BIODIVERSITAS
Volume 18, Number 2, April 2017
Pages: 788-794

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d180250

Seagrass community structure of Tayando-Tam Island, Southeast Moluccas, Indonesia

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Manuscript received: 21 April 2016. Revision accepted: 24 April 2017.

Abstract. *Fitrian T, Kusnadi A, Persilette RN. 2017. Seagrass community structure of Tayando-Tam Island, Southeast Moluccas, Indonesia. Biodiversitas 18: 788-794.* Seagrass bed is one of the marine ecosystem that having the highest productivity that could sustain coastal resources. The research purposes of this paper is to determine the community structure of seagrass at Tayando-Tam Island, Southeast Moluccas, Indonesia. The method of observation of seagrass bed using a line transect, transect ran perpendicular to the shore line for 100 meters. The field of observations include identification of seagrass species, counting the number of shoots and percentage (%) of seagrass cover. Seven species of seagrass had been found in Tayando-Tam island, i.e. *Enhalus acoroides, Thalassia hemprichii, Cymodocea serrulata, Cymodocea rotundata, Halodule pinifolia, Halophila ovalis, Syringodium isoetifolium. Halodule pinifolia* had the highest density in Tam Island with the number of 684.18 shoots/m^2. The coverage in this area was between 4.64-43.1 %. Based on the number of species, diversity index and dominance index Tam Island had the most stable seagrass communities, with moderate value of diversity index (H'=1.26), high evenness Index (E=1.63), and low value of dominance index (D=0.34). Seagrass resources in the Tayando-Tam islands is good and the potential for biota the association, which is supported by the quality of water is good for the growth of seagrass.

Keywords: Community structure, seagrass bed, Tayando-Tam waters

INTRODUCTION

Seagrasses are the specialized marine flowering plants (Angiospermae) which have the ability to adapt fully in waters that have high salinity fluctuations, live submerged in the water and have rhizomes, leaves and true roots (Nontji 1987). Seagrasses mostly grow in mud or sand, the only significant exception to this being *Phyllospadix*, which can cling to rocky shelves (Hemminga and Duarte 2000). Worldwide seagrasses do not comprise a large number of species: 58 or so species in 12 genera. Seagrasses are not restricted to tropical or subtropical latitudes, and extend into high northern and southern latitudes, although there is a tendency for more species to be present in the tropics. These marine plants usually dominate shallow coastal waters around the world. The distribution of seagrass species can be defined as the range over which a species occurs or the area within a location where a particular species is located (Short and Coles 2001). Globally, seagrass distributions suggest six regional floras as Temperate North Atlantic, Tropical Atlantic, Mediterranean, Temperate North Pacific, Tropical Indo-Pacific, Temperate Southern Ocean (Short et al. 2007). Seagrass meadows generally comprise very few species. In the Indo-West Pacific region, up to seven species may be found in the same meadow, with *Thalassia hemprichii* often the most abundant (Duarte 2001). Indonesia has around 12 species of seagrasses, i.e. *Syringodium isoetifolium, Halophila ovalis, Halophila spinulosa, Halophila minor, Halophila decipiens, Halodule pinifolia, Halodule uninervis, Thalassodendron ciliatum, Cymodocea rotundata, Cymodocea serrulata, T. hemprichii* and *Enhalus acoroides*.

Seagrass beds are one of the most productive marine ecosystems so as to support the potential of coastal resources (Azkab 2001). Seagrass beds have long been recognized as critical coastal nursery habitat for estuarine fisheries and wildlife (Bell et al. 1989). They function as direct food sources for fish, water flow, dugongs, manatees and sea turtles. They are also participants in nutrient cycling processes and are stabilizing agents in coastal sedimentation and erosion processes and they have received attention as biological indicators of estuarine water quality and ecosystem health as a result of their sensitivity to nutrient enrichment and eutrophication (Dennison et al. 1993). The structural function of seagrasses is a result of the morphology of seagrass plants. The seagrass plants possess an extensive underground rhizome/root system with erect shoots with bundles of leaves, which extend into the water column. As a result, they create a highly structured ecosystem from a relatively unstructured one (Philips and Milchakova 2003). When the seagrass ecosystem is intact, the seagrass beds serve as nursery grounds, places of both food and shelter for juveniles of a variety of finfish and shellfish of commercial and sports fishing importance. Healthy intact seagrass ecosystem provides services since they related to the health, stability and being of the environment in which they live, and also for human populations. Seagrasses provide physical structure on otherwise largely featureless sediment bottoms, enhancing community diversity, biomass and primary and secondary production. The leaves provide a substratum for the growth of epiphytic microalgae that fuel food webs and a shelter for invertebrates and fishes that reach substantially greater densities than in unvegetated benthic habitats (Heck and Orth 1980).

