Species Diversity and Abundance in Mangrove Forest of Island Cove in Kawit, Cavite, Philippines

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ABSTRACT

The flora and fauna species of a man-made Mangrove Forest of Island Cove in Binakayan, Kawit, Cavite were assessed for diversity, richness and abundance using the quadrat sampling method and analyzed with Simpson's Diversity Index. Collection of species was done twice on September 2016 and January 2017 representing wet and dry seasons, respectively. Results showed that dry season was well-diverse (very high) in terms of species diversity index with 0.04 (lowest) and 0.08; species richness of 29; and the most abundant species, *Chromolaena odorata* with 8.66% of the total 1,823 collected species compared to wet season with a diversity index of 0.17 (lowest); species richness of 12; and the most abundant species, *Coccina grandis* with 16.94% of the total 1,292 collected species. This was attributed to the environmental condition wherein during wet season, anthropogenic and natural disturbances were very prominent such as trashes and garbage that were transported into the mangrove forest by a strong current coming from the Manila Bay, anoxic water due to lack of oxygen, moist and watery substrates, and plant destruction due to storms and heavy rainfall. The presence of sanitary landfill near the shoreline of Cavite contributes to this garbage that would be flashed into the mangrove during storms and rainy season. The impact of climatic conditions like in wet and dry seasons greatly affects the mangrove vegetation and species diversity.

Keywords: abundance, biodiversity, Cavite, mangrove, species diversity and richness

INTRODUCTION

Mangrove is a type of forest growing along tidal mudflats and along shallow water coastal areas extending inland along rivers, streams and their tributaries where the water is generally brackish (Giri et al. 2011). They contain a complex salt filtration system and complex root system to cope with salt water immersion and wave action and are adapted to the low oxygen (anoxic) conditions of waterlogged mud. Thus, they are usually found at estuaries between the land and the sea and occur only in the tropics and sub-tropics (Giesen et al. 2007).

The term "mangrove" can refer to either the ecosystem or individual plants (Tomlinson 1986), and have been defined as a "tree, shrub, palm or ground fern (Duke 1992). They have tremendous social and ecological value (Wells et al. 2006) because it provides habitats for a large number of mollusks, crustaceans, birds, insects, monkeys, and reptiles, give income from the collection of the mollusks, crustaceans, and fish that live there, serves as recreational grounds for bird watching and observation of wildlife, good source of wood and timber, protecting coastal areas and communities from storm surges, waves, tidal currents and typhoons, and reduce organic pollution in nearshore area by trapping and absorption (McLeod & Salm, 2006).

Mangrove environment is highly dynamic and harsh and mangrove species are variously adapted to cope with these environmental conditions (FAO Regional Office for Asia and Pacific 2000). *Breathing roots:* underground tissue of any plant requires oxygen for respiration and in mangrove environment, oxygen in soil is very limited or nil. This necessitates mangrove root system to take up oxygen from the atmosphere. For this purpose, mangrove species have specialized above ground roots called breathing roots or pneumatophores. *Silt roots:* in some mangrove species, roots diverge from stems and branches and penetrate the soil some distance away from the main stem as in the case of banyan trees. These roots also have many pores through which atmospheric oxygen enters the roots (Hogarth & Cheng, 2001). *Vivipary:* saline water, unconsolidated saline soil with little or no oxygen is not a conducive environment for seeds to germinate and establish. In this method of reproduction, seeds germinate and develop into seedlings while the seeds are still attached to the parent tree (Boaden & Seed, 1993). These seedlings are normally called as propagules and they photosynthesize while still attached to the mother tree. The parent tree supplies water and necessary nutrients. They are buoyant and float in the water for some time before rooting themselves on suitable soil (FAO 2000).

Biodiversity is the variety of life, including variation among genes, species and function traits. It is often measured as: richness, a measure of the number of unique life form; evenness, a measure of the equitability among life forms; and heterogeneity, the dissimilarity among life forms (Cardinale et al. 2012). Biodiversity is one of the factors to look at when it comes to mangrove forest because the forest has the necessary physicochemical characteristics, such as pH, temperature, nitrogen, phosphorus and more that organisms can inhabit and do reproduction. Biodiversity is a key factor in the environment because it provides sustainability in the area we live in.

