Vol. 7 January 2016 CHED Accredited Research Journal, Category A-1 Print ISSN 2094-5019 • Online ISSN 2244-0461 doi: http://dx.doi.org/10.7828/ajob.v7i1.900

Spatial Morphological Variability of the Seagrass Halophila ovalis (R.Br.) Hooker f in Minahasa Peninsula waters

BILLY T. WAGEY

ORCID No. 0000-0002-7059-8701 bwagey@yahoo.com Faculty of Fisheries and Marine Science, Sam Ratulangi University Manado 95115

RIDWAN LASABUDA

ORCID No. 0000-0002-4122-8103 ridwanlasabuda@gmail.com Faculty of Fisheries and Marine Science, Sam Ratulangi University Manado 95115

FRANS TILAAR

ORCID No. 0000-0003-0448-2513 tilaar2135@gmail.com PhD Students in Aquatic Science Faculty of Fisheries and Marine Science, Faculty of Fisheries and Marine Science, Sam Ratulangi University Manado 95115

VIVIE KATUUK

ORCID No. 0000-0001-6325-4778 katuuk.vv@gmail.com PhD Students in Aquatic Science Faculty of Fisheries and Marine Science

ABSTRACT

The study was conducted to explore the spatial morphological variability of *Halophila ovalis* (R.Br.) Hooker f in seven sites of Minahasa Peninsula waters. The sites were Tanjung Merah Beach, Likupang Beach, Mantehage Beach, Likupang

Beach, Tongkeina Beach, Manado Beach and Arakan Beach. The Image-J software was applied to measure the leaves (length, wide, and cross veins), rhizomes, and nodes of the samples. Simple descriptive statistics were used to characterize the populations. Hobo pendant tempt/light loggers (UA-002-08) were used to measure light intensity and temperature. This research indicated that most of the leaves were larger in the subtidal area than those in the intertidal area.

Keywords: Morphometric, segrass, variability, Image-J, Hobo Loggers, *Halophila ovalis*

INTRODUCTION

Seagrass (seagrass) are the only flowering plants found in the marine environment as well as the grass on the ground. They have leafy shoots, upright and creeping stalks effective to breed and have roots and an internal system for transporting gas and nutrient substances (Calumpong and Meňez 1997; Romimohtarto and Juwana 2001).

Seagrass is also a plant that has adapted to live buried in shallow waters. They have roots and rhizomes (rhizome) gripping the seabed so as to help the coastal defences of scouring waves and waves. Beds of seagrass vegetation can consist of a single type or a mixed type (Hemminga and Duarte 2000).

Seagrasses are angiosperms that are related to terrestrial flowering plants. They are living partially or entirely submerged in marine waters. They have erect leaves, buried root-like structure (rhizomes) that hold the plants in the sediments, and roots that take up nutrients from sediments for growth. As a result, seagrasses are not a taxonomically unified group but a 'biological' or 'ecological' group. The evolutionary adaptations required for survival in the marine environment have led to convergence in morphology (den Hartog 1970; den Hartog and Kuo 2006).

Seagrasses are interesting because they form long-lived, structurally-complex benthic communities. There are about 60 known seagrass species in the world, 12 of which have been recorded in Indonesian Waters. Because of this high diversity, there has recently been an expanding interest in evaluating various morphometric structural and dynamic parameters in seagrasses. Moreover, Seagrasses play an important role in the coastal ecosystem as one of the major primary producers, forming the base of the food chain. Seagrasses beds form an extremely complex ecosystem that function through detritus-based as well as herbivore food webs. The importance of seagrasses beds in contributing to fish abundance and diversity continue to be a major focus of marine biologists because of their ecological and economical role in many coastal ecosystems (Green and Short 2003; Kuriandewa *et al.* 2003).

Dealing with climate change (climate change), seagrass ecosystem is one of the most obvious affected. Seagrass beds could disappear, especially near the estuary of the river and in the intertidal waters. The main cause of this is rising temperatures, particularly in some places in the shallow water habitat. Increasing the temperature influence the distribution and reproduction process of seagrass. Besides the temperature, other factors that influence the increasing sedimentation and resuspension of sediment due to high rainfall and the frequency of floods from rivers that affect the intensity of light (Vermaat *et al.* 1997; Poejirahajoe 2013). Numerous researchers have related seagrass health to environmental stressors. Salinity, depth, light, nutrients, sediment characteristics and temperature are some of the variables identified as contributing to patterns in the measured seagrass response variable (Dennison 1987; Dawson and Denisson 1996).

OBJECTIVES OF THE STUDY

This study aimed to assess the morphometric variation of seagrass species *Halophila ovalis* (R.Br.) Hooker f on the dominant seagrass habitat in Minahasa Peninsula coastal waters.

MATERIALS AND METHODS

Sampling and Study Sites

Sampling was carried out from January to December 2014 at selected sites in the seagrass beds area of Arakan, Manado Bay, Tongkeina, Siladen, Mantehage, Likupang, and Tanjung Merah (Figure 1).

Sample plots were used for sampling measuring 50 cm x 50 cm which is divided again into 25 subplots with a size of 10 cm x 10 cm. Percentage cover of seagrass at some point is the average of the six replications.

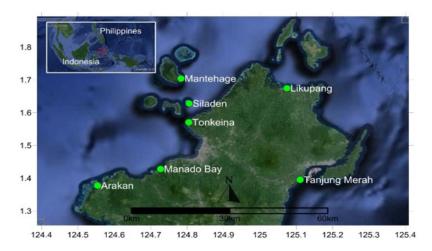


Figure 1. Showed the map of location of the sites in Minahasa Peninsula Waters

Density Measurements

Percentage cover of each species was determined by counting the number of sub quadrats occupied. This was categorized into: 0 percentage cover (when frequency was 0), < 10 percentage cover, 10 - 50 percentage cover, and > 50 percentage cover (Tomasko *et al.* 1993; Short and Coles 2001).

In this present study, the shoot density has been broadly classified into two, low and high-density bed.

Morphometric Measurements and Analysis

A total of fifty samples (n = 50) of each species from the intertidal (with low *Halophila* density), intertidal (with high *Halophila* density), subtidal (with low *Halophila* density) and subtidal (with high *Halophila* density) were randomly collected from all the quadrats for measurements. Samples of *Halophila* were collected, rinsed free of sediment using seawater, then placed in labelled net bags. They were brought to Marine Laboratory Sam Ratulangi University and kept in a bucket for subsequent processing and analysis. The next day, shoots were carefully cleaned in filtered seawater, and epiphytes attached to the leaves were removed by gently scraping them with the hand. After cleaning, each sample was photographed with a ruler as a scale and the following were measured using Image-J software 1.42u;java 1,6; 32 bit (Rasband 2011). All photos were stored

and saved in .jpg files according to its species name, site, tidal area or station and density, and the date of collection.

