SPECIES DIVERSITY AND COMMUNITY STRUCTURE OF BEACH FORESTS IN SAN FERNANDO, SAN JOSE, ANTIQUE, PHILIPPINES

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ABSTRACT

Beach forests play a vital role in disaster mitigation and climate change mitigation. These forests protect coastal communities against natural calamities. It has been observed that areas with less or absence of beach forests and mangrove systems were highly devastated compared to those with. However, these ecosystems were neglected due to lesser studies and baseline information about the species diversity and community structure and its role in the overall ecology of the area. The study assessed the species diversity and community structure of beach forests in San Fernando, San Jose, Antique, Philippines. The study used the transect line plots method in an area that was purposively selected. The general floristic composition was based on an ocular survey of the

selected site. Characterization of community structure was done using accepted parameters. Results showed a total of sixteen (16) beach forest species that belong to twelve (12) families. Tabernaemontana pandacaqui and Jatropha gossypifolia were found to be the most frequently occurring species. The plant diversity of the area is low (mean H' = 0.968) which is attributed to anthropogenic disturbances. The species with the highest Importance Value was Capparis micracantha (IV =61.02). Overall, beach forest in San Fernando, San Jose has a high species evenness (J' = 0.929) which proves that conservation and preservation efforts must be increased. It is recommended that local government units must develop plans to promote awareness and strengthen values for conservation and protection of the beach forests among its people.

Keywords: Beach Forest, Forest Conservation, Biodiversity, Importance Value.

INTRODUCTION

Trees are vital to all life on earth. The ecosystems they create serve as sanctuary to a large variety of plants and animals both discovered and undiscovered. For many millennia, trees have provided us with all the goods and services which greatly eased the way humans live from the economically in-demand lumbers, medicinal potent leaves, and roots to the nutrient-full fruits. However, forests like any other ecosystem are affected by the rapid changes in climate patterns and global warming as well as anthropogenic activities, and beach forests are among these. Further, beach forests are ecosystems composed of trees and shrubs found slightly above the high tide mark. Beach forests form an effective barrier against the forces of the ocean for some coastal communities. Beach forest species have evolved with adaptive responses against the wind, rain, waves, and salt spray from the ocean (Primavera & Sadaba, 2012).

Beach forests are naturally classified by their dominant species just like the Indo-Pacific Region that the dominant tree species are *Barringtonia asiatica (L.) Kurz, Calophyllum inophyllum, Terminalia catappa, Pandanus tectorius Parkinson ex Zucc, Hibiscus tiliaceus*, and *Casuarina equisetifolia* J.R. & G. Forst (Kongapai et al, 2016). The majority of beach woods have been destroyed and cultivated for tourism, to the point that their native state has been lost. Furthermore, there are still misunderstandings, and individuals have planted alien species such as decorative palm trees in place of native species for aesthetic reasons. Such acts have a significant impact on the coastal forest environment.

Primavera and Esteban (2008) reported that despite often being ignored due to the lack of economic significance among its trees, in terms of ecology, beach forests are essentially considered a valuable resource. Aside from holding together soil to avoid erosion, the coastal forest has been also proven to have a role as a bio-shield that slows the wind action, protect lives, and as well as properties against wave energy, tornados, and storm tides and surges.

The Philippine coast covers a coastline extent of 36,289 km (Water Environment Partnership in Asia, 2003) which encompasses a wide range of ecosystems and associated resources. However, the Philippine mangrove ecosystems and beach forests, over the past decades have undergone massive destruction which brought a significant threat to biological diversity (Padua, Abocejo and Mirasol, 2011). On the other hand, the province of Antique lies in the western region of the Visayan

archipelago comprising 18 municipalities and a vast coastline extending from north to south. The majority of the municipalities have coasts leaving only the municipalities of Valderrama, Sibalom, and San Remegio (DENR, 2019). With this, the coasts of Antique are a haven for beach forest species. Patches of mangrove systems and beach forests can be seen along the coasts of the province which provide protection against sea wind and waves for the coastal communities. But these pristine ecosystems face an unpredictable future like any others in the world. Coastal modifications due to urbanization are among the many threats that beach forests face along with human consumption.