Mangrove species diversity is well known for the larger animals and plants, but poorly known for micro-organisms and insects. A crucial aspect of biodiversity for mangrove management is that many species use the mangrove forest ecosystem only part of the time (e. g. fish, birds, crustaceans, shellfish) (Twilley & Robadue, 1993). Thus, the mangrove habitat supports many more species as visitors, or indirectly, and these support functions must be considered as part of conservation management. Because mangroves occupy the intertidal zone, they interact strongly with aquatic,

inshore, upstream and terrestrial ecosystems and in this way, mangroves help to support a diverse flora and fauna of marine, freshwater and terrestrial species (Macintosh & Ashton, 2002).

There are many species of mangroves that can be found in the Philippines. It has been estimated that there are 47 true mangrove and associated species belonging to 26 families. True mangroves grow in the mangrove environment; associated species may grow on other habitat types such as the beach forest and lowland areas (Melana & Gonzales, 1996).

In Kawit, Cavite, the mangroves are beneficial because they are located near the shore line which they can block the waves that will hit the seaside community as well as protect the wildlife present in that area during high tides, storm surges and typhoon. In this study, mangrove forest of Island Cove in Binakayan, Kawit, Cavite will be assessed to determine its potential in species diversity and effects of anthropogenic disturbances to its ecosystem. Hence, the study aimed to assess the flora and fauna of mangrove forest of Island Cove in Binakayan, Kawit, Cavite, specifically, to: 1) determine taxonomical classifications of flora and fauna up to species level; 2) identify anthropogenic and natural disturbances within the mangrove forest; and 3) determine the abundance and diversity of flora and fauna in the mangrove forest. This study can be used by the Local Government Unit of Cavite for awareness and in addition, information in managing and protecting mangrove forest that would lead private owners of the resort, to develop strategies on how to make use of natural resources beneficial to people as well as to the local government. Lastly, it can serve as baseline information for future researchers on the concept of biodiversity in mangrove forests.

MATERIALS AND METHODS

The study is quantitative and qualitative type of research designed to assess the species diversity of the mangrove forest in Binakayan, Kawit, Cavite, as well as the environmental conditions, species richness and abundance, and substrates that provides habitat for the organisms in the intertidal zone.

An ocular inspection of the study area was conducted twice during wet and dry seasons from August 2016 to January 2017. The researchers gathered and collected data during wet and dry seasons on September 30, 2016 and January 21, 2017, respectively. Study sites were established in the mangrove forests near the intertidal zones through convenience sampling. Water and soil appearance, odor, and texture for additional information regarding the species thriving in the area were observed.

Study Site

Figure 1. Island Cove showing sampling study site and Philippine Map (inset).

The study was conducted in Kawit, Cavite, which is a first-class urban municipality in the Philippines. It is located at 14.4333°N and 120.9000°E (Figure 1). It has a population of 78,209 people (NSO 2010) occupying a land area of 22.86 square kilometers (km^2). The mangrove forest is situated in a private-owned hotel, Island Cove, in Binakayan, Kawit, Cavite. The land area of its inhabitant is more or less 4 hectares according to the hotel management.

The mangrove forest in Binakayan, Kawit, Cavite, is a manmade forest that was introduced and owned by the father of the recent Governor of Cavite. They introduced this kind of plants in their area to prevent the water from the Manila Bay to hit the seaside community during high tides, storms and typhoons.

The study sites are prone to surges from Manila Bay and are contaminated by garbage wastes disposed by people from their water systems. These wastes are driven out to the Manila Bay and then to the landmasses such as the mangrove forests along Binakayan, Kawit, Cavite.

The first study site, Line 1, was near the shore line, elevated, with soft and pulpy substrates during wet season, while during dry season, substrates were solid and firm. Second study site, Line 2, substrate during the wet season, was moist, having a water depth of about two feet, while during dry season, it was soft and dry. Furthermore, the second study site, is consists of stagnant water. There is also presence of garbage which aggregates the water and becomes anoxic, meaning, that the water surrounding the area is polluted and has a foul odor due to absence of oxygen. There is also presence of benthic green algae.

