Asian Journal of Conservation Biology, July 2015. Vol. 4 No. 1, pp. 15-19 AJCB: FP0050
ISSN 2278-7666 ©*TCRP* 2015

Assessment of mangrove flora of Palaui Island Protected Landscape and Seascape (PIPLS) San Vicente, Sta. Ana Cagayan valley, Philippines

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(Accepted June 30, 2015)

ABSTRACT

The status and species composition of mangrove forest is a basic and pre-requisite for the management and conservation of mangrove resource. The study was conducted to determine the status and species composition of mangrove forests of Palaui Island Protected Landscape and Seascape (PIPLS), San Vicente Sta. Ana, Cagayan, Philippines. A Transect Line Plot (TLP) method was employed to obtain data on the structure of mangrove community. Results revealed that there were 16 true mangrove species belonging to 7 families and 10 associate species belonging to 9 families where *Rhizophora apiculata* was the densest species (23.36%), most dominant (22.5%), most frequent (17%) and has the highest importance value (62.88%). Mangrove forest is still in good condition with 53% crown cover, stand density of 2,335 trees/hectare and regeneration of 10 seedlings per plot. Three genera of *Rhizophora* were identified (*Rhizophora apiculata, Rhizophora mucronata*, and *Rhizophora stylosa*). Other genera of major and minor mangrove species are well distributed in the study area. The adaptability and diversity of mangrove species highly depends on favourable ecological and environmental conditions however; the anthropogenic and natural disturbances observed may possess a great threat to mangrove biodiversity.

Key words: Assessment, composition, mangrove, species, Palaui Island, Philippines

INTRODUCTION

The term mangrove describes the intertidal ecosystem or highly adopted plant families that live in the coastal environment (Tomlinson, 1986). The species composition and structure depend on their physiological tolerances and competitive interactions (Alongi, 2008). They are among some of the most productive and biologically important ecosystems of the world (FAO, 2007) because they provide wide range of economic and ecological functions as widely demonstrated by Archarya (2002), Kathiresan and Rajendran (2005).

However, the worldwide extensive clearing of mangroves over the last 50 years has caused many areas to vanished and degraded (Ashton and Macintosh, 2002) along with varied range of environmental factors like pollution and global climate change (Adeel and Pomeroy, 2002; Alongi 2002). Therefore, in order to support management and conservation objectives, ecological baseline of mangrove forest is required especially in Palaui Island. Studies on mangroves in the Philippines are numerous. Unfortunately, limited baseline information and studies on mangroves were conducted in Palaui Island yet it is one of the most diverse and large mangrove forests in the Province of Cagayan Valley Region. The total mangrove area of Palaui Island Protected Landscape and Seascape (PIPLS) is 105.5 hectares (DENR R02, 1994) which defines the landscape of the island but due to growing population and other varied range of natural and anthropogenic factors, it is not certain for this pristine mangrove forest not to be degraded. This typhoon-prone island is located within the Pacific Ring of Fire and the mangroves play significant role as bio-belting for tidal surges in the area.

Likewise, the knowledge of the exact species plant composition is a basic pre requisite in the management and conservation of the resource. Thus, a study on the species composition and status of mangrove forest was conducted.

MATERIALS AND METHODS

Location of the Study

The study site lies between 18°30’ to 18°35’ North latitude and 122°05’ to 122°10’ East longitude. It is bounded on the East by the Pacific Ocean, on the North and West by Philippine Sea and on the South by San Vicente Sta. Ana Strait (Figure 1). It has a length of 10

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kilometers long and width of 4.5 kilometers. It was declared as Marine Reserve in August 1994 under the category of Protected Landscape and Seascape based on RA 7586 known as the NIPAS Law and it is being managed by the Protected Area Management Board (PAMB-2010).