Besides, the provincial government of Antique initiated a multi-million coastal development project which involves the construction of a coastal barrier for both disaster and tourism purposes. The infrastructure was designed in such a way that it helps decrease the force of waves to protect communities along the coast at the same time providing a tourist-attracting esplanade running from south to north of the province. However, this development comes at the expense of nature. Beach forests were destroyed along the way of the construction sites. Shrubs and seedlings were buried, and century-old trees, both endemic and invasive, were cut down in order to give way to heavy equipment during the construction period of the said project. Aside from these, the sandy shores of the province where sea turtles usually nest and lay eggs have been blocked which prevents future visits and thereby affects sea turtle populations.

Generally, the beach forest is one of the ecosystems that is being understudied among the terrestrial ecosystems. A little is known about beach forests, resulting in unfamiliarity among Filipinos and, as a result, dismal conservation efforts that go unreported in the Philippine Forestry Statistics (Primavera & Sabada, 2012). With the given scenario, the present study was conducted to determine species diversity and community structure of beach forest in San Fernando, San Jose de Buenavista, Antique, Philippines. In fact, there is no existing published scientific report on the plant diversity and community structure of beach forests in the province of Antique, thus, this also encouraged the researchers to do this kind of study.

The study determined the species diversity and community structure of beach forest in San Fernando, San Jose de Buenavista, Antique, Philippines. Specifically, it (1) identified the beach forest species present in the area; and (2) described the community structure in terms of species composition, diameter at breast height, stand height, stand basal area, and (3) determined the importance value, index of diversity, and species evenness of the beach forest species in the area.

METHODOLOGY

Description of Study Area

San Jose de Buenavista, the capital town of the provinces, is among the eighteen (18) towns comprising the lone District of Antique, Philippines. It is located at coordinates, 10°45′ N and 121°57′ E. Overlooking the Island of West Philippine Sea to the west, San Jose de Buenavista is bounded by the towns of Belison to the north, by Sibalom to the east, by Hamtic to the south. San Jose de Buenavista has two pronounced seasons: dry from November to April and wet during the rest of the year. The municipality has a land area of 48.56 square kilometers (18.75 square miles),

accounting for 1.78 percent of Antique's total area of 2,729.17 square kilometers or 1,053.74 square miles (PhilAtlas, 2019).

Data Gathering Procedure

Scoping. Scoping was done to substantiate the evidence to conduct the study through literature survey, information gathering, and mapping of the location.

Ocular Survey. Ocular survey was done to validate the data gathered during scoping. A survey was conducted at the coastal area of barangay San Fernando, San Jose, Antique in order to have a picture of the location and the status of the coastal margin, identify existing species, determine coverage of beach forest, and for the selection of the area for transect establishment. The ocular survey was also done to record human settlements and activities on beach forests.

Analysis of Community Structure

Selection of sites and establishment of sampling sites. Data were gathered on December 7, 2019. The extent of coastal forest covers as well as the economic and ecological importance of beach forest to other coastal habitats were given due consideration.

Sampling plots were established in the identified area at the northern end of San Fernando bordering the barangay of Magcalon, San Jose, Antique. Transectline was established on the area with dense beach forest species to represent the general area. Them, the researchers used the transect line plots method adopted from English et. al. (1994) in assessing selected sites. Transects were established with 100 m in length constituting three (3) 10 m x 10 m plots. This method employed a detailed, scientific and qualitative characterization of the beach forest as to species abundance approximation, density, and basal area. The seedling and sapling profile of every species were considered.

Identification of species. Beach forests species were identified using the field guide, Beach Forest Species and Mangrove Associates in the Philippines, by Primavera and Sadaba (2012). Each tree species was identified from their scientific names, and local names, and their habitat. All species were photographed for verification, identification, and documentation.

