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Engineering Method of Turf TERFS Modification on Seagrass *Enhalus acoroides* in Beach Waters, Waai Village, Central Maluku Regency

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Abstract. Seagrass beds are the richest and most productive marine ecosystems, with high primary production. Utilization of coastal areas such as sand and stone extraction and disposal of solid and liquid waste to the beach can cause damage to coastal ecosystems, including seagrass. These conditions can be restored through transplant activities. Turf TERFS modification is a modified method of the turf method where the seagrass is taken from the donor area and its substrate, then the seagrass seedlings are tied to an iron frame (TERFS method) and then planted in holes where the substrate is partly from the donor area and partly from the transplant area. This research was carried out from May 2019 – July 2019 in the coastal waters of Waai Village, Central Maluku Regency, which aims to analyze the survival rate, growth rate, biomass, production and recovery speed of *Enhalus acoroides* leaves using the tagging method. The results showed that the *Enhalus acoroides* had a survival rate of 86.67%, a growth rate of 0.884 cm/day, a biomass of 0.400 g/m^2, leaf production of 0.019 g/m^2/day with a leaf recovery rate of 4.75%.

INTRODUCTION

Waai Village is one of the coastal water areas where there are seagrass communities that directly or indirectly contribute to the local community as users of the area. Waai Village has a fairly large seagrass bed supported by a type of sandy substrate that is suitable for the growth of sea grass. Seagrass ecosystems have an important role in the ecology of coastal areas, because they are the habitat of various marine biota including feeding ground for green turtles, dugongs, fish, echinoderms and gastropods [1]-[2]. Economically, seagrass can be used as food, animal feed, paper raw materials, craft materials, fertilizers and medicinal materials [3].

The total area of seagrass beds in Indonesia was originally estimated at 30,000 square kilometers, but has shrunk by about 30-40% [4]. Damage to seagrass ecosystems is generally caused by human activities in coastal areas such as development activities, dredging, coastal reclamation and fishing activities using fishing gear that are not environmentally friendly. Lack of information and low understanding of the community about seagrass ecosystems and their ecological functions, causes this potential ecosystem to be neglected and results in damage or degradation of seagrass ecosystems.

One of the efforts to restore seagrass ecosystems is by transplanting. Broadly speaking, seagrass transplantation methods in Indonesia are divided into two, namely seagrass transplantation without anchors and seagrass

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transplantation using anchors [5]. Some methods of planting seagrass without anchors are turfs, plugs and seeds. The sprig anchored method is a transplant method by taking plant seeds without a substrate using a knife which is then transplanted to a new location [6].

Research and development of seagrass transplantation methods is needed to produce environmentally friendly seagrass transplantation techniques. The modification method "turf TERFS modification" is a combination of the plug method and the sprig anchored method where seagrass is taken from the donor area and its substrate (turf method) then the seagrass seedlings are tied to an iron frame and planted in the transplant area using a combination of substrate from the donor area with the substrate in the transplant area (TERFS method). *Enhalus acoroides* was chosen as the seagrass species used in this research activity because the population is easy to find, has a large size and has a higher survival ability compared to other seagrass species. The purpose of this study was to determine the survival rate, growth rate, biomass, production and recovery rate of *Enhalus acoroides* seagrass leaves transplanted using the “TURF TERFS modification” method in the coastal waters of Waai Village, Central Maluku Regency.

EXPERIMENT

Research Time and Location

This research was conducted in February 2019 – May 2019 during the western season in the coastal waters of Waai Village, Central Maluku Regency. Astronomically, Waai Village is at the position of 03º29'5" South Latitude - 03º58'2" South Latitude and 128º29'5" East Longitude - 128º3'9" East Longitude (Figure 1). This research was conducted in the coastal waters of Waai with sandy substrate conditions. During the research process, measurements of temperature, pH, and salinity as environmental factors that support seagrass growth were carried out