Sampling Collection

Two study sites were established in the area for the determination of species. Study site, Line 1, and study site, Line 2. Each line was measured 100 m in length as basis for selecting random quadrats. Four quadrats with a measurement of 10 x 10 m were plotted in each of the study sites (Line 1 and Line 2) and collected all the species present inside each of the quadrats.

Before going to the study site, the researchers prepared the things needed for the collection of species samples such as gloves, cooler, zip-locked plastic bags, masks, straw strings, cutter/scissors, marker and masking tape. In the site, the researchers wore gloves and masks to prevent inhalation and skin contact with the species that was collected. Flora species samples were collected by carefully removing it at its node to prevent the plant to be destroyed and for easy identification of the species, while fauna species samples were carefully taken from its habitat to prevent disturbances to other species thriving in the area.

All collected species per quadrat were counted and recorded for measurement of species diversity index. Samples were placed in different zip-locked plastic bags with labels to prevent confusion and were placed inside the cooler for easy transportation of the samples.

Duration

The researchers gathered samples on September 2016 and January 2017 (wet and dry seasons, respectively) to observe species abundance and diversity, for it may increase or decrease in either dry or wet seasons.

Species Identification

Species collected per quadrat were counted and recorded and were initially identified by the researchers at the Emilio Aguinaldo College (EAC) School of Arts and Sciences (SAS) research laboratory using the following references: The Guide for Identification (Primavera 2009); Development and conservation of Philippine mangroves (Primavera 2000); Handbook of mangroves in the Philippines. Panay (Primavera 2009); Co's Digital Flora of the Philippines (Pelser et al. 2011); Shells of the Philippines (Springteen & Leobrera, 1986); and A Taxonomic Listing of Benthic Macro- and Megainvertebrates from Infaunal & Epifaunal Monitoring and Research Programs in the Southern California Bight (Cadien & Lawrence, 2013).

Verification for the flora species was done at the Jose Vera Santos Memorial Herbarium, Institute of Biology, University of the Philippines, Diliman, Quezon City, and for the fauna species, verification was done also by a Malacology Professor of the Institute of Biology, College of Science, University of the Philippines, Diliman, Q.C.

Data Analysis

Simpson's index (**D**) is a measure of diversity, which considers both species richness, and an evenness of abundance among the species present. It measures the probability that two individuals randomly selected from an area will belong to the same species (Sagar & Sharma, 2012). The formula for calculating D is presented as:

$$\boldsymbol{D = \frac{\sum ni(ni-1)}{N(N-1)}}$$

Where:

n_i = the total number of organisms of each individual species

N = the total number of organisms of all species

The value of **D** ranges from 0 to 1. With this index, 0 represents infinite diversity and, 1, no diversity. That is, the bigger the value the lower the diversity.

Table 1. Simpson's index with the level of diversity.

Simpson's Index (D)	Level of Diversity
0.09	Very High
0.10 – 0.50	High
0.51	Medium
0.52 – 1	Low

Relative Frequency was used to show the dominant flora and fauna found in the mangrove forests. To know the percentage, this formula was utilized;

$$P = \frac{x}{N}\, x\, 100$$

Where:

P = Percentage
x = Number of each estimated organisms
N = Total number of estimated organisms

After the verification of the collected species, the researchers tabulated and calculated the species samples using Simpson's Index and Relative Frequency (%) to measure the species diversity for each quadrant.

RESULTS AND DISCUSSION

Quadrat 4 of Line 1 had the highest number of collected species (Table 2) during the dry season with 48% (Figure 2B) of the total species collected. The most dominant species in Line 1 during the dry season was *Chronolaena odorata* with 8.66% (Table 2) while during the wet season was *Coccina grandis* with 16.94% of the total species richness. Line 1 had a very high level of diversity with a diversity index of 0.04 in quadrat 4.

Table 2. Relative frequency of species in Line 1 during wet and dry seasons (September 2016 and January 2017).

