Updated Status of the Maribojoc Bay Mangrove Forest, Bohol, Philippines

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Introduction

In a survey conducted in 1997 (SUML, 1997), 25 mangrove species in 13 families were recorded from 3 (deLa Paz, Lincod, San Vicente) barangays in Maribojoc Bay. One of the barangays (San Vicente) was revisited in 2013 and an additional 2 barangays (Upper de la Paz, Dipatlong) were further surveyed adding 7 species to the list but 6 species were not seen (PROCESS-FPE, 2013). The 7 new records include the endangered *Camptostemon philippinensis* (IUCN, 2016), locally called 'gapas-gapas'.

This resurvey was requested by PROCESS-Bohol to confirm the species composition of the mangroves fringing Maribojoc Bay with a view towards establishing the area as a "living ecological museum". Generally, the project aims to gather data as basis for stronger legislation to protect the mangrove forest ecosystem in Maribojoc Bay and formulation of a management plan to address its degraded condition as reported by PROCESS-Bohol.

Specifically, the project aimed at(1) verifying the presence of the seven new records of mangrove species as well the 6 species not seen in 2013; (2) mapping the location of the species; (3) determining tree sizes (diameter at breast height) and abundance (in terms of tree counts per species); (4) training local community researchers in basic mangrove taxonomy. Expected outputs of this resurvey include (1) species list, species location (GPS way points), average size per species, density per species per barangay; (2) Georeferenced map per species for the whole Maribojoc Bay; and (3) at least 4 mangrove parataxonomists trained per barangay.

Methods

Training. On the job training was the strategy used. Local community researchers participated in a one-day lecture workshop on mangrove taxonomy and methods of assessment, after which the trainees undertook the assessment of their assigned barangay under the tutelage of an SU researcher. Trainees were given mangrove photoguides to help them in the identification. Each species encountered was georeferenced, photographed and measured. When the survey was completed, the whole group validated the results.

Assessment. Pre-mapping, based on the 1997 and 2013 surveys, was done by SU researchers prior to the survey to determine sites to be sampled. The Bay was then divided into four barangays, each barangay assigned to one SU researcher and 4 trainees. Two samplings were

conducted, one in May 2016, the other in October 2016. Sampling was purposive, i.e., each team set out to find species in the list. A GPS device was used to mark the location of species found and waypoints mapped using Surfer. The plot method of English et al. (1997) was used to determine density of mature trees, seedlings and saplings per species and diameter at breast height (dbh). A caliper was used to measure diameter at breast height (DBH) but for large trees, girth at breast height (gbh) was taken using a tape measure and the resulting value was divided by pi (3.1416) to get DBH. All mature trees within a 10 x 10 m plot were identified, counted, photographed, and measured. Saplings (<4 cm in dbh, >1 m tall) were identified and counted with a 5 x 5 m plot. Seedlings (<1 m tall) were identified and counted with 1 x 1 m plot. Fauna seen in the area were noted as well threats to mangrove ecosystems such as garbage, new fishponds, reclamations, etc.

Results

Training. Sixteen members of four peoples' organizations completed the training on Mangrove Taxonomy and Assessment. The list of trainees and their PO affiliation is found in Annex 1.

Lectures and practice were conducted on Day 1 at the Abatan Tourist Center in Cortes (see Annex 2-3). The training module consisted of the following topics: 1) What are mangroves and what are the services and goods that they provide? 2) How do we identify mangrove species? 3) How do we assess mangroves? 4) How do we do mangrove mapping? During the first sampling the actual field surveys and mapping were done on Days 2 and 3 (see Annex 5) while validation of data and closing ceremonies were completed on Day 4 (see Annex 5).

Survey Sites. Six barangays (de la Paz, Upper de la Paz in Cortes, Lincod, Cabawan, San Vicente, Dipatlong in Maribojoc) in two municipalities (Cortes, Maribojoc) were surveyed (Fig. 1). The survey tracks and plots are shown in Figure 2.



Figure 1.Barangays surveyed in Maribojoc Bay, Bohol.

