Colegio de Postgraduados

Vegetation structure of coastal dunes in Paraiso, Tabasco

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ABSTRACT

Objective: conducted with the objective of identifying the diversity and structure of the flora present in the coastal dunes of Paraíso, Tabasco, Mexico.

Design/Methodology/Approach: The present research was using the Canfield line method, four monitoring sites were established with six repetitions of 20 linear meters each, where plant species intersecting the line were recorded, taking into account height, diameter, and length. Floristic richness and the Shannon-Wiener diversity index were calculated.

Results: A total of 98 species belonging to 36 botanical families were recorded. Of these, 17 were erect herbs, 10 were vines, 7 were shrubs, one was a tree, and one was a palm. The botanical families Fabaceae and Asteraceae were the most abundant.

Findings/Conclusions: The lowest diversity index was 1.770, recorded at site one, while the highest index was 3.88, observed at site two. The remaining sites showed intermediate values. Due to their coverage, the most dominant species were *Ipomoea pes-caprae* and *Ipomoea stolonifera*.

Keywords: Dunes, Candfield, diversity.

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INTRODUCTION

Coastal dunes and beaches are dynamic systems that result from the complex interaction between geology, coastal dynamics, and prevailing climatic factors (Martínez *et al.*, 2020). These environments not only serve as natural barriers against erosion, saltwater intrusion, and storm surges but also host unique biodiversity that has evolved to thrive under extreme conditions, playing a critical role in maintaining the ecological balance of coastal regions (Rodríguez *et al.*, 2019; Martínez, 2021). Coastal dunes, in particular, are geological formations primarily shaped by wind action, which significantly influences sediment dynamics and the structure of adjacent ecosystems (Coronado *et al.*, 2018). In the state

of Tabasco, dunes and beaches exhibit distinct characteristics due to their allochthonous origin (Gutiérrez-Estrada *et al.*, 2017). This results in narrow coastal strips that promote the rapid accumulation of wind-transported sediments, leading to extensive dune formation (González *et al.*, 2020). The configuration and evolution of these dunes are affected by geological and climatic factors, as well as river discharge systems that transport inland sediments to the coast, forming various sedimentary accumulations (Valenzuela *et al.*, 2022). River dynamics and interactions with ocean waves also play a fundamental role in shaping these landscapes (Sánchez *et al.*, 2018). Anthropogenic activities have increasingly influenced coastal dune ecosystems, contributing to their degradation and transformation. Uncontrolled urban development, agricultural expansion, and the exploitation of natural resources have significantly altered coastal landscapes (Martínez *et al.*, 2021; Rodríguez *et al.*, 2019). This is particularly critical in Tabasco, where infrastructure development such as ports and tourist facilities has disrupted sediment dynamics, reducing the dunes' natural capacity to stabilize the coastline (Gutiérrez-Estrada *et al.*, 2017). Additionally, deforestation and river course modifications have led to the loss of dune-stabilizing vegetation, heightening vulnerability to extreme weather events (Mendoza *et al.*, 2019). Degradation of coastal dunes in Tabasco is evident in areas where geographic, climatic, and human factors converge. Recent studies indicate that these areas exhibit both desert and semi-desert characteristics due to the lack of natural regeneration (Rodríguez *et al.*, 2021). Field assessments have identified 36 conflict zones across the region, many of which face multiple pressures, including pollution from industrial waste, intensive farming, and river alterations (González *et al.*, 2020). Consequently, the total area affected by these pressures spans 5,529 km^2, concentrated along major basins in the semi-arid region (Mendoza *et al.*, 2019). Spatial analysis of semi-arid dunes in Tabasco has been conducted using integrated soil and vegetation mapping, coupled with GIS technologies, enabling accurate assessments of dune distribution and evolution (Valenzuela *et al.*, 2022). This methodology has been crucial in identifying high-risk zones and predicting future scenarios under climate change, accounting for the interplay between climate patterns and human activities (Sánchez *et al.*, 2018). The urgent need for sustainable management of these systems is increasingly recognized not only for their ecological significance but also for their role in mitigating extreme natural events such as hurricanes and tropical storms (Gutiérrez-Estrada *et al.*, 2017). Globally, numerous studies highlight the ecological importance of coastal dunes and their role in protecting coastlines from erosion, saltwater intrusion, and climate change impacts. Levin *et al.* (2019) emphasize the ability of dunes to buffer storm surges by absorbing wave energy, thus protecting inland areas. They also note the dunes' adaptability to sea-level rise, contingent upon the preservation of stabilizing vegetation. Vegetation is a key factor in dune resilience, as shown by Van der Meulen *et al.* (2017), who demonstrated that native plant species play a vital role in stabilizing dunes and preventing wind erosion.