Seagrass ecosystems that are vulnerable to climate change. Seagrass ecosystems will be one of the most affected real. The extent of seagrass beds will be reduced or even disappear, especially in the area of river estuaries and in shallow waters. The main cause of this is the increasing water temperatures, especially in some of the shallow waters. Seagrass ecosystems will continue to experience damage from year to year, so we need a temporal observations, especially related problems seagrass community structure in order to know the changes extensive seagrass beds and do the planning rehabilitation.

Increased fishing activities in the area Tayando-Tam Islands will affect the vast changes in the area seagrass beds. The existence of this problems, it is necessary to conduct research on seagrass community structure that aims to identify the community structure of seagrass in the Tayando-Tam Island. Basic study on the distribution, composition, and density are fundamental as the initial research resource for studying seagrass (Mukai et al. 1980). The results of this research can be used as a material discussion or basic information in decision making for the management of seagrass ecosystems in the region. It is important to document seagrass species diversity and distribution and identify areas requiring conservation measures before significant areas and species are lost.

MATERIALS AND METHODS

Site description

The study was conducted on September 12th-21th, 2015 in the Tayando-Tam Island. Tayando-Tam Island is one of the subdistricts located in the City of Tual, Moluccas (Maluku) Province, Indonesia; precisely located in the southeast of the province. Five locations were studied in Tayando-Tam Island, namely: Tayando (station 1), Vat (Station 2), Reer (Station 3), Tam (Station 4), Wailir (Station 5) (Figure 1).