Three sites were assessed in 1997: de la Paz, Lincod and San Vicente; de la Paz was not was reassessed in 2013 but Dipatlong, and Upper de la Paz were added while a new site (Cabawan), was added in 2016 but only the site along the Abatan River was surveyed.





Figure 2A. Survey tracks in Upper de la Paz and de La Paz (top) and Lincod (bottom).

Calumpong et al. (2016). Mangroves of Maribojoc Bay





Figure2B. Survey tracks in San Vicente (top) and Dipatlong (bottom).



Figure2C. Survey tracks along Abatan River.

Species Composition. A total of 35 mangroves in 15 families, including one hybrid, and 20 associated species in 17 families (excluding unidentified ones) were identified in the area (Table 1). Three new records in three families are added to the list; *Heritiera littoralis* Dryand. (Malvaceae), *Scyphiphora hydrophyllacea* Gaerten. f. (Rubiaceae), and *Xylocarpus rumphii* (Kostel) Mabb (Meliaceae). The first one was found only in Cabawan while the last two were found only in San Vicente. Photos of all species, including the associates are found in Plate 1. Mangrove classification follows the scheme found in Massó et al. (2010). It should be noted that under this scheme, 4 species originally put in the true mangrove list are transferred to the mangrove associates category. These are *Barringtonia asiatica* (L.) Kurz, *Derris trifoliata* Lour., *Dolichandrone spathacea* (L.) K. Schum., *Pongamia pinnata* (L.) Pierre. Also, three families are merged, Aviceniaceae with Acanthaceae, Myrsinaceae with Primulaceae and Lythraceae with Sonneratiaceae.

Four species are in the IUCN (2015) threatened species list: *Aegiceras floridum* Roem. and Schult.–Near Threatened ver. 3.1, *Avicennia lanata* Ridley– Vulnerable B1+2c ver 2.3, *Camptostemon philippinensis* (S.Vidal) Becc.– Endangered C1 ver. 3.1 and, *Ceriops decandra* (Griff.) Ding Hou– Near Threatened ver. 3.1.

All sites had increased number of species over the 2013 survey, except Upper de la Paz with six less species seen in 2016. Dipatlong had the most dramatic increase, from 7 species in 2013 to to 26 species in this current survey. The breakdown per barangay is given in Table 1.

This could be due to the more systematic search conducted. Three species were found only in San Vicente: *Xylocarpus rumphii* (Kostel) Mabb. (Meliaceae), *Scyphiphora hydrophyllacea* C.F.Gaertn. (Myrtaceae) and *Aegiceras floridum* Roem.& Schultes (Myrsinaceae), although the latter was recorded in Upper de la Paz in 2013 but not found there during this survey. The endangered *Camptostemon philippinensis* was not seen in the areas surveyed in San Vicente but was found in Lincod. This may be because the stations surveyed in 2013 were not the same as the one in the current survey as no specific locations of survey stations were given in the 2013 report. Three species were not seen in this current survey and were put on the watch list: *Acanthus ilicifolius, Sonneratia caseolaris* (L.) Engler., and *S. ovata* Backer. This is because we rely on the flowers/fruits for the species confirmation and it was not their flowering/fruiting period.

Eight species in 5 families were found in all sites, *Avicennia marina* (Forsk.) Vierh. (Acanthaceae), *Excoecaria agallocha* L. (Euphorbiaceae), *Nypa fruticans* (Thun.) Wurmb (Arecaceae), 4 species in the Rhizophoraceae –*Ceriops decandra* (Griff.) Ding Hou, *Rhizophora apiculate* Blume, *R. mucronata* Lamk., *R. stylosa* Griffith, and *Sonneratia alba* J. Smith (Lythraceae).

Based on local knowledge, the unidentified mangrove in 1997 locally called "maudo" was identified as *Lumnitzera littorea* (Jack) Voigtand the unidentified fern, *Acrostichum speciosum* Willd. "Tungki" is not a mangrove species but the local name for the propagules of *Rhizophora*.

Based on studies conducted at SU-IEMS (unpub.), *Acanthus ebracteatus* Vahl. and *A. ilicifolius* L. can change leaf morphology depending on exposure to sunlight and can take the form of *A. volubilis* Wall. We have retained *Acanthus ebracteatus* in this listing.