Measurements of the following morphological variables were taken: the length of rhizomes, length of upright shoot, the length of longest leaf (cm), the number of leaves, the number of nodes and the present of flower and fruit. The cross-veins in the leaves were counted. The blade width/length, petiole diameter/length and rhizome diameter/length ratios were computed. Simple descriptive statistics were used to characterize the populations.

Light and Temperature Measurements

Onset Hobo pendant loggers temp/light (UA-002-08) were used to measure temperature and light intensity. A pendant logger was deployed in each of the intertidal and subtidal zones for about a month at the time the seagrasses were collected. The loggers were programmed to store data of temperature and light intensity every fifteen minutes and were set up with actual date and time when installed. Each logger was covered with plastic tape and tied to an iron bar. The iron bars were stuck into the seafloor within the seagrass bed with the tip of the loggers facing the equator. This allowed each data logger to receive the maximum light intensity. The loggers were inspected every six days for any damage and were cleaned from all marine growths. Every two weeks, the loggers were taken out to upload the data. The data were exported and tabulated into Microsoft Excel 2010 program to get the mean of temperature and light intensity per day per month. Sampling and measurements were conducted during the southwest monsoon (August 2014). Generated data were summarized using descriptive statistics such as mean and standard deviation.

RESULTS AND DISCUSSION

The observation of morphometric variation of seagrass in seven (7) locations Minahasa Peninsula coast shows in detail the fluctuations in size according to the observation location. The images of this species based on the sites can be seen in Figure 2. Whereas the average number of cross veins, blade width (BW), length (BL), and BW/BL ratio of the second leaf, petiole diameter (PD), length (PL), and PD/PL ratio of the second petiole and rhizome diameter (RD), rhizome length (RL), and RD/RL ratio of the second rhizome can be seen in Table 1 below.



Figure 2. Variation in leaf morphology of *H. ovalis* collected from seven sites in Minahasa Peninsula, North Sulawesi, Indonesia.

Site	No. x-veins	Ave BL	Ave BW		Ave 2PL	Ave 2PD	Ave	Ave. RL	Ave RD	
		(mm)	(mm)	Ave 2BW/BL	(mm)	(mm)	2PD/2PL			Ave 2RD/2RL
Arakan	15 ± 3	18.72 ± 2.67	9.67 ± 1.98	0.52 ± 0.06	17.34 ± 6.23	0.86 ± 0.12	0.06 ± 0.02	23.22 ± 7.45	0.06 ± 0.02	0.06 ± 0.02
(Range)	(10-26)	(14.04-27.07)	(5.21-14.5)	(0.32-0.65)	(6.69-33.21)	(0.63-1.29)	(0.02-0.1)	(12.01-43.32)	(0.91-2.04)	(0.04-0.11)
Manado Bay	13 ± 3	15.38 ± 2.15	7.75± 1.38	0.50 ± 0.05	15.40 ± 6.04	0.91 ± 0.17	0.07±0.03	15.36 ± 5.58	1.20 ± 0.24	0.09 ± 0.04
(Range)	(9-18)	(9-19.4)	(4.29-10.68)	(0.39-0.65)	(6.41-28.89)	(0.052-1.42)	(0.02-0.17)	(5.22-32.48)	(0.79-1.56)	(0.03-0.20)
Mantehage	16± 3	16.05 ± 3.78	9.70 ± 2.21	0.61±0.07	17.41+ 7.56	0.9 ± 0.2	0.06+0.03	20.91+ 7.19	1.46 ± 0.33	0.07 ± 0.02
(Range)	(12-22)	(9.49-25.16)	(5.53-15.66)	(0.45-0.75)	(4.01-25.9)	(0.45-1.47)	(0.02-0.17)	(10.16-45.11)	(0.86-2.42)	(0.04-0.13)
Siladen	12 ± 2	12.0 ± 1.89	6.94 ± 1.17	0.58 ± 0.06	10.73 ± 5.76	0.68 ± 0.15	0.08±0.04	20.30 ± 8.09	1.00 ± 0.024	0.05 ± 0.02
(Range)	(10-15)	(7.91-17.58)	(3.71-9.15)	(0.41-0.74)	(3.17-28.51)	(0.09-1.14)	(0.02-0.18)	(9.10-41.54)	(0.63 -1.44)	(0.03-0.11)
Tanjungmerah	16 ± 2	17.60 ± 2.72	10.47± 2.00	0.59 ± 0.06	17.67 + 7.50	0.76 ± 0.15	0.06 + 0.04	19.64 ± 6.32	0.92 + 0.16	0.05 + 0.02
(Range)	(12-24)	(11.07-22.58)	(5.61-13.51)	(0.50-0.71)	(4.12-34.02)	(0.46-1.43)	(0.01-0.19)	(6.69-34.01)	(0.60-1.42)	(0.02-0.15)
Likupang	14 ± 2	14.14± 2.68	7.39 ± 1.55	0.53 ± 0.10	15.28+ 6.05	0.71+0.33	0.05+0.02	20.04+ 8.94	1.07±	0.06+0.03
									0.10.26	
(Range)	(10-20)	(8.15-22.31)	(3.74-16.58)	(0.39-1.47)	(4.35-35.69)	(0.35-1.10)	(0.02-0.19)	(5.06-34.13)	(0.62-1.44)	(0.03-0.19)

Table 1. Average number of cross veins, blade width (BW), length (BL), and BW/BL ratio of the second leaf, petiole diameter (PD), length (PL), and PD/PL ratio of the second petiole and rhizome diameter (RD), rhizome length (RL), and RD/RL ratio of the second rhizome. Ranges are in parentheses. N = 50.

Morphology

Arakan – The plants collected from this site were relatively the largest among those collected from all sites and were found growing in 6 m to 12 m deep in rocky's substrate. The leaves are more round than ovate (Figure 2) with average blade to length ratio of 0.52 ± 0.06 (Table 1). The leaf pairs are also unevenly sized and shaped. Average leaf width for one of the second pair of leaves = 9.81 \pm 2.02 mm; leaf length = 18.39 ± 2.58 mm or a ratio of 0.53 ± 0.07 while for the other leaf width was 9.60 ± 2.00 mm while leaf length was 19.15 ± 2.87 mm a ratio of 0.50 ± 0.06 . Average petiole diameter= 0.87 ± 0.13 mm; petiole length = 16.46 ± 6.34 mm for the first the second pair of petioles or a ratio of 0.08 ± 0.04 while for the 2nd of the second pair of petioles, average petiole diameter = 0.84 ± 0.16 mm; petiole length of the second pair of petioles = 18.22 ± 6.41 mm; or a ratio of 0.07 ± 0.04 ; rhizome diameter = 1.34 ± 0.23 rhizome length of the second rhizome = 23.22 ± 7.45 or a ratio of 0.06 ± 0.02 . Average number of cross veins is 15 ± 3 with a range of 10-26.

