Mangrove Assessment of Sasmuan Bangkung Malapad Critical Habitat and Ecotourism Area (SBMCHEA)

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I. INTRODUCTION

Mangrove is a type of forest found along tidal mudflats and along shallow water coastal areas extending inland along rivers, streams and tributaries where water is generally brackish (Melana, et al., 2000). They grow well in tropical countries like the Philippines, and are an important part of the coastal and marine ecosystem that includes the seagrass and the coral reefs. Of the world's more than 70 mangrove species, around 46 species are known to occur in various parts of the country.

Mangroves have a variety of ecological and economic benefits by: 1) providing nursery grounds for aquatic resources such as fish, prawns, crabs, 2) producing leaf litter and detrital matter that nourish marine species, 3) protecting the environment and coastal areas and communities from storm surges, waves, tidal currents and typhoons, 4) producing organic biomass and reducing organic pollution, and by 5) serving as recreational grounds for bird watching activities (Melana, et al., 2000).

Mangrove forests are as considered major coastal resources that greatly contribute to the country's economy and in the maintenance of ecological balance, as these are one of the most productive and bio-diverse wetlands on earth. They are important ecosystems providing wood, food, fodder and medicine. A wide range of fish and shellfish depends on these coastal forests. Mangroves also help protect coral reefs against siltation from upland erosion and also provide shoreline protection from storm surge and typhoons.

Despite their importance, mangrove forests continue to face threats, such as deforestation and rapid expansion of aquaculture development (Cañizares & Seronay, 2016). Other threats include pollution, siltation, and sea level rise (Melana, et al., 2000).

In Sasmuan, mangroves play an important role in nurturing biodiversity. The town's mangrove islet, now known as the Sasmuan Bangkung Malapad Critical Habitat and Ecotourism Area (SBMCHEA), used to have plain mudflats in sight. The eventual growth of mangroves in the SBMCHEA paved the way for it to become a sanctuary

for various species of flora and fauna. Therefore, there is a need to assess SBMCHEA's existing mangrove species so as to help preserve and protect the coastal resources dependent on the mangrove forests in the area.

The conduct of mangrove assessment at the SBMCHEA is essential in ensuring the proper management and rehabilitation efforts of the different concerned entities for sustaining the area's biodiversity conservation. This would generate data and information to serve as basis for sustainable interventions for future plans and programs and in the formal declaration of the Sasmuan Bangkung Malapad as a Critical Habitat and Ecotourism Area.

II. MATERIALS and METHOD

The existing mangrove stand of the SBMCHEA covers an area of approximately 13 hectares, with geographical coordinates 14° 56' 19" North and 120° 36' 58" East. Located at the mouth of the Pasac River, the SBMCHEA is situated at Barangay Batang 2nd of the municipality of Sasmuan, bounded on the north by Guagua, on the east by the towns of Masantol and Macabebe, on the west by the town of Lubao, and on the south by the Manila Bay.

