The application of environment friendly technique for seagrass transplantation

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Abstract. Many attempts have been made to solve tremendous seagrass losses the marine environment in many area in the world. Artificial transplanting of shoots and spreading of seeds from intact meadows to non-vegetated coastal sediment are the most applied techniques. The study was aimed to apply environmentally seagrass tranplantation techniques in less vegetated area. Frame and small tube made from bamboo were used to do seagrass tranplantation in Jepara Waters. Vegetative shoots (springs) of *Enhalus acoroides dan Cymodocea serrulata* were collected from a healthy donor bed located nearby the transplantation site, and planted into unvegetated areas. Test transplant survival was assessed every month for three months. The result revealed that the survival rates of transplants were varied with the area. It might have due to difference in sediment characteristics of transplanting sites and transplant technique are discussed.
Keywords: seagrass, transplantation, bamboo, tranplant technique

1. Introduction

Seagrasses are plants with roots, stems and leaves adapted to living in the marine environment and capable of producing flowers, fruits and seeds. These plants are more evolved and complex than seaweed, which have a more simple structure, although the two species are often confused. Seagrass beds occur extensively in shallow waters and can reach up to depths of 40m or more, if the environmental conditions permit photosynthesis. Beside play a role in carbon cycle in the atmosphere [1][2], seagrass ecosystems have important roles as a source of primary productivity and a foraging and nursery ground for some marine biota [3]. Twelve out of 69 world seagrass species were found in Indonesia [4]. In Jepara waters, especially in Bandengan, Teluk Awur [5] and Karimunjawa [6] waters there were 5, 7 and 6 species of seagrass respectively. They live in variety habitats such as sand, sandy mud, mud, and rubble substrate.

Seagrass ecosystem conditions in some parts of Indonesia are found to be under threats from human activities such as tourism, ports, aquaculture, and sand mining. It was estimated that 58% seagrass ecosystems in the world has decreased the extents number [7]. According to [8], seagrass bed areas in Indonesia are declined by about 30-40% , and the biggest damage of seagrass beds is found in Java Island [4]. The coverage of seagrass in Teluk Awur and Bandengan waters, Jepara, also tends to decrease from 79% in 2000 [9] to 53% in 2012 [10]. This reduction occurs continuously every year as the effect of anthropogenic pressures.

Because seagrass habitats are so valuable, the protection of seagrass ecosystems needs to be done immediately as well as seagrass restoration. Seagrass habitat restoration can be accomplished by improving the habitat quality and transplanting seeds or adult shoots. Habitat improvement may be a very slow process and consequently, requires long periods of time whereas seagrass transplantation might be a rapid way to restore seagrass habitats. Transplanting can establish seagrass habitat before natural processes might permit recolonization [11]. Artificial transplanting of shoots and spreading of seeds from intact meadows to non-vegetated coastal sediment are the most applied techniques. Planted seagrass beds can function and grow exactly as natural beds. However, very few seagrass transplantation studies have been made In Indonesia to restore the damaged. Among of them were done by [12] at reef flat of Pari Island, [13]at Banten Bay, [11] at Westcoast of South Sulawesi, and [14] at Prawean waters, Jepara but are mostly done for *Enhalus acoroides* none for *C. serrulata*.

Seagrass transplantion have been conducted either transplanting adult plants, which is traditionally the most widely used method, probably because habitats are immediately created or planting seeds because of its reduced costs as collection, maintenance, transportation and planting processes are easier and more cost-effective. The transplantation is conducted by several method such as plug methods, in which seagrass and attached sediment are harvested using core tubes of various sizes; staple method, in which plants are dug up using shovels; peat pot method, in which sediment blocks are removed as when using the plug methods; and TERF or frame systems method, which is a modification of the staple method. All methods are involved metal material such as core tubes (plug methods), staple and metal wire (staple method), metal frames (frame systems) that have to be removed from the site, otherwise they pollute the environment [15][16]. Therefore an attempt to look for more environmentally material is urgently needed. In this study the bamboo was selected as material to transplant seagrass because they are easilly available in Indonesia, able to degrade in certain of time therefore no waste produced and relatively cost effective. The objectives of present work are to compare the performance (growth and survival rate) of *Enhalus acoroides* and *Cymodocea serrulata* transplantation done by different transplantion method (tube and frame method) using bamboo material in different locations.