In Europe, particularly in the Netherlands, coastal dune restoration projects have been widely implemented. Van der Meulen *et al.* (2017) document how these efforts based on reintroducing native coastal plants enhanced both dune stability and biodiversity. Similarly, in China's coastal regions, Zhao *et al.* (2020) report that restoration programs, including native reforestation, have effectively countered the negative effects of urban expansion and agricultural change. In Australia, Dugan *et al.* (2019) highlight the success of community-based coastal management policies in rehabilitating degraded dunes. In Mexico, coastal dunes are protected under the General Law of Ecological Balance and Environmental Protection (LGEEPA, 1988), which provides a legal framework for conserving coastal ecosystems. González *et al.* (2021) note that this law has been instrumental in preserving coastal biodiversity and dune habitats. Additionally, the General Law of National Assets (2003) regulates coastal land use and restricts unplanned development in dune areas. López and Rivera (2019) observe that this law has helped conserve dunes in regions such as Baja California Sur and Veracruz. The Ecological Restoration Program in the Yucatán Peninsula (PREY) has successfully reforested over 70 km^2 of dunes, improving habitat for migratory species like birds and turtles (Sánchez *et al.*, 2023). In Baja California, integrated coastal management projects have used vegetative barriers to restore dunes, while the National Commission of Natural Protected Areas (CONANP) has supported dune conservation within protected areas (Sánchez *et al.*, 2020). The National Coastal Dune Restoration Project in Jalisco also emphasizes community participation in restoring 50 km^2 of dunes (Sánchez & Morales, 2020). In Tabasco, coastal dunes are essential components of the coastal ecosystem, mainly formed by wind-transported sediments and shaped by the interaction of trade winds with river systems such as the Usumacinta and Grijalva (Martínez *et al.*, 2020; López *et al.*, 2021). These systems contribute large volumes of sediment to the coast, forming dunes that help protect shorelines and biodiversity (Vargas *et al.*, 2022). Gómez and Rodríguez (2019) report that these dunes host diverse flora, including *Cakile edentula* and *Sesuvium portulacastrum*, which enhance soil stability and reduce wind erosion. However, recent studies show that agricultural expansion and urban development particularly the cultivation of African palm have accelerated erosion and biodiversity loss (Vargas *et al.*, 2022). Climate change also threatens dune stability through sea-level rise and altered rainfall patterns, which promote erosion and salinization of soils (Salazar *et al.*, 2020). Although the Coastal Ecosystem Restoration Program (PRECO) has achieved some successes, Sánchez and Morales (2021) argue that it lacks ongoing monitoring and sufficient community involvement. The Ecological Restoration Project of the Dunes in the Paraíso Region has focused on revegetation and natural windbreaks to limit erosion (CONANP, 2020). Globally, research has underscored the vulnerability of coastal dunes to erosion and climate change (Hughes *et al.*, 2020; Williams *et al.*, 2021). McLachlan *et al.* (2020) document dune formation and sediment dynamics in regions such as the southeastern U.S., Australia, and Europe. Williams *et al.* (2021) highlight the essential functions of dunes in inland protection and biodiversity support, dependent on geological and climatic contexts. In Mexico, research in Veracruz, Campeche, and Tabasco reveals common threats, including urbanization, intensive agriculture, and pollution, which impair dunes' protective functions (Martínez *et al.*, 2020; Vargas *et al.*, 2022). This study was developed to identify the diversity and structure of vegetation and flora present in the coastal dunes of Paraíso, Tabasco.

MATERIALS AND METHODS

Area of study

The study area is located in the coastal dunes of Paraíso, Tabasco, from Playa Paraíso (La Barra) to the mouth of the González River. The site's vegetation mainly consists of herbaceous dune vegetation, adjacent to coconut palm groves. Surveys at the work sites were conducted on foot, as there is no vehicle access. Four sites were established at the following coordinates: site one 18° 26' 32.20" N and 93° 5' 57.27" W; site two 18° 26' 31.98" N and 93° 6' 34.57" W; site three 18° 26' 30.09" N and 93° 7' 1.96" W; and site four 18° 26' 27.51" N and 93° 7' 39.87" W.