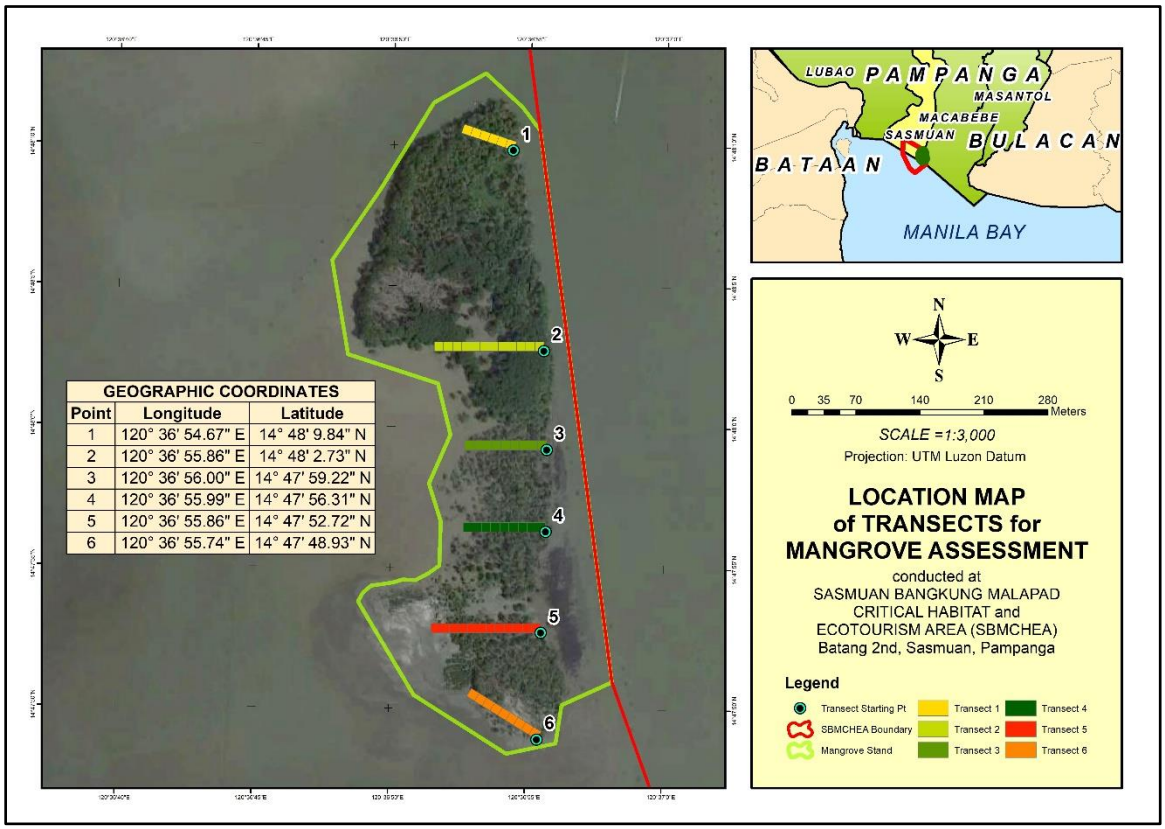

Figure 1. *Map showing the location of the transects for the mangrove assessment of the SBMCHEA,*

Prior to the conduct of the assessment, a leveling-off training on mangrove assessment on April 17-18, 2017 was facilitated by the DENR for the composite assessment team composed of DENR, BFAR, LGU and fisherfolk representatives. Information compiled includes maps generated by DENR from previous assessment and knowledge of the area by the barangay residents that frequent the area. The leveling-off training capacitated the members of the assessment team on mangrove species to ensure a standardized identification of the local name of each species prior to field work. The field activity was carefully planned for the efficient use of time, personnel and materials needed. Physical factors of the area were taken into consideration such as day time of low tide; altitude, substrate, wilderness and safety of the identified sites to be assessed; and docking area for boat to be used in transporting and fetching the assessment team. Since the assessment area is an hour away travel from the town proper, preparations such as assessment materials, food and accommodation and proper attire for assessment were secured (DA-BFAR, 2017).

The actual assessment was conducted at the SBMCHEA for three (3) days from May 16-18, 2017. Mangrove species inside each 10m x 10m quadrat along the transect line were identified, its height measured and estimated, diameter at breast height (DBH) of mangrove trees with defined trunk was also determined. Two readings of its crown diameter were recorded on the prepared field data sheet. Difference of a seedling, sapling and a mature tree were noted, e.g. seedling is up to 1 m height and a trunk size less than 4 centimeter (cm) in diameter, sapling is greater than 1 m height and a trunk size of 4 cm in diameter while a mature tree is greater than 1 m height and a trunk size greater than 4 cm in diameter. Also noted were the number of seedlings and saplings (regenerations) found inside the 1 m x 1 m quadrats which are established in two corners and middle of each 10m x 10m quadrat. Series of 10 m x 10 m quadrats along the transect line were measured until the transect line meets the open sea or end of mangrove area. After the first transect, series of transect lines were established perpendicular to the baseline performing the same data collection and measurements representing the mangrove area were covered/represented (DA-BFAR, 2017). Data gathering for mangrove assessment is illustrated in the next figure.