Likupang – The plants are small and were found growing in 0.5 m to 4 m deep in muddy mix with coral rubbles substrate. The leaves are more round than ovate (Figure 2) with average blade to length ratio of 0.53 ± 0.05 (Table 1). The leaf pairs are also unevenly sized and shaped. Average leaf width for one of the second pair of leaves was 7.49 ± 2.00 mm; leaf length was 13.82 ± 3.15 mm or a ratio of 0.56 ± 0.19 while for the other leaf width was 7.33 ± 1.51 mm while leaf length was 14.53 ± 2.65 mm or a ratio of 0.50 ± 0.05 . Average number of cross veins was 15 ± 2 with a range of 10-20. Average petiole diameter was 0.78 ± 0.65 mm; petiole length was 14.95 ± 6.81 mm for the first the second pair of petioles, average petiole diameter was 0.66 ± 0.16 mm; petiole length of the second pair of the second pair of 0.05 ± 0.02 ; rhizome diameter was 1.07 ± 0.26 rhizome length of the second rhizome was 20.04 ± 8.94 or a ratio of 0.06 ± 0.03 . Average number of cross veins was $15 \pm 1.51 \pm 5.84$ mm; or a ratio of 0.05 ± 0.02 ; rhizome diameter was 1.07 ± 0.26 rhizome length of the second rhizome was 15.5 ± 3 with a range of 12-18.

Manado Bay – The plants are small and were found growing in 6 m to 11 m deep in sandy substrate. The leaves are more round than ovate (Figure 2) with average blade to length ratio of 0.50 ± 0.05 (Table 2). The leaf pairs are also unevenly sized and shaped. Average leaf width for one of the second pair of leaves was 7.76 ± 1.42 mm; leaf length was 15.16 ± 2.18 mm or a ratio of 0.51 ± 0.06 while for the other leaf width was 7.92 ± 1.22 mm while leaf length was 15.93

 \pm 2.13 mm or a ratio of 0.50 \pm 0.06. Average petiole diameter was 0.93 \pm 0.19 mm; petiole length was 14.86 \pm 5.94 mm for the first the second pair of petioles or a ratio of 0.08 \pm 0.04 while for the 2nd of the second pair of petioles, average petiole diameter was 0.91 \pm 0.19 mm; petiole length of the second pair of petioles was 16.53 \pm 6.51 mm; or a ratio of 0.07 \pm 0.04; rhizome diameter was 1.20 \pm 0.24 rhizome length of the second rhizome was 15.36 \pm 5.58 or a ratio of 0.09 \pm 0.04. Average number of cross veins is 13 \pm 3 with a range of 9-18.

Mantehage – The plants are relatively big and were found growing in in 0.5 m to 4 m deep in sandy substrate. The leaves are more round than ovate (Figure 2) with average blade to length ratio of 0.50 ± 0.05 (Table 1). The leaf pairs are also unevenly sized and shaped. Average leaf width for one of the second pair of leaves was 9.77 ± 2.20 mm; leaf length was 15.83 ± 3.76 mm or a ratio of 0.62 ± 0.06 while for the other leaf width was 9.60 ± 2.30 mm while leaf length was 16.18 ± 3.90 mm or a ratio of 0.60 ± 0.08 . Average number of cross veins is 16 ± 3 with a range of 12-22 and 17 ± 2 with a range of 14-20, respectively. Average petiole diameter was 0.90 ± 0.23 mm; petiole length was 16.46 ± 7.91 mm for the first the second pair of petioles or a ratio of 0.06 ± 0.03 while for the 2nd of the second pair of petioles, average petiole diameter was 0.90 ± 0.22 mm; or a ratio of 0.06 ± 0.33 rhizome diameter was 1.46 ± 0.33 rhizome length of the second rhizome was 20.91 ± 7.19 or a ratio of 0.07 ± 0.02 .

Siladen – The plants collected from this site were relatively the smallest among those collected from all sites and were found growing in in 0.6 m to 4.5 m deep in mud and sandy substrate. The leaves are more ovate than round (Figure 2) with an average blade to length ratio of 0.58 ± 0.06 (Table 1). The leaf pairs are also unevenly sized and shaped. Average leaf width for one of the second pair of leaves was 6.93 ± 1.15 mm; leaf length was 11.89 ± 1.98 mm or a ratio of 0.59 ± 0.07 while for the other leaf. Leaf width was 6.94 ± 1.24 mm while leaf length was 12.13 ± 1.97 mm a ratio of 0.58 ± 0.07 . Average petiole diameter was 0.68 ± 0.20 mm; petiole length was 10.66 ± 5.75 mm for the first the second pair of petioles or a ratio of 0.08 ± 0.04 while for the 2nd of the second pair of petioles was 10.80 ± 5.96 mm; or a ratio of 0.08 ± 0.04 ; rhizome diameter was 1.00 ± 0.24 rhizome length of the second rhizome was 20.30 ± 8.09 or a ratio of 0.05 0.02. Average number of cross veins is 12 ± 2 with a range of 9-15.

Tanjung merah – The plants are small and were found growing in xx m to xx m deep in xx substrate. The leaves are more ovate than round (Figure 2) with an average blade to length ratio of 0.59 ± 0.06 (Table 1). The leaf pairs are also unevenly sized and shaped. Average leaf width for one of the second pair of leaves was 10.49 ± 2.04 mm; leaf length was 17.26 ± 2.70 mm or a ratio of 0.6 ± 0.06 . Average number of cross veins was 17 ± 3 . For the other leaf, leaf width was 10.44 ± 2.04 mm while leaf length was 17.90 ± 2.90 mm a ratio of 0.58 ± 0.07 . Average number of cross veins was 17 ± 2 . Average petiole diameter was 0.75 ± 0.20 mm; petiole length was 16.94 ± 7.38 mm for the first the second pair of petioles or a ratio of 0.06 ± 0.04 while for the 2nd of the second pair of petioles, average petiole diameter was 0.77 ± 0.15 mm; petiole length of the second pair of 0.92 ± 0.16 rhizome length of the second rhizome was 19.64 ± 6.32 or a ratio of 0.05 0.02. Average number of cross veins is 16 ± 2 with a range of 12-24.