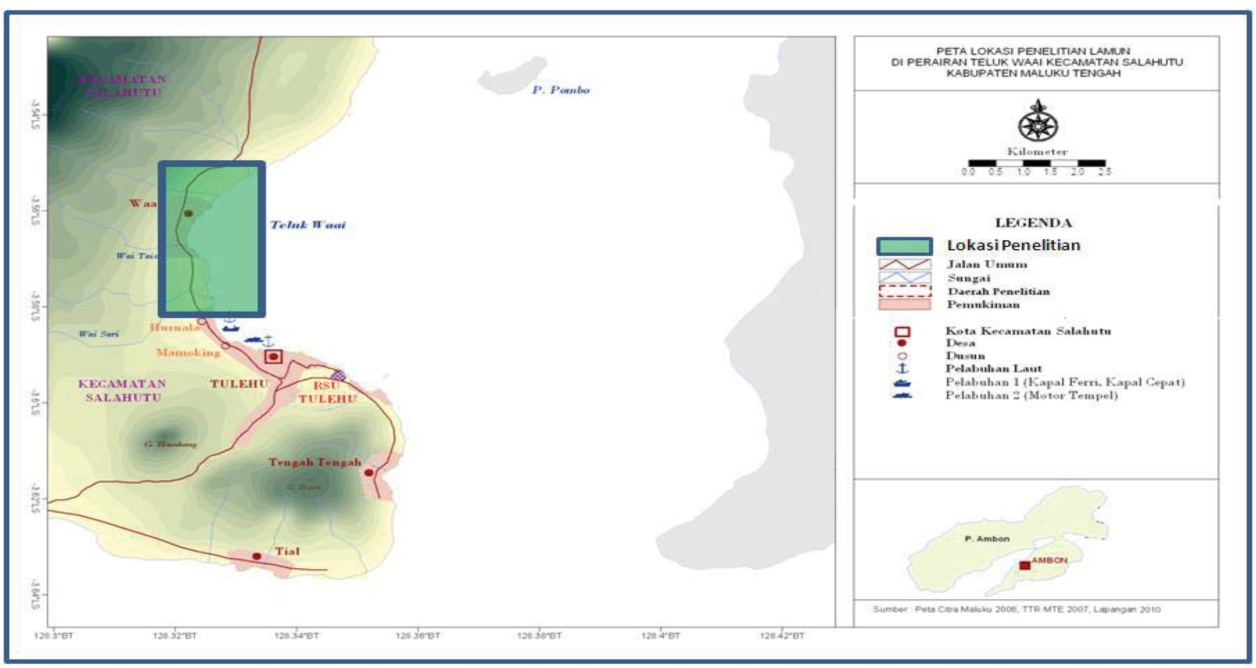

FIGURE 1. Research Location Map

Instruments and Materials

The tools used are iron frames measuring 1.5 m x 1.0 m, shovels, anchors measuring 15 cm and 30 cm, baskets, net cages, staplers, raffia ropes, cloth meters, ovens, digital scales, sample bottles, pipettes, hand refractometer, pH meter, DO meter, spectrophotometer. The materials used are sample bags, aquades, tissue, seagrass *Enhalus acoroides*.

Work Procedures

Selection of donor site and transplant site

The selection of sites for donors was determined based on the presence of a healthy population of *Enhalus acoroides* seagrass with indicators of dense and dense seagrass beds. Meanwhile, the selection of the transplant site was carried out through interviews with the surrounding community and direct surveys to the study site by considering the history of the presence of seagrass, the distance from the coastline and the range of human activities as well as the cleanliness of the transplant site. The donor site in this study is 58 meters from the transplant site.

Seed Selection and Handling

Seedlings of *Enhalus acoroides* seagrass from the donor site were taken as many as 30 stands at low tide conditions, but still in a waterlogged condition. Seagrass seedlings are taken using a shovel, cleaned of dirt that sticks and then put in a basket container but still in the water. The selected *Enhalus acoroides* seagrass seeds must have 4 leaves, rhizome length of 15 cm and leaf length of 30 cm.

Seagrass Transplant Using "TURF TERFS Modification" Method

Before planting, the seagrass leaves were perforated with a stapler which was 10 cm from the base of the leaf for the purposes of measuring the increase in leaf length for 3 weeks of observation which would be used in the growth rate analysis. Furthermore, 30 seagrass seedlings that have been tagged and labeled are tied to an iron frame measuring 1.5 mx 1 m using raffia rope then the roots and rhizomes are planted in holes previously dug 30 cm deep, of which 15 cm is filled with substrate from the donor site and 15 cm is filled with substrate from the transplant area. On each side of the frame is given iron pegs so that the iron frame does not drift away by the current Seagrass maintenance during the transplantation process is carried out in a net cage measuring 4 m x 4 m which aims to prevent predators or physical factors of the water, such as currents or waves. After 3 weeks of observation, the selected seagrass leaves were cut and cleaned from the substrate and attached biota then put into bags to be dried and weighed in the laboratory to be used for biomass, production and leaf recovery.

