Philippine Journal of Science
151 (S1): 135-156, Marine Botany
ISSN 0031 - 7683
Date Received: 05 Apr 2021

Macrophyte Diversity and Conservation Values of the Verde Island Passage, Philippines

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The diversity and distribution of marine macrophytes – including seaweeds and seagrasses – in the Verde Island Passage (VIP), Philippines, was assessed covering nine sites across four provinces (Batangas, Marinduque, Occidental Mindoro, and Oriental Mindoro). Presence-absence data were compared to those of other sites within the VIP collected in earlier studies. Data from the VIP were then compared to sites with similar environmental and geographical features in other parts of the Philippines. A total of 116 macroalgal species and nine seagrass species were recorded from the VIP. This macroalgal richness represents approximately 12% of the reported macroalgae, and the number of seagrass species represents almost half of the known species in the country, suggesting that VIP supports a high diversity of marine macrophytes. Data analyses showed significant clustering of sites within the VIP. Some of the neighboring sites with similar environmental conditions also clustered together. The separation of clusters with sites outside the VIP may, in part, be explained by differences in local environmental conditions such as types of substratum, water depth, and current patterns (water motion). The diversity and uniqueness of marine macrophytes in the VIP highlight the importance of the ecosystem services and functions that these organisms provide. The role of various abiotic and biotic factors in driving variations in macroalgal diversity in the passage needs to be further verified with increased sampling efforts to obtain a more comprehensive understanding of the conservation value of the VIP.

Keywords: biodiversity, macroalgae, macrophytes, seagrass, seaweeds, Verde Island Passage

INTRODUCTION

The Verde Island Passage (VIP) in the Philippines is a highly important marine corridor for conservation (EO 578; Asaad *et al.* 2018; Servonnat *et al.* 2019). It connects the West Philippine Sea and the Sibuyan Sea and is surrounded by five provinces: Batangas, Oriental Mindoro, Occidental Mindoro, Marinduque, and Romblon. Specifically, the VIP is bounded by all 15 coastal municipalities of Batangas, four municipalities of northern Occidental Mindoro (including Lubang and Looc), 10 municipalities of Oriental Mindoro, four municipalities on the western side of Marinduque, and

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three island municipalities of northern Romblon (Horigue *et al.* 2015; Figure 1). Several reports have highlighted the high biodiversity found in this corridor, including the high diversity of marine shorefish species (Carpenter and Springer 2005), the high number of coral species (CI 2009), and the presence of marine mammals and reptiles (DENR-PAWB 2009).

Despite the valuable functions and services of marine macrophytes in the marine ecosystem, biodiversity studies on marine macrophytes in the VIP are limited – some dated more than a decade ago or are spatially limited (Roleda *et al.* 2000; Genito *et al.* 2009; Saco *et al.* 2020). Marine macrophytes, including macroalgae and seagrass, occupy the base of the marine food web as primary producers. They provide structure for shelter and refuge to a variety of marine fauna and function in nutrient cycling, storm protection, and carbon storage (Duffy *et al.* 2019; Yoshida *et al.* 2019). Macroalgae and seagrass can also influence biodiversity and community structure by altering the environmental conditions (Lobban and Harrison 1997; van der Heide *et al.* 2012; Bellgrove *et al.* 2017). Considering these vital functions and services of marine macrophytes, the marine macrophyte diversity of the VIP may, therefore, be a key contributor to the vast marine biodiversity of the region, which requires holistic conservation and management of its resources. In turn, these efforts require baseline and updated monitoring data on the biology, abundance, and distribution of the different marine organisms in the corridor, including marine macrophytes. Additionally, macroalgae and seagrass are impacted by anthropogenic pressures and changing climate conditions. For this reason, monitoring the biodiversity of macroalgae or seagrass communities

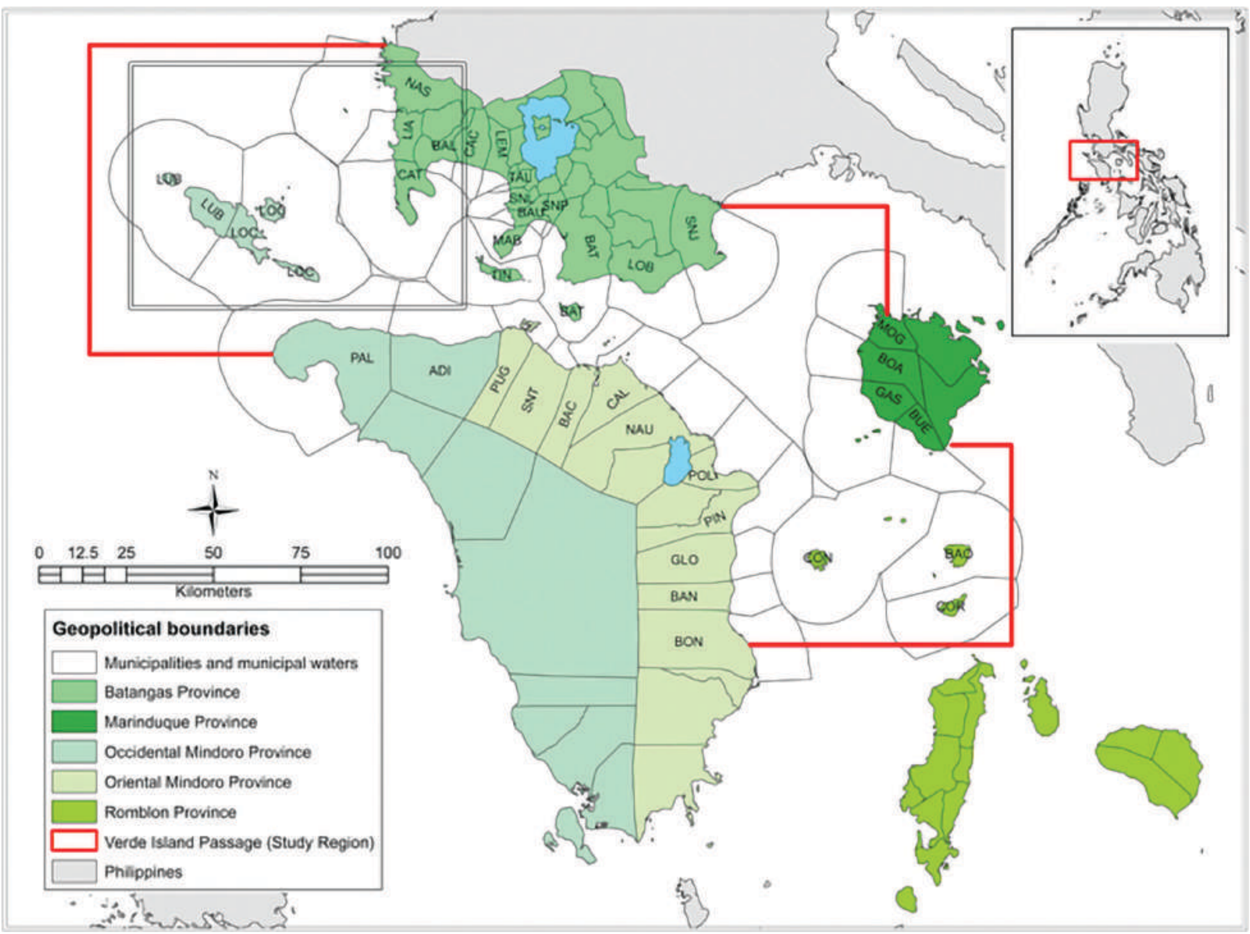


Figure 1. Map of geopolitical boundaries of the Verde Island Passage [adopted from Horigue *et al.* (2015)]. Inset shows location of the passage in the Philippines. The coastal municipalities surrounding the passage and their labels are as follows: [Batangas] NAS – Nasugbu, LIA – Lian, CAT – Calatagan, BAL – Balayan, CAC – Calaca, LEM – Lemery, TAL – Taal, SNL – San Luis, BAU – Bauan, MAB – Mabini, TIN – Tingloy, SNP – San Pascual, BAT – Batangas City, LOB – Lobo, SNJ – San Juan; [Marinduque] MOG – Mogpog, BOA – Boac, GAS – Gasan, BUE – Buenavista; [Occidental Mindoro] LUB – Lubang, LOC – Looc, PAL – Paluan, ADI – Abra de Ilog; [Oriental Mindoro] PUG – Puerto Galera, SNT – San Teodoro, BAC – Baco, CAL – Calapan City, NAU – Naujan, POL – Pola, PIN – Pinamalayan, GLO – Gloria, BAN – Bansud, BON – Bongabong; [Romblon] CON – Concepcion, BAO – Banton, COR – Corcuera.

is considered paramount in conservation (Neckles *et al.* 2012; D'Archino and Piazzi 2021).

The current study aims to assess the marine macrophyte diversity within the VIP and compare it to other relevant sites in the Philippines that have previously been assessed. This study is part of a larger study under the project entitled "Marine Biodiversity Assessment in Selected Sites along the Verde Island Passage," which focuses on obtaining diversity data for corals, macroalgae, and seagrass of selected areas in the VIP, as well as physicochemical properties of seawater that may shed light on explaining the spatial and temporal variability of the diversity and distribution of these organisms. This research aims to provide baseline knowledge for the region, which may then serve as the basic support and rationale for the conservation and management of marine resources in this passage.