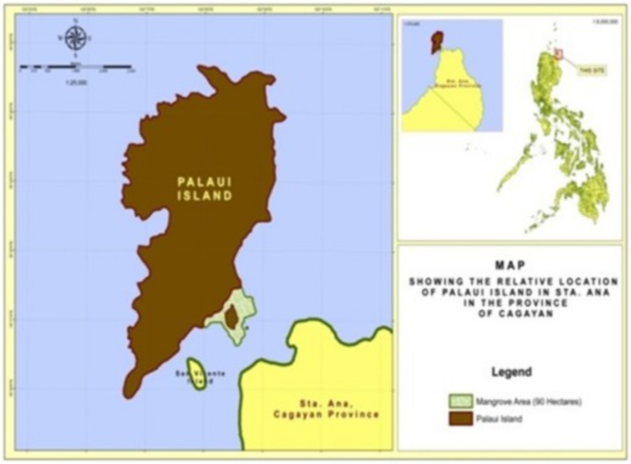

Figure 1. Map of Palaui Island Protected Landscape and Seascape San Vicente Sta. Ana Cagayan, Philippines.

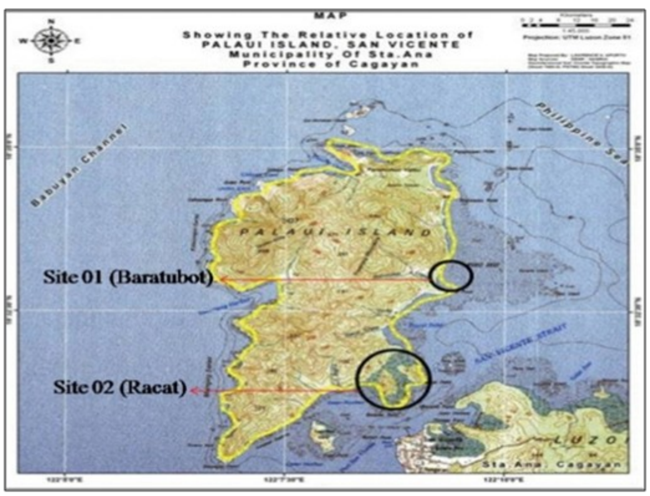

Figure 2. Map of Palaui Island showing the location of sampling sites

Line transect, plot sampling, and diameter breast height

Vegetation analysis was carried out in two blocks, Baratubot as Block 01 and Racat as Block 02 (Figure 2). Five (5) transect lines with a length of 110 meters were laid perpendicular to the shoreline especially in areas with abrupt changes of vegetation. A series of 10m x 10m quadrats were established along the transect line. Within each of the 10m x 10m quadrats, 1m x 1m quadrat were established equally distributed as regeneration plots. Within each strip transect and corresponding quadrats, individual mangroves were counted, identified, and recorded. Total height, crown cover, and diameter breast height were also measured. A tree caliper was used to determine the diameter of a tree and recorded as the basal area. A meter stick was used to measure the crown cover and height of the tree. For mangroves with irregularities, procedure of White *et al*. (2004) was followed.

Vegetation analysis

The data gathered were analyzed following the vegetation analysis formula of density, relative density, dominance, relative dominance, frequency, relative frequency, and importance value (IV). The latter provides the rank and order of mangroves thriving in a certain community and it is known to be a better index for the importance or function of species in its habitat rather than density alone (Odum and Barett, 2005; Kent and Coker, 1992; Kreb, 1985; Mueller-Dombois and Ellenberg, 1974; Rotaquio Jr, *et al*., 2007).

Actual observations, on the spot verbal and non structured interviews were employed to further determine the present state of the mangrove forest. Field guide of Lebata-Ramos (2013), handbook of Aragones *et al.* (1999) and other references were used to determine and identify the species. Photos were also taken to further confirm the species. The analysis is only limited to major and minor mangroves. Only listings were made on the associate mangroves due to the following reasons:

1. They are not real mangroves and are only disperesed naturally or accidentally from beach forest and upland areas and they are not true inhabitat of the mangrove forest.
2. They did not meet and satisfy the criteria as the real mangrove tree specified by Tomlinson (1986).