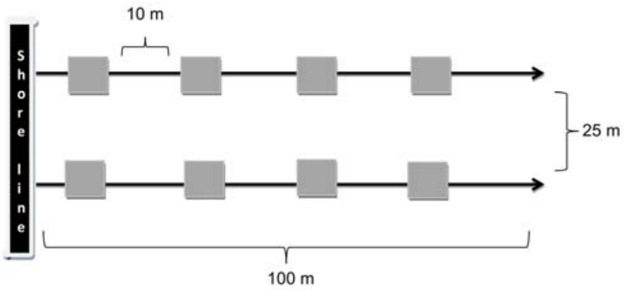

Figure 2. Line transect method

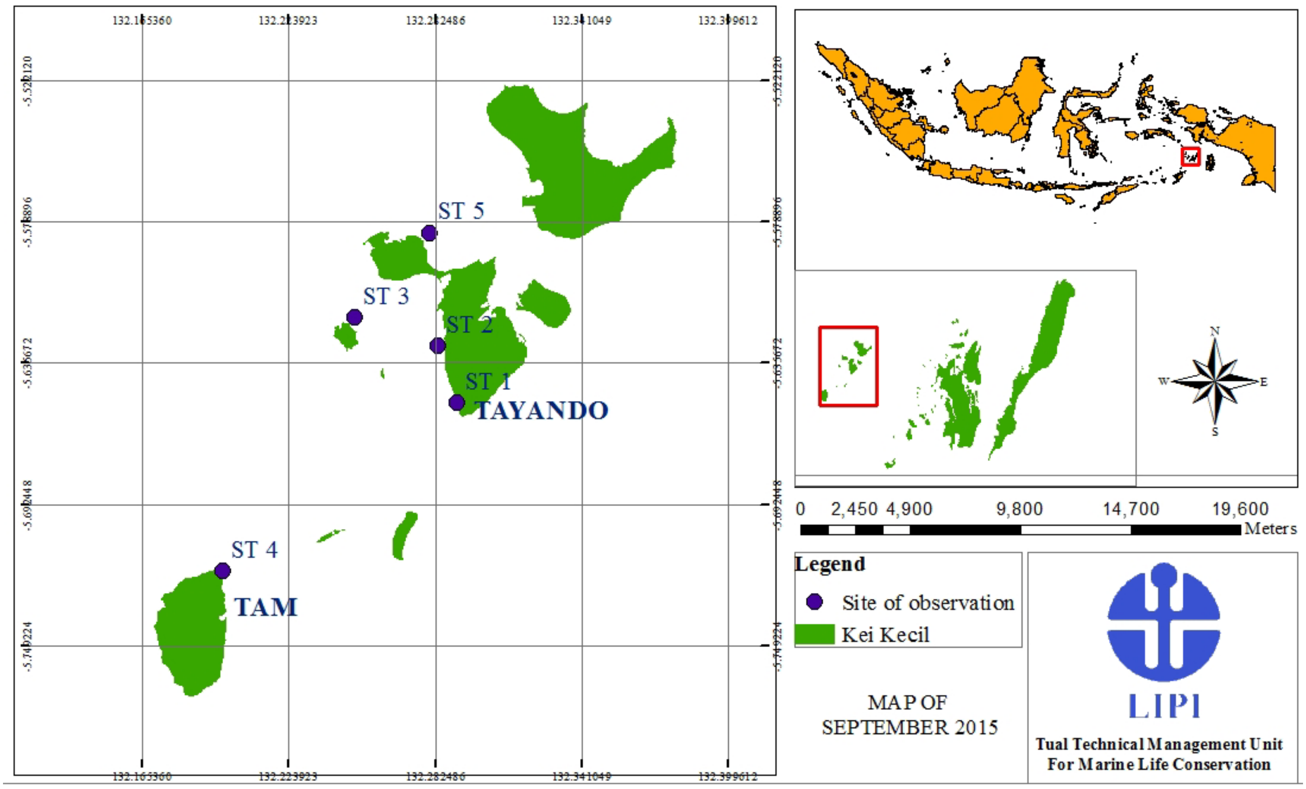

Figure 1. Map of the observation site at Tayando-Tam Island, Southeast Moluccas, Indonesia

Transect profile

The line transect method had been done at several locations of seagrass beds at Tayando-Tam island. Transect ran perpendicular to the shoreline for 100 meters (Fig.2). Two parallel transect lines created with a distance of 25 m between the transect line. On each line transect sampling specified points within 10 meters between sampling points, resulting in a line transect along 100 m transects gained 11 points. Transects conducted at low tide using transect quadrant made from PVC pipe measuring 50 x 50 cm. Observations of seagrass in the field include the identification of the types of seagrass, count the number of individuals/stand, data percentage (%) of seagrass cover and the characteristics of the substrate. Seagrass identification is done by using the identification key Azkab (1999). Sea water samples were taken from each station to be analyzed as supporting data. Parameters measured directly in the field is the temperature, current, pH and salinity

Data analysis

The data sampling results were analyzed to determine the density value types, species richness index (D), diversity index (H), evenness index (E) and dominance index as follows:

The density of each type was calculated using the formula Odum (1971):

$$Di = \frac{ni}{A}$$

Di = Density type (stand/1 m^2)
ni = Number of individuals (stand)
A = Area transect quadrant (1 m^2)

Species Richness Index/Index Margalef

$$D = \frac{S-1}{Ln\, N}$$

S = Number of total species in a habitat
N = Number of individuals in a habitat

Diversity Index (H ')

Diversity Index using the formula of Shannon-Wiener (Shannon 1948):

$$H' \quad \sum_{i-1}^{N} (Pi \ln Pi)$$

$$Pi = \frac{ni}{N}$$

H ' = Diversity index
ni = Number of an individual species i
N = Total number of individuals
Pi = Proportion frequency of species of the i-th of the total amount

