The composition of reef-associated fishes in Ulee Lheue breakwater Banda Aceh, Aceh, Indonesia

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Abstract. The tsunami of December 26, 2004, damaged Ulee Lheue Port that located in Meuraxa sub-district of Banda Aceh. In the rebuilding of Ulee Lheue Port, the breakwater with a length of approximately 2 km along the coastline of Ulee Lheue, also constructed. Artificial structure in coastal areas such as the breakwater not only crucial for engineering science but also essential for the biological and ecological study. However, the study of marine biodiversity especially reef fishes in Ulee Lheue breakwater is not available until this study. Hence, the present study was aimed to catalog the reef-associated fishes species in Ulee Lheue breakwater. The research was conducted from February to October 2015. The sampling sites were designed by systematic sampling. Sampling sites were located on the outer side and inner side the breakwater with each station spacing of 250 m. The reef fish data were collected using the Underwater Visual Census in 3 meters depth on each station. There were 87 species of reef fishes found in the Ulee Lheue water. This result showed that the construction of artificial structures on the coast is not only crucial in the development of a city but also significant for marine biology and ecology study.

1. Introduction
The Indian Ocean tsunami of 26 December 2004 was one of the most massive tsunamis recorded on the coasts of Indian Ocean and the Bay of Bengal [1-4]. The tsunami damaged nearly the entire coast of Aceh Province including its beaches, dunes, tidal creeks, river channels, coral reefs, mangroves, seagrass beds, coastal vegetation, aquaculture farms, and human settlements, including its capital city Banda Aceh [2, 5-7]. Banda Aceh is located between 05°16’15”– 05°36’16” North Latitude and 95°16’15”– 95°22’35” East Longitude with an average of altitude above sea level 0.80 meter. The tsunami damaged nearly two-thirds of the city, measuring 9 m high and reaching as far as 5 km inland [7-10]. In addition, JICA [7] reported that the population in Banda Aceh was reduced from 263,669 to 192,194 inhabitants following this catastrophe. Also, the tsunami washed away thousands of buildings and most of the urban infrastructure including roads, electricity, water supply, telecommunication networks including Ulee Lheue Port. Community services such as education, health, and public transportation were all also interrupted [11].

The Ulee Lheue Port is the most vital seaport in Banda Aceh. Many ferries have used this port to connect Banda Aceh and Sabang as well as some nearby islands. Before the tsunami, Ulee Lheue region was one of the areas that had diverse marine ecosystems. This area has unique coastal...
vegetation and coral reefs ecosystem. However, the region was destroyed, and most of the land was submerged due to the tsunami on 26 December 2004 [12]. One year later, the Ulee Lheue Port was rebuilt by the Rehabilitation and Reconstruction Agency (BRR) and the structure was completed in 2009. During the construction, approximately two (2) km mountain rocks breakwater along the port coastline Ulee Lheue were also constructed. Artificial structures built in coastal areas such as the breakwater in Ulee Lheue are not only vital for the development of engineering but also essential for biological and ecological science. The jetty can create a new habitat for marine biota including coral reefs and reef-associated fishes. Bulleri and Chapman [13] reported that the seawall built on the northern coast of Italy became a new habitat for some aquatic biota living in the area. Until this study, research on marine diversity including reefs fishes in the Ulee Lheue breakwater has never been carried out.

Marine biodiversity data including an accurate species list of reefs fishes is one of the baseline data that must be owned by Banda Aceh city especially in developing their fisheries management plan. A well managed marine resources, for example, a good coral reefs ecosystem may provide very significant ecology services and provide economic impacts directly to coastal communities. For Indonesia itself, coral reefs offer benefits of 1.6 million US dollars per year both through fisheries, pharmaceuticals, trade in ornamental fish and corals, tourism and so on [14]. Not to mention the benefits that cannot be assessed with money, including as a place for recycling nutrients, providing food, protected areas and spawning of fish and various other marine organisms [15]. Therefore, the present study aimed to inventory the reefs fishes in the Ulee Lheue breakwater.

2. Materials and Method
This research was carried out from February to October 2015. The study was conducted at the Ulee Lheue breakwater. The sampling sites were designed by systematic sampling covered the outer side and inner side of Ulee Lheue breakwater with each station spacing of 250 m (Figure 1). The outer side of Ulee Lheue breakwater was dominated by the new coral reefs colonies that grew after the tsunami, while, the inner side was an area dominated by sandy mud substrate. The reef fish data were collected using the Underwater Visual Census in 3 meters depth on each station[16]. The fishes were identified and recorded based on Allen and Adrim [17] and Kuiter [18].

