

## Condition of coral reefs in East Belitung, Bangka Belitung Islands, Indonesia

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**Abstract.** Belitung Island has abundant fishery resources. In terms of the coastal ecosystem, Belitung Island has three crucial components, namely the mangrove, seagrass, and coral reef ecosystems. The purpose of the present study is to examine the diversity of coral reefs in the coastal areas of the eastern part of Belitung Island. Sampling locations are in Pekandis Island, Gosong Semut, and Keran Island. The results show that the diversity of coral reef in this region is medium based on the Shannon-Wiener Diversity Index. High evenness of species distribution and no dominant species was indicated. This study concludes that coral reef in East Belitung was not affected by external factors at the time of study, but new studies are needed.

**Key Words:** coral condition, coral coverage, coral diversity, GIS analysis, *Scleractinia*.

**Introduction.** The eastern part of Belitung Island presents a variety of coastal ecosystems (mangrove, seagrass, and coral reef ecosystems). Belitung Island and a few small islands surrounding it have a relatively high biodiversity (Johan et al 2015). However, the high exploitation of tin mining in Bangka Belitung Islands can increase the threat to coastal resources (Nurtjahya et al 2017). The coral reef ecosystem in Bangka Belitung Islands is in a critical condition because of the impact of anthropogenic activities, especially sedimentation caused by tin mining (Siringoringo & Hadi 2013; Putra et al 2018). Besides the natural factors that affect coral growth and development, the impact of sedimentation processes can also damage coral reefs. The mangroves, seagrass beds, and shallow coral reefs appear to be the main nursery biotopes for the juveniles of the different water organisms (Nagelkerken et al 2002).

The location of Belitung Island is near Bangka Island, which also has a problem with mining activity (Siringoringo et al 2006; Siringoringo & Hadi 2013, 2015). The study location (i.e., Pekandis Island, Gosong Semut, Keran Island) is situated in the Subdistrict of Kelapa Kampit. The islands are directly facing the Pering Bay area, which is the border between Kelapa Kampit and Damar Subdistrict. The marine ecosystems in this area are interesting because the islands are surrounded by many of offshore tin mining businesses (issued by the local government of East Belitung). The condition of coral reef ecosystems, especially at Pekandis Island, can become critical.

Several researchers have studied coral reefs in Bangka Belitung Island, with even a recent report by Putra et al (2019). However, information about coral diversity in Belitung Island and the small islands surrounding it is still scarce. This present study aims to present the condition and diversity of a coral reef in the eastern part of Belitung Island, Bangka Belitung Islands, and adds new information, completing previous studies.

## Material and Method

**Study location.** This study was conducted in the coastal waters of East Belitung Regency, Belitung Island, in November 2012, in three places (i.e., Pekandis Island, Keran Island, and Gosong Semut) (Figure 1). The coordinates of the sampling sites are presented in Figure 1.

**Coral reef survey.** The coral survey was carried out using SCUBA diving. Line Intercept Transect (LIT) method was used for the observation (English et al 1997) of a fifty-meter-long transect line layed parallel to the coastline at 4-5 m depth (Hill & Wilkinson 2004). The coral colony was counted and identified to the lowest taxonomy level on sites based on Veron et al (2016), and updated following taxonomic revisions (Hoeksema & Cairns 2019).

**Data analysis.** The Shannon-Wiener Diversity Index ( $H'$ ), Simpson's Dominance Index ( $D$ ), and Evenness Index ( $E$ ) were determined (Krebs 1985). The coral reef area was calculated using a geographic information system (GIS) analysis from the Indonesian Basic Map provided by Badan Informasi Geospasial (BIG) Indonesia. The geometric correction was carried out with Google Maps (2012) comparisons. The digitized reef area on the map was considered as a shallow-water habitat with coral reefs. The extent of coral reefs (hectares,  $m^2$ , or  $km^2$ ) was calculated with geographical calculation tools in Arc-GIS software.