Total enumerations was only made to all mangrove associates and recorded as part of the observation.

Formula/equations used

The following formula was used based on the definitions on the books by White *et al*. (2004); Odum and Barett (2005); Cox (1996); Kent and Coker (1992); Krebs (1985); and Mueller-Dumbois and Ellenberg (1974).

Diameter Breast Height (m) = DBH/100

Diameter^2 = Diameter Breast Height x Diameter Breast Height

Basal Area = $D^2 \times 0.7854$

Crown Cover = $0.7854 \times (\text{Crown Diameter})^2$

$$\text{Population Density}_{\text{species}} = \frac{\text{No. of individuals}}{\text{Total area sampled}}$$

$$\text{Relative Population Density} = \frac{\text{Density of a species}}{\text{Total density of all species}} (100)$$

$$\text{Frequency}_{\text{species}} = \frac{\text{No. of plots in which a species occurs}}{\text{Total no. of plots/segments sampled}}$$

$$\text{Relative Frequency} = \frac{\text{Frequency value for a species}_{(100)}}{\text{Total frequency value for all species}}$$

$$\text{Dominance}_{\text{species}} = \frac{\text{Total basal area individual species}}{\text{Total basal area of all species}}$$

$$\text{Relative Dominance} = \frac{\text{Dominance for a species}_{(100)}}{\text{Total dominance for all species}}$$

Importance Value = Relative Frequency + Relative Density + Relative Dominance

RESULTS AND DISCUSSION

Field observations

Block 01 (Sitio Baratubot)

Mangrove forest in Block 01 is located at 18” 33’ 02.0 North latitude and 122” 09’19.9 East longitude. No logging observed except for the minimal cuttings of mangroves. Substrate was sandy gradually turning muddy towards the shore. In the landward part of the muddy mid portion, an old growth stand of mangroves dominated by *Avicennia marina* and *Avicennia officinalis* were found. An old growth of *A. officinalis* in the area was observed attaining more than 60 centimeters in diameter.

Conversely, the sandy-muddy portion of the area was dominated with *Rhizophora apiculata*, *Rhizophora mucronata, Rhizophora stylosa, Avicennia officinalis, Ceriops tagal,* and *Bruguiera gymnorrhiza*. The seaward portion was planted with a mix species of Rhizophora and Avicennia and these were already planted since 1993 when the Coastal Environmental Project (CEP) started. As observed, mangroves are not dense in this area, this could possibly due to its demographic location since it directly facing the Pacific Ocean and during typhoon season strong winds and high wave energy hit the mangroves which causes low recruitment of mangrove propagules and mature trees to be uprooted.

Block 02 (Sitio Racat)

Mangrove forest in Block 02 is located at 18” 31’ 46.8 North latitude to 122” 08’ 52.0 East longitude. The recent history of conversion of mangrove area to fishponds was observed and illegal cutting and logging was found. Mangroves were de-barked until the mangrove tree will die. As soon as the mangrove trees died, these will be burned for charcoal. Mangrove diebacks were also observed in the area, perhaps due to strong wave action and strong typhoons. Mangrove rehabilitation and old growth mangroves are found in this site. Presence of garbage and debris ranging from broken bottles, plastics, tin cans, rags and other non-biodegradable materials were observed. Flocks of Philippine wild ducks and some egrets were observed in the area. Destroyed dikes were also found planted with *C. tagal*. The site has sandy-muddy mudflats which are dominated by *R. apiculata, R. mucronata,* and *C. tagal.*

Generally, mangrove forest of PIPLS is very diverse represented by approximately 26 species of mangroves, 12 of these are major species, 4 minor species and 10 mangrove associates (Table 1). Tomlinson (1986) stated that major mangrove species are recognized because of their distinct features like complete fidelity to the mangrove environment, they have ability to form pure stand, they have major role in the community, have the morphological specialization that keeps them to be adaptive in their environment, have the ability excrete saltwater, and are taxonomically isolated from terrestrial mangroves.