With the value category:
H ': 0 < H < 1 = Low
1 ≤ H ' ≤ 3 = Medium
H ' > 3 = High

Evenness index (E)

Value index Evenness Odum (1971)

$$E = \frac{H'}{H\, max} = \frac{H'}{log_2(S)}$$

E = Number of evenness
S = Number of taxa/types

This index shows the distribution pattern of biota evenly or not. Evenness index value ranging between 0-1 by category as follows:
E < 0.4 = Small evenness
0.4 ≤ E < 0.6 = Medium evenness
E ≥ 0.6 = High evenness

Dominance Index

Dominance Index calculated by the formula Simpson (1949):

$$D - \sum_{i-1}^{n} (Pi)^2$$

D = Dominance Index Simpson
Pi = Proportion of species of the i-th of the total amount.

When there is an increase D, there will be a decrease in the value of evenness (E) Brower et al. (1990). Where the value of the index ranges between 0-1 domination by category as follows (Setyobudiandi et al. 2009);
0.00 < D < 0.50 = Low dominance
0.50 < D < 0.75 = Medium dominance
0.75 < D < 1.00 = High dominance

RESULTS AND DISCUSSION

Seagrass diversity

The research result obtained seven seagrass species those are *Enhalus acoroides, Thalassia hemprichii, Cymodocea serrulata, Cymodocea rotundata, Halodule pinifolia, Halophila ovalis, Syringodium isoetifolium*. *T. hemprichii* and *Cymodocea rotundata* most widely spread than the other species, as both were found in each location (Table 1).

Thalassia hemprichii is the most widespread vegetation unit. This species has a characteristic range of habitats is quite wide, from the brightness level of the clear water to turbid, from single up to mix vegetation and various types of substrates Kiswara (1997). The seagrass species that dominate in this observation is *T. hemprichii* as spread over all observation sites in the Tayando-Tam Islands waters. *T. hemprichii* is found in almost all the waters of Indonesia, often dominance the mix vegetation with a distribution vertical can reach 25 m and can grow on various types of substrates ranging from muddy sand, sand medium-sized and rough up the fragments coral (Takaendengan and Azkab 2010). Lanyon (1986) revealed that the morphologies of this type have a thick rhizome and strong that allows it to grow on a substrate varies. *Cymodocea rotundata* is a widespread common seagrass in clear water reef habitats throughout the Indo-west Pacific. *Cymodocea rotundata* often grows in mixed species meadows which are important nursery grounds for prawns and other invertebrates. This species is fast-growing and plays a role in habitat recovery (Waycott et al. 2004).

Tropical and temperate seagrass may vary in distribution, density and species mix within time spans of months (Coles and Lee long 1999). Seagrass distribution varies at each location, Tam Island has the most species of seagrasses among the other location. Seven types of seagrass found in Tam Island is *E. acoroides, T. hemprichii, C. serrulata, C. rotundata, H. pinifolia, H. ovalis* and *S. isoetifolium,* while Island Tayando, Vatlev, Reer and Wailir only found three species of seagrasses, and each island has a kind seagrass different. Kiswara (1997) stated that the distribution of seagrass in each location has different variations and there is a relationship between the composition of the characteristic habitat types. Habitat characteristics of the study sites are presented in Table 2.

The composition of seagrass species is highest in Tam Island which has a substrate of sand muddy water with high levels of brightness. While the composition of the lowest found in the first location of Tayando Island that has sand substrate rubble. The quality of environmental in Tayando Island is relatively lower than the other sites because in these locations they are various types of fishing activities such as pearl farming activities, etc.

Seagrass density

The density of seagrass species has a dependency on the type because it deals with the size and layout leaf growth. Short and Coles (2001) stated that the stand density of seagrass is influenced by various factors such as the type of seagrass, substrate conditions, seasons, tides, wave energy strength, the content of organic matter in the sediment and other environmental factors. The density of seagrass species in the Tam-Tayando Islands can be seen in Table 3.