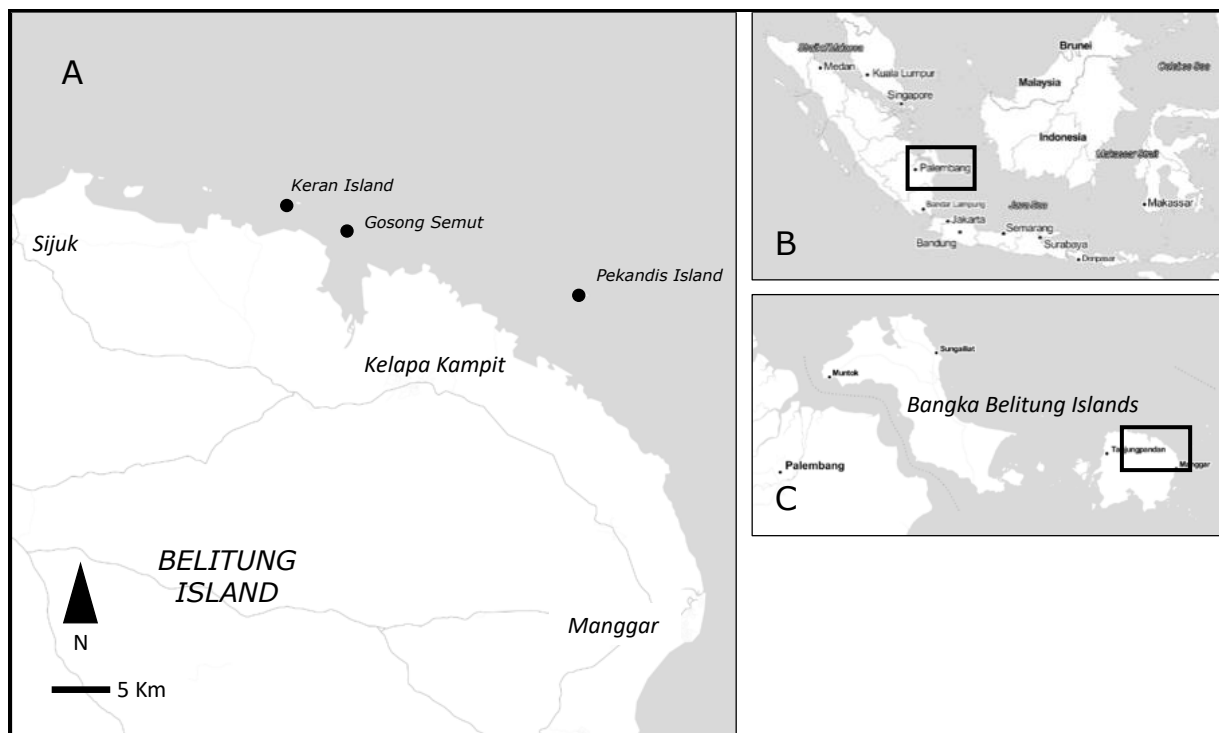


Figure 1. Map of study location. A - location of sampling sites; B - location of Bangka Belitung Islands; C - location of Belitung Island. Sampling site coordinates: Pekandis Island ( $02^{\circ}37'06.7''S$   $108^{\circ}12'10.4''E$ ); Gosong Semut ( $02^{\circ}34'03.8''S$   $108^{\circ}01'23.3''E$ ), and Pekandis Island ( $02^{\circ}32'57.0''S$   $107^{\circ}58'40.1''E$ ).

## Results and Discussion

**Coral reef diversity.** The coral reef ecosystem was found in all sampling sites. In 2012, Putra et al (2019) reported coral reef in these locations was in poor to excellent condition

(Gosong Semut 21.56%, Keran Island 55.17%, and Pekandis Island 76.27%). The high level of coral cover is relevant to the excellent natural condition of the area in Pekandis and Keran Island. Those locations are far from the mainland and, thus, more spared from sedimentation, runoff, and anthropogenic activities. The coral mortality index was also high in the location where the coral cover was low. Coral diversity calculated shows medium diversity (1.89-2.44). No dominant species were indicated ( $D < 0.5$ ), with a high evenness index (Table 1). This value shows that the coral reefs were not pressured by external factors.

A total of thirty-five species from six families of hard corals (Scleractinia) were found in this location. The family of Acroporidae was found dominantly, consisting of 22 species (Putra et al 2019). Some of the coral species generally found in study location are *Acropora millepora* and *Porites lutea*. The most abundant species is *Montipora turtlensis*, found in 17 colonies in Keran Island. Uncommon corals species were also found, such as *Tubastrea faulkneri*, *Lithophyllon undulatum*, *Pectinia alcornonis*, *Oulastrea crispata*, *Goniopora eclipsensis*, and *Porites eridani* (Table 2). Putra et al (2019) estimated about 22 species are considered as new records from their study.

This result shows that corals are relatively healthy. There are many algae in some spots, and corals are not in a relatively high distribution because there are areas with a sand substrate not covered by corals. The competition between hard corals and macroalgae is a critical ecological process in coral reefs, especially during reef degradation, which often involves a 'phase-shift' from coral to algal dominated reefs (Jompa & McCook 2003). Also, this competition is essential to the structure of coral reef communities. Widespread replacement of coral by algae may often indicate coral mortality due to external disturbances, rather than competitive overgrowth. It may lead to competitive inhibition of coral recruitment, with consequences for reef recovery (McCook et al 2001).

In this region, many different species of reef fish were reported (survey in 2012 by Akbar et al 2018), and typical biota was also found, like giant clams (*Tridacna* spp.). This condition indicates that fishing activity was rare. Blast fishing produced no local reduction in coral recruitment. Live hard coral cover increased in oligotrophic reefs, indicating the potential for coral recovery if managed effectively (Sawall et al 2013).