Worldwide, the categorization of mangroves by Tomlinson (1986) indicates that there are 34 species of major mangroves, 20 species of minor mangroves and 46 species of mangrove associate. It was also confirmed by Zamora (1995) that there are 17 species of major mangroves, 12 species of minor mangrove and 40 species of mangrove associates known to occur in the country wherein there are 94 species of vascular flora in mangals and associated coastal communities. Considering this available data, Palaui Island shares 35% of the major mangroves species worldwide (12 species out of 34 species from Tomlinson’s list) and shares 71% of the major mangroves species in the Philippines (12 species out of 17 species from Zamora’s list).

On the other hand, minor mangrove species share only 20% percent of the worldwide mangrove species (4 out of 20 species from Tomlinson’s list) and 33% in the country (4 out of 12 from Zamora’s list).

Of the 16 true mangroves species subjected for analysis, *R. apiculata* had the highest relative density; relative frequency, relative dominance and importance value of 23.36%, 17%, 22.5%, and 62.88%, respectively (Table 2). On the other hand, *Camptostemon philippinense* received the lowest rank in terms of relative density, relative frequency, relative dominance, and importance value of 1.09%, 2.25%, 0.64%, and 3.98%, respectively.

R. apiculata was observed to occur in all plots and dominated the mangrove forest which could have the highest contribution to energy cycle of the ecosystem (Smith, 1992). The domination of the species could probably due to muddy substrate which is favorable for its growth (Hogarth, 1999) since most of the area is occupied with muddy portion. According to Buot and Sinfuego (2008), the extensive root system of the Family Rhizophoraceae contributed a lot to its adaptability in an otherwise stressful habitat. Mangrove seedlings and saplings of the dominant species also contributed to the recruitment of mangrove in Palaui Island. A total number of 558 seedlings and 967 saplings of *R. apiculata* were recorded and only few were recorded for other mangrove species in the area.

Generally, the status of the mangrove forest is still in good condition as reflected by its 53% crown cover even slight disturbances and few cuttings were observed. The stand density is 2, 3345 trees per hectare with 10 regeneration of seedlings per plot.

Threats to mangroves

The mangrove forest of Palaui Island is subjected to natural and anthropogenic disturbances. Mangrove trees

Table 1. List of mangrove species recorded in Palaui Island Cagayan Valley Region, Philippines

Scientific Name	Local Name	Family Name
Major Mangrove Species		
Avicennia officinalis L.	Api-api	Avicenniaceae
Avicennia marina (Forsk.) Vierh.	Bungalon	Avicenniaceae
Rhizophora mucronata Lamk.	Bakawan Babae	Rhizophoraceae
Rhizophora apiculata BI.	Bakawan Lalaki	Rhizophoraceae
Rhizophora stylosa Griff.	Bakawan Bato	Rhizophoraceae
Bruguiera gymnorrhiza (L.) Lamk.	Busain	Rhizophoraceae
Kandelia candel (L.) Druce	Candel	Rhizophoraceae
Bruguiera parviflora (Roxb.)	Langarai	Rhizophoraceae
*Ceriops decandra (*Griff.) Ding Hou	Malatangal	Rhizophoraceae
Ceriops tagal (Perr.)	Tangal	Rhizophoraceae
Sonneratia alba Griff.	Pagatpat	Sonneratiaceae
Sonneratia caseolaris (L.) Engler	Pedada	Sonneratiaceae
Minor Mangrove Species		
Camptostemon philippinense (Vidal) Becc.	Gapas-gapas	Bombacaceae
Excoecaria agallocha (L.)	Buta-buta	Euphorbiaceae
Osbornia octodonta	Tawalis	Myrtaceae
*Aegiceras floridum (*Roemer and Schultes*)*	Tinduk-tindukan	Myrsinaceae
Associate Mangrove Species		
Terminalia catappa L.	Talisay	Combretaceae
Cocos nucifera L.	Niyog	Arecaceae
Pandanus tectorius ex Z.	Pandan	Pandanaceae
Cerbera manghas L.	Baraibai	Apocynaceae
Casuarina equisetifolia Forst. and Forst.	Agoho	Casuarinaceae
*Barringtonia asiatica (*L) Kurz.	Botong	Lecythidaceae
Hibiscus tiliaceus L.	Malubago	Malvaceae
Acanthus ilicifolius L.	Diluario	Acanthaceae
Instia bijuga (vesi)	Ipil	Fabaceae
Pongamia pinnata (L.)	Bani	Fabaceae