One hydrid was identified: Rhizophora x lamarckii Montr. (R. stylosa x R. apiculata).

 Table 1. Mangrove species identified in Maribojoc Bay. Totals are per sampling.

Legend: X = 1997; / = 2013; + = 2016; NS = not surveyed; () =total to date. Abbrev: PAZ = De la Paz; UPA = Upper de la Paz; LIN = Lincod; VIC = San Vicente; DIP = Dipatlong; CAB = Cabawan; DD = Data Deficient; EN = Endangered; LC = Least Concern; NT = Near Threatened; V = Vulnerable; NA = Not Assessed

	Species	Family	Local Name	IUCN	PAZ	UPA	LIN	VIC	DIP	CAB
1	<i>Acanthus ebracteatus</i> Vahl	Acanthaceae	Lagiwliw-puti	LC		+	+	/+	+	
2	Acanthus ilicifolius L.	Acanthaceae	Diliuatiao/Lagiwliw	LC	Х	/			/	
3	Acanthus volubilis Wall.	Acanthaceae	Ragoyroy	LC		/		/		
4	Acrostichum aureum L.	Pteridaceae	Paku-laut/Lagolo	LC			+	+	+	
5	Acrostichum speciosum Willd.	Pteridaceae	Paku-laut/Lagolo	LC	X+		+	X+	+	

	Species	Family	Local Name	IUCN	PAZ	UPA	LIN	VIC	DIP	CAB
6	Aegiceras corniculatum (L.) Blanco	Primulaceae (=Myrsinaceae)	Saging-saging	LC	Х+	/	+	X/+	+	
7	Aegiceras floridum Roem. and Schultes	Primulaceae (=Myrsinaceae)	Tinduk-tindukan/	NTver 3.1	х			+		
8	Avicennia lanata Ridley	Acanthaceae (=Avicenniaceae)	Api-api	VuB1 + 2c ver 2.3	+		+	+	+	
9	Avicennia marina (Forssk.) Vierh.	Acanthaceae (=Avicenniaceae)	Piapi/Bungalon	LC	Х+	/+	Х+	X/+	/+	
10	Avicennia officinalis L.	Acanthaceae (=Avicenniaceae)	Api-api/Piapi	LC	+	/+	X+	X/+		
11	Avicennia rumphiana	Acanthaceae (=Avicenniaceae)				/				
12	<i>Bruguiera cylindrica</i> (L.) Blume	Rhizophoraceae	Pototan-lalake	LC	+	/			+	
13	<i>Bruguiera gymorrhiza</i> (L.) Lamk.	Rhizophoraceae	Busaing	LC		/		х	+	
14	<i>Bruguiera parviflora</i> Wight & Arnold ex Griffith	Rhizophoraceae		LC	X+	/+	+			
15	<i>Bruguiera sexangula</i> (Lour.) Poir.	Rhizophoraceae	Pototan	LC		/				+
16	Camptostemon philippinensis (S. Vidal) Becc.	Malvaceae	Gapas-gapas	EN C1 ver. 3.1			+	/		
17	<i>Heritiera littoralis</i> Dryand.	Malvaceae	Dungon							+
18	<i>Ceriops decandra (</i> Griff.) Ding Hou	Rhizophoraceae	Malatangal/Lapis- lapis	NT ver. 3.1	X+	/+	X+	X/+	+	
19	<i>Ceriops tagal</i> (Perr.) C.B. Rob.	Rhizophoraceae	Tungog	LC	X+	+		/+		
20	Excoecaria agallocha L.	Euphorbiaceae	Alipata/Buta-buta	LC	+	/+	Х+	/+	+	
21	Lumnitzera racemosa Willd.	Combretaceae	Kulasi	LC	+	/	+	X+		
22	Lumnitzera littorea (Jack) Voigt	Combretaceae	Tabao/Maudo	LC		+	X+		+	
23	<i>Nypa fruticans</i> (Thun.) Wurmb	Arecaceae	Nipa	LC	X+	/+	X+	X/+	/+	
24	<i>Osbornia octodonta</i> F. Mueller	Myrtaceae	Tawalis	LC	+		+	/+		
25	<i>Rhizophora apiculata</i> Blume	Rhizophoraceae	Bakhauan-laki	LC	X+	/+	X+	/+	/+	
26	<i>Rhizophora mucronata</i> Lamk.	Rhizophoraceae	Bakhauan-baje	LC	X+	/+	X+	/+	/+	
27	<i>Rhizophora stylosa</i> Griffith	Rhizophoraceae	Bakauan/Bakhawan- tigrihon	LC	+	/+	+	/+	+	
28	Rhizophora x lamarckii Montr.	Rhizophoraceae	Hybrid bakauan	LC				+	+	
29	Scyphiphora hydrophyllacea C.F.Gaertn.	Rubiaceae	Nilad	LC				+		
30	Sonneratia alba J. Smith	Lythraceae (=Sonneratiaceae)	Pagatpat	LC	X+	/+	+	X/+	/+	
31	<i>Sonneratia caseolaris</i> (L.) Engler	Lythraceae (=Sonneratiaceae	Pagatpat	LC	х	/	х			
32	Sonneratia ovata Backer	Lythraceae (=Sonneratiaceae	Pagatpat	NT		/		/	/	