The growth of seagrass thought to be influenced by internal factors such as the physiological and metabolism, as well as external factors such as nutrients and fertility waters and stand density of seagrass is influenced by various factors as described by Short and Coles (2001) i.e., the type seagrass, substrate conditions, seasons, tides, wave energy strength, the content of organic matter in the sediment and other environmental factors. Shoot density is a parameter which is easily determined and often used as a rough estimate for standing stock (Vareschi and Jacobs 1984).

Halodule pinifolia have the highest density value from all types of seagrass found that 684.18 shoots/m^2 and this type is only found in the Tam Island. The high density of *H. pinifolia* in Tam island due to a suitable substrate as habitat. The density of seagrass species per unit area depends on the type and characteristics of seagrass as habitat. This relates to the very nature of seagrass need light for photosynthesis (Kiswara 1997). The more clear the water, the more the intensity of sunlight entering thereby stimulating the growth of shoots stand seagrass. *H. pinifolia* also *Halodule uninervis* occupies a wide range of habitats, from the muddy intertidal to reef tops and is tolerant of large fluctuations in salinity. The species is widely distributed throughout the Indo-west Pacific and is almost ubiquitous in tropical seagrass meadows often being dominant (Waycott et al. 2004). This species is a rapid colonizer from seed and through vegetative growth, it plays an important role in maintaining seagrass habitat in areas of high disturbance and actively stabilizes sediments with an intertwining mat of rhizomes and fibrous roots.

The Table 4 above shows that overall seagrass cover ranges from 4.64 to 43.1%, which is dominated by *T. hemprichii* and *H. pinifolia*. The low percentage of seagrass cover in area Tam Island is expected because of the high activity of the community around the site, where the location there is a company engaged in the pearl farming. Based on the decision of the State Minister of Environment No. 200 of 2004 on standard criteria and guidelines for the determination of the extent of damage the status of seagrass, seagrass cover ≥60% relatively rich/healthy, 30 to 59.9% classified as less healthy and ≤ 29.9% were classified as poor. It can be concluded that the status of the seagrass beds around the island waters Tayando-Tam as a whole, including the category of less wealthy/less healthy.

Table 1. Biodiversity of Seagrass Species at Tayando-Tam Islands, Southeast Moluccas, Indonesia

Species	Location 1		Location 2		Location 3		Location 4		Location 5	
	I	II	I	II	I	II	I	II	I	II
Hydrocharitaceae										
Enhalus acoroides	-	-	-	-	-	-	+	+	-	-
Thalassia hemprichii	+	+	+	+	+	+	+	+	+	+
Halophila ovalis	-	-	-	-	+	+	-	+	+	+
Cymodoceaceae										
Cymodocea serrulata	+	-	+	+	-	-	+	+	-	-
Cymodocea rotundata	-	+	+	+	+	+	+	+	+	+
Halodule pinifolia	-	-	-	-	-	-	+	+	-	-
Syringodium isoetifolium	-	-	-	-	-	-	-	+	-	-
Total species	2	2	3	3	3	3	5	7	3	3
Total individual	453	573	1376	1486	1310	1149	4288	3896	1595	2388

Temperature affects seagrasses from the global to the molecular level. It influences the biogeographical distribution of seagrasses worldwide. The temperature of the water within and above seagrass beds may vary locally depending on the density of the vegetation and the hydrodynamic conditions prevailing in the area. The results of temperature measurements in the waters of Tayando-Tam Island, Southeast Maluku, is in the range still in the optimum range for growth of seagrass. The normal temperature for the growth of seagrass in tropical waters ranges 24-35^{o}C (Hutomo 1985)

The salinity of the water may not only affect the distribution and growth of seagrasses but can also be environmental stress rendering seagrasses more or less vulnerable to diseases. Salinity data can be a good indicator of the origin of the water mass in the seagrass bed (oceanic or riverine) and may also provide some information about seagrass diversity and ecology in a specific area. Seagrass species have tolerance to different salinity in the range of 10-40 ‰, the optimum value of seawater salinity tolerance is good for seagrass growth amounted to 35 ‰. Dahuri et al. (2001). The value of salinity in five observation stations ranged between 32.3-34.5‰. The results showed that the salinity of the waters in the locations of the research is still in the range specified. Salinity effect on the quantities which are the product of or related to photosynthesis such as biomass, productivity, density, leaf width, and speed recovery of seagrass.