Table 2. Vegetation analysis of mangrove species recorded in Palaui Island Cagayan Valley, Philippines

Species	PD	RPD	F	RF	D	RD	IV	Rank
Avicenia officinalis L.	0.116	11.6	0.53	9.32	1.3	15.7	36.58	3
Rhizophora mucronata Lamk.	0.179	17.91	0.85	15.1	1.41	16.9	49.88	2
Camptostemonphilippinense (Vidal) Becc.	0.011	1.09	0.13	2.25	0.05	0.64	3.98	16
Rhizophora stylosa Griff.	0.11	10.98	0.58	10.3	0.83	9.95	31.22	4
Rhizophora apiculata Bl.	0.234	23.36	0.96	17	1.88	22.5	62.88	1
Avicenia marina (Forsk.) Vierh.	0.047	4.673	0.33	5.79	0.39	4.67	15.13	6
Bruguiera gymnorrhiza (L.) Lamk.	0.029	2.882	0.27	4.82	0.37	4.48	12.19	8
Ceriops decandra (Griff.) Ding Hou	0.019	1.869	0.15	2.57	0.18	2.2	6.638	13
Sonneratia alba Griff.	0.025	2.492	0.24	4.18	0.3	3.12	9.789	11
Bruguiera parviflora (Roxb.)	0.03	2.96	0.24	4.18	0.19	2.28	9.423	12
Sonneratia caseolaris (L.) Engler	0.039	3.894	0.16	2.89	0.29	3.46	10.25	10
Ceriops tagal (Perr.)	0.033	3.271	0.29	5.14	0.2	2.35	10.76	9
Excoecaria agallocha (L.)	0.021	2.103	0.11	1.93	0.18	2.16	6.187	14
Kandelia candel (L.) Druce	0.062	6.231	0.33	5.79	0.42	5.01	17.03	5
Osbornia octodonta	0.017	1.713	0.13	2.25	0.11	1.3	5.263	15
Aegiceras floridum (Roemer and Schultes)	0.03	2.96	0.36	6.43	0.28	3.39	12.78	7

PD – Population density; RPD – Relative population density; F – Frequency; RF – Relative frequency;
D – Dominance; RD – Relative Dominance; IV – Importance value

are naturally uprooted due to high wave energy that hit the shoreline especially during typhoon. Mangrove propagules are also uprooted and could not easily established themselves on the muddy ground due to high current movement. Some portions of the mangrove area have been cleared for fishponds and other domestic purposes. Wastes are also dumped on the mangrove forest. De-barking of mangrove trees for charcoal making was also observed. The absence of mangrove management plan in the area somehow affects the state of the mangrove forest.

CONCLUSION

Based on the result of the study, it was concluded that the adaptability, diversity and dominance of mangrove trees highly depends on the ecological and environmental conditions of the area. The diversity of mangrove can also occur in small mangrove ecosystem as long as the ecological and environmental factors are all favorable for the mangroves to grow. However, threats ranging from improper waste disposal, cutting activities, debarking for charcoal and disturbance of environment affects the stands of mangroves in the area specifically mangroves with highest importance value.

ACKNOWLEDGEMENT

The authors would like to thank the Department of Environment and Natural Resources (DENR) Region 02 personnel and staff and the Protected Area Management Board (PAMB) of Palaui Island San Vicente, Sta. Ana, Philippines. The study was financially supported by Department of Science and Technology – Accelerated Science and Technology and Human Resource Development Program.

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