest logging. A variance analysis was used to assess PFT response to disturbance focusing on the following variables: percentage of species and individuals; percentage of rare species and individuals; recruitment rate; mortality rate and basal area percentage.

Results

Five functional types were identified using stratum and growth rate traits *(Table 1)*, as reproductive traits were evenly distributed across all PFTs and did not assist in the differentiation of groups. Out of all plant functional types, PFT-5 showed the highest percentage of individuals, mainly due to the high dominance of the *Pentaclethra macroloba* (Fabaceae) species, which has toxic seeds that are not easily preyed on and are tolerant to shade and infertile soils, and thus manage to survive and grow in the dense undergrowth of primary forests (Hartshorn 1983). This PFT and particularly *P. macroloba* are probably influencing many ecosystem processes because it has been widely recognized that the traits of dominant species are the ones that govern and direct such processes (Chapin *et al.* 1993, Cornelissen *et al.* 2003).

More than 50% of species were classified as rare at the local level (< 1 individual/ha) (Hubbell and Foster 1986); *Hyeronima alchorneoides* (Euphorbiaceae—PFT-4) and *Sclerolobium costaricense* (Fabaceae—PFT-3) were specially noted as species of high commercial value that are susceptible to a population decline in the area. Other species such as *Humiriastrum diguense* (Humiriaceae—PFT-5), (*Lecythis ampla* (Lecythidadeae—PFT-5) and *Vitex cooperi* (Verbenaceae—PFT-5) were not classified as rare but still showed low population densities, thus underscoring the limitations of these categories of abundance (Gallego and Finegan 2004) and the need to develop strategies for their management and conservation.

The percentage of individuals, recruitment rates and basal area percentage were the most sensitive variables for assessing the response to disturbance. Even though the mortality rate is a commonly used variable to assess forest dynamics, it has been widely documented that trees are more 'sensitive' to environmental changes in their seedling and juvenile stages at DBH < 10 cm (Hubbell and Foster 1990, Alvarez-Buyulla and Martinez-Ramos 1992, Clark and Clark 1992). Therefore, the mortality patterns recorded for adult individuals may not exclusively reflect their response to disturbance but may also be linked to the maximum longevity of species, species size and the number of forest clearings (Swaine *et al.* 1987, Hartshorn 1990), or to the mortality dynamics of each individual determined by limited resources or neighbouring competition (Sheil and May 1996).

Conclusion

The functional diversity approach can help to simplify and understand the functioning of tropical forests, where tree species diversity is so high and the range of responses and interactions in terms of environmental variables is so complex. However, it should be noted that this approach cannot be a substitute for taxonomic classifications and their capacity to classify genetic diversity, and should therefore be used as a complementary approach (Díaz *et al.* 2002).

Five groups

Table 1: Tree species functional types identified in La Tirimbina and Corinto

FUNCTIONAL GROUP	TRAIT STATUS		NUMBER OF SPECIES	NUMBER OF INDIVIDUALS
	Stratum	*Growth rate*		
PFT-1	Lower tree	Very slow to very fast	38 (11.99%)	412 (3.58%)
PFT-2	Medium tree	Very slow to slow	86 (27.13%)	2295 (19.96%)
PFT-3	Medium tree	Moderate to very fast	102 (32.18%)	2258 (19.64%)
	Upper tree	Fast to very fast		
PFT-4	Upper tree	Very slow to moderate	51 (16.08%)	1706 (14.84%)
	Emergent	Very slow to slow		
PFT-5	Emergent	Moderate to very fast	40 (12.62%)	4827 (41.98%)

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