Water flow affects almost all biological, geological and chemical processes in seagrass ecosystems. On seagrass beds, current speed has a significant influence, the productivity of seagrass beds visible from state effect of water flow speed, which has the maximum ability to produce "standing crop" when the current speed of 0.5 m/sec (Dahuri et al. 2001). The flow velocity based on measurements in the waters Tayando-Tam is from 0.7 to 0.31 m/sec. These conditions indicate the current speed is medium, according to the statement Mason (1981), where the waters flow velocities grouped fast-very fast (> 100 cm/sec), fast (50-100 cm/sec), medium (25-50 cm/sec), slow (10-25 cm/sec), and very slow (<10 cm/sec). Relatively calm water conditions will cause the leaf surface is overgrown with algae will seagrass epiphytes and covered by sediment trapped at the bottom, this is particularly the seagrass that are substrates of mud. In addition, the movement of water also causes leaf bent and formed a dense canopy, thereby reducing light penetration, this led to the effectiveness of photosynthesis decreases due to the amount of light incident on the chloroplast reduced (Susetiono 2004).

Seagrass community structure

Natural ecosystems are generally so rich in species and affected in such complex ways by environmental variables that there is little scope for testing the relationship between diversity, productivity, and stability. Ecologists have therefore resorted to manipulation of artificial ecosystems, where levels of diversity and combinations of species can be controlled, and key aspects of ecosystem function (Hogarth 2015). The ecological index is used to look at the sustainability of communities and community structure of seagrass. The ecological index consisted of Species Richness (D), Diversity Index (H '), Evenness index (E) and Dominance Index. A community that has a high species diversity if the abundance of the species or proportions between species as a whole it just as much or nearly as much (Brower et al. 1990).The results of data analysis Ecological index seagrass communities in the Tayando-Tam Island is summarized in Table 5.

Table 2. Description Substrate of Seagrass in Tayando-Tam Island Waters, Southeast Moluccas, Indonesia

Location	**Description of substrate**
Tayando	To the land: rubble dead and life coral To the sea: rubble dead and life coral
Vat	To the land: rubble, dead and life coral To the sea: rubble coral and sand
Reer	To the land: rubble, life coral, and sand To the sea: sand
Tam	To the land: soft muddy-sand To the sea: sand
Wailir	To the land: muddy-sand To the sea: sand

Table 3. Density of seagrass at Tayando-Tam Island Waters, Southeast Moluccas, Indonesia

Species	**Density of seagrass (shoots/m^2) at each location**				
	1	**2**	**3**	**4**	**5**
Hydrocharitaceae					
Enhalus acoroides				20.91	
Thalassia hemprichii	170	474.36	286.36	472.91	527.45
Halophila ovalis			143.82	1.1	79.82
Cymodoceaceae					
Cymodocea serrulata	1.82	8		131.27	
Cymodocea rotundata	31.27	38	16.91	128.91	116.91
Halodule pinifolia				684.18	
Syringodium isoetifolium				98.54	

Table 4. Percentage of coverage and species dominance at every observation sites at Tayando-Tam Island, Southeast Moluccas, Indonesia

Location	**Percentage (%)**	**Dominance**
1	4.64	*Thalassia hemprichii*
2	8.91	*Thalassia hemprichii*
3	6	*Thalassia hemprichii*
4	43.1	*Halodule pinifolia*
5	14.36	*Thalassia hemprichii*

Table 5. Ecology Index of seagrass community structure in Tayando-Tam Island, Southeast Moluccas, Indonesia

Ecology index	Location				
	1	2	3	4	5
Species Richness	0.16	0.27	0.28	0.60	0.26
Diversity	0.24	0.33	0.62	1.26	0.74
Evenness	0.80	0.70	1.31	1.63	1.54
Dominance	0.86	0.84	0.62	0.34	0.57