![Figure 1. Map of the study sites.](image-url)
3. Result and Discussion
In total, 87 species in 28 families were found in the study sites (Table 1). Chaetodontidae (29%), Caesionidae (18%), Carangidae (15%) and Acanthuridae (15%) were the common fish family found in the outer side of Ulee Lheue breakwater, respectively (Figure 2), while Gobiidae (24%) followed by Acanthuridae (15%) and Caesionidae (10%) were the dominant fish family found in inner side (Figure 3). The composition and species found in this study are comparable with the findings of [19]. They found Acanthuridae, Serranidae, Labridae, and Chaetodontidae were the common fish family in the coral reefs ecosystem in Aceh.

Chaetodontidae is a group of fish that can be used as indicators of the health of the coral reef ecosystem. An area with high coral cover is very likely to be inhabited by more Chaetodontidae compared to regions with lower coral cover [20]. The majority species of Chaetodontidae are corallivory both as obligate or facultative corallivores and most species preferentially consuming corals of the genus Acropora and Pocillopora [21]. These two coral genera were the dominant coral genus found in the outer side of Ulee Lheue breakwater. In addition, Acanthuridae is a group of fish that are known to consume algae (herbivores) and to provide new site for the coral larva to settle [22]. By contrast, the inner side of Ulee Lheue breakwater was an area dominated by sandy mud substrate which is a favorable habitat for Gobiidae. Gobies are benthic or bottom-dweller fish, and most of them live in sandy mud substrate [23].

The higher number of fish species found in this study indicate that the development of artificial structures on the coastal area such as Ulee Lheue breakwater is not only crucial in the development of a city but also important for the biology and marine ecology study. The breakwater generating a new habitat for coral reefs and providing shelter as well as food for reef-associated fish. The existence of reef fish had a firm relationship with the condition of coral reefs. In Weh Island, for example, the abundance of coral reef fishes were higher in a location that has "good" and "excellent" coral cover [24]. Generally, in Aceh, sites that had good or excellent coral conditions were found in marine protected areas [25].

Beside its function in protecting the coastal area, Ulee Lheue breakwater also becomes a favorite fishing spot in Banda Aceh. Hundreds of recreational fishers are fishing in this area mostly during the weekend. Without a comprehensible base fisheries management plan, there is a possibility that reef fish catches in this area will be overfished. The results of the present study provide the baseline data of the fish and may contribute to better management of fisheries in this area. In addition, the results of this study also can be used to promote the public awareness in saving coral reefs ecosystem in Ulee Lheue breakwater. Coral transplantation project in Weh Island, for example, had raised public awareness in protecting coral reefs [26].