Fieldwork

Trails and the Canfield Line

An initial survey was conducted along the coastline from the current refinery to Gobernador Cruz. Although the vegetation adjacent to the dunes was similar, it exhibited noticeable variation. Due to these differences, sampling units were established in the area that presented the most ecological similarity. This field reconnaissance also identified species that were not present during sampling but are native to the dunes. To monitor species, the Canfield line method was used, employing 20-meter linear transects along the coast. Four randomly selected sites were established, each with six repetitions. Species located directly on the Canfield line and within 5 cm on either side were recorded as part of the sample. For each plant, height was measured, and either diameter or length was recorded, depending on the species. Known species were identified in the field using their scientific names, while unknown specimens were collected and later identified at the herbarium of the Colegio de Postgraduados. The results were then analyzed accordingly.

Shannon Wiener Diversity Index

This index is one of the most commonly used in the analysis of biological diversity of flora and fauna, as it considers the number of species and the number of individuals per species in a sampling unit. This index states that if the data to be analyzed are taken randomly and their abundance comes from a large community or a fraction of it, the results obtained can be reliably used and is presented as follows:

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

H'=Shannon-Wiener diversity index; p_i=n/N n=number of individuals of species i; N=total number of individuals of all species; p_i=proportion of the number of individuals occurring in species i.

Species richness

Species richness refers to the number of species recorded per unit of studied area (Nagelkerken, 2020). The simplest way to measure species richness is by directly counting the total number of species (S) obtained directly from the list of recorded individuals.

RESULTS AND DISCUSSION

Based on the characteristics of the various sampled sites, the Shannon-Wiener diversity index exhibited notable variability. Site one corresponded to a dune area nearly devoid of herbaceous vegetation due to the constant wind-driven movement of sand. Consequently, the highest plant diversity was observed on the leeward side of the dune, albeit still within the sandy environment. Species richness at this site was 12, with *Spartina spartinae*, *Ipomoea stolonifera*, *Croton punctatus*, *Ipomoea pes-caprae*, and *Sporobolus indicus* identified as dominant species, exhibiting marked overdominance compared to the rest. Despite recording a total of 208 individuals during the sampling, the Shannon diversity index was 1.77 (Table 1), reflecting lower diversity relative to the other sites within the same area (Annex 1). Site two displayed a higher level of conservation compared to the previous site, as it was located behind a dune adjacent to a palm grove. This site was characterized by low topography and residual soil moisture, conditions conducive to the establishment of a greater number of species. Moreover, certain species typically associated with conserved environments or recovering secondary vegetation were also documented. The proximity to local communities may have influenced the plant diversity, given the common dispersal of seeds and fruits through human activity. In total, 157 individuals were recorded, encompassing 67 species distributed among 36 botanical families. The diversity index reached 3.8815, a considerably high value, comparable to other well-vegetated ecosystems. This result is attributable to the relatively balanced distribution of individuals across most species. Site three exhibited less vegetation cover than the previous sites, with a total of 58 individuals and 27 species. The only species with a notably higher number of individuals was Bidens pilosa (eight individuals), while the remaining species displayed a more uniform abundance. The resulting diversity index, 3.077, indicated a more even distribution of individuals among species. Site four, which presented greater vegetation cover and higher soil moisture, supported several species not observed in the preceding sites. Species richness at this site was 28, with a total of 77 individuals, and a Shannon diversity index of 3.3514. The most abundant species included *Asclepias curassavica* and *Ipomoea purpurea*, each with eight individuals, followed by *Ricinus communis* and *Mimosa pigra*, each with five. Across the four sampling sites, a total of 98 species were recorded. Some of these were not characteristic of dune environments or of the region, such as *Agave angustifolia*, whose presence may be attributed to human-mediated dispersal. Similarly, *Canna indica* L., not a dune species, appeared likely due to the moisture conditions in certain sites. *Cornutia pyramidata* L., a species typical of recovering secondary environments, was among the least frequently encountered. In this regard, Martínez *et al.* (2021) report that approximately 5% of flora species in coastal dunes are exotic or introduced; this figure increases to 8.7%

Table 1. Shannon-Wiener diversity Index.