Genetic Analysis for Species Confirmation

PCR Condition

Kit: 2X KAPA Taq ReadyMix with dye (Kapa Biosystem)

Primer

-	1F (5'-ATG TCA CCA CAA ACA GAA AC-3)
-	724R (5'-TCG CAT GTA CCT GCA GTA GC-3')

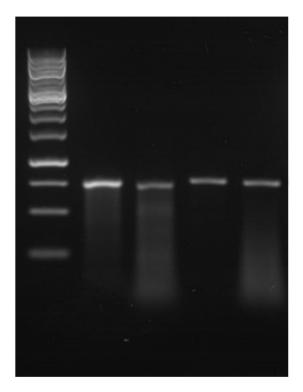
Setting PCR Machine

95°C 3 minutes



72°C 1 minute

Gel Elektroforesis 1%



Ladder 1 kb (inbase pair): 250, 500, 750, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 5000, 6000, 8000, 10000

Alignment

	1 10 20	30	40 50
Consensus HO2	TAAAGCCGGTGTTGGATTTC	AAGCTGGTGTAAAAGAT AAGCTGGTGTAAAAGAT	ATAAATTGACTTATTATATACTC
HOAR	TAAAGCCCGGTGTTGGATTTC TAAAGCCCGGTGTTGGATTTC	AAGCTGGTGTAAAAGATT AAGCTGGTGTAAAAGATT	ATAAATTGACTTATTATACTC ATAAATTGACTTATTATACTC
TC2	TAAAACGGGTGTTGGATTCA	AAGCTGGTGTTAAAGATT	ACAAATTGACTTATTATACTC
Consensus	CAGAATATGAÅACCAAAGAT	ACTGA TATA TTGGCAGCA	TTCCGAGTTTCTCCGCAACCT
HO2 HOAR	CAGAATATGAAACCAAAGAT CAGAATATGAAACCAAAGAT	ACTGA TATATTGGCAGCA ACTGATATATTGGCAGCA	ATTCCGAGTTTCTCCGCAACCT ATTCCGAGTTTCTCCGCAACCT
HOTM TC2	CAGAATATGAAACCAAAGAT CTGAATATGAAACCAAAGAT	ACTGATATATTGGCAGCA ACTGATATCTTGGCAGCA	ATTCCGAGTTTCTCCGCAACCT ATTCCGAGTTTCTCCGCAACCT ATTCCGAGTTTCTCCGCAACCT
Consensus	120 130 GGAGTTCCCCCTGAAGAAGC	140 GGGGGCTGCAGTAGCTGC	180 CCGAATCTTCCACTGGTACATG
HO2 HOAR	GGAGTTCCCCCTGAAGAAGC	GGGGGCTGCAGTAGCTGC	CCGAA TCTTCCAC TGGTACATG
HOTM TC2	GGAGTTCCCCCTGAAGAAGC GGAGTTCCCCCTGAAGAAGC GGGGTTCCACCTGAAGAAGC	GGGGGCTGCAGTAGCTGC	CGAATCTTCCACTGGTACATG CGAATCTTCTACTGGTACATG
Consensus	180 190	200 210	220 230
HO2	GACCACTGTGTGGACTGATG	GACTTACTAGCCTTGACC	GTTACAAAGGACGATGCTATC
HOAR HOTM	GACCACTGTGTGGACTGATG GACCACTGTGTGGACTGATG	GACTTACTAGCCTTGACC	CGTTA CAAA GGA CGA TG CTA T C CGTTA CAAA GGA CGA TG CTA T C CGTTA CAAA GGA CGA TG CTA C C
TC2	240 250	260 270	280 290
Consensus HO2		GAAGAAGAGCAATÁTAT GAAGAAGAGCAATATAT	
HOAR	ACATCGAACCTGTTGCTGGA	GAAGAAGAGCAATATAT GAAGAAGAGCAATATAT	CCTTATGTAGCTTATCCTTTA CCTTATGTAGCTTATCCTTTA CCTTATGTAGCTTATCCTTTA
TC2	ACATCGAGCCTGTTGTTGGG	GAAGAAGATCAATATAT 320 330	GCTTATGTAGCCTATCCTTTA
Consensus		CGTTACTAACATGTTTAC	CTTCCATTGTCGGGAATGTATT
HO2 HOAR	GATC TTTTTGAAGAAGG TTC GATC TTTTTGAAGAAGG TTC	CGTTACTAACATGTTTAC CGTTACTAACATGTTTAC	TTCCATTGTCGGGAATGTATT TTCCATTGTCGGGAATGTATT TTCCATTGTCGGGAATGTATT
HOTM TC2	GACCTTTTTGAAGAAGGTTC	CGTTACCAACATGTTTAC	CTTCCATTG TAGG TAATGTATT
Consensus	380 STGGGTTCAAAGCTCTCCGAG	380 CTCTACGCTTGGAGGATI	400 TGCGAATTCCTCCTGCCTATT
H02 H0AR	THE COMPONENCE TO THE TOTAL CARE	CHCHACCCHHCCACCAH	TGCGAATTCCTCCTGCCTATT TGCGAATTCCTCCTGCCTATT
HOTM TC2	TGGGTTCAAAGCTCTCCGAG	CTCTACGCTTGGAGGATT	TGCGAATTCCTCCTGCCTATT TGCGAGTTCCTCCTGCTTATT
Consensus	420 430	440 450	460 470 GAAAGAGA TAGA TTGAACAAA
HO2			
HOAR HOTM TC2	CCAAAACTTTCCAAGGTCCA CCAAAACTTTCCAAGGTCCA CCAAAACTTTCCAAGGTCCG	CCTCATGGAATCCAAGTG	GAAAGAGA TAGA TTGAACAAA GAAAGAGA TAGA TTGAACAAA GAAAGAGA TAGA TTGAACAAA GAGAGAGA TAGA TTGAACAAA
102	480 490	500 51	0 520 530
Consensus HO2	TACGGCCGCCCTCTACTAGG	ATGTACTATTAAACCAAA	ATTGGGATTÅTCCGCGAAAÅA ATTGGGATTATCCGCGAAAAA
HOAR	TACGGCCGCCCTCTACTAGG TACGGCCGCCCTCTACTAGG	A TGTACTATTAAACCAAA A TGTACTATTAAACCAAA	ATTGGGATTATCCGCGAAAAA ATTGGGATTATCCGCGAAAAA
TC2	TATGGTCGTCCCCTATTGGG 540 550	ATGTACTATTAAACCAAA 560	AATTGGGATTATCCGCGAAAAA 570 580 590
Consensus HO2	CTACGGTAGAGCAGTTTATG		TIGGATTTTACTAAAGATGATG TIGGATTTTACTAAAGATGATG
HOAR HOAR	CTACGGTAGAGCAGTTTATG	AATGTCTACGTGGTGGA	THE CATTER ACTA A AGA TEATE
TC2	CTACGGTAGAGCGGTTTATG 600 610		T T G G A T T T T A C T A A A G A T G A T G T T G A T T T T A C C A A A G A T G A T G 630 640
	AAAACGTAAÁTTCCCAGCCÁ	TTTATGCGTTGGAGAGAG	CGTTTCCTATTTTGTACCGAA
HO2 HOAR	AAAACGTAAATTCCCAGCCA AAAACGTAAATTCCCAGCCA	TTTATGCGTTGGAGAGAG TTTATGCGTTGGAGAGAG	CGTTTCCTATTTTGTACCGAA CGTTTCCTATTTTGTACCGAA CGTTTCCTATTTTGTACCGAA
HOTM TC2	AAAACGTAAATTCCCAGCCA AGAACGTGAACTCACAACCA	TTTATGCGTTGGAGAGAG TTTATGCGTTGGAGAGAG	CGTTTCCTATTTTGTACCGAA CGTTTCTTATTTTGTGCCGAA
Consensus		670 680 CGAAACAGGTGAAGTCAA	600 700 703
HO2 HOAR	TCCATTTATAAAGCGCAAGC TCCATTTATAAAGCGCAAGC	CGAAACAGGTGAAGTCAA	AGGACATTACTTGAAT
HOAR HOTM TC2	TCCATTTATAAAGCGCAAGC TCCATTTATAAAGCGCAAGC TCTATTTATAAATCGCAAGC	CGAAACAGGTGAAGTCAA	AGGACATTACTTGAAT
102	ICIAIIIAIAAAICGCAAGC	CONACAGO IGAAATCAA	INCONCALINCTI GAAT