MATERIALS AND METHODS

Study Period and Site Description

The study was conducted from November 2020–February 2021 during the northeast monsoon (*amihan*). Nine sites from four provinces in the VIP were surveyed – namely, Sawang and Pagkilatan in Batangas; Laylay, Amoingon, and Yook in Marinduque; Agsalin and Sabang in Oriental Mindoro; and Diumanod and Sigman in Occidental Mindoro (Table 1; Figure 2). The three islands in Romblon included in the VIP were not surveyed because of strict COVID pandemic protocols.

Research Design

A descriptive research design was used in the study to assess the marine macrophyte diversity of different sites in the VIP. The research was assisted by the local stakeholders, researchers from Marinduque State College, Mindoro State College of Agriculture and Technology, Occidental Mindoro State College, and the local

Table 1. Location and description of sites in Verde Island Passage surveyed in the present study during the northeast monsoon, 2020–2021.

Study site	Geographic coordinates	Description
Sawang	13.626993° N, 121.234388° E	Brgy. Sawang is located in the Municipality of Lobo, Batangas. Substrate in the area was generally sandy with rubbles. Depth of the surveyed sites ranged from ≤ 0.5–2 m.
Pagkilatan	13.635814° N, 121.051642° E	Brgy. Pagkilatan is located in Batangas City, Batangas. The site is in front of tourist resorts. Substrate was generally rocky-coralline, and depth ranged from 0.5–1 m. Rocky area extended to about 30–40 m from the shore.
Laylay	13.436125° N, 121.817519° E	Brgy. Laylay is located in the Municipality of Boac, Marinduque, near the old fishing port. Boac is considered to be one of the most affected municipalities by the Marcopper mine spill. Substrate in the site was mainly coarse sand, stone with coralline rocks at deeper parts. Depth of the surveyed site ranged from 1–2 m.
Amoingon	13.404821° N, 121.824726° E	Brgy. Amoingon is also located in Boac, Marinduque. Substrate in the site was mainly coarse sand and coralline rock. Depth of the surveyed site ranged from 1–2 m.
Yook	13.221763° N, 121.968163° E	Brgy. Yook is located in the Municipality of Buenavista, Marinduque. Substrate was mostly sandy-silty. Depth ranged from 0.5–1 m.
Agsalin	12.882426° N, 121.485991° E	Brgy. Agsalin is located in the Municipality of Gloria, Oriental Mindoro. The site is a marine protected area. Substrate was generally sandy. Depth ranged from 3–4 m.
Sabang	13.520819° N, 120.974787° E	Brgy. Sabang is located in the Municipality of Puerto Galera, Oriental Mindoro. The site is located in front of several resorts. The barangay has a sewage treatment facility draining into the site. Substrate was generally sandy. Depth was approximately 0.5 m.
Diumanod	13.477814° N, 120.811644° E	Sitio Diumanod is located in Brgy. Udalo, Municipality of Abra de Ilog, Occidental Mindoro. The survey site exhibited a sandy and rocky substrate stretching to about 30 m seaward. The area was exposed to high wave action. Depth was approximately 1–2 m.
Sigman	13.473830° N, 120.802420° E	Sitio Sigman is located in Brgy. Udalo, Municipality of Abra de Ilog, Occidental Mindoro. The site is located near the mouth of a river and exhibited a rocky bottom with coarse sand. Depth was approximately 1.5–2 m. A small community resides next to the site. High sedimentation from river runoff after a heavy downpour was observed during site reconnaissance. The visibility was greatly reduced to a few centimeters when the actual survey was conducted a day after.

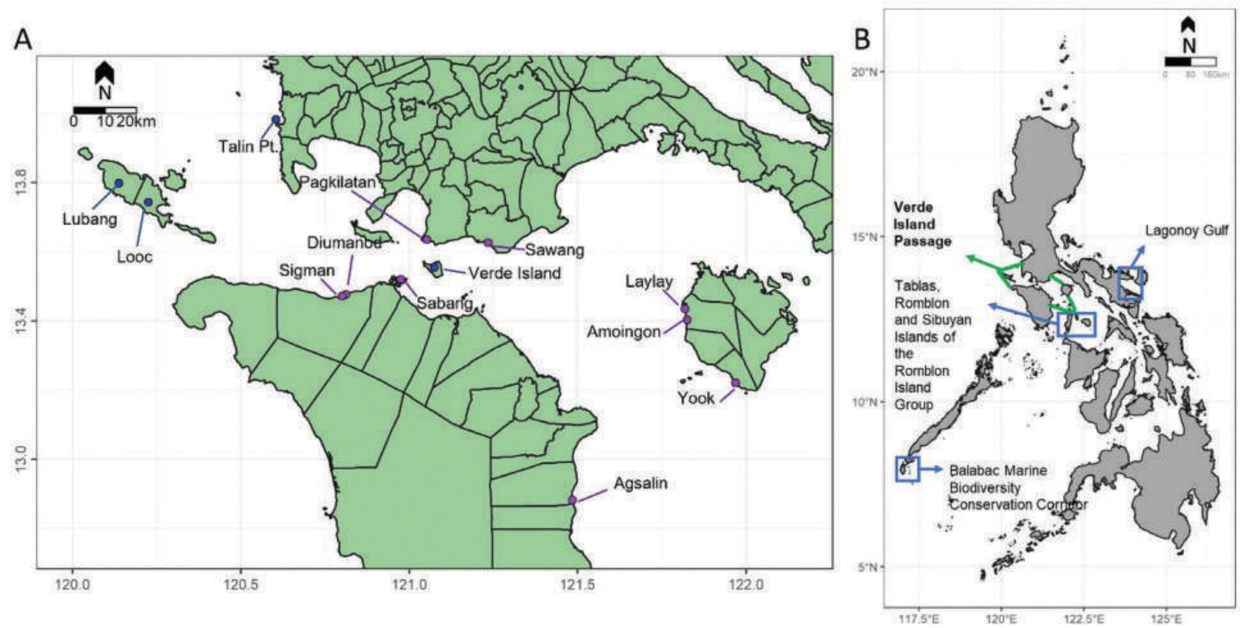


Figure 2. [A] Map showing the location of the study sites (purple) in Verde Island Passage (VIP) surveyed in the present study for marine macrophyte composition. Locations of other collection sites from the literature (blue): Lubang and Looc (Genito *et al.* 2009), Talin Point (Roleda *et al.* 2000), and Verde Island (Saco *et al.* 2020). [B] Map of the Philippines showing the location of the VIP and other representative sites with macroalgal studies: Tablas and Sibuyan Islands in Romblon (Clemente *et al.* 2017), Lagonoy Gulf (Mendoza and Soliman 2013), and Balabac Marine Biodiversity Conservation Corridor (Santiañez *et al.* 2015) outside the VIP.

government units of each surveyed site. The line transect-quadrat was used to assess marine macrophytes in each site (Saito and Atobe 1970; Ganzon-Fortes 2011; Saco *et al.* 2020). Species were identified *in situ* but were collected and identified in the laboratory when on-site identification was not possible. Species collected were deposited in the herbarium of the VIP CORALS Marine Repository Hub with herbarium code BATSTATEU (Index Herbariorum).

Data Analysis

Data obtained from the northeast monsoon survey were used to calculate the Shannon diversity (H'), species richness, and Pielou's evenness (J) for each site. Presence-absence data from the current study were compared with those from earlier studies on other sites within the VIP with the available literature on macrophyte composition. Data for macroalgal composition in Talin Point, Lian, Batangas were obtained from the study of Roleda *et al.* (2000), whereas those in Isla Verde, Batangas City, Batangas were obtained from Saco *et al.* (2020). Data for seagrass composition in Lubang and Looc were obtained from the study by Genito *et al.* (2009).

The presence-absence data on marine macroalgal diversity in the VIP were then compared with those in selected sites in other parts of the Philippines with comparable geographical conditions, *i.e.* Balabac Marine Biodiversity Conservation Corridor (Santiañez *et al.* 2015) and Lagonoy Gulf (Mendoza and Soliman 2013) and to a site adjacent to the VIP (Tablas, Romblon, and Sibuyan Islands of the Romblon Island Group; Clemente *et al.* 2017).

All analyses and visualization were performed using the R software (4.1.0). To visualize differences among marine macrophyte communities within the VIP and against sites outside the VIP, nonmetric multidimensional scaling (nMDS) was conducted based on Jaccard's dissimilarity (1 − Jaccard's similarity) using the vegan package. The Jaccard distance (dissimilarity) matrix was also obtained using the vegan package. Clustering and test of significance ($p < 0.05$) were conducted through the similarity profile test (SIMPROF) using the clustsig package.

RESULTS

A total of 71 marine macrophytes were recorded in the current survey, comprising 64 seaweed species (42% green, 22% brown, and 36% red seaweeds) and seven seagrass species. When combined with previous macroalgal studies [*e.g.* Roleda *et al.* (2000); Saco *et al.* (2020)], macroalgal richness increased to 116 for the VIP (Table 2). Some of these, however, are identified only up to the genus level (see Appendix Table A1 for a species checklist). When combined with the work of Genito *et al.* (2009), the number of seagrass species recorded within

Table 2. Diversity indices for marine macrophytes in sites within Verde Island Passage (VIP) surveyed in the present and earlier studies and in selected sites outside the VIP (SW – seaweed species; SG – seagrass species).