Site	Shannon-Wiener
1	1.770
2	3.881
3	3.077
4	3.351

when focusing solely on species specific to dune ecosystems. According to Zaldívar *et al.* (2022), invasive species negatively impact native dune plant communities by disrupting their structural composition. Notably, site one had the highest number of individuals (208) and the greatest vegetation cover, primarily due to the dominance of *Spartina spartinae*, *Ipomoea stolonifera*, *Croton punctatus*, and *Ipomoea pes-caprae*. These four species accounted for 180 of the 208 individuals recorded, underscoring their potential for sand retention and stabilization in coastal dunes. Although site two exhibited higher species diversity, no species were overly dominant, as individual distribution was relatively uniform. A similar pattern was observed at site three, where species abundance was balanced and no single species prevailed. At site four, *Asclepias curassavica* and *Ipomoea purpurea* each recorded eight individuals, while *Ricinus communis* and *Mimosa pigra* had five each. Figure 1 illustrates the behavior of the diversity index across the four monitoring sites. It is evident that although all sites belong to the same dune system, species-specific population dynamics vary significantly. These differences are influenced by the environmental quality of each site, demonstrating that even under similar conditions, notable ecological distinctions may arise.

Figure 2 illustrates the variation in species richness and the number of individuals across the sampling sites. The highest number of individuals was recorded at site one, likely due to favorable edaphic conditions that allow for plant clustering, thereby ensuring species perpetuation. From an ecological perspective, species dynamics are inherently fluid, and the same site may yield different outcomes within a single sampling year. This variability is influenced by the presence of annual, biennial, or perennial species. Coastal dune vegetation typically exhibits greater plant cover during the rainy season, nortes, and early stages of the dry season. The residual soil moisture during these periods enables many species to complete their biological cycle and disperse seeds, thus perpetuating their presence within the ecosystem.

Of the 98 species recorded across the four sampling sites, 17 species are erect herbs, mainly annuals; 10 species are annual and biennial vines (*Ipomoea pes-caprae*); 7 are shrub species not exceeding one meter in height; one species is a developing tree; and one

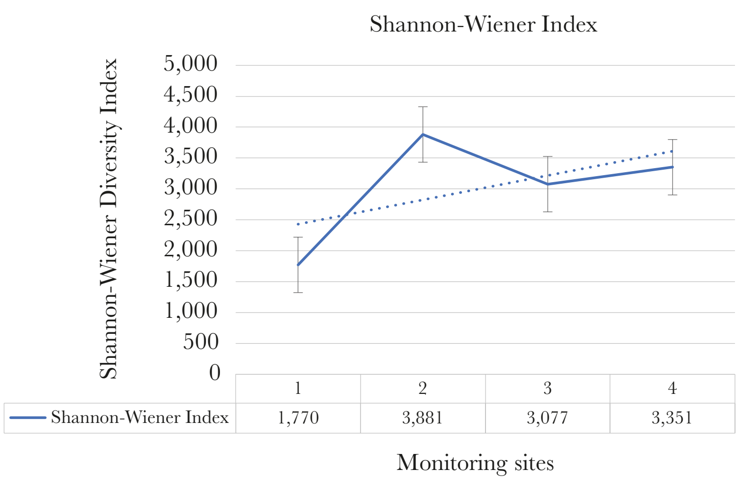

Figure 1. Floristic diversity index for plants in coastal dunes. Paraíso Tabasco.

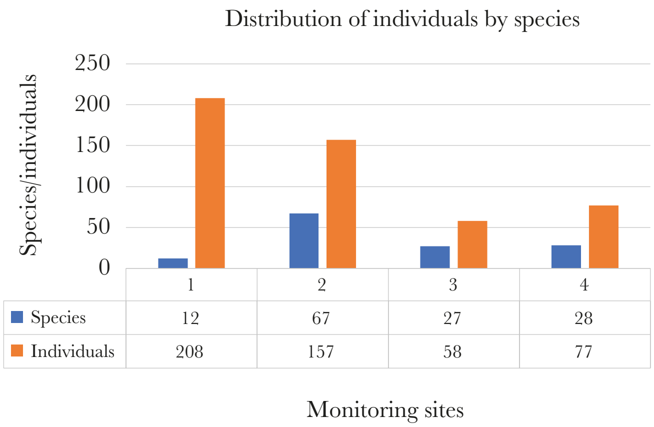

Figure 2. Distribution of species and individuals by sampling site in coastal dunes of Paraiso Tabasco.

species is a palm. A relevant aspect of this type of plant community is the environmental services it provides to society, such as acting as a protective barrier against the harmful action of wind and tides, stabilizing dunes by allowing organic matter accumulation, and serving as habitat for numerous species of insects, birds, reptiles, and mammals (Ley *et al.*, 2007).