	1 10 20 30 40 50	
Consensus		TC
HO2		• •
HOAR HOTM TC2		11
	80 70 80 90 100 110	• •
Consensus	ĊAGAATATGAÁACCAAAGATÁCTGATATATŤGGCAGCATTĊCGAGTTTCTĊCGCAAC	CT
HO2 HOAR		::
HOTM TC2	.T	× •
	120 130 140 150 180 170	
Consensus HO2	GĠAGTTCCCCCTGAAGAAGCGĠGGGCTGCAGTAGCTGCCGAATCTTCCACTĠGTACA	TG
HOAR		0.1
HOTM TC2		::
0	180 190 200 210 220 230	TC
Consensus	GAČCACTGTGTGĠACTGATGGAČTTACTAGCCŤTGACCGTTAĊAAAGGACGAŤGCTA	TC
HO2 HOAR HOTM		::
TC2	, A	Ċ.
Consensus	240 250 260 270 280 280 280 280 280 280 280 280 280 28	ΨA
H02		
HOAR HOTM		$\sim \cdot$
TC2	G	0.1
Consensus	300 310 320 330 340 350 GATCTTTTTGAAGAAGGTTCCGTTACTAACATGTTTACTTCCATTGTCGGGAATGTA	ТТ
HO2		
HOAR		::
TC2	C	
Consensus	TGGGTTCAAAGCTCTCCGAGCTCTACGCTTGGAGGATTTGCGAATTCCTCCTGCCTA	тт
HO2 HOAR		
HOTM		11
TC2		۰. ۱
Consensus	CCAAAAĊTTTCCAAGG†CCACCTCATĠGAATCCAAG†GGAAAGAGA†AGATTGAACÅ	AA
HO2 HOAR		
HOTM TC2		G
	480 490 500 510 520	530
Consensus HO2	tacggccgcctctactággatgtactáttaaaccaaáattgggattátccgcgaaa	AA
HOAR		11
HOTM TC2	TTTCT.G.	· ·
Consensus	540 550 560 570 570 570 580 CTACGGTAĠAGCAGTTTAṫGAATGTCTAĊGTGGTGGATṫGGATTTTACṫAAAGATGA	590
HO2		1.9
HOAR		
TC2	C.TC.	::
Consensus	600 610 620 630 840 AAAACGTAAATTCCCAGCCATTTATGCGTTGGAGAGACCGTTTCCTATTTTGTACCG	AA
H02		
HOAR HOTM		::
TC2	.GGCAA	
Consensus	850 660 670 880 500 700 703 TCCATTTATAÁAGCGCAAGCĊGAAACAGGTĠAAGTCAAAGĠACATTACTTĠAAŤ	
HO2 HOAR		
HOTM	······································	
TC2	T	

Distances

	HO2	HOAR	HOTM	TC2
HO2		100%	100%	90.2%
HOAR	100%		100%	90.2%
HOTM	100%	100%		90.2%
TC2	90.2%	90.2%	90.2%	

Sekuens

TAAAGCCGGTGTTGGATTTCAAGCTGGTGTAAAAGATTATAAATTGACTTATTATACT CCAGAATATGAAACCAAAGATACTGATATATTGGCAGCAGCATTCCGAGTTTCTCCGCAA CCTGGAGTTCCCCCTGAAGAAGCGGGGGGCTGCAGTAGCTGCCGAATCTTCCACTG GTACATGGACCACTGTGTGGACTGATGGACTTACTAGCCTTGACCGTTACAAAGGA CGATGCTATCACATCGAACCTGTTGCTGGAGGAGAAGAAGAGCAATATATTGCTTATGTA GCTTATCCTTTAGATCTTTTTGAAGAAGGTTCCGTTACTAACATGTTTACTTCCATTG TCGGGAATGTATTTGGGTTCAAAGCTCTCCGAGCTCTACGCTTGGAGGATTTACTTCCATTG ATTCCTCCGCCTATTCCAAAACTTTCCAAGGTCCACCTCATGGAGAATCCAAGTGGAA AGAGATAGATTGAACAAATACGGCCCCCCTACTAGGATGTACCAAGTGGAA TTGGGATTGAACAAATACGGCCGCCCTCTACTAGGATGTACTACGAGTGGGA ATTGCGCGAAAAACTACGGTAGAGCAGTTTATGAATGTCTACGTGGGG ATTGGATTTACCAAAGATGCAACGTAAAACTTCCCAGCCATTTAGATGTCTACGTGGGG ATTGGATTTACCAAAACTACGGTAGAGCAGTTTATGAATGTCTACGTGGGG ATTGGATTTACTAAAGATGATGAAAACGTAAATTCCCAGCCATTTATGCGTTGGAG AGACCGTTTCCTATTTTGTACCGAATCCATTTATAAAGCGCAAGCCGAAACAGGTGA AGTCAAAGGACATTACTTGAAT