Diversity index	Sites within the VIP												VIP (summary)	Sites outside the VIP		
	Sawang	Pagkilatan	Yook	Laylay	Amoingon	Agsalin	Sabang	Diumanod	Sigman	Verde Island, Batangas	Talin Point, Batangas	Lubac and Looc Islands, Occidental Mindoro		Romblon Island Group	Lagonoy Gulf, Bicol Region	Balabac Marine Biodiversity Conservation Corridor
Shannon index (H')	1.24	2.32	1.86	1.05	1.95	1.07	1.77	1.70	0.91	1.69–2.02	1.29–1.31	–	0.91–2.32	–	1.06–2.68	–
Richness	13 (9 SW, 4 SG)	28	26 (20 SW, 6 SG)	9	23 (21 SW, 2 SG)	9 (3 SW, 6 SG)	29 (24 SW, 5 SG)	14	13	63 (58 SW, 5 SG)	60	8	125 (116 SW, 9 SG)	128	55	171
Pielou's evenness (J)	0.48	0.70	0.57	0.48	0.62	0.49	0.52	0.64	0.35	0.64	0.68–0.71	–	0.35–0.71	–	0.42–0.96	–
Source	This study	This study	This study	This study	This study	This study	This study	This study	This study	Saco *et al.* (2020)	Roleda *et al.* (2000)	Genito *et al.* (2009)	This study, Roleda *et al.* (2000), Genito *et al.* (2009), and Saco *et al.* (2020)	Clemente *et al.* (2017)	Mendoza and Soliman (2013)	Santiañez *et al.* (2015)
Remarks	SW and SG	SW	SW and SG	SW	SW and SG	SW and SG	SW and SG	SW	SW	SW and SG	SW	SG	SW AND SG	SW; 129 species on paper, 128 species based on updated names	SW	SW; 176 taxa on paper; 175 taxa based on updated names; 171 species when infraspecific names are excluded

the VIP increased to nine (Table 2; Appendix Table A1). Biodiversity indices were calculated for each site surveyed during the northeast monsoon. Pagkilatan showed the highest diversity, whereas Sigman, the least diversity (H'; Table 2). Sabang registered the highest species number among the sites, whereas Agsalin and Laylay registered the lowest species number. Species evenness (J) was highest in Pagkilatan and lowest in Sigman.

Comparison of Marine Macrophyte Diversity within the VIP

The marine macrophyte diversity in the present study was compared to those from earlier studies on other sites within the VIP. Results of the nMDS show grouping of sites dominated by seagrass species (Figure 3A), as confirmed also by significant clustering using Jaccard distance (Figures 3B and C). Specifically, Agsalin, Lubang, and Looc in Occidental Mindoro clustered together. Sawang in Batangas, Amoingon and Yook in Marinduque, and Sabang in Oriental Mindoro grouped together. The remaining groups comprise sites dominated by macroalgae. Pagkilatan and Isla Verde in Batangas clustered with Talin Point in Batangas. Laylay in Marinduque grouped with Diumanod and Sigman in Occidental Mindoro.

A separate analysis was conducted considering only macroalgal composition (Figure 4) to remove the extreme influence of seagrasses in some sites. Based on macroalgae diversity only, the nMDS plot and clustering showed a different grouping of sites. Agsalin, Laylay, and Talin Point each separated from the other sites, and Sawang, Diumanod, and Sigman clustered together. Isla Verde and Pagkilatan in Batangas, Amoingon and Yook in Marinduque, and Sabang in Oriental Mindoro clustered separately as different groups.

Comparison of Marine Macroalgal Diversity of the VIP with Selected Sites outside the VIP

Analysis of macroalgal diversity in the VIP in comparison with selected sites outside the VIP showed interesting clustering patterns (Figure 5). Agsalin in Oriental Mindoro, Lagonoy Gulf in Bicol, and Talin Point in Batangas separated from the rest. Balabac in Palawan and Romblon clustered together. The rest of the sites in the VIP formed a separate cluster.

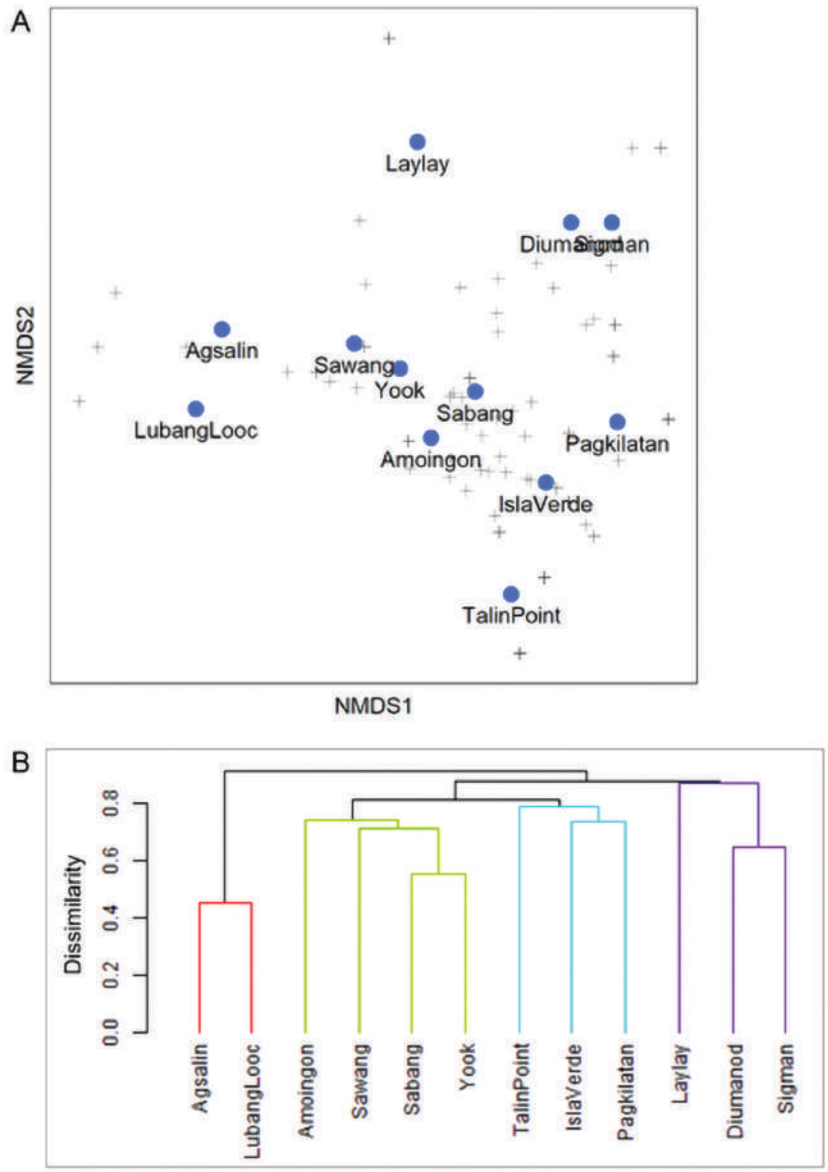
DISCUSSION

The number of seaweed species in the current surveys (64) represents approximately 6.48% of the total number of seaweed species recorded in the Philippines (988, excluding infraspecific taxa; Lastimoso and Santiañez 2020). The number of seagrass species in the current study (7) represents 39% of the total number of seagrass species (18) recorded in the country (Fortes 2013). When combined with previous macroalgal studies [*e.g.* Roleda *et al.* (2000); Saco *et al.* (2020)], the macroalgal richness of the VIP (116) comprises approximately 12% of the reported macroalgae in the country. The record for VIP is higher than that of Lagonoy Gulf (55) (Mendoza and Soliman 2013) but lower than those of the Balabac Marine Biodiversity Conservation Corridor (171, excluding infraspecific names) (Santiañez *et al.* 2015) and Tablas, Romblon, and Sibuyan (128, based on updated names) (Clemente *et al.* 2017). The overall species richness reported from VIP may still be a conservative estimate, considering that other sites in the VIP – such as the islands in Romblon that are part of the passage – were not included in the present survey.

Macroalgal diversity among sites within the VIP appeared to be influenced by varying factors in the area. The proximity of sites did not necessarily result in similar macrophyte diversity. Agsalin in Oriental Mindoro grouped with Lubang and Looc, which may be attributed to the dominance of seagrass in these areas with the mostly sandy substratum. Agsalin also harbored macroalgae, but the number is very low with only three species. Amoingon, Sawang, Sabang, and Yook clustered as a group mainly because of the presence of both macroalgae and seagrass in the areas. These sites have sandy to rocky substrata, allowing macroalgae to grow with seagrasses that are distributed in patches.