Measurement of GBH. Using the technique prescribed by English et al. (1994), girth at breast height (GHB) was determined. This was measured in centimeters using a tape measure. The tree GBH was measured at 1.3 meters from the ground. For trees that have grown irregularly, the following procedures were used: *(a)* Each branch was assessed as a distinct stem when a stem forked below breast height or sprang from a single base close to the ground or above. (b) The girth at breast height or slightly above the swelling induced by the fork was measured when the stem forks at breast height or slightly above it. (c) Girth was measured 20 cm above the root collar when the stem had prop roots or a fluted lower trunk. (d) The girth was measured slightly above or below the irregularity when the stem had swelling, branches, or irregularities at the time of measurement.

Measurement of the Height. Tree height was measured with a rough estimation in meters from the substrate to the canopy. Only true wood-tree species were measured.

Analysis of Data. Beach forest community structure was calculated using the formulas adopted from English et.al. (1994) and Odum and Barret (2005) such for basal area stand basal area, stems

per hectare, relative density, frequency, relative dominance, importance values, Shannon index of diversity, and evenness index.

RESULTS AND DISCUSSION

Floristic Diversity of Beach Forest

As shown in Table 1, a total of 16 beach forest species was recorded from surveyed sites in San Fernando, San Jose, Antique belonging to 12 families (Table 1) which is about 8% of the Philippine beach forest species listed by Primavera and Sadaba (2012).

The study also revealed that species composition was highest at Plot 1 with 12 beach forest species identified. On the other hand, Plot 2 had the least number of species identified with only six (6) species. Family Euphorbiaceae, Lamiaceae, Apocynaceae, Phyllanthaceae were the most represented families with two (2) representative species each. According to Auld (1996) the dominance of Euphorbiaceae, Lamiaceae, Apocynaceae, Phyllanthaceae families could be attributed to the dynamic processes within the life cycle of representative species from flowering to seed dispersal to germination. Also, this can be attributed to the presence of root nodules which allows the plant to make its food in such a hostile environment through the process called nitrogen fixation. This happens when the presence of microorganism rhizobium collects nitrogen from the air, thus giving the species the advantage to grow well even in unfertile lands such as beach areas.

Table 1
List of Beach Forest Species Identified in San Fernando, San Jose, Antique, Philippines

No.	Family	No. of species per family	Species	Plot 1	Plot 2	Plot 3	No. of occurrence	Overall freq. of occurrence (%) across site	Overall freq. of occurrence (%) across species
1	Annonaceae	1	*Annona squamosa*	1			1	0.33	4%
2	Apocynaceae	2	*Tabernaemontana pandacaqui*	1	1	1	3	1.00	12%
			Wrightia pubiscens subsp.laniti	1	1		2	0.67	8%
3	Boraginaceae	1	*Carmona retusa*	1		1	2	0.67	8%
4	Convolvulaceae	1	*Ipomea pes-caprae*	1			1	0.33	4%
5	Capparidaceae	1	*Capparis micracantha*	1	1		2	0.67	8%
6	Euphorbiaceae	2	*Jatropha curcas*	1	1		2	0.67	8%
			Jatropha gossypifolia	1	1	1	3	1.00	12%
7	Fabaceae	1	*Canavalia maritima*	1			1	0.33	4%
8	Lamiaceae	2	*Vitex trifolia subsp. litoralis*	1			1	0.33	4%
			Vitex parviflora			1	1	0.33	4%
9	Lauraceae	1	*Cassytha filiformis*	1			1	0.33	4%
10	Sterculiaceae	1	*Sterculia foetida*			1	1	0.33	4%
11	Meliaceae	1	*Azadirachta indica*			1	1	0.33	4%
12	Phyllanthaceae	1	*Bridelia stipularis*	1		1	2	0.67	8%
			Breynia vitis-idaea		1	1	2	0.67	8%
Total Number of Families				**10**	**4**	**7**			**100%**
Total Number of Species				**12**	**6**	**8**	**26**		