HO (Bali)

Consensus	1 10 20 30 40 50 50 70 80 90 TITATATGTCA CAGA AACTA AAGC CGGTGTTGGATTTCAAGCTGGTGTA AAGA TTATAAATTGACTTATATACTCCAGAATA TGAA
FWD HO2_1F.ab1	
REV HO2_724R.ab1	Anone - And Markow Mark
Consensus	ACCAAGATACTGATATTGGCAGCATTCCGGGGTTCCCCCGCAGCTGGCGGGGGGGG
FWD HO2_1F.ab1	
REV HO2_724R.ab1	
Consensus	CCACTGGTACATGGACCACTGTGTGGGACTGATGGACTTACTÁGCCTTGACCGTTACAAAGGÁCGATGCTATCGAAACCTGTTGCGGGAC 157 167 177 197 197 297 217 227 237 247
FWD HO2_1F.ab1	
REV HO2_724R.ab1	
Consensus	AGAAGAGCAATATATTGCTTA TGTAGCTTA CCTTTACATCTTTTG ÅAGAAGGTTCCGTTACTAACA TGTTTACTTCCATTGTC GGGAATGTA 257 297 297 297 397 397
FWD HO2_1F.ab1	AGAAGAGCAATATTATGCTTATGTAGCTTATCCTTTAGAACATGTTTTTTGAAGAAGGGTTCCGTTACTACATGCATG
REV HO2_724R.ab1	www.www.www.www.www.www.www.www.www.ww
Consensus	TTTĠGGTTCAAAGĊTCTCCGAGCŤCTACGCTTGĠAGGATTTGĊĠAATTCCTĊĊŢGCTATTCĊĂAAACTTTCĊĂAGGTCCACĊŤCATGGAATCĊ 347 357 387 387 407 417 427 437
FWD HO2_1F.ab1	MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
REV HO2_724R.ab1	www.www.www.www.www.www.www.www.www.ww
Consensus	AAGTGGAAAĞAGATAGATTĞAACAAATACĞGCCGCCCCTCTACTAGGATGTACTATTAAACCAAAATTGGĞATTATCCGCĞAAAAACCTACĞGTAG 447 457 457 457 457 557 557
FWD HO2_1F.ab1	
REV HO2_724R.ab1 Consensus	Martigua each the action to the second construction of the second
Consensus	637 647 667 507 577 687 597 007 017
FWD HO2_1F.ab1	
REV H02_724R.ab1	Manufarther the second se
Consensus	060 700 730 740 740 CTATTTTGACCGAATCCATTTATAAAGCGCAAGCCGAAACAGGTGAAGTCAAGGGAGATTTACTTGAATGCTACTGCAGGAGAAA 627 637 647 667 707 710
FWD HO2_1F.ab1	
REV HO2_724R.ab1	man the man the second second

HOAR (Arakan)

Consensus	10 11 11 11 11 11 11 12 11 12 13 14 14 14 14 14 14 14 14 14 14
FWD HOAR_1F.ab1	722 713 703 603 603 603 603 603 603 603 603 603 6
REV HOAR_724R.ab1 Consensus	ТИТТТАТОТСКССССКАЛАТАТТОСЁКОСАТТСССКЁАЛССТСКАЛ "ТОСТОСКАЛА "ТАТАТАТОК" ТАТАТАТОК "ТАТАТАТОК" ТАТАТАТОК" ТАКАТАТА АЛСЕЙЛАКСАТАСТЕКАТАТАТТОСЁКОСАТТСССКЁСТТСТСССЕЙЛАССТСКАЛ "ТАТАТАТОК" ТАТАТАТОК" ТАКАТАТОК" ТАКАТАТАТОК" ТАКАТАТА
FWD HOAR_1F.ab1	
REV HOAR_724R.ab1 Consensus	MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
FWD HOAR_1F.ab1	Man I man a construction of the second secon
REV HOAR_724R.ab1 Consensus	$\underbrace{M_{M}}_{M} \underbrace{M_{M}}_{M} \underbrace{M_{M}} \underbrace{M_{M}}_{M} \underbrace{M}_{M} \underbrace{M}_{M} \underbrace{M}_{M} \underbrace{M}_{M} \underbrace{M}_{M} \underbrace{M}_{M} \underbrace{M}_{M} \underbrace{M}_{M} \underbrace{M} \underbrace{M}_{M} \underbrace{M} \underbrace{M}_{M} \underbrace{M} \underbrace{M}_{M} \underbrace{M} \underbrace{M}_{M} \underbrace{M} \underbrace$
FWD HOAR_1F.ab1	
REV HOAR_724R.ab1 Consensus	ADAMGAGCAATATATECTTATGATC 400 ADAMGAGCAATATATECTTATGATC 400 TTGGGTTCAAAGCCTCTCCCGGGCTCTACGCTTTAGATC 400 TTGGGTTCAAAGCCTCTCCGGGCTCTACGCTTTAGATC 400 TTGGGTTCAAAGCCTCTCCGGGCTCTACGCTTTAGAGCCTCCTCCTCCTCCTCCCTC
FWD HOAR_1F.ab1	Minter and a second sec
REV HOAR_724R.ab1 Consensus	
FWD HOAR_1F.ab1	
REV HOAR_724R.ab1 Consensus	๛๚๚๚๛๚๛๚๛๚๛๚๛๚๛๚๛๚๛๚๛๚๛๚๛๚๛๚๛๚๛๚๛๚๛๚๛๚
FWD HOAR_1F.ab1	
REV HOAR_724R.ab1 Consensus	
FWD HOAR_1F.ab1	THE STATE AT THE STATE AND THE STATE AND THE STATE AT THE
REV HOAR_724R.ab1	

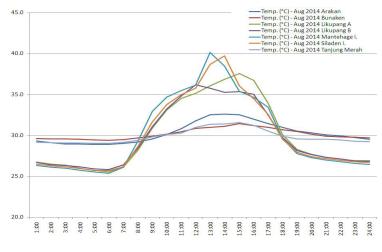
HOTM (Tanjung Merah)