Similarly, when focusing only on macroalgal diversity within the VIP, differences in macroalgal diversity among sites may have resulted from a combination of different factors such as variability in types of substratum, plus water depth and current (water motion), among others. For example, Agsalin again separated from all other sites, given the few macroalgal species present in this seagrass-dominated area. Laylay separated as well from the other sites, with the dominance of *Sargassum* in the area. Its rocky substratum in deeper waters and good water movement were suitable for the growth of this canopy-forming seaweed. Some of the adjacent sites, such as Diumanod and Sigman in Occidental Mindoro, exhibited similar site features and, therefore, supported more similar macroalgal composition. Isla Verde, Pagkilatan, Amoingon, Sabang, and Yook grouped together because of the high number of macroalgal species in these areas. It should be noted that the high number of algal species from Isla Verde is likely a result of multiple sampling over different periods and, hence, its high diversity and dissimilarity from the other sites.

Macroalgal diversity in sites within the VIP, especially from those covered in the current surveys, appears



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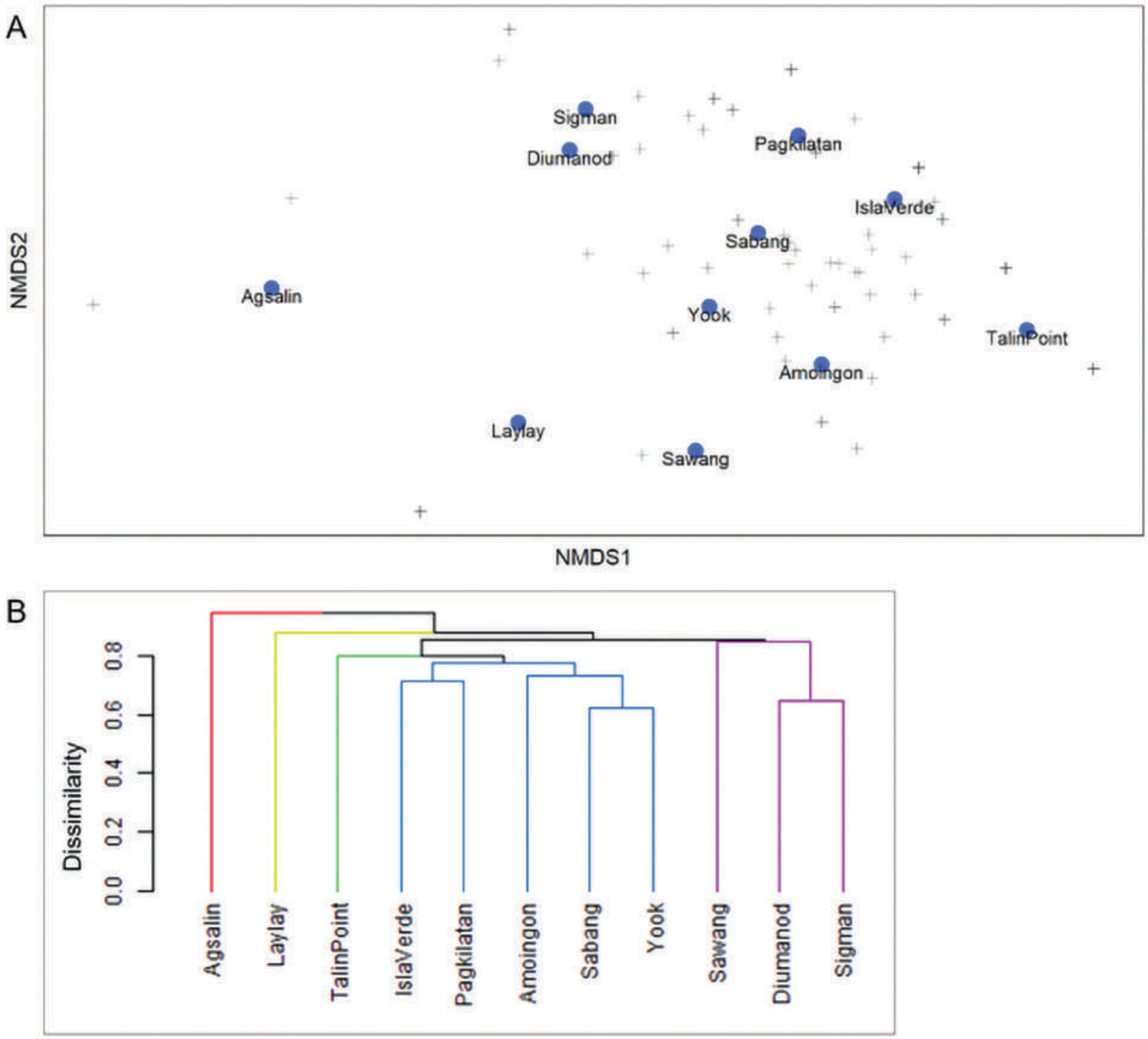
	Ags	Amo	Diu	Ver[a]	Lay	LL[b]	Pag	Sab	Saw	Sig	Tal[c]	Yoo
Ags	-											
Amo	0.93	-										
Diu	0.90	0.88	-									
Ver[a]	0.94	0.79	0.87	-								
Lay	0.94	0.81	0.90	0.94	-							
LL[b]	0.45	0.93	1.00	0.94	1.00	-						
Pag	0.97	0.84	0.83	0.74	0.94	1.00	-					
Sab	0.85	0.76	0.81	0.74	0.91	0.84	0.70	-				
Saw	0.78	0.80	0.88	0.85	0.90	0.76	0.86	0.73	-			
Sig	0.95	0.91	0.65	0.90	0.84	1.00	0.83	0.83	0.87	-		
Tal[c]	1.00	0.80	0.96	0.74	0.95	1.00	0.84	0.81	0.93	0.97	-	
Yoo	0.79	0.68	0.86	0.78	0.79	0.79	0.80	0.55	0.70	0.85	0.85	-

Legend	
Ags	Agsalin
Amo	Amoingon
Diu	Diumanod
Ver	Isla Verde
Lay	Laylay
LL	Lubang and Looc
Pag	Pagkilatan
Sab	Sabang
Saw	Sawang
Sig	Sigman
Tal	Talin Point
Yoo	Yook

Figure 3. [A] nMDS representations of marine macrophyte (macroalgae and seagrass) diversity in sites within the Verde Island Passage (VIP); crosses represent the different macrophyte species; stress value: 0.12. [B] Results of cluster analysis; different colors represent clusters separated by significant dissimilarity (SIMPROF test, $p < 0.05$). [C] Jaccard distance (dissimilarity) matrix showing dissimilarity comparisons in macrophyte composition between sites within the VIP.

Sources of data from the literature: [a]Isla Verde, Batangas City (Saco *et al.* 2020); [b]Lubang and Looc, Occidental Mindoro (Genito *et al.* 2009); [c]Talin Point, Lian, Batangas (Roleda *et al.* 2000).



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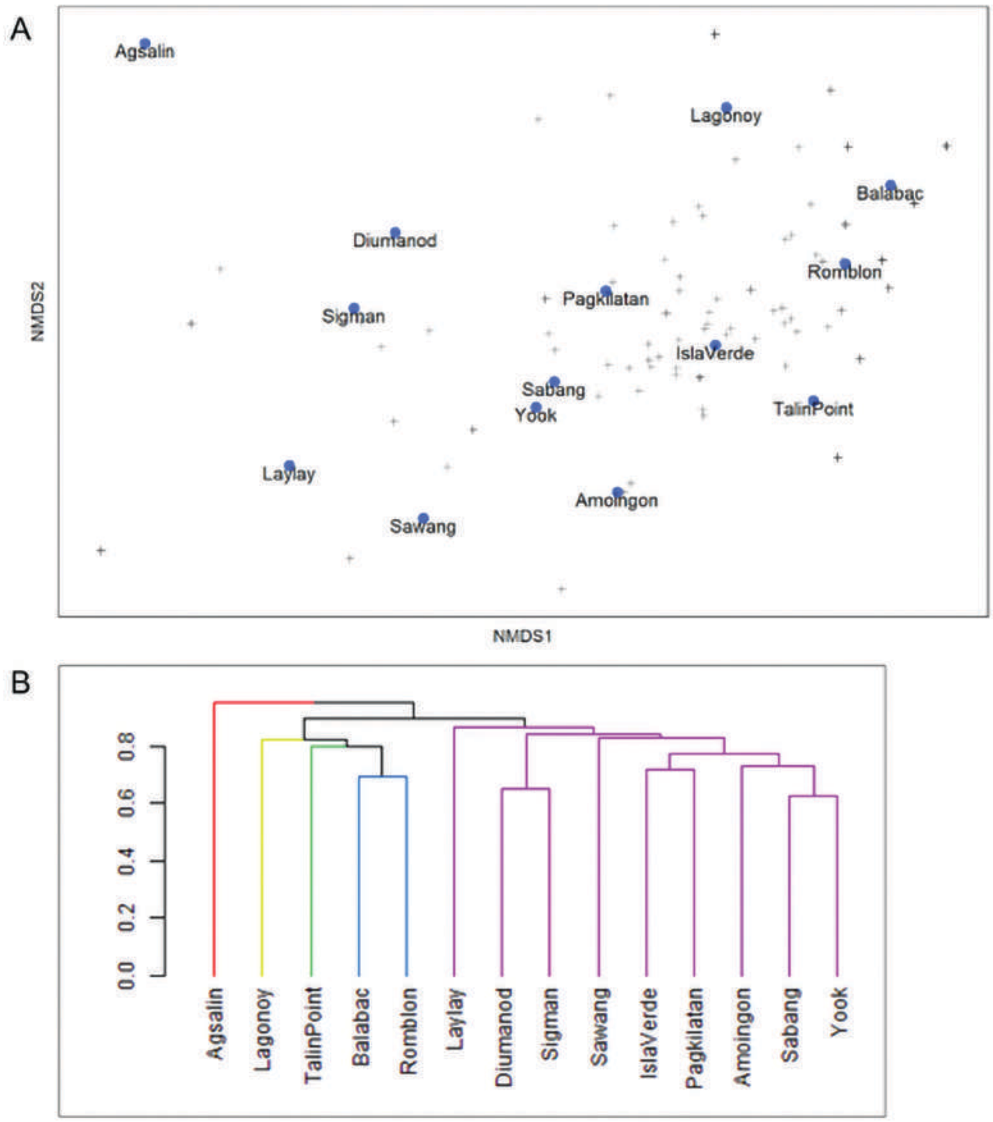
	Ags	Amo	Diu	Ver[a]	Lay	Pag	Sab	Saw	Sig	Tal[b]	Yoo
Ags	-										
Amo	1.00	-									
Diu	0.87	0.87	-								
Ver[a]	0.98	0.78	0.86	-							
Lay	0.91	0.80	0.90	0.94	-						
Pag	0.97	0.83	0.83	0.72	0.94	-					
Sab	0.96	0.78	0.77	0.78	0.90	0.67	-				
Saw	0.91	0.80	0.85	0.90	0.88	0.84	0.82	-			
Sig	0.93	0.90	0.65	0.89	0.84	0.83	0.81	0.84	-		
Tal[b]	1.00	0.79	0.96	0.73	0.95	0.84	0.80	0.92	0.97	-	
Yoo	0.95	0.68	0.83	0.82	0.74	0.77	0.63	0.79	0.82	0.84	-