Data analysis

Analysis of the survival rate of seagrass using the formula [7] :

$$SR = \frac{Nt}{No} \times 100\%$$

Where
SR = Survival rate (%)
Nt = Number of transplant units at time t (months)
No = Number of transplant units at the start

Leaf growth rate and leaf biomass using the formula [8] :

$$P = \frac{Lt - Lo}{\Delta t} \qquad and \qquad B = \frac{W}{A}$$

Where
P = Growth rate of leaf length (cm)
Lt = Length of the final seagrass leaf after time t (cm)
Lo = Seagrass leaf length at the initial measurement (cm)
Δt = Measurement time interval (days)
B = Biomass of seagrass leaves (g/m^2)
W = Dry weight of seagrass leaves (gram)
A = Area (m^2)

Analysis of production and leaf recovery speed refers to the formula [9]:

$$P = \frac{B}{t} \qquad and \qquad KP = \frac{P}{B} \times 100\%$$

Where :

P = Production of seagrass leaves ($g/m^2/day$)
B = Biomass of seagrass leaves (g/m^2)
T = Time (days)
KP = Seagrass leaf recovery speed (%)

RESULTS AND DISCUSSION

Enhalus acoroides Survival Rate

The survival rate of *Enhalus acoroides* is the ability to survive without dying during the study period expressed in percent (%). *Enhalus acoroides* transplanted using the TERFS modification turf method had a survival rate of 86.67%. This decrease was due to the decrease in seagrass stand units due to the seagrass being uprooted or detached from the iron frame caused by the water currents in the form of strong waves considering that the study was carried out during the transition period from the west season to the east season. In March to May and September to November there is a transition season, where in this season the movement of surface currents is irregular [10]. In these seasons the wind speed and direction varies and in certain periods, the wind speed is very large to generate strong waves and currents [11]. Conditions with strong currents and waves can cause the transplanted seagrass material, especially the rhizome and roots to be uprooted from the bottom of the substrate. The decrease in the number of transplanted seagrasses that live occurs due to the influence of aquatic environmental conditions including water currents, substrate and depth of seagrass roots that sink into the substrate, the influence of seasonal patterns and aquatic environmental conditions that do not support the growth of transplanted seagrasses [12].

Enhalus acoroides Leaf Growth Rate

The average growth rate of *Enhalus acoroides* leaves transplanted using the TERFS modification method was 0.884 cm/day. This high value is related to the high percentage of sediment grain size in the form of gravel and mud as well as the phosphate and nitrate content of the sediment considering that the substrate used is a combination of substrate from the donor area and the transplant area. In the turf TERFS modification method, the roots and rhizomes of seagrass are embedded in the bottom substrate of the water so that the nutrient absorption process is more optimal because there are no barriers. The growth rate of seagrass leaves is related to the increase in the average leaf length, meaning that the longer the leaves of the seagrass, the higher the growth rate at the same time (Figure 2).

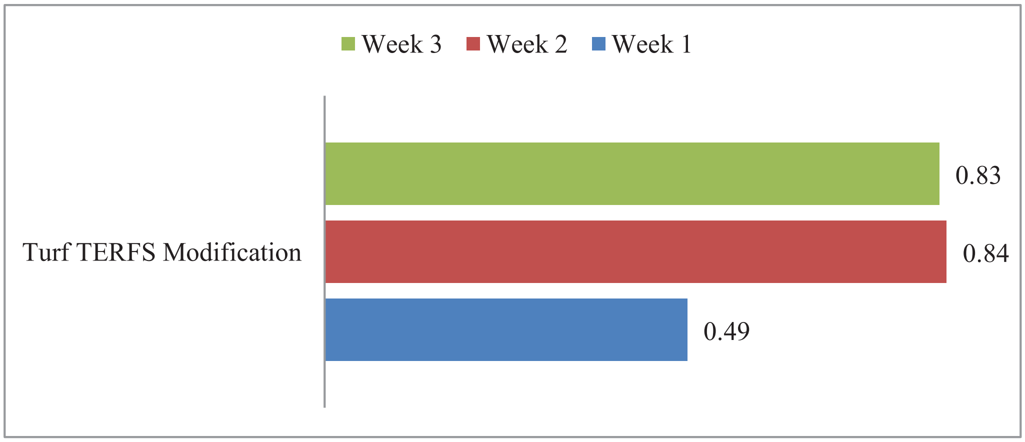

FIGURE 2. Graph of Average Growth Rate of Leaves *Enhalus acoroides* (cm/day)

Figure 2 shows that in the first week of observation (7th day), *Enhalus acoroides* leaves did not show a significant growth rate (0.49 cm/day). This is because at the beginning of planting the seagrass leaf is tagged, so from the beginning of planting until the first week of observation, this seagrass plant must carry out a recovery process on body parts that are injured due to tagging and make adjustments in advance to the transplant location as an environment. the new one. Differences in growth rates were caused by leaf cutting at the beginning of planting, resulting in fluctuations in the number of live leaves. After adapting, seagrasses can grow slowly [13].