2. Material and method

Two seagrass species *Enhalus acoroides* and *Cymodocea serrulata* were replanted in two different location, i.e. Bandengan and Teluk Awur waters, Jepara. Bottom sediment of both locations are characterized as sanddy to sandy mud (Bandengan) and sandy mud (Teluk Awur) sediment with coral fragments. The locations are semi-closed and protected from waves, the depth of water were ranged of 0.5-1 m and 2-2,5 m during lowest and highest tides respectively.

Seagrass (*E. acoroides and C. serrulata*) was randomly retrieved from well developed seagrass beds in the same area where they will be replanted. The collector followed the blades of the shoot to the substrate, uprooted approximately 15-20 cm of the rhizome by digging under the rhizome by hand, and snapped the rhizome to remove the plant. This technique allowed us to minimize disruption of root-rhizome layer. The plants then were temporarily stored in large coolers with a small amount of seawater to prevent exposure.

Transplantation of *E. acoroides* and *C. serrulata* were performed in June-September 2017 using two methods, i.e. modified plug and frame methods of [15][16]. In both, environment-friendly transplantation material i.e. bamboo as tubes and frames were used. Transplantation at each site was done in triplicate to create three patch sizes. A plot size of 3 m x 3 m was designed with spacing of 0,5 m intervals between planting units within a row. For convenience seagrasses were transplanted at both stations during low tide. For plug method, since the rhizome size of each species of seagrass could be different, the donor were planted in 10 and 5 cm length bamboo cut for *E. acoroides* and *C. serrulata* respectively. After the donor were planted into bamboo tubes, then the bamboo tube were inserted in the bottom substrate and filled with sediment/sand taken from nearby. For frame method transplantation, a 3 meter x 3 meter bamboo frame is lowered into the water until it rests on the bottom. The donor shoots are attached with cotton rope ties, aligned in parallel with distance of 50 cm in the frame. The anchor were tied up in the corner of the frame so it is steady in the position at the bottom of the waters and not be carried away by the current.

Growth and survival rates of transplanted seagrasses were assessed monthly. Growth was measured using leaf marking technique where twenty five plants at each transplanting plot were marked on leaf sheath. After a period of 2-3 d, leaves were remarked again. Growth was then measured as the difference between the first mark and the initial baseline after the second mark has been done. The total number of remaining plants at each plot was counted to examine the survival rate. Sediment samples were collected from transplanted sites using hand corer to determine grain size distribution, total organic matter, phosphat and nitrate analyses. Oceanographic condition of planting sites were also monitored every month during the experimental period by measuring seawater temperature, salinity, current speed, and light penetration.

3. Result and discussion

In the seagrass transplantation, to select transplantation habitats carefully, and to optimize the transplantation techniques, it is necessary to consider on selection of an appropriate donor population, spreading of risks, and ecosystem engineering effects [17]. Therefore, two transplantation locations with almost same the similar physical properties between donor sites and transplanted sites were chosen. Sediment characteristic which support seagrass growing during the initial transplanting period is regarding to be one of the key factors contributed to seagrass transplantation success [18] although it is apparent that sediment physical properties cannot always predict the suitability of the areas for seagrass transplantation [17]. Grain size analysis of sediment in the transplantation and control location revealed that the sediment was mainly composed of sand (69,04-85,41%) to form sand to sandy muddy substrat (Table 1). The concentration on nitrate and phosphat we in in the range of 0,0143-0,5750 and 0,0131-0,0262 $mg.gr^{-1}$ respectively. Sediments are important parameters that have a major influence on the growth and spread of seagrass and therefore affect the success of seagrass transplantation [19]. Moreover, sediment characteristics also an important and critical factor in choosing a suitable transplanting method for a specific area.

Table 1. The sediment characteristic and nutrient of transplantation locations.