Legend	
Ags	Agsalin
Amo	Amoingon
Diu	Diumanod
Ver	Isla Verde
Lay	Laylay
Pag	Pagkilatan
Sab	Sabang
Saw	Sawang
Sig	Sigman
Tal	Talin Point
Yoo	Yook

Figure 4. [A] nMDS representations of marine macroalgal diversity in sites within the Verde Island Passage (VIP); crosses represent the different macroalgal species; stress value: 0.10. [B] Results of cluster analysis; different colors represent clusters separated by significant dissimilarity (SIMPROF test, $p < 0.05$). [C] Jaccard distance (dissimilarity) matrix showing dissimilarity comparisons in macroalgal composition between sites within the VIP.

Sources of data from the literature: [a]Isla Verde, Batangas City (Saco *et al.* 2020); [b]Talin Point, Lian, Batangas (Roleda *et al.* 2000).



C

	Ags	Amo	Bal[a]	Diu	Ver[b]	Lag[c]	Lay	Pag	Rom[d]	Sab	Saw	Sig	Tal[e]	Yoo
Ags	-													
Amo	1.00	-												
Bal[a]	0.98	0.91	-											
Diu	0.87	0.87	0.94	-										
Ver[b]	0.98	0.78	0.80	0.86	-									
Lag[c]	0.96	0.88	0.84	0.92	0.84	-								
Lay	0.91	0.80	0.97	0.90	0.94	0.93	-							
Pag	0.97	0.83	0.88	0.83	0.72	0.88	0.94	-						
Rom[d]	0.98	0.89	0.69	0.93	0.77	0.81	0.96	0.85	-					
Sab	0.96	0.78	0.91	0.77	0.78	0.92	0.90	0.67	0.90	-				
Saw	0.91	0.80	0.96	0.85	0.90	0.97	0.88	0.84	0.95	0.82	-			
Sig	0.93	0.90	0.96	0.65	0.89	0.95	0.84	0.83	0.95	0.81	0.84	-		
Tal[e]	1.00	0.79	0.83	0.96	0.73	0.83	0.95	0.84	0.77	0.80	0.92	0.97	-	
Yoo	0.95	0.68	0.92	0.83	0.82	0.86	0.74	0.77	0.90	0.63	0.79	0.82	0.84	-

Legend	
Ags	Agsalin
Amo	Amoingon
Bal	Balabac
Diu	Diumanod
Ver	IslaVerde
Lag	Lagonoy
Lay	Laylay
Pag	Pagkilatan
Rom	Romblon
Sab	Sabang
Saw	Sawang
Sig	Sigman
Tal	TalinPoint
Yoo	Yook

Figure 5. [A] nMDS representations of marine macroalgal diversity in sites within the Verde Island Passage (VIP) in comparison with data from representative sites outside the VIP; crosses represent the different macroalgal species; stress value: 0.10. [B] Results of cluster analysis; different colors represent clusters separated by significant dissimilarity (SIMPROF test, $p < 0.05$); [C] Jaccard distance (dissimilarity) matrix showing dissimilarity comparisons in macroalgal composition among sites.

Sources of data from the literature: [a]Balabac Marine Biodiversity Conservation Corridor in Palawan (Santiañez *et al.* 2015); [b]Isla Verde, Batangas City (Saco *et al.* 2020); [c]Lagonoy Gulf (Mendoza and Soliman 2013); [d]Romblon Island Group [*i.e.* Tablas, Romblon, Sibuyan; Clemente *et al.* (2017)]; [e]Talin Point, Lian, Batangas (Roleda *et al.* 2000). Isla Verde and Talin Point were also included as part of the VIP.

to be rather similar but differs generally from that of representative sites outside the VIP. Sites in the present study were sampled only during the northeast monsoon. Different environmental conditions characteristic of these sites during this period may have contributed to its unique macroalgal assemblage.

Colder waters are generally observed in Oriental Mindoro and the part of Romblon included in the passage (Apaya 2018). Current flow, on the other hand, has been reported to exhibit seasonal reversal within the passage, moving westward into the West Philippine Sea during the northeast monsoon and inwards to the Sibuyan Sea during the southwest monsoon (Han *et al.* 2009; Gordon *et al.* 2011). The pattern of macroalgal composition in the Romblon Island Group has been shown to be possibly influenced by water circulation, hence the high similarity in macroalgal species among neighboring sites (Clemente *et al.* 2017). The influence of this oceanographic process on macrophyte diversity patterns, however, is less evident among sites examined in the present study. Macrophyte diversity could be affected by seasonality (Saco *et al.* 2020), which in turn could be affected by seasonal changes in current patterns. Differences in sampling periods between current and previous studies make it difficult to evaluate the effect of current patterns on macrophyte diversity among sites. More in-depth evaluation of this effect should be possible when more data are expected to be collected at different seasons from more sites within the VIP.

Some unique and noteworthy macroalgae were recorded in the current study compared with that in previous studies (*i.e.* Isla Verde and Talin Point). The red seaweed *Asparagopsis taxiformis,* which is recently gaining interest for its potential as methane-mitigating feed (Brooke *et al.* 2020), was encountered in Diumanod and Sigman (Appendix Table A1). The green seaweed *Chaetomorpha vieillardii* was found abundant and forming mats on seagrass beds in Sabang, Oriental Mindoro, and *Ulva intestinalis* was observed in Sigman. Many species of *Chaetomorpha* [*e.g.* Deng *et al.* (2013), Gao *et al.* (2013)] and *Ulva* [*e.g.* Zhao *et al.* (2013), Chávez-Sánchez *et al.* (2018)] have been reported to form blooms. Blooms are known to occur naturally for native species that are ephemeral or opportunistic; however, anthropogenic impacts may intensify the occurrence of these blooms (Lyons *et al.* 2012; Joniver *et al.* 2021). Changes in the abundance of these species should be monitored to understand better the relationship between the environment and the macrophyte community.

Data on the distribution and composition of habitats that support a high variety of organisms in a region are needed to support conservation and management efforts (Margules and Pressey 2000; Fulton *et al.* 2020). In comparison with the representative sites outside the VIP, some macroalgal species unique to the VIP include the brown seaweed *Colpomenia sinuosa*, the green seaweeds *Caulerpa verticillata* and *Cymopolia vanbosseae*, and the red seaweeds *Amphiroa dimorpha* and *A. taxiformis*. The high species richness of macrophytes in the VIP region and the presence of unique macroalgal species suggest the high conservation value of the VIP. Many marine macroalgae are utilized as pharmaceuticals and provide raw materials for various applications. Several species in the current study are known to be commercially valuable (*e.g. A. taxiformis, Gelidiella acerosa*, *Halymenia durvillei*, and *Caulerpa* spp., among others). The potential economic contributions of these macrophytes add value to the macroalgal diversity of the passage. Marine macrophytes also form important ecological habitats. Canopy-forming seaweed beds provide food and shelter for diverse assemblages of tropical fish, including targeted species for fisheries [Fulton *et al.* (2020) and references therein]. In the VIP, the canopy-forming brown seaweed *Sargassum* was recorded to be forming dense thickets (*e.g.* in Laylay and Amoingon, Marinduque). Although not quantified or assessed, a variety of fish and invertebrates were observed in these areas. In addition, seagrass meadows are recognized as key habitats for a range of fish, invertebrates, and megafauna (Nordlund *et al.* 2016; Sievers *et al.* 2019). These macrophytes also provide numerous functions such as coastal protection, sediment accretion and stabilization, and carbon sequestration (Nordlund *et al.* 2016). Large seagrasses such as *Enhalus*, which were recorded in the VIP, are generally perceived to provide a wide range of ecosystem services (Nordlund *et al.* 2016). Although small, the seagrasses *Halophila*, *Halodule*, and *Cymodocea* – which were recorded in many of the seagrass sites in the VIP – are important food sources for dugongs (Nordlund *et al.* 2016; Akbar *et al.* 2021). Although less known, seagrasses are also sources of pharmaceuticals and raw materials (Nordlund *et al.* 2016). Overall, these functions and services of marine macroalgae and seagrass species indicate the vital roles of marine macrophytes in the marine environment and underscore the contribution of marine macrophyte diversity to the high conservation value of the region.