	Species	Family Local Name II		IUCN	PAZ	UPA	LIN	VIC	DIP	САВ
33	<i>Xylocarpus granatum</i> König	Meliaceae	Tabigi	LC		/+	X+		+	
34	Xylocarpus moluccensis (Lamk.) Roem.	Meliaceae	Tabigi/Piagau	LC		+	+	X/	+	
35	Xylocarpus rumphii (Kostel) Mabb.	Meliaceae	Tabigi/Piagau	LC				+		
	SUBTOTAL				13/ 17	21/15	10/ 21	9/1 6/2 1	7/19	2
	B. Mangrove Associates									
1	<i>Barringtonia asiatica</i> (L.) Kurz	Lecythidaceae	Bitobitoon	LC	+		X+			
2	Calophyllum inophyllum L.	Clusiaceae	Bitaug	LC			+		+	
3	Cordia subcordata Lamk.	Boraginaceae	eae Agutug						+	
4	Corypha utanLamk.	Arecaceae	Buli	LC			+			
5	Derris trifoliataLour.	Fabaceae	Tuble	NA	+		Х+	+	+	
6	Dolichandrone spathacea (L.) K. Schum.	Bignoniaceae	Tui	LC	х		х			+
7	Ficus cumingii Miq.	Moraceae		NA			+	+		
8	Finlaysonia maritima Back. ex K. Heyne (=F. obovata Wall.)	Asclepediaceae		NA			+			
9	<i>Gymnanthera oblonga</i> (Burm. f) P.S. Green	Apocynaceae	Bagon	NA			+			
10	Hibiscus tiliaceusL.	Malvaceae	Malobago							+
11	<i>Ipomea-pescapre</i> (L.) R. Brown	Convolvulaceae		NA			+			
12	Morinda citrifolia L.	Rubiaceae	Noni	NA			+	+		
13	<i>Pandanus tectorius</i> F. Brown	Pandanaceae	Pandan	DD				+		
14	Premna odorata Blco.	Verbenaceae	Abgao	NA				+	+	
15	<i>Pongamia pinnata (</i> L.) Pierre	Fabaceae	Bani/Bawok-bawok	LC				X/+	+	
16	<i>Prosopis juliflora</i> (Swartz) DC.	Fabaceae	Aroma				+			
18	Sesuvium portulacastrum (L.) L.	Aizoaceae	Olasimang-dagat	NA			+		+	
19	Sterculia ceramic R. Brown	Sterculiaceae	Owas/	NA				+		
20	Terminalia catappa L.	Combretaceae	Talisay	NA	+		+	+	+	
21	Unidentified sp.1		· · ·				Х			
22	Unidentified sp.2						Х			
23	Lumboy-lumboy						Х			
24	Bagon-bagon						X			-
	SUBTOTAL				1/3	0	7/1 2	1/1/ 8	7	2
	OVERALL TOTAL				14/ 20	21/15	17/ 33	11/ 18/ 29	7/26	2

Community Structure. The mangrove forest of Maribojoc Bay is a combination of natural and reforested areas. Reforested areas are generally planted to *Rhizophora stylosa* and these are found in the seaward portion of the forest. The river banks are fringed with *Nypa fruticans* with its associated fern species (*Acrostichum*). Landward is where most of mangrove

associates are found. Large areas, are still protected, e.g., in San Vicente but in Lincod, only a small portion is left as most of it has been converted to fishponds.