Locations	Fraksi Substrat (%)			Clasification	Nitrate ($mg.gr^{-1}$)	Phosphate ($mg.gr^{-1}$)
	Gravel	Sand	Silt			
Control Teluk Awur	3,54	76,32	20,14	Sandy muddy	0,2393	0,0262
Control Bandengan	8,96	74,31	16,73	Sandy muddy	0,5750	0,0171
Teluk Awur1	2,46	81,38	16,16	Sandy muddy	0,1790	0,0220
Teluk Awur2	11,13	69,04	19,83	Sandy muddy	0,1964	0,0171
Teluk Awur3	12,9	68,65	18,45	Sandy muddy	0,1857	0,0128
Bandengan 1	5,81	85,41	8,78	Sand	0,3857	0,0210
Bandengan 2	21,11	71,66	7,23	Sandy muddy	0,0143	0,0131
Bandengan 3	16,35	76,76	6,89	Sandy muddy	0,2500	0,0184

The water quality measured during present work were presented in Table 2. All measured parameters fall within the range of seagrass. Seagrass growth was influenced not only external factors such as temperature, salinity, turbidity, bottom substrate and nutrient resources[20] but also internal factors including physiology and metabolism processes of seagrass. Tropical seagrasses grew optimum

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at temperature of 28-30 ^{0}C and salinity of 20-35 $^0/_{00}$. Organic matter content was almost the same for both locations (3,3-3,6%). [20] Benham et al (2016) stated that high sediment thickness and soft-sediment contain organic material needed for seagrass growth. Light intensity reached the bottom (0,75-1,70 meter) supporting seagrass growth. Seagrasses require a minimum of 20% of surface light to survive [21].

Tabel 2. Physical and chemical parameter of Teluk Awur and Bandengan waters.

Parameters	Teluk Awur Waters	Bandengan Waters
Temperature (^{o}C)	28-29,5	28,5-30
Salinity ($^o/_{oo}$)	32-33	32-33
Current speed (m.s^{-1})	1,2	1,1
Organic matter (%)	3,3	3,6
Depth (m)	0,75-1,50	0,85-1,70
Light penetration (m)	0,75-1,50	0,85-1,70

The average growth rate of tranplanted *E. acoroides* dan *C. serrulata* in different location are represented in Figure 1, and showed that the highest growth rate was *E. acoroides* (0,313 %.day^{-1}) transplanted with bamboo tube methods at Bandengan waters, and *C. serrulata* transplanted with same method shows the highest growth rate (0,041 %.day^{-1}). Compare to control location, they have lower growth rate. The growth rate of *E. acoroides* and *C. serrulata* of control location in Teluk Awur waters were 0,365 and 0,048 mm.day$^{-1.}$. In control location Bandengan waters, growth rate of *E. acoroides* and *C. serrulata* were 0,428 and 0,047 mm.day$^{-1.}$. This slower growth rate of transplant seagrass compared to plants at the donor sites [22] suggesting that *seagrass* transplants needed time to acclimatize to new environment.

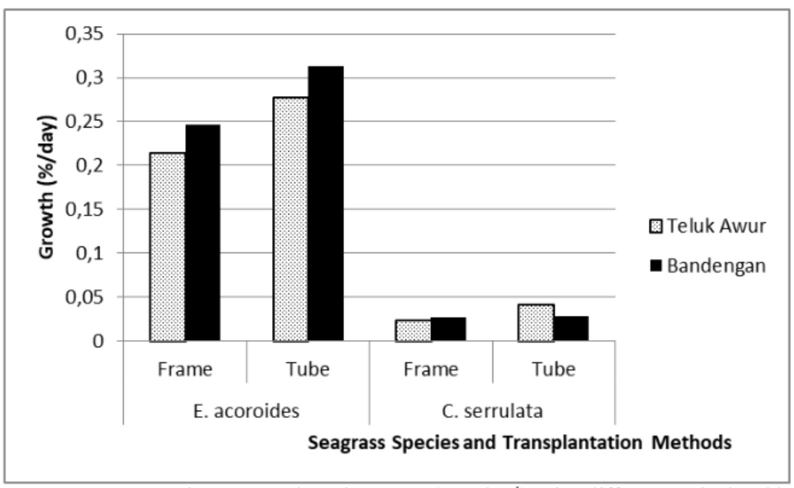

Figure 1. Average growth rate transplanted seagrass (mm.day^{-1}) using different method and locations (FE = Frame *E. acoroides*, TE = Tube *E. acoroides,* FC = Frame *C. serrulata,* TC = Tube *C. serrulata*)