Wet season		Scientific Name	Dry season	
Species Abundance	Total Number of Species		Total Number of Species	Species Abundance
4.89%	30	*Acacia farnesiana*	10	0.73%
3.75%	23	*Achyranthes aspera*	73	5.36%
7.17%	44	*Aegiceras corniculatum*	66	4.84%
5.21%	32	*Ageratum conyzoides*	32	2.35%
0.00%	0	*Alteranthes sessilis*	64	4.70%
0.00%	0	*Apocynaceae*	47	3.45%
0.00%	0	*Avicennia marina*	15	1.10%
1.30%	8	*Azadirachta indica*	25	1.83%
0.00%	0	*Chloris barbata*	49	3.60%
3.09%	19	*Chromolaena odorata*	118	8.66%
0.00%	0	*Cissus incisa*	1	0.07%
16.94%	104	*Coccina grandis*	70	5.14%
5.86%	36	*Cucurbita maxima*	3	0.22%
0.00%	0	*Cyperus esculentus*	47	3.45%
6.19%	38	*Cyperus rotundus*	39	2.86%
0.00%	0	*Cyperus schomburgkianu*	45	3.30%
0.00%	0	*Derris trifoliata*	4	0.29%
0.33%	2	*Eclipta alba*	40	2.93%
7.65%	47	*Eleusine indica*	0	0.00%
0.49%	3	*Fimbristylis autumnalis*	17	1.25%
4.23%	26	*Graminea*	24	1.76%
7.49%	46	*Imperata cylindrica*	28	2.05%
0.00%	0	*Ipomoea pes-caprae*	26	1.91%
0.00%	0	*Justicia*	10	0.73%
0.81%	5	*Leucaena leucocephala*	14	1.03%
6.35%	39	*Luffa cylindrica*	10	0.73%
0.81%	5	*Lumnitzera racemosa*	14	1.03%
6.51%	40	*Malachra capitata*	29	2.13%
0.00%	0	*Malachra fasciata*	1	0.07%
0.00%	0	*Malvaceae*	14	1.03%
1.14%	7	*Mikania cordata*	2	0.15%
0.81%	5	*Momordia charantia*	63	4.62%
0.00%	0	*Morinda citrifoila*	34	2.49%
2.12%	13	*Operculina alata*	39	2.86%
0.33%	2	*Passiflora foetida*	110	8.07%
0.00%	0	*Pongamia pinnata*	44	3.23%
0.00%	0	*Prosopis Juliflora*	32	2.35%
0.49%	3	*Samanea saman*	11	0.81%
0.00%	0	*Scirpus cyperinus*	15	1.10%
1.30%	8	*Solanum biflorum*	5	0.37%
0.65%	4	*Synedrella nodiflora*	34	2.49%
0.00%	0	*Terminalia catappa*	13	0.95%
1.63%	10	*Tridax procumbens*	0	0.00%
2.44%	15	*Urena lobata*	17	1.25%
0.00%	0	*Verronia cinerea*	9	0.66%

Chronolaena odorata (weed) is a tropical and subtropical species of flowering and multi-stemmed shrub to 2.5 m (100 inches) tall in open areas. In shady areas it becomes etiolated and behaves as a creeper, growing on other vegetation. The plant is hairy and glandular, and the leaves give off a pungent, aromatic odor when crushed (Schmidt & Schilling, 2000). They are mostly spread by the wind, but can also cling to fur, clothes and machinery, enabling long distance dispersal. It is considered an invasive weed of field crops and natural environments in its introduced range (Struhsaker et al. 2005). It has been reported to be the most problematic invasive species within protected rainforests in Africa and it affects species diversity and plant's flammability in southern

Africa. In Western Africa the plant was accidentally introduced with forestry seeds and as an ornamental plant in Southern Africa (Uyi 2014).