Density. The most common species is Sonneratia alba as shown in Fig. 3 with mean density of 318 ± 317 stems ha⁻¹. This is followed by *Rhizophora apiculata* and *R. stylosa* with mean densities of 229 ± 228 and 2221 ± 378 stems ha⁻¹, respectively. Avicennia marina ranked fourth with a mean density of 137 ± 113 stems ha⁻¹. The large standard deviations is are due to the clumped distribution of mangrove species. Five species had mean densities between 100-50 stems ha⁻¹while 11 species had mean densities below 50 stems ha⁻¹. Only one stem was found in the surveyed plots for the following species: *Aegiceras floridum, Bruguiera gymnorrhiza* and *Xylocarpus rumphii*. For *Lumnitzera racemosa*, only the shrubby form was seen.



Figure 3. Density of mangrove tree species in Maribojoc Bay.

For shrubby and herbaceous mangrove species, these were quantified using per cent cover (see Table 2). Nypa fruticans had mean cover of $42.0 \pm 36.3\%$, the mangrove ferns (Acrostichum spp.) had a combined average cover of $3.7 \pm 9.8\%$, Derris trifoliata covered 1.5 ± 6.9 while Acanthus ebracteatus covered only $8.7 \pm 24.8\%$. The large standard deviations are due to plots without presence of the species (zero values) while Nypa and its associated ferns are found only along riverbanks.

Table 2.	Per cent cover of shrubby	y and herbaceous	mangrove	species in	Maribojoc	Bay
	Bohol.					

Spe	ecies	% Cover
1. Nypa fru	ıticans	42.0 <u>+</u> 36.3
2. Acanthus	s ebracteatus	8.7 <u>+</u> 24.8
3. Acrostic	hum aureum	0.5 <u>+</u> 3.4

4.	Acrostichum speciosum	3.1 <u>+</u> 9.4
5.	Derris trifoliata	1.5 <u>+</u> 6.9

Regeneration potential. Of the more than 30 species of mangroves, seedlings/saplings of 19 species and 1 associated species were seen (see Fig. 4). This gives a regeneration potential of about 50%. *Bruguiera parviflora* had the highest number of seedlings (2605 ± 5414 seedlings ha⁻¹) but almost no saplings were found (1 ± 2 saplings ha⁻¹) while *Ceriops decandra* had the most number of saplings (902 ± 1057 saplings ha⁻¹) but no seedlings were seen. No seedlings were seen for 4 species with saplings and no saplings were seen for 5 species with seedlings.



Figure 4. Density of seedlings and saplings.

Relative Density and Size

<u>De la Paz</u>. De la Paz was surveyed in 1997 but not in 2013. The two plots visited in 1997 were revisited in 2016 (see suvey tracks in Fig. 2A). Twenty species were seen, an increase of 6 species over the previous survey. Based on relative density *Rhizophora apiculata* was the most abundant in the seaward portion while *Avicennia officinalis* was the most abundant in the landward portion of the forest (see Fig. 5). Biggest trees were *Avicennia lanata*, found in the seaward portion (see Table 3) with maximum diameter at breast height (DBH) of 41.4 cm and average basal area (BA) of 1114.9 cm².



Figure 5. Relative density of mangrove species in de la Paz and Upper de la Paz.

Table 3. Minimum, maximum a	and average DBH	and basal area (BA) of mangrove t	rees in
surveyed plots in de l	a Paz.			