Figure 2 illustrates the transplantation survival rate of *E. acoroides* and *C. serrulata* at Teluk Awur and Bandengan waters. It showed that transplantation using bamboo tube were more survived than on the frame method. The highest survival rate of both species was showed in Teluk Awur waters using bamboo tube (45% and 24,6% respectively) and while the lowest survival rate of both species was transplanted at Bandengan waters using bamboo frame (13,4 and 0% respectively).

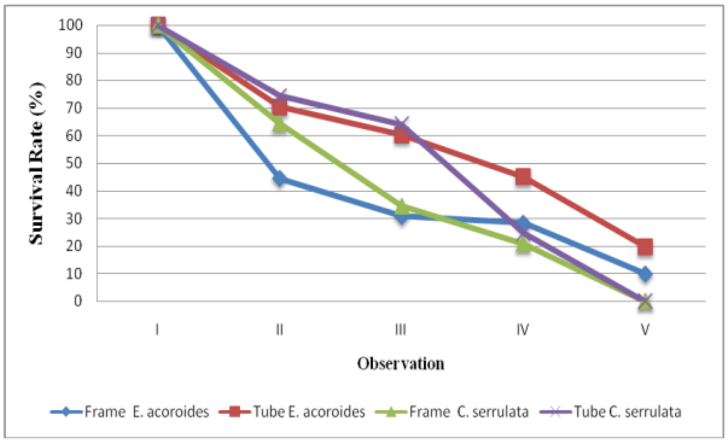

Figure 2. Survival rate (%) transplanted seagrass in the end third month using different method at Teluk Awur

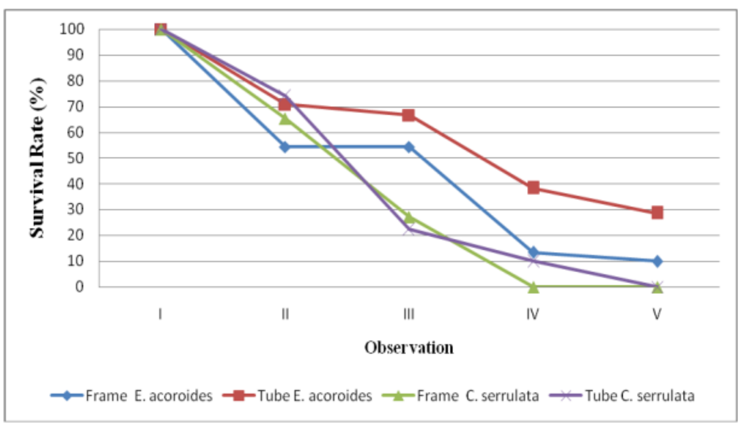

Figure 3. Survival rate (%) transplanted seagrass in the end third month using different method at Bandengan

The survival rates of seagrass transplanted in bamboo tube were relatively high during the first month of transplantation, i.e. more than 70% in both transplantation location. First one-month period is a phase of adaptation for the transplants to their new substrate and environments. High survival rate after one month transplantation indicated that no critical physical and biological disturbances to the transplants at transplanting sites [11]. But in the third month the survival rate were decreased considerably especially whom transplanted with frame method. Figure 2 also showed that transplantation using bamboo tube were better than frame method. The tube gave better protection for rhizome from waves and currents. Bamboo frame methods weaker than bamboo tube, since many seagrasses were seen lifted from the sea floor. This condition lead to decrease the growth rate, and some seagrass could not grow well and some died. Data shows that the highest growth rate for seagrass transplanted at Bandengan was 0.313 $mm.day^{-1}$ for *E acoroides*. It was expected that physical and chemical oceanography characteristic of Bandengan suited for the growth of *E acoroides*. The differences in seagrass covers that was influenced by their growth rate were caused by several factors including seagrass topography, physical and chemical water condition, coastal community activities around the seagrass, and distribution of seagrass species [23]. It can be seen that coastal community in Bandengan Waters was more activities (fishing and tourism) than Teluk Awur Waters. According to [24], if the location of seagrass ecosystems was very close to the mainland it had the potential to receive the negative effects of anthropogenic activities from that mainland. In addition to the base of substrate and water conditions, number of residents in a region, which was correlated with anthropogenic stress, was another factor affecting seagrass cover and distribution. [25][26].