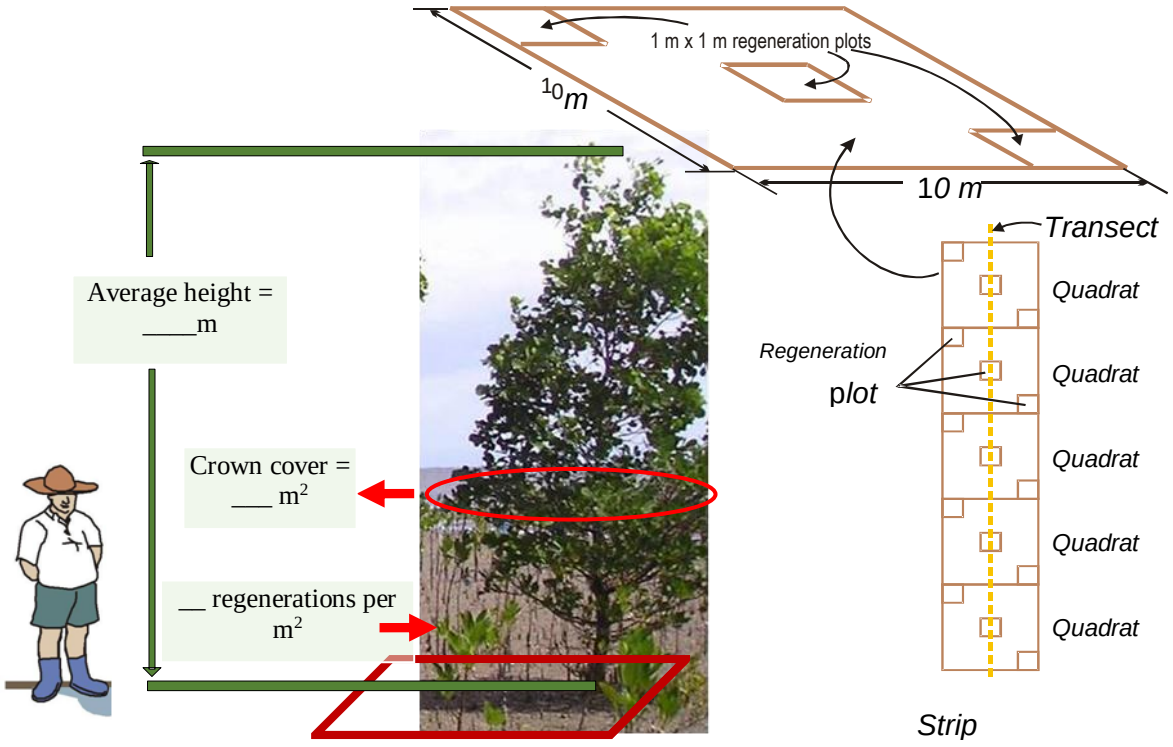

Figure 2. *Mangrove assessment establishing quadrat and strip transect (right side); assessment output parameters (left side) (Deguit et al, 2004).*

Collected data from the field were transcribed from the data sheet or writing slates into a tabulated form. Data processing and analysis were performed for discussion in the report, using the following formula:

- Crown diameter (2 measures) - the average of the crown width at the widest point and a second width measurement made 90° to the diameter at the widest point.
- Crown cover is calculated using the formula $\pi/4d^2$ or $0.7854d^2$ (d as the total crown diameter)
- To get the crown cover for each tree = 0.7854 x (average crown diameter)^2
- To get percent crown cover: $\left\{\frac{\text{Total crown cover of all trees}}{\text{Total area sampled}}\right\} \times 100$
- To get the average height = Total height of all trees recorded

- Total number of trees recorded per transect, then total per site
- To get the regeneration per m^2 = Total regeneration count

- To get the regeneration per m^2 = $\frac{\text{Total regeneration count}}{\text{Total number of regeneration plots}}$

Data per transects were then consolidated to represent sites, then sites summarized to provide an overview condition of the mangrove habitat. The derived parameters were analyzed based on the criteria and condition below:

Table 1. Criteria for Determining Condition of Mangrove.

CONDITION	CRITERIA
Excellent	76% and above in % Crown Cover 1 Regeneration per m^2 Above 5m in average tree height Undisturbed to negligible disturbance
Good	51% – 75% Crown Cover 0.76 – <1 regeneration per m^2 3m – <5m average height of trees Slight disturbance and few cuttings
Fair	26% – 50% Crown Cover 0.50 – 0.75 regeneration per m^2 2m – <3m average height of trees Moderate disturbance and noticeable cuttings
Poor	0 – 25% Crown Cover <0.50 regeneration per m^2 <2m average height of trees Heavy disturbance/ cuttings/ pollution, rampant conversion to other uses, nearly destroyed

The mangrove habitat assessment establishes landward transect stations perpendicular to the shoreline. Using a GPS device to mark location, a transect walk was undertaken to take the landward extent of the mangrove habitat. Mangrove trees were identified as well as other organisms found in the habitat as well. With obtained GPS location coordinates, area is mapped and generated using Google Earth (DA-BFAR, 2017).

III. RESULTS and DISCUSSION

Species Composition

Based on the six (6) transect stations assessed, results show that there are nine (9) mangrove species belonging to five (5) families found in transect assessed. These

are *palapat asu*(*Sonneratia alba*), *bakawang lalaki* (*Rhizophoraapiculata*), bakawang babae (*Rhizophora mucronata*), *palapat tutu* (*Sonneratia caseolaris*) *dalwari baligtad* (*Acanthus ilicifolius*), *dalwari masuksuk (Acanthus ebracteatus)* and *dalwari bilug* (*Acanthus volubilis*), apiapi (*Avicennia rumphiana* and *Avicennia alba*) and nipa (*Nypa fruticans*). A total of 944 trees were counted. The list of observed mangrove species is shown in Table 2. Figure 5 presents the percent composition of mangrove species. An inventory of mangrove species was also prepared and described in Table 3.

