Marine Macrophytes As Bioindicator of Environmental Degradation In Spermonde Archipelago

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Abstract
Macrophyte consists of diverse seagrass, macroalgae and other aquatic plants. These plants have various economic and ecological functions, one of them is as bioindicator of the environmental condition of their habitats. Main constraints affecting macrophyte like seagrass, mangrove and other coastal vegetation are destruction caused by dredging and filling activities, eutrophication, pollution and industrial sewage disposal, oil pollution, seacage aquaculture activities and overfishing. In order to describe the condition of macrophyte based on their habitat naturalness, a study has been done within Spermonde Archipelago. Three islands within Spermonde Archipelago were selected to compare the composition and condition of macrophyte based on their different distances from the mainland. A quadrate transect was deployed to estimate coverage percentage of macrophyte in the selected sites. Results of this study showed that the percentage cover and density of seagrass increased as the distance from the mainland increased. In contrast, the coverage and diversity of macroalgae decreased as the distance from the mainland increased. This suggested that macrophyte assemblages could be used as indicators for environmental impact such as sedimentation and eutrophication.

Keywords: Bioindicator, macrophyte, seagrass, macroalgae, Spermonde

1. Introduction

One abundant marine plant that widely distributed along coastal areas of Indonesia is macroscopic vegetation or macrophyte.

As primary producer in the aquatic environment, macrophyte has significant ecological roles such as increase habitat biodiversity by providing attachment substratum, refugee, and food sources. Therefore, macrophyte acts as nursery ground for diverse marine animals including fish and crustacean. Macrophyte also plays significant role in global carbon and other nutrient cycles (Hemminga dan Duarte, 2000; Krause-Jensen et al., 2006). Macrophyte has strong chemical impact in the aquatic environment (Lee and McNaughton, 2004; Lukacs et al., 2009). Therefore, macrophyte is used as good indicator and integrator of environmental condition (Melzer, 1999; Håkanson and Bryhn, 2008).

In general, this study was aimed to test the role of the aquatic plants (macrophytes) as
biindicator of coastal water condition due to eutrophication stimulated by increasing anthropogenic pressure in the coastal areas.

2. Materials and Methods

Study Site

This study was conducted from June to September 2013 at three islands within Spermonde Archipelago, South Sulawesi i.e. Lae-Lae, Barranglompo and Kapoposang Islands. These three islands have different distances from the mainland (Sulawesi Island).

At each island, three stations were deployed based on their different distances from the shoreline. Station 1 was at the shoreline where the first macrophyte was found. Station 2 was located in the middle, and station 3 was in the outer zone.

Measurement of Water Quality

To determine eutrophication level in the aquatic environment, it was conducted measurement to several related water quality parameters. These parameters were Total Suspended Solid (TSS), Total Nitrates and Total Phosphate. Measurement of these parameters followed Strickland & Parsons (1984).

Ecological Evaluation Index (EEI)

Ecological Evaluation Index (EEI) was designed to estimate ecological status of the transition and coastal waters where benthic macrophytes (seagrass and macroalgae) were used as

Fig. 1. Study sites in Spermonde Archipelago
bioindicator of ecosystem shifts due to anthropogenic pressure, from natural condition of the latest species succession to the degraded state with opportunistic species (Orfanidis et al. 2003).

Change in structure and function of marine ecosystem was evaluated by grouping benthic marine macrophytes into two ecological status groups representing two different ecological status e.g. in natural or degraded areas. Group 1 comprises of all seagrass species and macroalgae with thick thallus or calcareous, slow growth rate and including perennial species with long life cycle (late successional), whereas, Group 2 is represented by macroalgae with sheet-like thallus and filamentous with fast growth rate and annual species with shorter life cycle (opportunistic) and ruderal (Orfanidis et al. 2001; 2003).

Mean abundance of macrophyte in both groups was plotted at a matrix (Figure 1) to determine the ecological status of the areas inhabited by these macrophytes.