The first period is a critical period for the transplanted seagrass to try to adapt to its new environment [14]. In the second week of observation (day 14), the average leaf growth rate showed a significant growth rate (0.84 cm/day), considering that the transplanted seagrass plants had begun to adapt to live in their new environment. Meanwhile in the third week (day 21), there was a decrease in the average growth rate of seagrass leaves (0.83 cm/day). This is thought to be related to the increasing age of the seagrass leaves which are getting old with the indicator of the color of the leaves starting to turn yellow so that photosynthetic activity is also reduced and results in decreased growth of seagrass leaves. Photosynthetic activity will decrease as the leaves get older [15]. Thus, the ability to make food or produce organic matter decreases in old leaves so that growth decreases and eventually stops [16].

Enhalus acoroides Leaf Biomass

Seagrass *Enhalus acoroides* transplanted using the TERFS modification turf method had a leaf biomass of 0.400 g/m^2. The high and low biomass of seagrass leaves is closely related to the physical and chemical variables of the coastal waters of Waai Village which were measured during the study, namely temperature, depth, current strength, turbidity, brightness, sediment grain size, pH, salinity, dissolved oxygen content, phosphate and nitrate content, both in the water column and in the sediment. Seagrass ecosystems are limited by several environmental factors, namely temperature, light, salinity, depth, basic substrate, nutrients and sea water movement [17].

Average seagrass biomass ranged from 1 – 1.479 g/m^2 [18]. When compared with the average value of the leaf biomass of *Enhalus acoroides* seagrass in this study, it was relatively small, only 0.400 g/m^2. This is because the growth of transplanted seagrass leaves is lower than the natural growth of seagrass because the energy obtained from the photosynthesis process decreases as a result of adaptation to a different transplant location with the new environment. This causes the temporary photosynthesis process to not run perfectly and will ultimately affect the growth of seagrass leaves. In addition, changes in aquatic environmental conditions are factors that affect the life of aquatic biota, including seagrass [19]. The energy from photosynthesis will temporarily be used to repair plant tissue, after being saturated, the new tissue will perform cell division for the growth of new tissue in the form of the growth of young leaves and old leaves [20].

Production and Recovery Speed of Seagrass Leaves Enhalus acoroides

The production of *Enhalus acoroides* seagrass leaves transplanted using the TERFS modification turf method was 0.019 g/m^2/day while the leaf recovery rate was 4.75%. These results are different from the research conducted by Supriadi (2003) in Barrang Lompo Makassar waters, namely the production of *E. acoroides* leaves of 0.847 ± 0.213 – 1.430 ± 0.223 g/m^2/day while the highest leaf recovery rate was 0.079 leaves/day (7.90%). The low value of these two is due to the seagrass used in this study is a transplanted seagrass that requires an adaptation process to its new environment. The value of leaf production is influenced by the value of growth rate and biomass. Production refers to the observed increase in biomass over a period plus any part lost due to respiration, excretion, secretion, and death as well as from grazing [21]. Seagrass production and biomass are strongly influenced by various factors, especially nutrients and light, species and other water conditions such as water brightness, water circulation, depth, and temperature as well as the type of bottom substrate [22].

The high and low value of the speed of recovery of seagrass leaves is related to the number of new leaves that appear in a certain period of time. Gradual leaf fall begins with the cutting of old leaves little by little. Old seagrass leaves will undergo a natural cutting process before finally falling. Seagrass leaves are generally cut off for two reasons, namely because they are old and because they dry when exposed to sunlight. Generally, the leaves of Enhalus acoroides begin to cut naturally due to aging at the 5th week. Before dying, seagrass leaves transfer their nutrients to leaves that are still actively growing, which is known as the internal cycle [8].

CONCLUSIONS

The use of the TERFs modification method is a modified method resulting from a combination of turf and TERFS methods that affects the survival rate of seagrass (86.67%), growth rate (0.884 cm/day), biomass (0.400 g/m^2), leaf production (0.019 g/m^2/day) and leaf recovery rate (4.75%). These results indicate that the TERFs modification turf method can be recommended in seagrass rehabilitation activities through transplantation as a restoration effort to overcome the decline in the seagrass population of *Enhalus acoroides*.

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