CONCLUSIONS

Species diversity within this dune environment is notably high, with 98 species documented an impressive contrast to the 30 species reported by Noguera-Savelli for Sabancuy. Species richness in these areas is influenced by both the timing of sampling and site quality; although the soils are predominantly arenosols, certain zones retain a significant percentage of clay, enhancing ecological conditions. The diversity indices recorded were remarkably high, akin to those of a primary environment. A total of 67 species were distributed across 36 botanical families, suggesting that a broader survey along the state's coastline could yield an even greater number of species. The most represented families were Fabaceae with 16 species, Asteraceae with 11, and Poaceae with 6, while other families were less prominently represented. These findings align with the observations of Espejel *et al.* (2017), who noted that these families encompass approximately 34% of the species present in Mexico's coastal dunes and beach flora. Ecologically, the species with the greatest impact on sand retention among herbs are *Ipomoea pes-caprae* and *Ipomoea stolonifera*. Although not the most numerous, these species exhibit a sprawling growth habit and dense foliage, attributes that enable them to effectively stabilize sand and mitigate erosion.

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Annex 1. Species and individual by repetitions in the dunes.

Species	Site	Repetitions						Total
		1	2	3	4	5	6	
Amaranthus dubius Mart.	1	7	0	0	0	0	0	7
Croton punctatus Jacq.	1	0	2	3	12	7	13	37
Dalbergia retusa Hemsl.	1	2	1	0	0	0	0	3
Euphorbia postrata A.T.	1	0	0	1	0	0	0	1
Ipomoea pes-caprae (L.) Roth.	1	7	8	0	6	6	0	27
Ipomoea stolonifera (Cyril) Gmel.	1	6	7	20	8	6	7	54
Pasiflora foetida L.	1	1	0	0	0	0	0	1
Phaseolus lathyroides L.	1	0	0	0	0	1	0	1
Randia aculeata L.	1	2	0	0	0	0	0	2
Rivina humilis	1	1	0	0	0	0	0	1
Spartina spartinae (Trin.) Merr.	1	0	0	0	17	19	26	62
Sporobulus indicus (L.) R. Br	1	3	9	0	0	0	0	12
								208
Croton punctatus Jacq.	2	0	2	3	12	7	13	8
Abrus precatorius L.	2	1	0	0	0	0	0	1
Acacia cornigera (L.) Willd.	2	1	0	0	0	0	0	1
Aeschynomene americana L.	2	1	0	0	0	0	0	1
Agave angustifolia Haw.	2	1	0	0	0	0	0	1
Amaranthus spinosus L.	2	1	0	0	0	0	0	1
Amarnthus dubius Mart.	2	0	1	0	0	0	0	1
Asclepias curassavica L.	2	1	1	0	0	0	0	2
Bidens pilosa L.	2	1	0	1	1	0	0	3
Caesalpinia bonduc (Linneo) Roxb.	2	0	0	3	3	0	0	6
Caperonia palustris (L.) A. St.-Hil	2	0	1	0	1	2	1	5
Carica mexicana (A.DC.) L.	2	1	0	0	0	0	0	1
Catharanthus roseus (L.) Donn.	2	0	1	0	0	0	0	1
Chrysobalanus icaco L.	2	0	0	1	0	0	0	1
Citharexylum hexangulare Greenm.	2	0	0	0	1	0	0	1
Coccoloba uvifera L.	2	0	0	0	0	1	0	1
Cocos nucifera L.	2	0	0	0	0	1	0	1
Crotalaria retusa L.	2	0	0	1	0	0	0	1
Croton punctatus Jacq.	2	1	3	2	0	0	1	7
Cyperus ferax Rich.	2	0	0	0	0	0	1	1
Cyperus luzulae (L.) Retz.	2	0	0	0	0	0	1	1
Dalbergia brownii (Jacq.) Urban.	2	0	0	0	0	0	2	2
Dalbergia glabra (Mill.) Standl.	2	0	0	0	1	0	2	3
Emilia sonchifolia (L.)Dc.Ex Wright	2	0	0	0	0	0	1	1

Annex 1. Continues...