Table 6. Water environmental condition at Tayando-Tam Island, Southeast Moluccas, Indonesia

Environmental parameters	Locations				
	1	2	3	4	5
Temperature (^{o}C)	27.1	29.6	27.5	29.3	26.6
Current (m/s)	0.09	0.31	0.11	0.13	0.07
pH	8.19	8.42	8.17	8.42	8.16
Salinity (‰)	34.4	34.4	33.2	34.5	32.3

Value index of species richness in Tayando-Tam Islands waters has a range of 0.16 to 0.6. The lowest index value contained in the first location that is on the Tayando Island of 0.16 which means that the species found at the site of one fewer than in the other locations and species richness was highest in four locations namely at Tam Island at 0.6 due in Tam Island is most prevalent types of seagrass. This shows that the type of the muddy sand substrate Tam Island suitable for the majority of the growth of seagrass in Tayando-Tam Islands. In general, species richness of seagrasses correlates with higher biomass and production. However, this effect appears to be related not to species richness as such, but to the variability within the seagrass meadow of the size of its constituent species. Larger species function in some respects differently from smaller ones, and the functional complementary of species of different sizes may serve to enhance the function of the community as a whole.

Diversity index is used to determine the abundance of seagrass communities based on the number of species and the number of shots of each species in a region, biodiversity spanning two important things, they are the number of species and number of individuals of each species in a region, the more the number of species, the more diverse community. From the calculation results obtained Shannon diversity index of diversity in Tayando-Tam Islands ranging between 0.24 to 1.26 (Table 6). Based on the criteria Shannon diversity index, the location of the Tam island has the highest index value, which can be interpreted Tam Island waters are still relatively moderate and location diversity Tayando island have the lowest index value relatively low category.

Evenness index is used to determine the abundance of a community based on the degree of similarity several shoots in an area, from the calculation of the index value evenness Odum (1971) seagrass species in Tayando-Tam island waters has a range of 0.7 to 1.63 (Table 6). Based on the criteria of evenness Odum (1971), the highest evenness was found in Tam Island and evenness is the lowest in Vat Islands. This shows that the Tam island addition to having a relatively higher diversity compared to other locations, Tam Island also have an evenness distribution pattern seagrass.

Dominance Index is used to see how big a dominant species in a region. The index value ranges between 0-1 domination of the greater value of dominance is indicated the more likely their one dominant species population. The observation and calculation of the index values obtained dominance in the Tayando-Tam Island waters has a range of 0.34 to 0.86. Domination lowest index value contained in the Tam Island Waters at 0.34 which is included in the low category, thus can be interpreted that in the waters of Tam Island not found a certain species predominate in these waters. The index value is the highest dominance in the waters of Tayando Island at 0.86 which included a high category, it can be interpreted that in the waters of Tayando Island there is one type that dominates the region, which is a type *T. hemprichii*

Based on the number of species found, diversity index and dominance index than at 4 locations namely in the waters of Tam Island can be said to have the most stable communities, due to have a diversity index being (H '= 1.26), high evenness Index (E = 1, 63), a low dominance index (D = 0.34) and which has the highest kind species richness much as seven species.

To conclude, in the Tayando-Tam island waters discovered seven species of seagrasses those are *Enhalus acoroides, Thalassia hemprichii, Cymodocea serrulata, Cymodocea rotundata, Halodule pinifolia, Halophila ovalis* and *Syringodium isoetifolium*. The highest density of seagrass is *Halodule pinifolia* at Tam Island with a value of 684.18 shoots/m^2. Seagrass cover in these waters ranged from 4.64 to 43.1%. Resource potential seagrass best with the most stable community structure contained in the Tam Island. Seagrass resources in the Tayando-Tam island are good and the potential for biota the association, which is supported by the quality of water is good for the growth of seagrass.

ACKNOWLEDGEMENTS

The author would like to thank Tual Technical Management Unit for Marine Life Conservation, Moluccas, Indonesia, which has funded research activities. Thanks also all the research staff and technicians and special thanks to Prof. Dwi Eny Djoko for helpful discussion.

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