![Matrix for ESG I and ESG II](image)

**Fig. 2.** A matrix based on mean abundance ESG to determine the ecological status of the transition and coastal waters (Orfanidis et al. 2001)

### 3. Results and Discussion

Composition and coverage of macrophytes at three islands having different distances from the
mainland of Sulawesi Island showed different assemblages. In Lae-Lae Island macroalgae showed higher coverage compared to seagrass. In this island the only seagrass species found was *Enhalus acoroides*. Opportunistic macroalgae dominated macrophyte assemblages in this island. In contrast, better seagrass condition was observed in Kapoposang Island. In this island, coverage of macroalgae was lower compared to other islands.

In natural seagrass beds, high seagrass coverage usually followed by low macroalgal density with less species, in contrast, in polluted or disturbed habitats, the biodiversity may decreased, however, it will occur particular species having high abundance and biomass (Verheij & Erftemeijer 1993; Sidik *et al.* 2001).

Table 1. Coverage of marine macrophytes (seagrass and macroalgae) each Ecological Status Group(ESG) in Lae-Lae, Barranglompo and Kapoposang Islands

<table>
<thead>
<tr>
<th>Location</th>
<th>Ecological Status Group</th>
<th>Station</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lae-Lae</td>
<td>I</td>
<td></td>
<td>51.25</td>
<td>58.75</td>
<td>45.00</td>
<td>51.67</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td></td>
<td>86.25</td>
<td>96.25</td>
<td>87.50</td>
<td>91.67</td>
</tr>
<tr>
<td>Barranglompo</td>
<td>I</td>
<td></td>
<td>56.50</td>
<td>57.33</td>
<td>55.67</td>
<td>56.50</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td></td>
<td>14.66</td>
<td>50.33</td>
<td>31.67</td>
<td>32.22</td>
</tr>
<tr>
<td>Kapoposang</td>
<td>I</td>
<td></td>
<td>86.50</td>
<td>90.50</td>
<td>87.50</td>
<td>88.17</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td></td>
<td>8.00</td>
<td>5.00</td>
<td>6.00</td>
<td>6.33</td>
</tr>
</tbody>
</table>

Based on the ESG values, it is determined that Lae-Lae Island was categorised as “low”, Barranglompo was “moderate” and Kapoposang Island was “high”. These results suggested that opportunistic macroalgae in eutrophic environments may inhibit seagrass coverage. Some previous studies i.e. Hauxwell *et al.*, 2001 and McGlathery (2001) demonstrated that macroalgae overgrowth may reduce seagrass coverage. Another study revealed that invasion of macroalgae to seagrass beds may reduce seagrass coverage as observed in Mediterranean where shift of seagrass by opportunistic green algae from genus *Caulerpa* caused extensive loss of seagrass beds (Hendriks *et al.* 2009).

Under oligotrophic conditions, increased nutrient loads may initially be beneficial to seagrass community by stimulating primary production, leading to greater secondary production by...
consumers. However, under continued high nutrient loads, algae are superior competitors and their increased abundance can be deleterious to seagrass (Sutula et al., 2011)

**Water Quality**

Average value of Total Suspended Solid (TSS) in Lae-Lae, Barranglompo and Kapoposang were 13.94 mg/L, 11.98 mg/L and 3.98 mg/L, respectively. These values indicated that TSS is higher in island closer to the mainland especially Makassar City. Makassar City is the biggest city in eastern part of Indonesia. There are two estuaries i.e. Tallo and Jeneberang Estuaries that potentially increase the nutrient loads to Makassar Coast including closer islands in western side of Makassar City. In addition, many drainage of urban sewage disposal that ended in Makassar beaches particularly in Losari Beach.

Similar trend was performed by concentration of nitrate and phosphate. Total nitrate in Lae-Lae was ranged between 0.117-0.481 mg/L, 0.035-0.040 mg/L in Barranglompo Island and 0.016-0.019 mg/L in Kapoposang Island. Values of phosphate concentration in Lae-Lae, Barranglompo, and Kapoposang were 0.243-0.039 mg/L, 0.019-0.053 mg/L, and 0.024-0.029 mg/L, respectively.

These three water quality parameter (TSS, nitrate and phosphate) are related to increased anthropogenic activities (Romero et al., 2006).

**4. Conclusion**

This study indicated strong relationship between macrophyte assemblages and eutrophication level as shown in Makassar coastal areas. Opportunistic macroalgae may significantly reduce the seagrass coverage.

**References**