Table 2. Species composition and conservation status of mangroves in SBMCHEA

No.	Scientific Name*	Common Name*	Family Name*	Conservation Status (IUCN*)	Percent Compo-sition
1	*Acanthus ebracteatus*	Dalwarimasuksuk	*Acanthaceae*	*Least concern*	1.91%
2	*Acanthus ilicifolius*	Dalwaribaligtad	*Acanthaceae*	*Least concern*	2.01%
3	*Acanthus volubilis*	Dalwaribilug	*Acanthaceae*	*Least concern*	1.17%
4	*Avicennia alba*	Apiapi	*Avicenniaceae*	*Least concern*	0.11%
6	*Nypa fruticans*	Sasa	*Palmae*	*Least concern*	0.11%
7	*Rhizophora apiculata*	Bakawang-lalaki	*Rhizophoraceae*	*Least concern*	24.36%
8	*Rhizophora mucronata*	Bakawang-babae	*Rhizophoraceae*	*Least concern*	13.35%
9	*Sonneratia alba*	Palapatasu	*Lythraceae*	*Least concern*	50.21%
10	*Sonneratia caseolaris*	Palapat tutu	*Lythraceae*	*Least concern*	6.78%

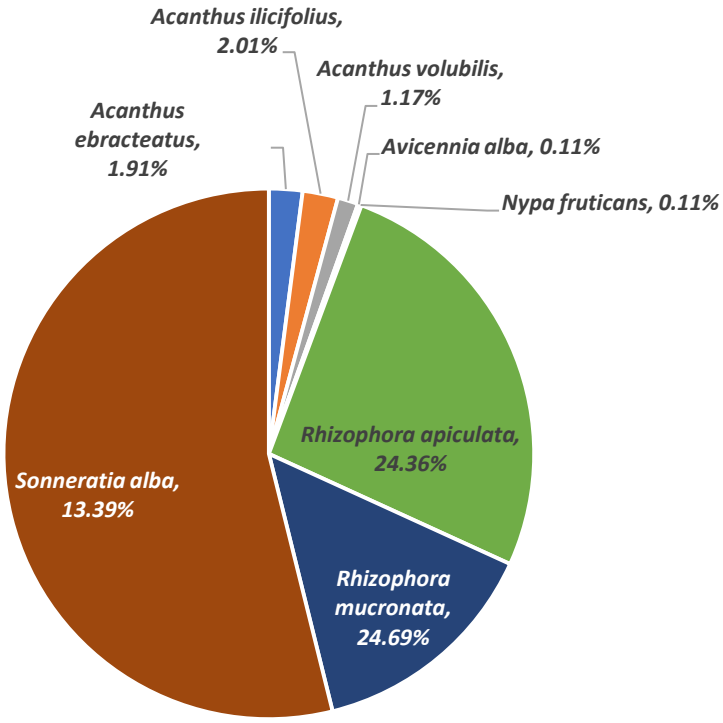

Figure 3. *Percent Composition of Mangrove Species at SBMCHEA*

Table 3. Inventory and description of mangrove species found in Brgy. Batang Dos, Sasmuan, Pampanga (2017).

No.	Scientific Name	Name and IUCN Status	Description* and Location**
1	*Acanthus ebracteatus (AE)*	Common Name: Dalwari masuksuk Family Name: *Acanthaceae* IUCN Status: Least concern	These are erect shrubs with thick, stiff stems and nodes (leaf insertions) with sharp spines. Leaves are called mangrove thistle or sea holly because leaves are serrate, deeply lobed with sharp spines; dark green and shiny. The petals of the flowers are white with shorter inflorescence. Location: Transect 1
2	*Acanthus ilicifolius (AI)*	Common Name: Dalwari baligtad Family Name: *Acanthaceae* IUCN Status: Least concern	These are low, sprawling shrubs with thick, stiff stems and spiny nodes. Leaves are called mangrove thistle or sea holly with serrate margins, slightly lobed with sharp spines that is pale to yellow green and glossy. The petals of the flower is light blue with purple hue and longer inflorescence. Location: Transect 1
3	*Acanthus volubilis (AV)*	Common Name: Dalwari bilug Family Name: *Acanthaceae* IUCN Status: Least concern	These are semi-erect to sprawling, climbing shrubs with slender stems and nodes unarmed or with 2 small spines. The margins of the leaves are usually smooth in younger leaves, older ones may have small spines and is colored dark green. The petals of the flower is white with shorter inflorescence. Location: Transect 1
4	*Avicennia alba (AA)*	Common Name: Apiapi Family Name: *Avicenniaceae* IUCN Status: Least concern	Medium-sized trees, which tolerate high salinity and colonize the soft, muddy banks of rivers and tidal flats. The tree's usual location is low intertidal, marine. Leaves are pointed, slender and its underside is whitish to silver. The flowers are small, light orange with subtle scent. Fruits are distinctly elongated, pointed, chili-like and pale green. Bark are sooty black and rough. Location: Transect 5
5	*Avicennia marina (AM)*	Common Name: Apiapi Family Name: *Avicenniaceae* IUCN Status: Least concern	The most widely distributed mangroves forming stands located at low to mid-intertidal marine to intermediate estuarine. Leaves are smaller, dark green to yellow, blades flat to curly. Flowers are small, yellow, slight scent. Fruits are heart-shaped with beak, light green to yellow, slightly hairy. Bark are shiny, flaky, light green to light brown.