Consensus	10 20 30 40 50 70 70 80 70 70 80 70 70 70 70 70 70 70 70 70 70 70 70 70
FWD HOTM_1F.ab1	
REV HOTM_724R.ab1 Consensus	ттиптальносос ссама сама собатите саматите состатите составание то политите составляет составл
FWD HOTM_1F.ab1	
REV HOTM_724R.ab1 Consensus	алсалаана толата толата тола тола тола тола тола
FWD HOTM_1F.ab1	
REV HOTM_724R.ab1 Consensus	MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
FWD HOTM_1F.ab1	$= \underbrace{\begin{smallmatrix} 2q_{7} & 2q_{$
REV HOTM_724R.ab1	MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
Consensus	300 400 410 420 430 440 450 450 470 TGGGTTCLAAGGTCTCCGAGCTCTACGCTTGGGAGGATTCCCACGCTATTCCAAAGCTCCCCCCCC
	$\underbrace{ \begin{array}{c} \text{TGGGTTCA}_{AAA} \text{GCTCTCCG}_{AAA} \text{GCTCTCG}_{AAA} \text{GCTCTA}_{AAA} \text{GCTCA}_{AAA} $
Consensus	
Consensus FWD HOTM_1F.ab1 REV HOTM_724R.ab1	
Consensus Feb HOTM_1F.ab1 REV HOTM_724R.ab1 Consensus	
Consensus F8D HOTM_1F.ab1 REV HOTM_724R.ab1 Consensus F8D HOTM_1F.ab1 REV HOTM_724R.ab1	
Consensus PBD HOTM_1F.ab1 PEV HOTM_724R.ab1 Consensus PBD HOTM_1F.ab1 REV HOTM_724R.ab1 Consensus	
Consensus FBD HOTM_1F.ab1 FEV HOTM_724R.ab1 Consensus FBD HOTM_1F.ab1 Consensus FBD HOTM_724R.ab1 CONSENSUS FBD HOTM_724R.ab1	

TC2 (Mantehage)

Consensus	10 20 30 40 50 70 80 70 80 10 10 10 10 10 10 10 10 10 10 10 10 10
FWD TC2_1F.ab1	
REVTC2_724R.ab1 Consensus	TTTATATSTCCCCCCALAISAAACTAAAACCOSTATTSAATTSAATTSAATTSAATTAATTAATTAATTAA
FWD TC2_1F.ab1	
REVTC2_724R.ab1 Consensus	MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
Consensus	
FWD TC2_1F.ab1	
REV TC2_724R.ab1	CTACTOR TACATOR ACAN TO TO TO TACON TRACKAT CALL AND AN ANALAN ANAL
Consensus	AGAAGATĆAATATATGĊTTATGTAGCĊTATCCTTTAĞACCTTTTTĞAAGAAGGTTCĊGTTACCAACÅTGTTACTTĊCATTGTAGGŤAATGTA 259 269 279 289 269 319 329 339
FWD TC2_1F.ab1	
REV TC2 724R.ab1	Market
	380 380 400 410 420 430 440 450 480 47
Consensus	300 400 410 400
Consensus	
FWD TC2_1F.ab1 REV TC2_724R.ab1	340 350 340 370 380 340 40 40 40 40 1111100001110AAG01100AAG011000000000000
FWDTC2_1F.ab1	340 350 350 370 380 360 400 410 420 43 1111000011000000000000000000000000000
FWD TC2_1F.ab1 REV TC2_724R.ab1	340 350 340 370 380 340 400 410 420 420 1000000000000000000000000000000000000
FWD TC2_1F.ab1 REV TC2_724R.ab1 Consensus	340 350 340 770 380 340 <
FWD TC2_1F.ab1 REV TC2_724R.ab1 Consensus FWD TC2_1F.ab1 REV TC2_724R.ab1	340 350 340 770 380 340 400 410 420 430 1111 10001 11 CAACC 1111 10001 11 CAA
FWD TC2_1F.ab1 REV TC2_724R.ab1 Consensus FWD TC2_1F.ab1 REV TC2_724R.ab1 Consensus FWD TC2_1F.ab1 REV TC2_724R.ab1	340 350 350 370 380 370 380 400 410 420 430 1111000110000000000000000000000000000
FWD TC2_1F.ab1 REV TC2_724R.ab1 Consensus FWD TC2_1F.ab1 REV TC2_724R.ab1 Consensus FWD TC2_1F.ab1	340 350 350 370 380 370 380 400 410 420 420 111111011101101101101101101101101101101
FWD TC2_1F.ab1 REV TC2_724R.ab1 Consensus FWD TC2_1F.ab1 REV TC2_724R.ab1 Consensus FWD TC2_1F.ab1 REV TC2_724R.ab1	340 350 350 770 350 340 40 40 40 40 111110021112AAAGUT2 AACGACCE CAC OT TOGGACA TETE CAC 10 92

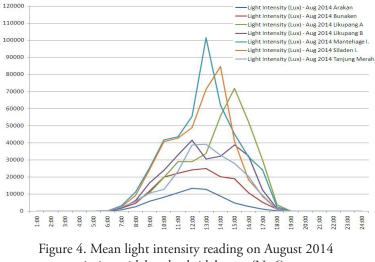
Environmental Factors



1. Temperature Reading

Figure 3. Mean Temperature reading on August 2014 in intertidal and subtidal areas (N=6).

2. Light intensity Reading



in intertidal and subtidal areas (N=6).

The results showed that sites at Manado beach and Arakan beach have a percentage cover higher than the most other sites; 62% and 65% respectively. This is expected for such beaches that has the most extensive seagrass closure in this coastal region. Conditions quiet beach without much disruption of ecosystems, causing seagrass cover in this area appears to be in still quite good condition. Based the Decree of State Ministry of Environment No. 200/2004 on the status of seagrass beds by closing percentage above 60% indicated that the seagrass bed is considered as healthy ecosystem (Anonym 2004).

The low numbers of percentage cover found in the sites of Bunaken, Mantehage, and Siladen are 35%, 40%, and 37% respectively. Furthermore, the percentage cover of seagrass in Tanjung Merah only reaches below 25%, which indicates that this area is the poorest area among all sites. Allegedly for that the sites get crowded with tourists and high activities of fishing vessels in the region, making it difficult to avoid turbidity. As it is known that the turbidity inhibits photosynthesis. The reduced photosynthesis means reducing primary productivity of the growth of seagrass.

Overall, this research found only leaves that showed the variation of morphological difference compared with others. Moreover, despite the density it was found that most of the leaves were larger in the subtidal sites than those in the intertidal sites.