Species	Site	Repetitions						Total
		1	2	3	4	5	6	
Eragrostis reptans Wolf	2	2	2	0	1	0	0	5
Euphorbia postrata A.T.	2	0	1	0	0	0	0	1
Fimbristylis spadicea (L.) Vahl.	2	0	0	0	0	1	1	2
Gossypium hirsutum L.	2	1	0	0	1	0	0	2
Hamelia patens Jacq.	2	0	0	0	4	1	2	7
Ipomea pes-caprae (L.) Rot.	2	2	2	0	0	1	0	5
Ipomea stolonifera (Cyril) Gmel.	2	0	1	0	0	0	0	1
Ipomoea purpurea (L.) Roth.	2	0	0	0	0	1	0	1
Lantana camara L.	2	0	0	1	0	1	0	2
Leucaena glauca (L.) Benth et Hook.	2	0	0	0	1	0	0	1
Ludwigia octovalis (Jacq.) Raven.	2	0	0	1	0	0	3	4
Malachra alceifolia Jacq.	2	0	0	1	0	0	0	1
Malvaviscus arboreus Cav.	2	0	0	1	0	0	0	1
Mimosa pudica L.	2	0	0	1	0	0	0	1
Mimosa sp.	2	0	0	0	1	0	0	1
Momordica charantia L.	2	0	0	2	3	0	0	5
Neptunia postrata (Lam.) Baill.	2	0	0	0	1	0	0	1
Odonellia hirtiflora (M. M.& Galeotti) K.R. R.	2	0	2	0	2	2	0	6
Opuntia decumbens Mill.	2	0	0	0	1	0	0	1
Panicum maximum Jacq.	2	2	0	3	0	1	0	6
Parthenium hysterophorus L.	2	0	0	2	1	2	0	5
Passiflora foetida L.	2	0	0	0	0	1	0	1
Pennisetum ciliare (L.) Link.	2	0	0	1	0	0	0	1
Phaseolus lathyroides L.	2	0	1	0	0	0	0	1
Physalis angulata L.	2	0	0	0	0	1	0	1
Priva lappulacea (L.) Pers.	2	1	0	0	0	0	0	1
Psidium guajava L.	2	0	0	0	0	0	1	1
Randia aculeata L.	2	0	0	1	0	0	0	1
Recinus communis L.	2	0	0	1	0	0	0	1
Rinchelitrum repens (Willd.) C.F.H..	2	0	0	0	1	3	1	5
Rivina humilis L	2	0	0	0	0	0	3	3
Senna occidentalis (L.) Irwi & Barneby	2	0	2	0	0	0	0	2
Serjania triquetra Radlk.	2	0	0	1	0	0	0	1
Sida acuta Burm.	2	0	0	0	1	0	0	1
Sida rhombifolia L.	2	0	0	3	3	0	1	7
Solanum lycopersicum L.	2	0	0	0	0	0	1	1
Spartina spartinae (Trin.) Merr.	2	0	0	1	0	0	0	1

Annex 1. Continues...