Species	Min DBH (cm)	Max DBH (cm)	Average DBH (cm)	Average BA (cm ²)
Avicennia lanata	33.1	41.4	37.6	1114.9
Avicennia marina	5.1	19.1	13.8	164.8
Rhizophora apiculata	4.5	19.4	10.7	107.5
Sonneratia alba	28.6	35.0	31.8	803.7

<u>Upper de la Paz</u>. Upper de la Paz was not surveyed in 1997 but surveyed in 2013 and 2016. Area surveyed was mostly along the Abatan River (see Fig 2A). Thirteen species were seen, a decrease of seven species over the previous survey. Noteworthy was *Bruguiera sexangula* which was not seen in this survey but was seen up River in Cabawan area. One plot along Abatan River was monospecific with large trees of *Bruguiera parviflora*. This is the only site where large trees of *Lumnitzera littorea* were found but were also threatened by girdling (see Fig. 10).

Based on relative density *Rhizophora apiculata* was still the most abundant in the seaward portion while four species formed monospecific patches in the landward portion and along riverbanks: *Sonneratia alba, Bruguiera parviflora, Xylocarpus moluccensis and Excoecaria agallocha* (see Fig. 5). Biggest trees were *Sonneratia alba* found along Bacong River (see Table 4),with maximum DBH of 51.6 cm and average BA of 543.2 cm². There were also big trees of *Avicennia marina* (maximum DBH of 39.8 cm) in the seaward portion of the forest.

Table 4. Minimum, maximum and average DBH and basal area (BA) of mangrove trees in surveyed plots in Upper de la Paz.

Species	Min DBH	Max DBH	Average DBH	Average BA (cm ²)
Avicennia marina	4.1	39.8	11.4	139.1
Avicennia officinalis	10.8	31.5	19.6	362.4
Bruguiera parviflora	5.1	28.6	10.9	114.8
Bruguiera cylindrica	5.4	9.2	7.9	50.8
Ceriops decandra	4.8	6.7	5.7	26.5
Ceriops tagal	10.2	13.1	11.6	107.6
Excoecaria agallocha	4.5	33.1	14.7	247.7
Lumnitzera littorea	5.1	17.5	11.8	120.5
Rhizophora apiculata	4.8	29.6	10.5	99.6
Rhizophora stylosa	5.0	14.0	8.1	58.3
Sonneratia alba	6.4	51.6	23.2	543.2
Xylocarpus moluccensis	11.8	23.9	14.9	195.1
Xylocarpus granatum	24.5	24.5	1 tree only	471.8

Dipatlong. Among all sites, Dipatlong showed highest increase in the number of species, from 7 in 2013 to 19 in the current survey. This may be due to a more systematic sampling and more areas covered (see Fig. 2B).

In terms of relative density per plot *Sonneratia alba* was the most dominant, being present in 5 out of 7 plots followed by *Rhizophora apiculata* occurring in 4 out of 7 plots (see Fig. 6). *Rhizophora mucronata*occurred in3 out of 7 plots, *R. stylosa* and *Avicennia marina* in 2 out of 7 plots. All the rest were found in only one plot (See Fig. 6).

In terms of tree size, *Sonneratia alba* were the largest mangroves reaching maximum diameter at breast height of 102 cm with average BA of 1292.7cm², while the largest mangrove associate was *Pongamia pinnata* with maximum DBH of 71.6 cm with average BA of 18502.7 cm² (see Table 5).

Noteworthy was the hybrid of *Rhizophora x lamarckii* hybrid between the reforested area and the natural forest. Also, single plants of *Bruguiera gymnorrhiza* and *Bruguiera cylindrica* were found at the edge of the navigation highway.



Figure 6. Relative density of mangrove species in Dipatlong.

Species	Min DBH (cm)	Max DBH (cm)	Average DBH	Average BA (cm ²)
Rhizophora apiculata	6	24.5	6.7	3978.3
Sonneratia alba	4	102	20.3	1292.7
Rhizophora mucronata	4	13	6.9	44.1
Rhizophora stylosa	4.5	7.5	4.6	28.6
Aegiceras corniculatum	4	5	3.7	16.1
Avicennia marina	5	17	10.3	103.9
Excoecaria agallocha	8	26	15.9	221.4
Xylocarpus moluccensis	5	18	11.4	143.8
Pongamia pinnata	30.2	71.6	45.1	18502.7

Table 5. Minimum, maximum and average DBH and basal area (BA) of mangrove trees in surveyed plots in Dipatlong.