No.	Scientific Name	Name and IUCN Status	Description* and Location**
			Location: outside transects, near Transect 5
6	*Avicennia rumphiana (AR)*	Common Name: Apiapi Family Name: *Avicenniaceae* IUCN Status: *Vulnerable*	Medium to large trees, located at mid-intertidal to back mangrove, also near upstream estuarine creeks. Leaves are rounded, undersurface brownish and hairy, terminal leaves point upwards. Flowers are small, darker yellow, distinct scent. Fruits are small, heart-shaped, yellowish-brown and hairy. Bark are light to dark and rough. Location: Transect 7, outside transect and near Transect 5
7	*Nypa fruticans (NF)*	Common Name: Sasa Family Name: *Palmae* IUCN Status: Least concern	The only palm among mangrove, *Nypa fruticans* that forms extensive belts or individual plants found in mixed mangrove communities. It has creeping stems called rhizomes from which tall compound leaves arise. Commercially important for many uses. Location: Transect 1
8	*Rhizophora apiculata (BL)*	Common Name: Bakawang-lalaki Family Name: *Rhizophoraceae* IUCN Status: Least concern	Medium to tall trees reaching 20 m located at low to mid-intertidal to marine. Leaves are narrow, dark red interpetiolary stipules. There are 2 sessile flowers on short (1-2 cm) peduncle. Propagules are up to 30 cm long, dark green, smooth. Location: Transect 1, 2, 3, 4 and 5
9	*Rhizophora mucronata (BB)*	Common Name: bakawang-babae Family Name: *Rhizophoraceae* IUCN Status: Least concern	Medium to big trees reaching 15m to 30m located at low to mid-intertidal marine to estuarine. Leaves are broadest, light green interpetiolary stipules. Flowers are pendulous, stalk with 6-8 flowers; short style. Propagules are the largest up to 80 cm long, green to dark green and warty. Location: Transect 1, 2, 3, 4 and 5
10	*Sonneratia alba (SA)*	Common Name: Palapat asu Family Name: *Lythraceae* IUCN Status: Least concern	Pioneering species of medium to large trees, located at seaward; low to mid-intertudal, high salinity and associated with *A. marina*. Leaves have big rounded shape, with thick, light green petiole. Flowers have white filaments and petals. Fruits are smooth with calyx lobes reflexed or spread out. Seeds are large, U to V-shaped and pointed. Location: Transect 1, 2, 3, 4, 5 and 6
11	*Sonneratia caseolaris (SC)*	Common Name: Palapat tutu	Prominent trees located at low to mid-intertidal, along upstream rivers, low salinity found with *N. fruticans.* Leaves are smaller,

No.	Scientific Name	Name and IUCN Status	Description* and Location**
		Family Name: *Lythraceae* IUCN Status: Least concern	elliptical, thin, reddish petiole, end branches drooping. Flowers have filaments with red base and white tips and red petals. Fruits are shiny, top-shaped with long style; calyx reflexed; fruit edible. Seeds have shape similar to, but 1/4 the size of *S. alba.* Location: Transect 1, 2, 3, 4 and 5

* Description is derived from Primavera J.H., R.S. Sadaba, M.J.H.L. Lebata and J.P. Altamirano. 2004. **Handbook of Mangroves in the Philippines - Panay**. SEAFDEC Aquaculture Department, Iloilo, Philippines. 106 pp.

** Location is based on results of assessment.

Relative Abundance Percent

The top three (3) dominant mangrove species are *palapat asu* or *Sonneratia alba* (*S. alba*) at 50.21%, *bakawang lalaki* or *Rhizophora apiculata (R. apiculata)* at 24.36% and *bakawang babae* or *Rhizophora mucronata (R. mucronata)* at 13.35%. Relative abundance of mangrove species is presented here emphasizing dominant and species with low values. Meanwhile, three species with noted low value are: *Avicennia alba* or apiapi at 0.11% and *Nypa fruticans* or *sasa* at 0.11%.