In summary, this study provides initial results on the marine macrophyte diversity of the VIP. Marine macrophyte diversity data obtained from surveys in selected sites during the northeast monsoon season were analyzed, along with previous data from relevant studies conducted in the VIP. Data from the VIP were also compared to other representative sites outside the VIP. In general, clustering among sites may, in part, be explained by differences in local environmental conditions – such as variability in the types of substratum, water depth, and current patterns (water motion). However, further studies are needed to verify the role of these factors and other environmental conditions in driving variations in macroalgal diversity within and among sites in the passage. Macroalgae are known to exhibit seasonality, which could be related to changing local conditions as affected by the monsoons. Biotic interactions – which have been shown to be a crucial factor in influencing macroalgal distribution, especially in the tropics (Keith *et al.* 2013) – should also be considered as possible drivers of macroalgal diversity change in the passage. Further sampling surveys to examine temporal variation and the inclusion of more sites, especially areas at the edges of VIP (*e.g.* Looc and Lubang in Occidental Mindoro and Banton, Concepcion, and Corcuera in Romblon), may capture other species that have not been reported here. A thorough understanding of the spatial and temporal patterns of macroalgal diversity is fundamental in understanding the ecosystem functions and services of these marine macrophytes.

ACKNOWLEDGMENTS

The authors extend their sincere gratitude to Dr. Doreen R. Mascareñas, Mr. Regie F. Mampusti, Mr. Dustin Fritz M. Fiedalan, Mr. Ryan Mark A. Ambong, and Mr. Artemio T. Bañaga for their assistance during the data collection. We would like to thank Ms. Alecs L. Persia, Mr. Enriquo Martin C. Velasquez, Mr. Symon Jade Binay, Mr. Luigi Villalobos, Ms. Manilyn Casa, Dr. Miguel Enrique A. Azcuna, and Dr. Jonel M. Corral for their technical assistance, as well as encouragement and support in writing this manuscript. We thank the local government units and fisherfolk for sharing their knowledge and assistance during our site surveys.

This study was funded by the Department of Science and Technology–Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development through the project "Marine Biodiversity Assessment in Selected Areas Along the Verde Island Passage (MBioAssess-VIP)." The researchers gratefully acknowledge the support of the Batangas State University, Marinduque State College, Mindoro State College of Agriculture and Technology, Occidental Mindoro State College, and the local government units of Batangas, Marinduque, Oriental Mindoro, and Occidental Mindoro.

NOTE ON APPENDICES

The complete appendices section of the study is accessible at https://philjournsci.dost.gov.ph

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APPENDIX

Table A1. List of marine macrophyte species in sites within the VIP during the northeast monsoon survey in selected sites in the Verde Island Passage (VIP). Macroalgae and seagrass data were compared to data from previous studies with sites within the VIP [[a]Talin Point, Lian, Batangas per Roleda *et al.* (2000); [b]Verde Island, Batangas City per Saco *et al.* (2020); [c]Lubang and Looc, Occidental Mindoro per Genito *et al.* (2009)]. Macroalgal data from the VIP were compared to those from studies outside the VIP [[d]Balabac Marine Biodiversity Conservation Corridor in Palawan per Santiañez *et al.* (2015); [e]Lagonoy Gulf per Mendoza and Soliman (2013); [f]Tablas, Romblon, and Sibuyan Islands of the Romblon Island Group per Clemente *et al.* (2017)]. Sites acronyms: Ags – Agsalin, Amo – Amoingon, Diu – Diumanod, Lay – Laylay, Pag – Pagkilatan, Sab – Sabang, Saw – Sawang, Sig – Sigman, Yoo – Yook, Tal – Talin Point, Ver – Verde Island, LL – Lubang and Looc, Bal – Balabac Marine Biodiversity Corridor, Lag – Lagonoy Gulf, and Rom – Romblon Island Group.

Species	Ags	Amo	Diu	Lay	Pag	Sab	Saw	Sig	Yoo	Tal[a]	Ver[b]	LL[c]	Bal[d]	Lag[e]	Rom[f]	Remarks
Brown seaweeds																
Canistrocarpus cervicornis (Kützing) De Paula & De Clerck (=*Dictyota cervicornis* Kützing)			x		x						x		x	x	x	
Colpomenia sinuosa (Mertens ex Roth) Derbès & Solier								x								
Dictyota bartayresiana J.V.Lamouroux													x			
Dictyota dichotoma (Hudson) J.V.Lamouroux	x												x	x	x	
Dictyota dichotoma var. *intricata* (C.Agardh) Greville														x		
Dictyota friabilis Setchell													x			
Dictyota implexa (Desfontaines) J.V.Lamouroux (=*Dictyota divaricata* J.V.Lamouroux)		x			x	x			x		x		x		x	
Dictyota sp. 1											x					
Dictyota sp. 2													x			
Dictyota sp. 3													x			
Dictyota sp. 4															x	
Dictyota mertensii (C.Martius) Kützing (=*Dictyota dentata* J.V.Lamouroux)													x			
Dictyotaceae															x	
Ectocarpus sp.											x					
Hormophysa cuneiformis (J.F.Gmelin) P.C.Silva		x		x					x	x	x		x	x	x	
Hydroclathrus clathratus (C.Agardh) M.Howe											x		x		x	
Hydroclathrus tenuis C.K.Tseng & Lu Baroen													x			
Lobophora sp.									x							
Lobophora variegata (J.V.Lamouroux) Womersley ex E.C.Oliveira										x					x	
Padina arborescens Holmes															x	
Padina australis Hauck										x			x		x	
Padina boryana Thivy															x	
Padina gymnospora (Kützing) Sonder															x	
Padina japonica Yamada										x			x	x	x	
Padina jonesii Tsuda															x	
Padina minor Yamada						x			x	x			x	x	x	
Padina sp. 1		x	x		x	x	x	x	x							
Padina sp. 2				x												

Species	Ags	Amo	Diu	Lay	Pag	Sab	Saw	Sig	Yoo	Tal[a]	Ver[b]	LL[c]	Bal[d]	Lag[e]	Rom[f]	Remarks
Padina sp. 3				x												
Padina sp. 4											x					
Padina sp. 5										x						
Padina sp. 6														x		
Padina tetrastromatica Hauck															x	
Sargassum aquifolium (Turner) C.Agardh (=*Sargassum crassifolium* J.Agardh)													x		x	
Sargassum fulvellum (Turner) C.Agardh															x	
Sargassum gracillimum Reinbold													x			
Sargassum ilicifolium (Turner) C.Agardh (=*Sargassum cristaefolium* C.Agardh)										x	x		x		x	
Sargassum kushimotense Yendo													x			
Sargassum oligocystum Montagne													x		x	
Sargassum piluliferum (Turner) C.Agardh															x	
Sargassum polycystum C.Agardh										x			x		x	
Sargassum siliquosum J.Agardh													x			
Sargassum sp. 1		x		x			x		x							
Sargassum sp. 2				x												
Sargassum sp. 3											x					
Sargassum sp. 4										x						
Sargassum sp. 5										x						
Sargassum sp. 6										x						
Sargassum sp. 7										x						
Sargassum sp. 8										x						
Sargassum sp. 9										x						
Sargassum sp. 10										x						
Sargassum sp. 11													x			
Sargassum sp. 12													x			
Sargassum sp. 13													x			
Sargassum sp. 14														x		
Sargassum sp. 15														x		
Sargassum sp. 16															x	
Sirophysalis trinodis (Forsskal) Kützing													x			
Sphacelaria sp.										x						
Turbinaria conoides (J.Agardh) Kützing		x											x		x	
Turbinaria decurrens Bory													x			
Turbinaria luzonensis W.R.Taylor													x			
Turbinaria ornata (Turner) J.Agardh		x								x	x		x		x	
Turbinaria sp. 1													x			
Turbinaria sp. 2														x		
Green seaweeds																
Acetabularia dentata Solms-Laubach						x			x	x			x			
Acetabularia major G.Martens			x					x			x		x	x	x	
Acetabularia sp. 1											x					
Acetabularia sp. 2											x					