Lincod. This is one of the two most diverse sites with 21 mangrove species but also the most threatened with fishponds occupying what used to be mangrove forest (see Fig. 7). The endangered *Camptostemon philippinensis* was also found here The most abundant species were *Sonneratia alba, Avicennia marina* and *Rhizophora mucronata*. There were also monospecific patches of *Xylocarpus moluccensis, Lumnitzera littorea,* and *Excoecaria agallocha*.

Biggest trees were *Sonneratia alba* with maximum DBH of 51.9 cm and average BA of 327.0 cm² (see Table 6).



Figure 7. Relative density of mangrove species in Lincod.

Species	Min DBH (cm)	Max DBH (cm)	Average DBH (cm)	Average BA (cm ²)
Aegiceras corniculatum	4	15	7.1	505.1
Avicennia lanata	4.80	36	16.6	145.4
Avicennia marina	5	41.10	15.1	357.8
Avicennia officinalis	5	16.50	8.7	345.6
Bruguiera cylindrica	5.0	5.0	5.00	19.63
Bruguiera parviflora	4	11	7.5	601.7
Camptostemon philippinensis	5.0	8.0	6.50	34.95
Ceriops decandra	6	6	only one tree	28.3
Excoecaria agallocha	5	36.00	14.1	148.8
Lumnitzera littorea	6	42.00	19.3	497.8
Rhizophora apiculata	4	23	10.6	355.8
Rhizophora mucronata	4	22	8.4	203.0
Rhizophora stylosa	6	13.60	9.5	76.7
Sonneratia alba	4	51.90	20	327.0
Xylocarpus granatum	5	21	11.9	84. 9
Xylocarpus moluccensis	6.70	11	8.9	65.2
Avicennia officinalis	8.0	8.0	8.00	50.27
Sonneratia alba	8.0	38.0	23	592.19

Table 6. Minimum,	maximum and	l average D	BH and I	basal area	(BA) of ma	ngrove t	trees in
Lincod.							

San Vicente. This is the other most diverse site with 21 species of mangroves and the most well protected forest in the whole Bay. Most abundant species is *Rhizophora apiculata* (see



Figure 8. Relative density of mangrove species in San Vicente.

Fig. 8). Biggest trees were *Rhizophora stylosa* with maximum DBH of 31.5 cm and average BA of 683.3 cm² and *Sonneratia alba* with maximum DBH of 30 cm and average BA of 555.3 cm² (see Table 7). This is because most of the trees measured were located in the fringes of the forest since it was difficult to get inside (see Fig. 8).

Species	Min DBH (cm)	Max DBH (cm)	Average DBH (cm)	Average BA (cm²)
Aegiceras floridum	9.5	9.5	only one tree	70.9
Avicennia marina	4	14.5	6.4	201.5
Avicenniao fficinalis	4.1	10.1	6.7	493.7
Avicennia lanata	10.1	15.5	12.8	134.4
Ceriops decandra	4	9.5	5.7	29.1
Ceriops tagal	4.7	4.7	only one tree	17.4
Osbornia octodonta	4	5	4.5	16.1
Rhizophora apiculata	4	9.6	7.2	79.9
Rhizophora mucronata	4.5	14.1	7.6	161.6
Rhizophora stylosa	4	31.5	7.4	683.3
Rhizophora x lamarckii	5	21.5	12.2	969.3
Scyphiphora hydrophyllacea	4.5	4.5	only one tree	15.9
Sonneratia alba	4.5	30	11.3	555.3

Table 7. Minimum, maximum and average DBH and basal area (BA) of mangrove trees inSan Vicente.

Cabawan. This site along the Abatan River was visited during the second sampling to verify the presence of *Bruguiera sexangula* although as was pointed out, this was already "outside" of Maribojoc Bay (see Fig. 9). Two new records were also found: the mangrove *Heritiera littoralis* and the mangrove associate *Hibiscus littoralis*. Largest trees in the plots surveyed were *Bruguiera parviflora* reaching 26 cm in dbh (Table 8).

Table 8. Minimum,	maximum and	l average	DBH a	nd basal	area	(BA) of	f mangrove	trees in
Cabawan.								