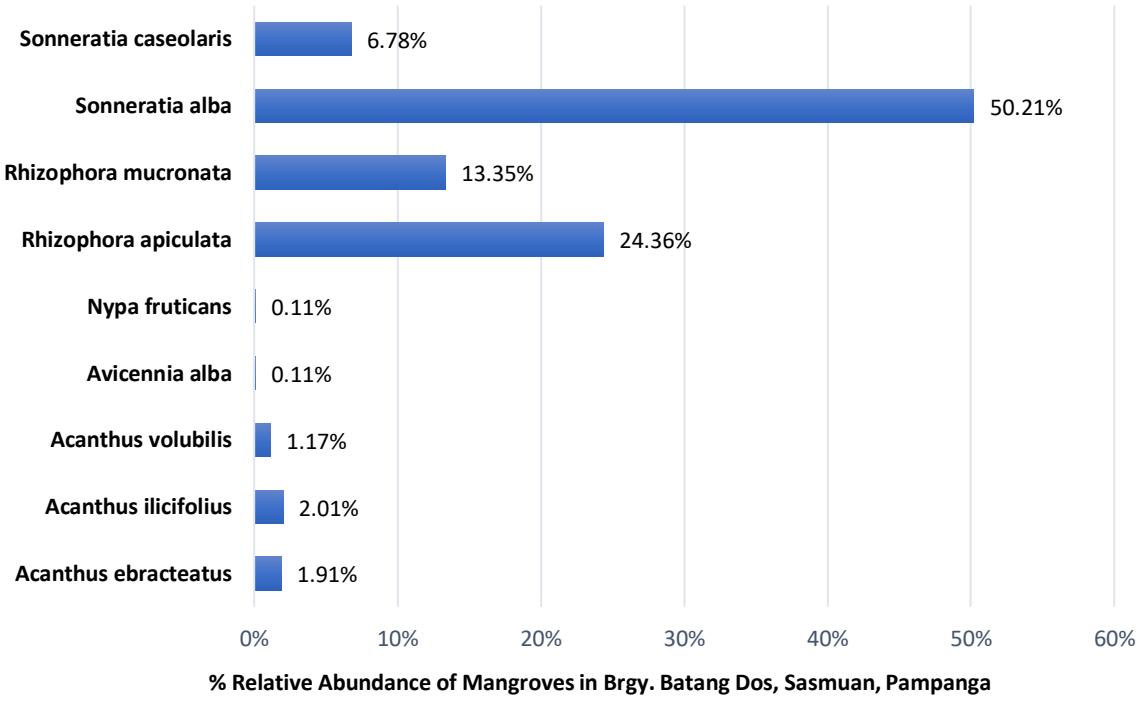

Figure 4. *Mangrove area per transects assessed in SBMCHEA*

Being the most dominant mangrove species, *S. alba* mangrove trees are found in clusters that is vastly distributed all over Bangku from the southern portion or seaward most portion to the center and northern part of the islet. They dominate the seafront, exhibiting territoriality of the area, precluding growth of any *Rhizophora spp* seedlings that have grown in the area. Taller *S. alba* tree releases plant sap or resin on the leaves of *Rhizophora* seedlings infesting its leaves, thereby killing the plant through time. The team note that there was a plantation of *Rhizophora spp* trees *a*bout five (5) meter high with intertwining stilt roots after the *S. alba* territory in Transect 6 on the seaward most portion of Bangku. These *Rhizophora* are mature enough to withstand the territoriality of the *S. alba*. Meanwhile, patches of *S. alba* were observed along the boardwalk at a random interval with *R. mucronata* and *apiculata* at the center or muddy part of the stretch of the transect south of the boardwalk. Then *S. alba* dominates again at the center of the islet, stretching from end to end of the mangrove forest exhibiting territoriality. Then just after the shrubs of *Acanthus spp*., there were patches of *S. alba* trees again bordering the northern portion. *R. apiculata* and *mucronata* trees are mostly located on the inner part of Bangku.

The wide distribution of *S. alba* is attributed to the characteristics of its seeds because it is light and could be vastly distributed by water current, meanwhile propagules of *Rhizophora* are heavy and may need a favorable muddy substrate to settle down. Regeneration observed inside the transects assessed were *Rhizophora* because their propagules are heavy.