Species	Ags	Amo	Diu	Lay	Pag	Sab	Saw	Sig	Yoo	Tal[a]	Ver[b]	LL[c]	Bal[d]	Lag[e]	Rom[f]	Remarks
Acetabularia sp. 3			x		x	x		x	x							
Anadyomene eseptata Gilbert													x			
Anadyomene plicata C.Agardh		x	x							x	x		x			
Anadyomene wrightii Harvey ex J.E.Gray															x	
Avrainvillea erecta (Berkeley) A.Gepp & E.S.Gepp													x		x	
Avrainvillea lacerata J.Agardh													x	x	x	
Avrainvillea obscura (C. Agardh) J. Agardh															x	
Avrainvillea sp. 1						x										
Avrainvillea sp. 2													x			
Boergesenia forbesii (Harvey) Feldmann					x	x	x		x	x	x		x	x	x	
Boodlea composita (Harvey) F.Brand					x	x				x	x		x		x	
Bornetella nitida Munier-Chalmas ex Sonder									x		x				x	
Bornetella oligospora Solms-Laubach													x	x	x	
Bornetella sphaerica (Zanardini) Solms-Laubach		x		x		x			x	x	x		x	x	x	
Bryopsis sp.													x			
Caulerpa brachypus Harvey													x			
Caulerpa chemnitzia (Esper) J.V.Lamouroux (=*Caulerpa peltata* J.V.Lamouroux)					x								x	x		
Caulerpa chemnitzia var. *turbinata* (J. Agardh) Fernández-Garcia & Riosmena-Rodriguez (=*Caulerpa racemosa* var. *turbinata* (J.Agardh) Eubank)													x			
Caulerpa cupressoides (Vahl) C.Agardh										x			x		x	
Caulerpa cupressoides var. *lycopodium* Weber Bosse													x			
Caulerpa dentata														x		Possibly misidentified, could be *Caulerpa freycinetii* f. *longidentata* Weber Bosse
Caulerpa lentillifera J.Agardh													x	x		
Caulerpa lentillifera var. *compacta* Trono & Ang													x			
Caulerpa mexicana Sonder ex Kützing													x			
Caulerpa microphysa (Weber Bosse) Feldmann													x		x	
Caulerpa racemosa (Forsskål) J.Agardh										x			x	x	x	
Caulerpa serrulata (Forsskål) J.Agardh		x								x	x		x	x	x	
Caulerpa sertularioides (S.G.Gmelin) M.Howe			x								x		x	x	x	
Caulerpa sertularioides f. *longipes* (J.Agardh) Collins (=*Caulerpa sertularioides* f. *farlowii* (Weber Bosse) Børgesen)													x			
Caulerpa taxifolia (M.Vahl) C.Agardh													x		x	
Caulerpa verticillata J.Agardh											x					
Caulerpa webbiana var. *pickeringii* (Harvey & Bailey) Eubank													x			
Caulerpa urvilleana Montagne (=*Caulerpa cupressoides* var. *urvilleana* (Montagne) L.M.Hodgson, P.H. Tri, K.Lewmanomont & K.J. McDermid)													x			
Chaetomorpha sp. 1															x	

Species	Ags	Amo	Diu	Lay	Pag	Sab	Saw	Sig	Yoo	Tal[a]	Ver[b]	LL[c]	Bal[d]	Lag[e]	Rom[f]	Remarks
Chaetomorpha sp. 2														x		
Chaetomorpha vieillardii (Kützing) M.J.Wynne						x				x			x		x	Correct name for tropical species identified as *C. crassa* (Wynne 2011)
Chlorocladus australasicus Sonder														x		
Chlorodesmis fastigiata (C.Agardh) S.C.Ducker													x	x	x	
Chlorodesmis hildebrandtii A.Gepp & E.S.Gepp													x			
Chlorodesmis sp.										x						
Cladophora aokii Yamada													x			
Cladophora sp.													x			
Cladophora vagabunda (Linnaeus) Hoek													x			
Cladophoropsis fasciculata (Kjellman) Wille													x			
Cladophoropsis vaucheriiformis (Areschoug) Papenfuss													x		x	
Codium arabicum Kützing											x		x		x	
Codium bartletti C.K.Tseng & W.J.Gilbert															x	
Codium edule P.C.Silva								x			x		x			
Codium sp. 1													x			
Codium sp. 2														x		
*Codium tenue (*Kützing) Kützing															x	
Cymopolia vanbosseae Solms-Laubach		x														
Dasycladus vermicularis (Scopoli) Krasser															x	
Dictyosphaeria cavernosa (Forsskål) Børgesen						x			x	x	x		x		x	
Dictyosphaeria sp.														x		
Dictyosphaeria versluysii Weber Bosse					x				x	x	x		x		x	
Enteromorpha sp.										x						
Halicoryne wrightii Harvey		x		x	x			x	x				x	x	x	
Halimeda cuneata Hering															x	
Halimeda cylindracea Decaisne													x			
Halimeda discoidea Decaisne													x			
Halimeda discoidea f. *subdigitata* Gilbert													x			
Halimeda gracilis Harvey ex J.Agardh															x	
Halimeda incrassata (J.Ellis) J.V.Lamouroux					x		x				x		x	x	x	
Halimeda macroloba Decaisne	x		x										x	x	x	
Halimeda macrophysa Askenasy													x			
Halimeda opuntia (Linnaeus) J.V.Lamouroux		x			x	x				x	x		x	x	x	
Halimeda simulans M.Howe													x		x	
Halimeda sp. 1											x					
Halimeda sp. 2													x			
Halimeda sp. 3													x			
Halimeda sp. 4														x		
Halimeda taenicola W.R.Taylor													x	x	x	
Halimeda tuna (J.Ellis & Solander) J.V.Lamouroux										x			x	x	x	

Species	**Ags**	**Amo**	**Diu**	**Lay**	**Pag**	**Sab**	**Saw**	**Sig**	**Yoo**	**Tal**[a]	**Ver**[b]	**LL**[c]	**Bal**[d]	**Lag**[e]	**Rom**[f]	**Remarks**
Halimeda velasquezii W.R.Taylor										x					x	
Microdictyon okamurae Setchell													x			
Monostroma nitidum Wittrock															x	
Neomeris annulata Dickie	x		x	x	x	x	x	x	x		x		x		x	
Neomeris sp.										x						
Neomeris vanbosseae M.Howe													x	x	x	
Tydemania expeditionis Weber Bosse													x			
Udotea argentea Zanardini													x			
Udotea geppiorum Yamada													x			
Udotea indica A.Gepp & E.S.Gepp															x	
Udotea occidentalis A.Gepp & E.S.Gepp														x	x	
Udotea orientalis A.Gepp & E.S.Gepp		x					x			x	x		x		x	
Udotea sp. 1					x											
Udotea sp. 2													x			
Ulva clathrata (Roth) C.Agardh											x		x	x	x	
Ulva flexuosa Wulfen													x			
Ulva intestinalis Linnaeus					x	x	x	x		x	x		x		x	
Ulva lactuca Linnaeus					x	x					x		x			
Ulva prolifera O.F.Müller															x	
Ulva reticulata Forsskål										x	x		x		x	
Ulva sp.														x		
Valonia aegagropila C.Agardh										x	x		x	x	x	
Valonia fastigiata Harvey ex J.Agardh													x			
Valonia sp.											x					
Valonia utricularis (Roth) C.Agardh															x	
Valonia ventricosa J.Agardh									x				x	x		
Red seaweeds																
Acanthophora muscoides (Linnaeus) Bory													x	x		
Acanthophora spicifera (M.Vahl) Børgesen			x		x	x		x			x		x		x	
Actinotrichia fragilis (Forsskål) Børgesen		x			x				x	x	x		x	x	x	
Amansia glomerata C.Agardh (=*Melanamansia glomerata* (C.Agardh) R.E.Norris)													x		x	
Amphiroa anastomosans Weber Bosse															x	
Amphiroa dimorpha Me.Lemoine										x						
Amphiroa foliacea J.V.Lamouroux		x			x	x			x	x	x		x	x	x	
Amphiroa fragilissima (Linnaeus) J.V.Lamouroux		x	x			x	x		x	x	x		x		x	
Amphiroa sp. 1													x			
Amphiroa sp. 2														x		
Asparagopsis taxiformis (Delile) Trevisan			x					x								
Betaphycus gelatinus (Esper) Doty ex P.C.Silva													x			
Bostrychia sp.															x	
Bostrychia tenella (J.V.Lamouroux) J.Agardh													x			