Environmental parameters like temperature reach the average of 29°C and showed a strong fluctuation ranging from 22°C to 40°C (see Figure 3). This research found that although the temperatures reach above 40°C, it can be assumed that the average temperature is still favourable for the seagrass growth for this range still within the range of dynamic seasonal fluctuation in the area of tropical waters (19.8-41°C) (McKenzie 1994; McKenzie and Campbell 2004; and Wagey 2015).

On the other hand, light intensity reaches maximum 105,734.1 Lux with the average of 3,444.9 Lux (Figure 4). Although the value of the maximum light intensity is exceeded more than expected, the average value of the light intensity obtained almost the similar with previous researches conducted on the other seagrass species (Zavodnik 1998; Rountos 2008; Wagey 2015). All the sequens of *Halophila* are identical (Clean without primer). Although this finding confirms that all the sequens are identical. It was shows that the rbcL primer which was using to observe in plant for chloroplast DNA cannot distinguish specifically the difference amongst the species. This research is recommended to be proceeded with a new marker such as Microsatellites to see the different among species found in different areas. Nonetheless this finding also projects that seagrass has a strong ability to survive in a wide range of environmental condition.

CONCLUSIONS

Among all the morphology of *Halophila ovalis* observed, only the leaves showed morphometric variations. Regardless the density, seagrass *Halophila ovalis* from intertidal had the lowest size range in leaf morphometric measurements, whereas those from subtidal had the highest. All the sequens are identical.

ACKNOWLEDGMENTS

The study was funded by Ministry of Research, Technology, and Higher Education of the Republic Indonesia; SIMLITABMAS in the skim research of International Collaboration and Publication. Appreciation given to Dr. Hilconida Calumpong as my co-researcher overseas, and to Dr. Janet Estacion as Director of Graduate Study, for the support and assistance. Thanks to IEMS graduate colleagues Ian Canlas, Julius, Diane, and my former undergraduate students; Webi Sake, Anas Sauyai and Enos Balaira for sampling and data collection. Finally, appreciation goes to LPPM ("Lembaga Penelitian dan Pengabdian") Sam Ratulangi University for administrative assistance research.

LITERATURE CITED

- Kementerian LH. 2004. Keputusan Menteri Lingkungan Hidup Nomor 200, Tahun 2004. Jakarta.
- Biber PD. 2007. Evaluating a chlorophyll content meter on three coastal wetland plant species. Agriculture, Food and Environmental Science 1:1-11. Available on line: www.scientificjournals.org/journals2007/articles/1247.
- Calumpong HP, Meňez EG. 1997. Field guide to the common mangroves, seagrasses and Algae of the Philippines. Bookmark, Makati City, Philippines. 197 pp.
- Dawson SP, Dennison WC. 1996. Effects of ultraviolry and photosynthetically active radiation of five seagrass species. *Marine Biology* 125:629-638
- Dennison WC. 1987. Effects of light on seagrass photosynthesis, growth and depth distribution. *Aquatic Botany* 27:15-26
- den Hartog C. 1970. The Seagrasses of the World. North Holland Publishing, Amsterdam. 275 pp.

- den Hartog C, Kuo J. 2006. Taxonomy and biogeography of seagrass. In: Seagrass Biology, Ecology and Conservation. A.W.D. Larkum, R.J.Orth and C.M. Duarte (eds.) Springer. Nederlands. Pp 1-23.
- Green EP, Short FT. 2003. World Atlas of Seagrasses. Prepared by the UNEP World Conservation Monitoring Centre. University of California Press. Berkeley, USA. 298 pp.
- Hemminga MA, Duarte CM. 2000. Seagrass Ecology. Cambridge University Press, Cambridge, UK.
- Kuriandewa TE, Kiswara W, Hutomo M, Soemodihardjo S. 2003. The seagrasses of Indonesia. In E.P. Green & F.T. Short (eds.), World Atlas of Seagrasses. Prepared by the UNEP World Conservation Monitoring Centre, Berkeley, CA: University of California Press, pp. 171–184
- Phillips RC, Meñez EG. 1988. Seagrasses. Smithsonian Contributions to the Marine Sciences (34). Smithsonian Institution Press, Washington D.C. 104 pp.
- Poedjirahajoe E, Mahayani NPD, Sidharta BR, Salamuddin M. 2013. Seagrass Coverage and Ecosystem condition at the Coastal area of Madasanger, Jelanga and Maluk, West Sumbawa. Jurnal Ilmu dan Teknologi Kelautan Tropis, Vol. 5, (1): 36-46
- Rasband WS. 1997-2011. ImageJ, U.S. National Institutes of Health, Bethesda, Maryland, USA. Retrieved from http://imagej.nih.gov/ij/
- Romimohtarto K, Juwana S. 2001. Biologi Laut. Ilmu Pengetahuan Tentang Biota Laut. Penerbit Djambatan. Jakarta.
- Rountos K. 2008. The role of porewater sulfide toxicity among other multiple stressors in *Zostera marina* populations in Long Island South Shore Estuaries. M.Sc.Thesis. Stony Brook University. 93 pp
- Short FT, Coles RG. 2001. *Global Seagrass Research Method*. Elsevier Science B.V., Amsterdam. 473 pp.

- Tomasko DA, Dawes CJ, Fortes MD, Largo DB, Alava MNR. 1993. Observations on a multi-species seagrass meadow offshore of Negros Oriental, Republic of the Philippines. Botanica Marina 36: 303-311.
- Vermaat JE, Agawin NA, Fortes MD, Uri JS, Duarte CM, Marba N, Enriquez S, van Vierssen W. 1997. The Capacity of seagrasses to survive increased turbidity and siltation: The significance of growth form and light use. *Ambio* 26 (1) 499-504
- Wagey BT. 2015. Morphometric Study on the Leaf Width of the Seagrass, *Halodule* in Relation to Density, Exposure, Light and Temperature in the Central Visayas, Philippines. Asian Journal of Biodiversity. Vol 6: 223-237. http://asianscientificjournals.com/publication/index.php/ajob/issue/ view/86
- Waycott M, McMahon K, Mellors K, Calladine A, Kleine D. 2004. A Guide to Tropical Seagrass of the Indo-West Pacific. James Cook University, Townsville. 72 pp.
- Zavodnik N, Travizi A, de Rosa S. 1998. Seasonal variations in the rate of photosynthetic activity and chemical composition of the seagrass *Cymodocea nodosa* (Ucr.) Asch. *Scientia Marina* 62 (4): 301-309. 62 (4): 301-3