Assuming appropriate light levels, sediments are important parameters that have a major influence on the growth and spread of seagrass and therefore affect the success of seagrass transplantation [19]. Sediment can affect the stand material of transplanted seagrass material through a process of erosion/deposition of sediment. Therefore sediment stabilization play important role to keep sediment and transplants in place and being not swept away by strong currents and waves [11]. The efficiency of anchoring device used in the present study especially for frame method is also an important factor determining the success of seagrass transplantation. The efficiency of anchoring device may depend on the sediment type at the transplanting sites. Coastal tidal flat of Teluk Awur and Bandengan Waters composed of sand and silt therefore anchoring device can not be pressed deeper into the sediment so that the bamboo frame can not hold seagrass transplants firmly against strong currents and waves. The efficiency of anchoring device used in the present study is also an important factor determining the success of seagrass transplantation.

In general, the growth and survival rate of *E. acoroides* is higher than *C. serrulata*. *E. acoroides* was characterized by long shoot, root and rhizome with slow rhizome branching frequency. Growth of *E.acoroides* varied with season and location where leaf growth rate can be varied from less than 1 cm d-1 up to more than 2 cm d-1 [27][28]. Comparing to other transplantation of *E. acoroides* by [29] and [11], transplantation in this present work had lower the survival rate. C. serrulata was rather robust seagrasses with ribbon-like curved leaves with serrated leaf tip, smooth herbaceous rhizomes and well developed leaf sheaths [30]. The shoot of *C. serrulata* has open leaf sheath scars. Transplantation of *Cymodocea rotundata* has been conducted by [31], with plug and sprig method revealed that the survival and growth rate were higher than *C. serrulata* in present work. There lower survival rate might be due to the different method and physical characteristic of locations.

4. Conclusion

It could be concluded that transplantation of seagrasses *Enhalus acoroides* and *Cymodocea serrulata* using tube method showed better growth and survival rate than bamboo frame methods. The transplantation locations had significant impact to transplantation success rate.

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References

[1] Duarte CM, Middelburg JJ, Caraco NF 2005 Biogeoscience **2(1)** 1-8
[2] Kennedy H, Beggins J, Duarte CM, Fourqurean JW, Holmer M, Marbà N, Middelburg JJ 2010 Global Biogeochem Cycles **24** GB4026, doi: 10.1029/ 2010GB003848.
[3] Erftemeijer PLA, Osinga R, Mars AE 1993 Aquat Bot **46** 67-90
[4] Kawaroe M, A H Nugraha, Juraij, I A Tasabaramo 2016 *BIODIVERSITAS* **17(2)** 585-591
[5] Hartati R, Trianto A, Widianingsih. 2017a. IOP Conf. Series: Earth and Environmental Science **55** 012041 doi: 10.1088/1755-1315/55/1/012041