Species	Site	Repetitions						Total
		1	2	3	4	5	6	
Sporobulus indicus (L.) R. Br	2	0	0	0	1	0	0	1
Stachytarpheta jamaicensis (L.) Vahl.	2	0	0	0	0	2	0	2
Stigmaphyllon humboldtianum (DC) A. Juss.	2	0	0	0	0	3	4	7
Thevetia ahouai	2	0	0	0	0	1	0	1
Typha latifolia L.	2	0	0	0	0	0	3	3
Vernonia cinerea (L.) Less.	2	0	0	1	0	0	0	1
								157
Abrus precatorius L.	3	2	1	0	0	0	0	3
Acacia cornigera (L.) Willd.	3	1	0	0	0	0	0	1
Acrostichum danaefolium Long. & F.	3	0	1	0	0	0	0	1
Adelia barbinervis Schlech & Cham.	3	0	0	0	0	0	0	1
Aeschynomene americana L.	3	0	2	0	0	0	0	2
Ageratum conyzoides L.	3	0	0	1	0	0	0	1
Albizzia sp.	3	0	0	0	0	0	0	1
Artemisa absintium L.	3	1	0	1	0	0	0	2
Asclepias curassavica L.	3	0	0	1	0	0	0	1
Baccharis trinervis (Lam.) Pers.	3	0	0	0	3	0	1	4
Bidens pilosa L.	3	1	3	0	3	0	1	8
Capraria biflora L.	3	1	0	0	0	1	2	4
Cardiospermum halicacabum L	3	0	0	0	1	0	0	1
Carica mexicana (A.DC.) L.	3	0	0	0	1	0	0	1
Cecropia obtusifolia Bertol.	3	0	0	0	1	0	0	1
Cecropia peltata L.	3	0	1	0	1	0	0	2
Cissus sicyoides L.	3	0	1	0	1	0	0	2
Citharexylum hexangulare Greenm	3	0	1	0	0	0	0	1
Coccoloba barbadensis Jaq.	3	0	0	0	0	0	0	0
Cocos nucifera L.	3	0	0	0	0	0	1	1
Cornutia pyramidata L.	3	0	0	0	0	0	1	1
Cyperus ferax Rich.	3	0	3	1	0	0	0	4
Cyperus luzulae (L.) Retz.	3	3	0	0	0	0	0	3
Eclipta prostrata (L.) L	3	0	0	0	0	0	0	0
Eugenia sp.	3	0	0	1	0	0	0	1
Eupathorium albicaule Sch. Bip.	3	0	0	0	3	0	0	3
Eupatorium odoratum (L.) R.M	3	0	1	1	0	0	0	2
								53
Neptunia postrata (Lam.) Baill.	4	1	0	0	0	0	0	1
Solanum ptychanthum Dun.	4	1	0	0	0	0	0	1

Annex 1. Continues...

Species	Site	Repetitions						Total
		1	2	3	4	5	6	
Artemisa absintium L.	4	0	1	0	0	0	0	1
Merremia umbellata Hall.	4	0	1	0	0	0	0	1
Pancratium littorale Jacq.	4	0	1	0	0	0	0	1
Syngonium podophyllum Schott.	4	0	1	0	0	0	0	1
Eupatorium odoratum L.	4	0	1	1	0	0	0	2
Penisetum purpureum Schumanch.	4	0	0	1	0	0	0	1
Carica mexicana (A.DC.) L.	4	0	0	1	0	0	0	1
Eclipta prostrata (L.) L.	4	0	0	1	0	0	0	1
Ludwigia octovalis (Jacq.) Raven.	4	0	0	0	1	0	0	1
Melothria pendula L.	4	0	0	0	1	0	0	1
Momordica charantia L.	4	0	0	0	1	0	0	1
Petiveria alliacea L.	4	0	0	0	1	0	0	1
Pithecoctenium echinatum Schum.	4	0	0	0	1	0	0	1
Portulaca oleracea L.	4	0	0	0	1	0	0	1
Priva lappulacea (L.) Pers.	4	0	0	0	1	0	0	1
Rivina humilis L	4	0	0	0	1	0	0	1
Thelypteris interupta (Willd.) Iwast.	4	0	0	0	1	0	0	1
Sabal mexicana Mart.	4	0	0	0	1	0	0	1
Amarnthus dubius Mart.	4	0	0	0	1	0	0	1
Mimosa pudica L.	4	0	0	0	1	0	0	1
Ageratum conyzoides L.	4	1	1	0	1	0	0	3
Passiflora foetida L.	4	1	0	0	1	0	0	2
Antigonon leptopus Hook. *et* Cham	4	1	0	0	0	0	0	1
Leucaena glauca (L.) Benth *et* Hook.	4	1	0	0	0	0	1	2
Asclepias curassavica L.	4	0	3	3	0	2	0	8
Ipomoea purpurea (L.) Roth.	4	0	5	1	0	0	2	8
Capraria biflora L.	4	0	2	0	0	0	0	2
Amaranthus spinosus L.	4	0	2	0	0	0	0	2
Thevetia ahouai A. Dc	4	0	0	1	0	0	0	1
Vernonia cinnerea (L.) Less	4	1	0	0	2	1	0	4
Canna indica L.	4	0	0	2	0	0	1	3
Pancratium littorale Jacq.	4	0	0	0	0	0	2	2
Priva lappulacea (L.) Pers.	4	0	0	0	3	0	0	3
Momordica charantia L.	4	0	0	0	3	0	0	3
Recinus communis L.	4	0	0	0	3	0	2	5
Mimosa pigra L.	4	0	1	0	2	2	0	5
								77