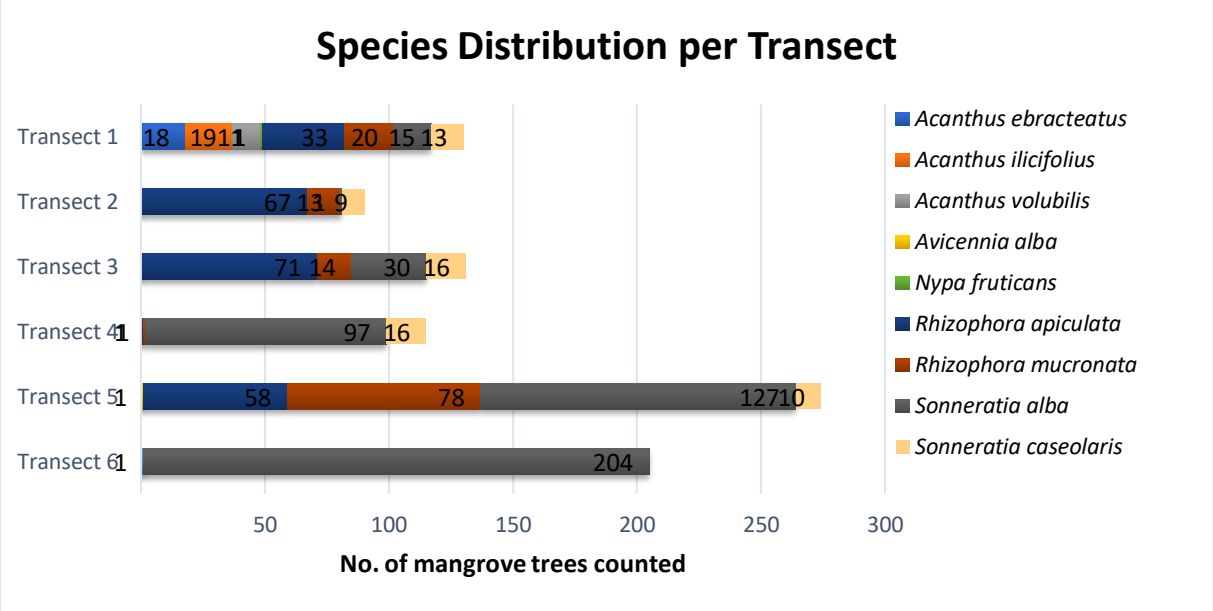

Figure 5. *Mangrove area per transects assessed in SBMCHEA*

As per species distribution per transect presented in Figure 7, the diverse area is located on the northern portion, edge of Bangku islet having 7 mangrove species while the *S. alba* territory could be found in Transect 6 and 4. Rhizophora territory is found in Transect 2 and 3. The longest transects assessed is Transect 5 while the shortest is Transect 2.

Biodiversity Index

To analyze the data gathered from the Biodiversity assessment the following parameters was used a) Frequency b) Relative Frequency c) Density d) Relative Density and was calculated using the formula below

a) Frequency (fi) = $\frac{\text{No. of occurrence}}{\text{Total no. of plots}}$ X 100

b) Relative frequency (Rfi) = $\frac{\text{Frequency of species}}{\text{Frequency of all species}}$ X 100

c) Density (Di) = $\frac{\text{Number of species}}{\text{Total area of plots}}$

d) Relative Density (RDi) = $\frac{\text{Density of species}}{\text{Density of all species}}$ X 100

While, the value of H was computed using the Shannon index Formula presented below

$$H = \sum_{i=1} pi\ (\log pi)\ ;$$

Wherein:

H = index of species diversity
S = no. of species
pi = proportion of total sample belonging to the nth species (Importance value)

Using the Shannon index formula, the Biodiversity index calculated was 1.36, based from the 944 individuals out of the 9-different species recorded. Also, through the Shannon index values, (H) can ranges from 0-7 using the natural log (versus log10).

If the calculated value of H is near 0, it indicates that every species in the samples is the same, on the other hand if the calculated value is near 7; it indicates that the number of individual is evenly distributed between the 9-species recorded. Using the calculated data, the value of H resulted to 1.36, which indicates for every plot there is a possibility of 1 species can be encountered in the area.

Table 4. Computed Biodiversity index of Floral species observed within SBMCHEA

Species	Total Count	Occurrence	Frequency	Density	Relative Frequency	Relative Density	Importance Value	Rank	Pi	ln(Pi)	Pi ln(Pi)	Diversity Index
Acanthus ebracteatus	18	4	7.02	0.0316	2.99	1.91	4.89	6	0.0191	-3.9598	-0.0755	
Acanthus ilicifolius	19	3	5.26	0.0333	2.24	2.01	4.25	7	0.0201	-3.9057	-0.0786	
Acanthus volubilis	11	5	8.77	0.0193	3.73	1.17	4.90	5	0.0117	-4.4522	-0.0519	
Avicennia alba	1	2	3.51	0.0018	1.49	0.11	1.60	8	0.0011	-6.8501	-0.0073	
Nypa fruticans	1	2	3.51	0.0018	1.49	0.11	1.60	8	0.0011	-6.8501	-0.0073	1.36
Rhizophora apiculata	230	30	52.63	0.4035	22.39	24.36	46.75	2	0.2436	-1.4120	-0.3440	
Rhizophora mucronata	126	23	40.35	0.2211	17.16	13.35	30.51	3	0.1335	-2.0138	-0.2688	
Sonneratia alba	474	39	68.42	0.8316	29.10	50.21	79.32	1	0.5021	-0.6889	-0.3459	
Sonneratia caseolaris	64	26	45.61	0.1123	19.40	6.78	26.18	4	0.0678	-2.6912	-0.1825	
	944		**235.09**	**1.6561**	**100**	**100**				**-32.824**	**-1.36172**	

General Result

The mangrove habitat assessment involves the determination of percent crown cover, regeneration per square meter (m^2) and average height in meters (m) of mature mangrove trees. Assessment results are presented in Table 5.