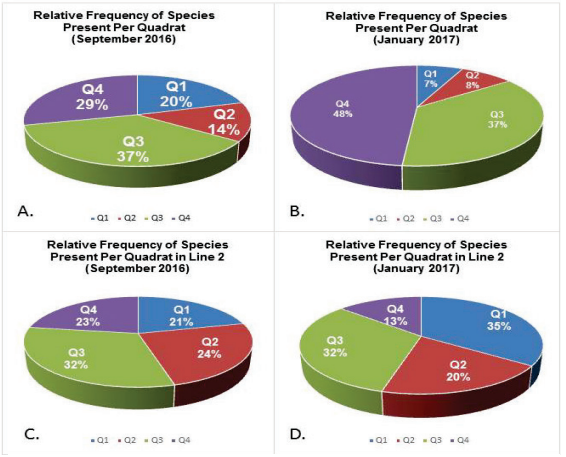

Figure 2. Percentage of species present per quadrat (September 2016 and January 2017, Island Cove, Binakayan, Kawit, Cavite.

The plant species grows on most soil types but prefers well drained soils in full sun. It has a competitive advantage over other plants in climates with distinct wet and dry seasons because it survives fires and grows back vigorously following rain.

Coccinia grandis, the ivy gourd, also known as scarlet gourd, tindora and kowai fruit, is a tropical vine. Its native range extends from Africa to Asia, including India, the Philippines, Cambodia, China, Indonesia, Malaysia, Myanmar, Thailand, Vietnam, eastern Papua New Guinea, and the Northern Territories, Australia (Linney 1986). This plant is a perennial climber with single tendrils and glabrous leaves (Tanaka 2007). It grows well in warm, humid, tropical regions. In Fiji, it occurs in cane fields, degraded and road sides. It can smother and kill native vegetation, including the mature trees. In Hawaii, where it is naturalized, it quickly spreads through disturbed sites, smothering both trees and understory vegetation and found at elevations of 0-245 m, whereas in China it can grow at elevations of up to 1100 m. (Muniappan et al. 2009; Pier 2013).

Table 3. Relative frequency of species in Line 2 during wet and dry seasons (September 2016 and January 2017).

Wet season		Scientific Name	Dry season	
Species Abundance	Total Number of Species		Total Number of Species	Species Abundance
26.84%	182	*Aegiceras corniculatum*	160	34.78%
26.84%	182	*Cassidula nucleus*	86	18.70%
20.94%	142	*Cerithidea californica*	57	12.39%
0	0	*Cerithidea rhizophorarum*	26	5.65%
0	0	*Telescopium telescopium*	29	6.30%
25.37%	172	*Terebralia sulcata*	102	22.17%

Quadrat 3 of Line 2 had the highest number of collected species (Table 3) during the dry and wet seasons with 32% (Figure 2 C and D) of the total species collected. The most dominant species in Line 2 during the dry season was *Aegiceras corriculatum* (Table 3) with 34.78% while during the wet season both *Aegiceras corriculatum* and *Cassidula nucleus* with 26.84% (Table 3) of the total species richness were abundant. Line 2 had a high level of diversity with a diversity index of 0.29 (Table 4) during the dry season in Quadrat 3.

Table 4. Diversity index and species richness of collected species in Line 2 during wet and dry seasons. (September 2016 and January 2017).

Scientific Name	Common Name	Family	Quadrant 1		Quadrant 2		Quadrant 3		Quadrant 4	
			Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Aegiceras corniculatum	River Mangrove / Khalsi	Primulaceae	18	18	58	54	51	72	55	16
Cassidula nucleus	Marine Snails	Ellobiidae	50	50	45	0	48	16	39	20
Cerithidea californica	California hornsnail	Potamididae	30	30	26	7	60	12	26	8
Cerithidea rhizophorarum	Water snail/ hornshell	Potamididae		9		8		9		0
Telescopium telescopium	Telescope Snail	Potamididae		6		4		15		4
Terebralia sulcata	Mud Creeper	Potamididae	46	46	37	18	55	24	34	14
Total species			144	159	166	91	214	148	154	62
Species richness			4	6	4	6	4	6	4	6
Diversity index			0.28	0.23	0.27	0.4	0.25	0.29	0.26	0.23
Level of diversity			High	High	High	High	High	High	High	High

Aegiceras corniculatum, the River Mangrove, also known as Black Mangrove, Khalesi, Saging-saging, and Tinduk-tindukan, is a shrub of about 2 to 3m tall with low spreading branches. Leaves simple, alternate and spirally arranged, stipules absent; petiole is frequently pink red in color. This plant can be seen along banks and creeks, and salt crystals can be seen on the upper surface of the leaf, secreted by salt glands. Bark is smooth, whitish to dark gray (Selvam et al. 2004) and are highly adaptable to climatic conditions and extreme salinity fluctuations that gives it high tolerance to high levels of salinity (Geisen et al. 2007).