Species	Ags	Amo	Diu	Lay	Pag	Sab	Saw	Sig	Yoo	Tal[a]	Ver[b]	LL[c]	Bal[d]	Lag[e]	Rom[f]	Remarks
Callophyllis fastigiata (J.Agardh) J.Agardh (=*Gracilaria fastigiata J.Agardh* 1852)													x			
Catenella sp.															x	
Ceramium sp.													x			
Ceratodictyon intricatum (C.Agardh) R.E.Norris													x		x	
Ceratodictyon sp. 1										x						
Ceratodictyon sp. 2															x	
Ceratodictyon spongiosum Zanardini					x	x					x		x			
Ceratodictyon variabile (J.Agardh) R.E.Norris															x	
Champia parvula (C.Agardh) Harvey															x	
Chondria armata (Kützing) Okamura													x			
Chondria sp. 1													x			
Chondria sp. 2													x			
Chondriopsis dasyphylla f. *pyrifera J.Agardh (=Laurencia intricata* Suhr)													x			
Chondrophycus cartilagineus (Yamada) Garbary & J.T.Harper (=*Laurencia cartilaginea* Yamada)													x		x	
Chondrophycus tronoi (E.Ganzon-Fortes) K.W.Nam (=*Laurencia tronoi* Ganzon-Fortes 1982)													x			
Claudea sp.											x					
Corallina berteroi Montagne ex Kützing (=*Corallina pinnatifolia* (Manza) E.Y.Dawson)															x	
Dasya antillarum (M.Howe) A.J.K.Millar													x			
Dichotomaria obtusata (J.Ellis & Solander) Lamarck (=*Galaxaura obtusata* (J.Ellis & Solander) J.V.Lamouroux)										x						
Digenea simplex (Wulfen) C.Agardh													x			
Eucheuma denticulatum (N.L.Burman) Collins & Hervey													x			
Eucheuma serra (J.Agardh) J.Agardh													x			
Eucheuma sp.														x		
Galaxaura divaricata (Linnaeus) Huisman & R.A.Townsend													x		x	
Galaxaura rugosa (J.Ellis & Solander) J.V.Lamouroux		x									x					
Galaxaura sp. 1										x						
Galaxaura sp. 2															x	
Ganonema farinosum (J.V.Lamouroux) K.-C.Fan & Y.-C.Wang (=*Liagora farinosa* J.V.Lamouroux)								x			x		x		x	
Gayliella sp.															x	
Gelidiella acerosa (Forsskål) Feldmann & Hamel		x					x			x			x		x	
Gelidiella sp.														x		
Gelidium divaricatum G.Martens															x	
Gracilaria arcuata Zanardini					x					x			x	x	x	
Gracilaria coronopifolia J.Agardh													x			
Gracilaria edulis (S.G.Gmelin) P.C.Silva										x	x		x			

Species	Ags	Amo	Diu	Lay	Pag	Sab	Saw	Sig	Yoo	Tal[a]	Ver[b]	LL[c]	Bal[d]	Lag[e]	Rom[f]	Remarks
Gracilaria eucheumatoides Harvey (=*Hydropuntia eucheumatoides* (Harvey) Gurgel & Fredericq)		x			x					x	x		x		x	
Gracilaria gigas Harvey													x			
Gracilaria salicornia (C.Agardh) E.Y.Dawson					x	x				x	x		x		x	
Gracilaria sp. 1			x			x										
Gracilaria sp. 2											x					
Gracilaria sp. 3													x			
Gracilaria sp. 4										x						
Gracilaria sp. 5													x			
Gracilaria sp. 6														x		
Gracilaria textorii (Suringar) Hariot											x				x	
Gracilariopsis longissima (S.G.Gmelin) Steentoft, L.M.Irvine & Farnham															x	
Halymenia durvillei Bory					x						x				x	
Halymenia floresii (Clemente) C.Agardh													x			
Halymenia maculata J.Agardh													x			
Halymenia sp. 1													x			
Halymenia sp. 2														x		
Hydrolithon sp.															x	
Hypnea cenomyce J.Agardh															x	
Hypnea cervicornis J.Agardh										x	x			x		
Hypnea charoides J.V.Lamouroux															x	
Hypnea cornuta (Kützing) J.Agardh													x			
Hypnea esperi Bory													x		x	
Hypnea musciformis (Wulfen) J.V.Lamouroux													x			
Hypnea pannosa J.Agardh		x				x				x			x		x	
Hypnea sp. 1						x										
Hypnea sp. 2													x			
Hypnea spinella (C.Agardh) Kützing													x			
Hypnea valentiae (Turner) Montagne													x		x	
Jania capillacea Harvey										x					x	
Jania pedunculata var. *adhaerens* (J.V.Lamouroux) A.S.Harvey, Woelkerling & Reviers (=*Jania adhaerens* J.V.Lamouroux; Jania decussatodichotoma (Yendo) Yendo)															x	
Jania pumila J.V. Lamouroux															x	
Jania sp. 1													x			
Jania sp. 2														x		
Jania ungulata (Yendo) Yendo															x	
Kallymenia sp.															x	
Kappaphycus alvarezii (Doty) L.M.Liao													x			
Kappaphycus cottonii (Weber Bosse) Doty ex H.D.Nguyen & Q.N.Huyn													x			
Kappaphycus striatus (F.Schmitz) L.M.Liao (=*Eucheuma striatum* F.Schmitz)													x			
Laurencia nidifica J. Agardh													x			
Laurencia obtusa (Hudson) J.V.Lamouroux					x								x		x	

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Laurencia okamurae Yamada													x			
Laurencia sp. 1													x			
Laurencia sp. 2													x			
Laurencia sp. 3															x	
Laurencia sp. 4															x	
Leveillea jungermannioides (Hering & G.Martens) Harvey													x		x	
Liagora ceranoides J.V.Lamouroux													x			
Liagora sp.														x		
Liagoropsis schrammii (P.Crouan & H.Crouan) Doty & I.A.Abbott													x			
Lithothamnion sp. 1													x			
Lithothamnion sp. 2														x		
Mastophora rosea (C.Agardh) Setchell										x			x	x	x	
Melanothamnus ferulaceus (Suhr ex J.Agardh) Diaz-Tapia & Maggs (=*Neosiphonia ferulacea* (Suhr ex J.Agardh) S.M.Guimarães & M.T.Fujii)													x			
Meristotheca coacta Okamura															x	
Meristotheca papulosa (Montagne) J.Agardh															x	
Mimica arnoldii (Weber Bosse) Santiañez & M.J.Wynne (=*Eucheuma arnoldii* Weber Bosse)													x			
Ohelopapa flexilis (Setchell) F.Rousseau, Martin-Lescanne, Payri & L.Le Galle (=*Laurencia flexilis* Setchell)					x					x	x		x		x	
Palisada perforata (Bory) K.W.Nam (=*Laurencia papillosa* (C.Agardh) Greville)										x	x		x	x	x	
Palisada thuyoides (Kützing) Cassano, Sentíes, Gil-Rodríguez & M.T.Fujii (=*Laurencia thuyoides* Kützing)													x			
Peyssonelia sp. 1													x			
Peyssonelia sp. 2													x			
Peyssonelia sp. 3													x			
Peyssonnelia rubra (Greville) J.Agardh													x		x	
Polysiphonia sp. 1								x								
Polysiphonia sp. 2															x	
Portieria hornemannii (Lyngbye) P.C.Silva			x		x						x		x		x	
Pterocladiella capillacea (S.G.Gmelin) Santelices Hommersand															x	
Rhodymenia sp. 1					x											
Rhodymenia sp. 2											x					
Rhodymenia sp. 3										x						
Spyridia filamentosa (Wulfen) Harvey											x		x			
Spyridia sp.															x	
Tolypiocladia calodictyon (Harvey ex Kützing) P.C.Silva													x			
Tolypiocladia condensata (Weber Bosse) P.C.Silva													x			
Tolypiocladia glomerulata (C.Agardh) F.Schmitz											x		x			
Tolypiocladia sp.															x	

Species	Ags	Amo	Diu	Lay	Pag	Sab	Saw	Sig	Yoo	Tal[a]	Ver[b]	LL[c]	Bal[d]	Lag[e]	Rom[f]	Remarks
Tricleocarpa fragilis (Linnaeus) Huisman & R.A.Townsend (=*Galaxaura oblongata* (J.Ellis & Solander) J.V.Lamouroux; *Galaxaura fragilis* (Lamarck) J.V.Lamouroux)		x	x	x		x		x	x	x	x		x	x	x	
Wrangelia bicuspidata Børgesen													x			
Wrangelia penicillata (C.Agardh) C.Agardh													x			
Yamadaella cenomyce (Decaisne) I.A.Abbott															x	
Zellera tawallina G.Martens					x					x					x	
Seagrass																
Cymodocea rotundata Ascherson & Shweinfurth	x					x	x		x		x	x				
Cymodocea serrulata (R.Brown) Ascherson & Magnus	x											x				
Enhalus acoroides (Linnaeus f.) Royle												x				
Halodule pinifolia (Miki) Hartog	x					x	x		x		x	x				
Halodule uninervis (Forsskål) Ascherson	x	x				x			x			x				
Halophila decipiens Ostenfeld											x					
Halophila ovalis (R.Brown) Hooker f.	x	x				x	x		x		x	x				
Syringodium isoetifolium (Ascherson) Dandy	x								x			x				
Thalassia hemprichii (Ehrenberg) Ascherson						x	x		x		x	x				
Total number of species																
Macroalgae	3	21	14	9	28	24	9	13	20	60	58	0	175*	55	128	
Brown	1	6	2	5	3	3	2	2	6	17	10	0	30	10	25	
Green	2	7	6	3	12	12	5	6	10	21	26	0	70	29	48	
Red	0	8	6	1	13	9	2	5	4	22	22	0	75	16	55	
Seagrass	6	2	0	0	0	5	4	0	6	0	5	8	0	0	0	

*Number of taxa based on updated names