Species	Min DBH (cm)	Max DBH (cm)	Average DBH (cm)	Average BA (cm ²)
Bruguiera parviflora	15.5	27.2	22.03	399.94
Bruguiera sexangula	8.1	27.0	13.83	196.56
Heritiera littoralis	10.1	12.2	11.23	99.70

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Threats

Several threats to the mangrove forest of Maribojoc Bay were seen. The primary threats are the continuing expansion of fishponds and settlements, leading to dredging and garbage. Minor threats are cutting and girdling, pests and diseases.



Fishponds in Lincod.

Girdled *Lumnizera littorea* (maudo) in Upper de la Paz.

Dredging and garbage.

Figure 10. Threats seen to the mangroves and forest of Maribojoc Bay.

Conclusions

The Maribojoc mangrove forest is one of the most diverse, if not the most diverse mangrove forest in the Philippines with 35 species in 15 families, including one hybrid and excluding mangrove associates. Four of the species four families are in the IUCN (2015) threatened species list: En - *Camptostemon philippinensis* (S.Vidal) Becc., NT- *Aegiceras floridum* Roem. and Schult., and, *Ceriops decandra* (Griff.) Ding Hou and V- *Avicennia lanata* Ridley. The most common species is *Sonneratia alba* with mean density of 385 <u>+</u> 37 stems ha⁻¹ while those with only one stem found in the surveyed plots were *Aegiceras floridum*, *Bruguiera gymnorrhiza*

and *Xylocarpus rumphii*. Among the herbaceous and shrubby species, *Nypa fruticans* was the most abundant with a mean cover of 42.0 <u>+</u> 36.3%.

Among the sites, Lincod and San Vicente are the most diverse with 21 species of mangroves, excluding associates but while San Vicente is the best protected, Lincod is the most threatened due to fishpond development. It is also the site where three of the threatened species are found.

Overall, the forest has a moderate regeneration potential of about 50% with seedlings and saplings of 19 species out of 35 found during the sampling period. No seedlings were seen for 4 species with saplings and no saplings were seen for 5 species with seedlings. *Bruguiera parviflora* had the highest number of seedlings (2605 ± 5414 seedlings ha⁻¹) but almost no saplings were found (1 ± 2 saplings ha⁻¹) while *Ceriops decandra* had the most number of saplings (902 ± 1057 saplings ha⁻¹) but no seedlings were seen.

Recommendations

- 1. A comprehensive management and conservation plan for the Maribojoc Bay mangrove forest is urgently needed.
- 2. In the meanwhile, activities that could be done at the barangay level include:
 - a. Enhancement planting of disappearing species and threatened species (marked with asterisk). The list below shows priority species and their seed/seedling source:

Species	Local Name	Seed/Seedling Source
Aegiceras floridum Roem. and Schultes*	Tinduk-tindukan/	San Vicente
Avicennia lanata Ridley*		Lincod
Bruguiera cylindrica (L.) Blume	Pototan-lalake	Dipatlong
Bruguiera gymorhiza (L.) Lamk.	Busaing	San Vicente
Bruguiera parviflora Wight & Arnold ex Griffith		Upper de la Paz, Cabawan
Bruguiera sexangula (Lour.) Poir.	Pototan	Cabawan
Camptostemon philippinensis (S.Vidal) Becc.*	Gapas-gapas	Lincod
Ceriops decandra (Griff.) Ding Hou*	Lapis-lapis	All sites
Lumnitzera littorea (Jack) Voigt	Tabao/Maudo	Upper de la Paz
Scyphiphora hydrophyllacea Gaerten. f.	Nilad	San Vicente
Xylocarpus rumphii(Kostel) Mabb.	Tabigi/Piagau	San Vicente

- 3. Regular inventory of existing species and monitoring of threats. Mangrove species that were not found in this survey and are put on the watch list for monitoring are:
 - a) Acanthus ilicifolius L.,
 - b) Sonneratia caseolaris (L.) Engler
 - c) Sonneratia ovata Backer

- 4. Awareness campaign on the importance of mangroves and their role in livelihood provision.
- 5. Initiation of new (bird watching) and strengthening of existing ecotourism (e.g., firefly tour) and other livelihood activities dependent on mangroves.

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