Frequency of Occurrence of Species Across Sites

The study revealed that in terms of frequency of occurrence of beach forest species across sites, two (2) species were listed as very frequent species with *Tabernaemontana pandacaqui* and *Jatropha gossypifolia* having 100% frequency of occurrence across sites respectively. This means that the two species are widely spread across the area because of their presence in all three plots. This could possibly be attributed to the successful germination and effective adaptation to the environment. In the same light, these two species appear in the majority of the beach forests across the country. Furthermore, it was found that six (6) species occurred as frequent (20-50% occurrence) namely: *Carmona retusa*, *Capparis micracantha*, *Jatropha curcas*, *Wrightia pubiscens subsp.laniti*, *Bridelia stipularis*, *Breynia vitis-idaea*. On the other hand, eight (8) species were infrequent (<20% occurrence) across sites namely *Annona squamosa*, *Ipomea pes-capre*, *Canavalia maritima*, *Vitex trifolia subsp. litoralis*, *Vitex parviflora*, *Cassytha filiformis*, *Sterculia foetida,* and *Azadirachta indica.* In contrast, in the study of Sabulao et. al (2020) Guiuan, Eastern Samar, they documented 39 species of beach forest flora where *Cocos nucifera L.*, *Artocarpus blancoi,* and *Premna odorata* are the common species of beach forest found in the area and these species are not found in the present study.

Frequency of Occurrence Across Species

Table 1 shows that in terms of frequency of occurrence across species, it was found that all sixteen (16) species occurred as 'very frequent' (>3%) across species with *Tabernaemontana pandacaqui* and *Jatropha gossypifolia* as the highest two having 12% frequency of occurrence (Table 2). Furthermore, six (6) species got 8% frequency across species namely *Carmona retusa, Capparis micracantha, Jatropha curcas, Wrightia pubiscens subsp.laniti, Bridelia stipularis, Breynia vitis-idaea*. The least frequently occurring across species were the eight (8) species namely Annona squamosa, Ipomea pes-capre, *Canavalia maritima, Vitex trifolia subsp. litoralis, Vitex parviflora, Cassytha filiformis, Sterculia foetida,* and *Azadirachta indica.*

Table 2

Overall Structural Characteristics of Beach Forest Species in San Fernando, San Jose, Antique

Species	BA	SBA	Stems per Ha	Tree density	Sapling density	Seedling density	RDm	RF	RD	IV	H'	J'
	(cm^2m^{-2})	$(m^2 ha^{-1})$	$(n\ ha^{-1})$	$(n\ ha^{-1})$	$(n\ ha^{-1})$	$(n\ ha^{-1})$	(%)	(%)	(%)	(I_v)		
Jatropha gossypifolia	53.32	0.18	166.67	166.67	266.67	325	1.72	11.69	23.81	37.22		
Annona squamosa	63.03	0.21	33.33	33.33	75.00	100	2.03	10.39	4.76	17.18		
*Unidentified species**	1344.86	4.48	33.33	33.33	0.00	0	43.38	5.19	4.76	53.33		
Wrightia pubiscens subsp. laniti	132.59	0.44	133.33	133.33	125.00	275	4.28	11.69	19.05	35.01		
Capparis micracantha	1355.12	4.52	66.67	66.67	75.00	150	43.71	7.79	9.52	61.02		
Jatropha curcas	16.71	0.06	66.67	66.67	50.00	50	0.54	10.39	9.52	20.45		
Bridelia stipularis	28.97	0.10	66.67	66.67	75.00	100	0.93	10.39	9.52	20.85		

	BA	SBA	RDm	RF	RD		IV				H'	J'
Breynia vitis-idaea	50.40	0.17	66.67	66.67	50.00	75.00	1.63	7.79	9.52	18.94		
Sterculia foetida	23.32	0.08	33.33	33.33	25.00	75	0.75	3.90	4.76	9.41		
Vitex parviflora	11.17	0.04	33.33	33.33	25.00	125.00	0.36	5.19	4.76	10.32		
Tabernaemontana pandacaqui	21.01	0.07	0.00	0.00	225.00	450	0.68	15.58	0.00	16.26		
Total	3100.48	10.33	700.00	700.00	991.67	1725.00	100.00	100.00	100.00	300.00	0.968	0.929

Legend: BA – Basal Area; SBA – Stand Basal Area; RDm – Relative Dominance; RF – Relative Frequency; RD- Relative Density; IV – Importance Value; H' – Species Diversity; J' – Evenness Index **Stand Basal Area (SBA)**

Then, Table 2 displays the overall structural characteristics of beach forest species in San Fernando, San Jose, Antique.