[6] Hartati R, Widianingsih, Trianto A, Zainuri M, Ambariyanto 2017b. BIODIVERSITAS **18(3)** 947-953
[7] Waycott M, McMahon K, Mellors J, Calladine A, Kleine D 2004. A Guide to Tropical Seagrasses of the Indo-West Pacific. James Cook University, Townsville.
[8] Vo ST, Pernetta JC, Paterson CJ 2013 Ocean Coast Manag **85** 153-163
[9] Riniatsih I, Hermawan I, Sedjati S. 2000. ILMU KELAUTAN (Indonesian Journal of Marine Science). **5** (19)
[10] Riniatsih I, Widianingsih W, Redjeki S, Endrawati H. 2013 ILMU KELAUTAN (Indonesian Journal of Marine Science) **18(2)** 84-90
[11] Lanuru M. 2011. Bottom Sediment Characteristics Affecting the Success of Seagrass (*Enhalus acoroides*) Transplantation in the Wescoast of South Sulawesi (Indonesia). 2011 3rd International Conference on Chemical, Biological and Environtmental Engineering IPCBEE vol. 20 (2011) IACSIT Press, Singapore.
[12] Azkab, M.H. 1988. Seagrass (*Thalassia hemprichii* Ehrenb Aschers) Transplantation at Reef flat at Pari Island Seribu Islands Jakarta Bay: Biology, Culture, Oceanography, Geology and Water Cindition) (Transplantasi Lamun *Thalassia hemprichii* (Ehrenb.) Aschers di Rataan Terumbu Pulau Pari, Kepulauan Seribu: Teluk Jakarta : Biologi, Budidaya, Oseanografi, Geologi dan Kondisi Perairan). P3O-LIPI, Jakarta. 1988
[13] Kawaroe M, Erlangga DK, Rahadian NP 2010 *Jurnal Mar. Res. Indonesia* **35(2)**
[14] Febriyantoro Febriyantoro, Riniatsih I, Endrawati H. 2013. Buletin Oseanografi Marina **2(1)** 23-26
[15] Calumpong HP, Fonseca MS 2001 Seagrass transplantation and other seagrass restoration methods. in : Global Seagrass Research Methods. Eds : Short FT and Coles RG. Elsevier Science. chapter **22**, pp: 425-442
[16] Ganassin C, PJ Gibbs 2008. A review of seagrass planting as a means of habitat compensation following loss of seagrass meadow . NSW Department of Primary Industries - Fisheries Final Report Series No. 96 . 41P.
[17] van Katwijk MM, Bos AR, de Jonge VN, Hanssen LSAM, Hermus DCR, de Jong DJ 2009 *Marine Pollution Bulletin* **58** 179-188.
[18] Vichkovitten T, Intarachart A, Khaodon K, Rermdumri S 2016 *GMSARN International Journal* **10** 113 – 120
[19] Newell RIE, Koch EW 2004 *Estuaries* **27(5)** 793-806.
[20] Benham, CF, SG Beavis, RA Hendry, EL Jackson. 2016. Marine Pollution Bulletin **109** 461-470.
[21] Dennison WC 1987 *Aquatic Botany*., 27: 15–26.
[22] Lepoint G, Vangeluwe D, Eisinger M, Paster M, van Treeck P, Bouquegneau J.-M, Gobert S. 2004 *Marine Pollution Bulletin* **48** 465-470.
[23] UNEP 2008. National Reports on Seagrass in the South China Sea.UNEP, Bangkok.
[24] Ambo-Rappe R. 2014 Mar Pol Bull **86**:298-303.
[25] Campbell SJ, McKenzie LJ. 2004. Estuar Coast Shelf Sci. **60** 477-490
[26] Waycott M, Longstaff BJ, Mellors J. 2005. Mar Pol Bull **51** 343-350.
[27] Vichkovitten T. 1998. *Kasetsart Journal (Natural Science)* **32** 109-115.
[28] Kenyon RA, Conacher CA, Poiner IR 1997 *Marine and Freshwater Research* **48** 335-342.
[29] Kawaroe M, Jaya I, Indarto HS. 2008. Technology Application of Seagrass Trabsplantation *Enhalus acoroides* at Seribu Islands Space Region of Jakarta. (Rekayasa Teknologi Transplantasi Lamun pada Jenis *Enhalus acoroides* dan *Thallassia hemprichii* di Kepulauan Seribu, DKI Jakarta). LPPM. IPB Bogor. 26 hal.
[30] Larkum AWD, Orth RJ, Duarte CM. 2006. Seagrasses Biology, Ecology and Conservation. Springer. Netherland.
[31] Riniatsih I, Endrawati H. 2013. Buletin Oseanografi Marina **2** 34 - 40

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