Cassidula nucleus, the Mangrove Helmet Snail, is a species of air-breathing marine snail, a pulmonate gastropod mollusk in the family ellobiidae. Commonly found on mangrove resources where they directly depend on mangrove resources for their survival (Prasana et al. 2013). Commonly found between rhizophora and avicennia plants where they utilize mangrove resources and they get adapted to various sediment conditions, tidal fluctuations, varying pH, and salinity (Prasana et al. 2013). Plays also an important role in larva distribution, competition, predation, and trophic level. Its distribution, an abundance can be used as an ecological indicator toward environmental change in mangrove ecosystems. (Ariyanto et al. 2018). *Cassidula sp.* are also known pollution indicator species where they can be found on polluted areas (Satheeshkumar & Khan, 2012).

Different species of mollusks can be found in mangroves. Some of the mollusk species include the telescope snail *Telescopium telescopium*, mudcreeper *Terebralia palustris,* zoned horn shell *Batillaria zonalis* and the obtuse horn shell *Cerithidea obtusa* (Feller & Sitnik, 2002). The common mangrove bivalves include the toothless lucina *Anodontia edentula*, sunset silique *Siliqua radiata* and the gaudy asaphis *Asaphis deflorata* (Giesen et al. 2007). Mangroves are one of the productive areas of water bodies both ecologically and economically (Lebata-Ramos 2013). Arthropods are also present in the mangrove, the most common orders were found to be Hymenoptera, Diptera and Psocoptera (Giesen et al. 2007). Birds are also home to mangrove forests they use the mangroves, for example as roosts daily, main bird in mangrove forests are water birds (MacNae 1968). Crabs is abundant in the mangrove forests, the density of individual species per square meters can be found, especially of burrowing species of the genera Cleistocoeloma, Macrophthalmus, Metaplax, Ilyoplax, Sesarma and Uca (Calling- or Fiddler Crabs) (Giesen et al. 2007).

Figure 3. Anthropogenic and natural disturbances in Line 1 during wet and dry seasons (September 2016 and January 2017, Mangrove Forest, Island Cove, Binakayan, Kawit,

Anthropogenic disturbances (Figure 3) in Line 1 during wet season such as garbage and trashes, could be attributed to the water that comes from the bay during heavy rain fall. The presence of sanitary landfill near the shoreline of Cavite contributes to this garbage that would be flashed into the mangrove during storms and rainy season. Barangays along the lowland areas of the province including Binakayan (Su & Macawille, 2009) are especially vulnerable to hydro meteorological hazards such as typhoons where it is observed in flood maps that the area is highly susceptible to flooding. The area is also within vicinity to certain dumpsites, Kawit and Noveleta dumpsites, where the Kawit dumpsite is considered an open dumpsite that contributed to the introduction of garbage washed into the mangrove area (State of the Coasts of Cavite Province, 2017).

Inefficient waste management in the province of Cavite brings implications affecting the environment and public health of surrounding cities and municipalities. The lack of sanitary landfills, lack of waste management, and poor sanitation practices are noticeable in some parts of the province. The continuous growth in population creates rising generation rate and characteristics of solid wastes (Su & Macawille, 2009). In addition, attitude of local government officials towards the solid management is a primary concern due to the lack of engagement in mitigating solid wastes in the province. The lack of waste disposal sites in Cavite contributes to the unwanted flux of waste generation increase and due to this, the people in some communities will resolve on open dumping in areas where dumping is illegal (Su & Macawille, 2009). This generates unwanted waste to migrate to communities when heavy rains are prevalent during the wet season. For the natural disturbances, this would include stagnant water that becomes anoxic and anaerobic, thus making the area having a foul odor (Sperling 2007). During dry season, trashes and garbage are seen with a dry substrate.