In terms of the Stand Basal Area (SBA), it was found that the beach forest in San Fernando, San Jose, Antique had a total SBA of 10.33 m^2ha^{-1} (Table 2). *Capparis micracantha* (4.52 $m^2\,ha^{-1}$) was found to have the largest SBA which can be attributed to the large count of trees and a large Basal Area with 1355.12 cm2 m^{-2} (Table 2). Meanwhile, *Vitex parviflora* (0.04 m^2ha^{-1}) was recorded to have the lowest SBA which is due to the few numbers of trees found in the area.

Importance Value

Importance value shows how a specific plant species influence the presence of other species in a community (Brower et al., 1990). In the study, it was found that among the sixteen (16) species listed, the highest importance value was on *Capparis micracantha* (IV =61.02) (Table 2). This can be due to its ability to be effectively dispersed in vast areas and its high tolerance to the unpredictable conditions of the coastal environment. It has a strong stem that can support the plant against strong winds. It also has wide leaves which maximize photosynthesis. Following *Capparis micracantha* is an unidentified tree species that has an Importance Value of 53.33. Although the tree stands alone in the area, its presence has a greater impact on the overall wellbeing of the beach forest. On other hand, Sterculia foetida was ranked lowest when it comes to importance value (9.41). This might be due to the absence of the species in two (2) plots and the plant's ability to disperse its seeds successfully across the area.

Diversity Index and Species Evenness

The beach forest in San Fernando, San Jose, Antique showed a low (mean H' = 0.968) diversity index (Table 2). This is because the area has only sixteen (16) plant families present. This might be due to the rapid land conversion, human settlements, and the recent transformation of beaches to recreational areas. The remaining clusters of the beach forests in the barangay can be seen in small patches of green between households and resorts.

These findings were similar to the findings of Lillo et al. (2019), it was found that the beach forest habitat type of Dinagat Island has a diversity value of 1.45, 0.926, and 2.26, respectively, according to Shannon, Simpson, and Brillouin diversity index computations. The low species diversity value of the coastal forest habitat type was shown by these results. Because the forest only contains 16 species, 15 families, and 15 genera, the data further demonstrates that the Dinagat Island beach forest habitat type has limited species richness. Although San Fernando has a low diversity index, its species evenness (J' = 0.929) as shown in Table 2 is considerably high. A probable cause of this might be due to the adaptation of the species to the coastal climate.

CONCLUSION AND RECOMMENDATIONS

The findings of the study revealed that the beach forest in San Fernando has (16) beach forest species belonging to twelve (12) families recorded with Euphorbiaceae, Lamiaceae, Apocynaceae, Phyllanthaceae as the most dominant. Also, the area was found to have low plant diversity, but the species evenness was found to be high. *Tabernaemontana pandacaqui* and *Jatropha gossypifolia* were the most frequently occurring species. *Capparis micracantha* was found to have the greatest stand basal area and the highest importance value. Thus, the researchers concluded that the said beach forests have very few species of beach forest trees as evidenced by low species diversity which is indicative of an existing environmental degradation. Species belonging to the same family dominate most of the areas which indicates that the condition of the area only allows the growth of those species with high adaptability to the hostile environment. Then, the majority of the beach forest land area is dominated by *Capparis micracantha* and plays a vital role in the growth of other species. These findings might be caused by anthropogenic disturbances such as land conversion and the establishment of resorts and recreational areas. Furthermore, the presence of unmatured trees reacts as a regeneration part and may be viewed as an early indicator of forest recovery.

With the findings of the study, the researchers recommend that further studies can be conducted on the carbon stock of the area and other beach forests in the province as the basis for a deeper understanding and management of these significant yet neglected ecosystems. Therefore, the provincial government, along with the local government of the municipality of San Jose may impose policies directed toward the protection, restoration, and rehabilitation of beach forests. Also, the community must actively engage in conservation efforts to save the beach forest in their community.

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