Table 1. List of reef fish species found in Ulee Lheue breakwater

| No | Species                        | Sites                                   |
|----|--------------------------------|-----------------------------------------|
|    |                                | Outer site                              | Inner site                              |
|    |                                | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 | Site 7 | Site 8 | Site 9 | Site 10 |
| 1  | Acanthurus lineatus            | -      | -      | -      | +      | -      | -      | -      | -      | -      | -       |
| 2  | Acanthurus leococsteron        | -      | -      | -      | -      | +      | +      | +      | +      | +      | +       |
| 3  | Acanthurus auranticavus        | -      | -      | -      | -      | -      | +      | -      | -      | -      | -       |
| 4  | Acanthochromis polyacanthus   | -      | -      | -      | -      | +      | -      | -      | -      | -      | -       |
| 5  | Acanthurus blocii              | +      | +      | +      | -      | +      | -      | -      | -      | -      | -       |
| 6  | Acanthurus leococsteron        | -      | -      | -      | -      | -      | +      | -      | -      | -      | -       |
| 7  | Acanthurus auranticavus        | +      | +      | +      | -      | -      | -      | -      | -      | -      | -       |
| 8  | Acanthurus lineatus            | +      | +      | +      | -      | -      | +      | +      | +      | +      | +       |
|   | Species                                    |   |   |   |   |   |   |
|---|--------------------------------------------|---|---|---|---|---|---|
| 9 | Acanthurus tristis                         | - | + | - | - | - | - |
| 10| Amblyglyphus semicinctus                   | - | - | + | + | - | - |
| 11| Apogon nigrocinclus                        | - | + | - | - | - | - |
| 12| Apogon termalis                            | - | + | - | - | - | - |
| 13| Asterosemipunctatus                        | + | + | - | - | - | - |
| 14| Aulostomus chinensis                       | + | - | - | - | - | + |
| 15| Balistapus undulatus                       | - | - | - | - | - | + |
| 16| Caesio xanthonata                          | - | - | - | - | + | - |
| 17| Caranx ignobilis                           | - | + | - | + | + | + |
| 18| Caranx melampygus                          | - | - | - | - | + | - |
| 19| Centropyge eibli                           | - | - | - | - | - | + |
| 20| Chaetodon andamanensis                     | - | + | - | - | - | - |
| 21| Chaetodon citrinellus                      | - | - | - | - | + | - |
| 22| Chaetodon collare                          | - | - | - | - | + | - |
| 23| Chaetodon decussatus                       | + | + | - | - | - | + |
| 24| Chaetodon falcula                          | - | - | - | - | - | - |
| 25| Chaetodon lunula                           | - | - | - | - | + | - |
| 26| Chaetodon lunulatus                        | - | - | - | - | + | - |
| 27| Chaetodon meyeri                           | - | - | - | - | + | - |
| 28| Chaetodon rafflesii                        | - | - | - | - | - | + |
| 29| Chaetodon trifascialis                     | - | + | - | - | + | + |
| 30| Chaetodon striatus                         | - | - | - | - | + | - |
| 31| Chelmon rostratus                          | - | + | - | - | - | - |
| 32| Chromis amboinensis                        | - | - | - | - | + | + |
| 33| Chromis dimidiata                          | - | - | - | - | + | + |
| 34| Chromis viridis                            | - | + | - | - | - | - |
| 35| Chrysiptera uninaculata                    | - | - | - | - | + | - |
| 36| Cryptocentrus leptocephalus                 | - | - | - | - | + | - |
| 37| Dasyxius carneus                           | - | - | - | - | + | + |
| 38| Diadon hystric                             | - | + | - | - | - | + |
| 39| Epinephelus coioides                       | - | + | - | - | - | - |
| 40| Gnatholepis anjerensis                     | - | - | + | - | - | - |
| 41| Gymnotherax javanicus                      | - | - | - | - | - | - |
| 42| Halichoeres binotopsis                     | - | - | - | - | - | - |
| 43| Halichoeres hotulans                       | - | - | - | - | - | - |
| 44| Halichoeres lamarii                        | - | - | - | - | - | - |
| 45| Heniochus varius                           | - | - | - | - | - | - |
| 46| Labroides dimidiatus                       | - | - | - | - | - | - |
| 47| Leiognathus fuscatus                       | - | - | - | - | - | - |
| 48| Latijanus ehringerii                       | - | - | - | - | - | - |
| 49| Latijanus fulvus                           | - | - | - | - | - | - |
| 50| Latijanus kasymra                          | - | - | - | - | - | - |
| 51| Latijanus sanguineus                       | - | - | - | - | - | - |
| 52| Latijanus russelli                         | - | - | - | - | - | - |
| 53| Melichthys indicus                         | - | - | - | - | - | - |
| 54| Monodactylus argenteus                     | - | - | - | - | - | - |
| 55| Mugil cephalus                             | - | - | - | - | - | - |
| 56| Mulliodichthys vanicolensis                | - | - | - | - | - | + |
| 57| Myripristis hexagona                       | - | - | - | - | - | - |
| 58| Neopomacentrus azysron                     | - | - | - | - | + | + |
| 59| Neopomacentrus taeniatus                   | - | - | - | - | + | + |
| 60| Paracanthurus hepatus                      | - | - | - | - | + | + |
| 61| Parapercis hexoplalma                      | - | - | - | - | + | + |
| 62| Parupenius macronema                       | - | - | - | - | + | + |
|   | Species                        | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 |
|---|-------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|   | Pempheris vanicolensis        | -  | -  | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Platax teira                  | +  | -  | -  | -  | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Plectopromus maculatus        | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Plectorhinchus chaetodonoides | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Plectorhinchus gibbosus        | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Plectorhinchus vittatus       | -  | +  | +  | -  | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Plectroglyphidodon dickii     | -  | -  | -  | -  | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Pteroecaio tile               | -  | -  | -  | -  | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Rhinecanthus verrucosus      | -  | -  | -  | -  | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Scolopsis ciliatus            | +  | +  | +  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Siganus canaliculatus         | +  | +  | +  | +  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Siganus guttatus              | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Siganus javus                 | -  | -  | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Siganus vermiculatus          | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Syngnathus cyanospilos        | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Thalassoma hardwicke          | -  | -  | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Thalassoma janseni            | -  | -  | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Thalassoma lunare             | -  | -  | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Upeneus tragula               | -  | +  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Upeneus vittatus              | -  | +  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Valenciennesa parva           | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Zanclus cornatus              | +  | +  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |
|   | Zebrasoma scopas              | -  | -  | -  | -  | -  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |   |

**Note:** (+) = found, (-) = not found.

**Figure 2.** The composition of reef fishes found in the outer site of Ulee Lheue breakwater
4. Conclusions
In total, 87 species in 28 families were found in the study sites. These findings indicate that the development of artificial structures on the coast is not only crucial in the development of a city but also crucial for the world of biology and marine ecology.

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