Based on results of assessment, mangrove percent (%) crown cover in all transects except Transect 2 have at least 76% crown cover and are classified to be in **excellent** condition based on criteria (Table 1). Computed average percent mangrove crown cover is 106.55% categorized to be in excellent condition. Transect 2 percent crown cover of 53.84% is considered to have a good condition, and is so far, the lowest percent crown cover among all transects. The area is characterized to be dominated by *Rhizophora apiculata* or bakawang lalaki trees with some vacant space at the western portion of the transect.

Meanwhile, the computed average mangrove tree height in all six (6) transects is 7.82m considered to be an excellent condition. All transects except Transect 6 have

at least 5m mangrove tree height and based on criteria is an excellent condition. The transect with the highest average mangrove tree height is in Transect 2, dominated by *Rhizophora apiculata* or bakawang lalaki mangroves. Meanwhile, the lowest average mangrove tree height is in Transect 6 classified as good condition where the area is dominated by *Sonneratia alba* or pagatpat trees.

For regeneration of mangroves, that is, the ability of the area to support growth of mangrove seedlings, assessment results show a 0.20 average regeneration per m^2 considered to be in poor condition. This is attributed to the dense mangrove forest having crown cover of more than 100% not permitting sunlight to penetrate, territoriality of mangrove species such as *Sonneratia alba* and a unique mixed of mangrove trees. The lowest regeneration is 0.04 found in Transect 4 that is located at the middle of the islet and is composed of almost *Sonneratia alba* trees that is described to be territorial and does not allow regeneration of *Rhizophora spp*.

Overall condition of mangroves analyzed are based on the assessment results of the three (3) criteria, that is, percent crown cover, average height and regeneration per m^2. Results of the three criteria on each transect may not be all found to satisfy the equivalent condition based on Table 1, thus, have to be averaged. For example, in case of Transect 1, where percent crown cover is 119.34% categorized to be in excellent condition, average tree height is 5.71 in excellent condition and regeneration per m^2 is 0.39 is equivalent to poor, the overall habitat condition for Transect 1 is averaged to be in good condition. The same goes with the remaining six (6) transects. All transects except Transect 2 is considered to exhibit good condition. Transect 2 is found to have a fair condition because of low percent crown cover and regeneration.

Generally based on the computed average parameters of mangroves assessed in Brgy. Batang Dos, results show that the percent crown cover of 106.55% is classified to be in excellent condition, average tree height of 7.82m is categorized to be as excellent condition and regeneration per m^2 of 0.20 in poor condition, with a total average condition categorized to be **GOOD** where mangrove has slight disturbance and few cuttings.

Table 5. Summary of Computed Parameters in SBMCHEA

Transect	Total Area Sampled (ha)	No. of Quadrats	Criteria			Habitat Condition
			% Crown Cover	Average Height (m)	Regenera-tion/m^2	
T1	600	6	119.34%	5.71	0.39	Good
T2	1200	12	53.84%	12.93	0.11	Fair
T3	900	9	114.02%	9.18	0.26	Good
T4	900	9	106.85%	8.22	0.04	Good
T5	1200	12	144.37%	6.33	0.11	Good
T6	900	9	100.86%	4.54	0.30	Good
Total/Average	5,700	57	106.55%	7.82	0.20	
			Excellent	**Excellent**	**Poor**	**Good**

Per parameter, the percent crown cover is classified to be in Excellent category as well as the average height of mangroves, while the regeneration per m^2 is classified under the Poor category.

IV. CONCLUSION

In summary, all the primary data gathered in the conducted mangrove assessment at SBMCHEA will serve as baseline data for sustainable interventions for future plans and developments in the area and also, in the official declaration of the Sasmuan Bangkung Malapad as a Critical Habitat and Ecotourism Area. Further, this assessment will strengthen the submitted requirements and increase the possibility of declaring the site as one of the official Ramsar sites in the country.

The output of this activity will also be used in ensuring the proper management, conservation and rehabilitation activities of the different concerned agencies/organization for sustaining the biodiversity richness can be found therein.

However, to sustain the biodiversity richness of the area, the concerned agencies and other organizations together with the LGU and BLGU should reinforce the strict implementation of local ordinances/resolutions and other guidelines concerning to the conservation and protection of the area.

Furthermore, to effectively protect and manage the area, the concerned agencies and/or authority should formulate and implement a strategic IEC campaign, e.g. community orientation and consultation emphasizing the importance and benefits

of mangrove and the critical habitat area; it is also important that with the undertakings of the conservation program, the community involvement in any means should be ensured; and lastly, to ease pressure on the natural resources and prior to establishing strict protection zones, the coastal communities should be supported in obtaining environment-friendly alternative livelihood through linkage or endorsement to external organizations or agencies.

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