Figure 4. Anthropogenic and natural disturbances in Line 2 during wet and dry seasons (September 2016 and January 2017), Mangrove Forest, Island Cove, Binakayan, Kawit,

Anthropogenic and natural disturbances (Figure 4) in Line 2 during the wet season such as garbage and trashes were seen very prominent around the area. Water was flashed into the mangrove forest when there is heavy rainfall and that would eventually become anaerobic condition (without oxygen) of the water leaving a very foul odor (Arceivala 1981). Organisms were hardly seen because of a high level of water. Organisms tend to stay in the mangrove trees and other higher places for them to survive. During dry season, the substrate in Line 2 is moist but still trashes and garbage were seen scattering around the area. Prominent organisms were seen at the soil substrates. Thus, there were more organisms collected due to the dry substrates.

The impact of climatic conditions like in wet and dry seasons greatly affects the mangrove vegetation and species diversity. Mangroves are known to occur in areas where the average annual temperature is at or above approximately 18ºC (Chapman 1976a; 1977) or that have absolute temperatures above 15ºC (Steenis 1958). Climatic conditions further affect mangroves, especially by influencing the salinity of the landward fringing (back- or hind-) mangroves, in wet seasons, water is abundant and salinity levels are high thus species thrive in wet seasons tend to hide while in dry seasons where water levels are low and species mostly thrive in that certain environment where requirements are adequate and by weather influence upon stream and river discharges, and affecting silt deposition along the coast.

Mangroves provide nursery grounds for many species such as fish, prawns and crabs, and support fisheries production (Melana et al. 2000). Hence, it is a habitat for the many commercially and recreationally important species and a habitat for other forms of wildlife including birds (Stewart & Fairfull, 2008). They also protect the environment by protecting coastal areas and communities from storm surges, waves, tidal currents and typhoons, they produce organic biomass (carbon) and reduce organic pollution in nearshore areas by trapping or absorption and they produce a good source of woods for housing materials, firewood and charcoal, and of poles for fish traps and produce food for many species from bacteria to big animals from their leaf litter and detrital matter

(Melana et al. 2000). In 1918, some 450,000 ha of mangroves had existed but has reduced to 117,000 hectares in the Philippines according to DENR 1995 statistics. Overtime, the Philippines has lost 70% of its mangrove forest, mostly due to fish pond conversion and development and other anthropogenic activities including cutting of mangroves for fuel wood and construction materials by coastal residents and throwing of wastes that lead to continued degradation of remaining forests (Walters 2004). Currently, there are studies and researches recommended to conserve and manage the mangrove forest by introducing protection and management strategies and plantation of NGOs, local residents and government units.

CONCLUSIONS

Mangrove Forest of Island Cove in Binakayan, Kawit, Cavite is disturbed and threatened with solid waste that comes from Manila Bay. There were more flora species in Line 1 than fauna species due to the soil substrate that makes flora to develop and grow well. The soil in Line 2 is anoxic, thus, few organisms can only be seen because they were threatened with lack of oxygen. There are more organisms such as snails attached to trees and rocks.

Despite the anthropogenic and natural disturbances that are present with in the mangrove forest, the man-made Mangrove Forest Ecosystem in Island Cove, Binakayan, Kawit Cavite is still well-diverse. It is then, very crucial to protect and preserve this man-made ecosystem by minimizing anthropogenic stressors and disturbances. Rehabilitation of the said ecosystem is highly recommended and should be prioritized to preserve flora and fauna species that are thriving in this ecosystem.

RECOMMENDATIONS

This research study could be a future reference on mangrove forest and its biodiversity, as well as for comparative study, for future researchers. Further study is recommended including climate change, soil and water analysis on the studied mangrove forest; for more relevant information on the biodiversity of the mangrove. For the community, it would encourage them in tree planting activities as they benefit from the mangrove forest that acts as a barrier of Cavite against flood and trashes from the Manila Bay; for the local government unit of Cavite, it would help them to be aware in protecting and managing biodiversity of the mangrove forest; and for the management, it would help them know that elevated barriers are important for the protection of mangrove forest ecosystem.

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