Table 1

Diversity of coral reef at Eastern Belitung, Bangka Belitung Islands

<i>Abundance, Richness and Biodiversity Index</i>	<i>Pekandis Island</i>	<i>Gosong Semut</i>	<i>Keran Island</i>
Abundance (N=226)	29	35	38
Species Richness (S=35)	11	17	12
H'	2.01	2.44	1.89
D	0.18	0.13	0.24
E	0.84	0.86	0.76

Note: H' - Shannon-Wiener diversity index (DI); D - Simpson's dominance index (SDI); E - evenness index (EI).

**Coral reef coverage.** The boundary of marine areas between the two districts is quite challenging to distinguish, because of the unavailability of a 'Map of Sea Boundaries' between sub-districts, making it difficult to calculate the extent of each sub-district. The shallow coral reef habitat region is divided into three major zones or polygons. Based on the analysis results, the total area of coral reef ecosystems in both sub-districts is 1507.12 ha. This area accounted for 16% of the total area of 9452.2 ha of the coral habitat of East Belitung Regency (Dinas Kelautan dan Perikanan 2011). The result of the calculation is presented in Figure 2 and Table 3.

Table 2

Presence or absence of coral species in Eastern Belitung, Bangka Belitung Islands

<i>Corals species</i>	<i>Pekandis Island</i>	<i>Gosong Semut</i>	<i>Keran Island</i>
<i>Acropora acuminata</i> (Verrill, 1864)	+		
<i>Acropora clathrata</i> (Brook, 1891)		+	
<i>Acropora cytherea</i> (Dana, 1846)	+		+
<i>Acropora digitifera</i> (Dana, 1846)			+
<i>Acropora donei</i> (Veron & Wallace, 1984)		+	
<i>Acropora humilis</i> (Dana, 1846)			+
<i>Acropora hyacinthus</i> (Dana, 1846)	+		
<i>Acropora kimbeensis</i> Wallace, 1999			+
<i>Acropora latistella</i> (Brook, 1892)			+
<i>Acropora millepora</i> (Ehrenberg, 1834)	+	+	+
<i>Acropora muricata</i> (Linnaeus, 1758)		+	
<i>Acropora robusta</i> (Dana, 1846)	+	+	
<i>Acropora tenuis</i> (Dana, 1846)	+	+	
<i>Acropora valenciennesi</i> (Milne Edwards, 1860)	+		
<i>Coelastrea palauensis</i> (Yabe & Sugiyama, 1936)		+	
<i>Euphyllia glabrescens</i> (Chamisso & Eysenhardt, 1821)		+	
<i>Favites halicora</i> (Ehrenberg, 1834)			+
<i>Goniopora eclipsensis</i> Veron & Pichon, 1982	+		
<i>Isopara palifera</i> (Lamarck, 1816)	+	+	
<i>Lobophyllia costata</i> (Dana, 1846)		+	
<i>Lobophyllia radians</i> (Milne Edwards & Haime, 1849)		+	
<i>Montipora aequituberculata</i> (Bernard, 1897)		+	
<i>Montipora danae</i> (Milne Edwards & Haime, 1851)			+
<i>Montipora flabellata</i> (Studer, 1901)		+	
<i>Montipora floweri</i> (Wells, 1954)			
<i>Montipora foliosa</i> (Pallas, 1766)			
<i>Montipora peltiformis</i> (Bernard, 1897)			
<i>Montipora turtlensis</i> (Veron & Wallace, 1984)			+
<i>Pavona decussata</i> (Dana, 1846)		+	
<i>Platygyra acuta</i> (Veron, 2000)		+	
<i>Pocillopora grandis</i> (Dana, 1846)	+		
<i>Porites attenuata</i> (Nemenzon, 1955)		+	
<i>Porites eridani</i> (Umbgrove, 1940)			+
<i>Porites harrisoni</i> (Veron, 2000)			+
<i>Porites lutea</i> (Milne Edwards & Haime, 1851)	+	+	+

Note: results in accordance with and partially reported by Putra et al (2019).

The extent obtained from the digitized results on the BIG Indonesia map is the minimum extent, based on the results of ground checks conducted by the coral reef inventory team in both sub-districts. There are islands and coral reefs that are not covered by the satellite imagery map. Such places are found on Pekandis Island, where there are also coral reef habitats on the slope of the island, which are not covered.

If the coral reef surface is calculated with small coral reef islands that are not covered by the shallow-water map, the contribution of coral reefs to these two sub-districts is predicted to reach 20% of the total of East Belitung Regency. Referring to the results of the Yayasan Terangi study in 2009 on the coral reefs of small islands, in Kepulauan Seribu coral reef average surface is about 20 times bigger than the area of the islands (Estradivari et al 2009). The development of the small islands strongly influenced by the extent of coral reefs (Perry et al 2011). The more damaged the coral reef is, the higher the chances of the island to experience erosion are, culminating with the risk of being submerged.

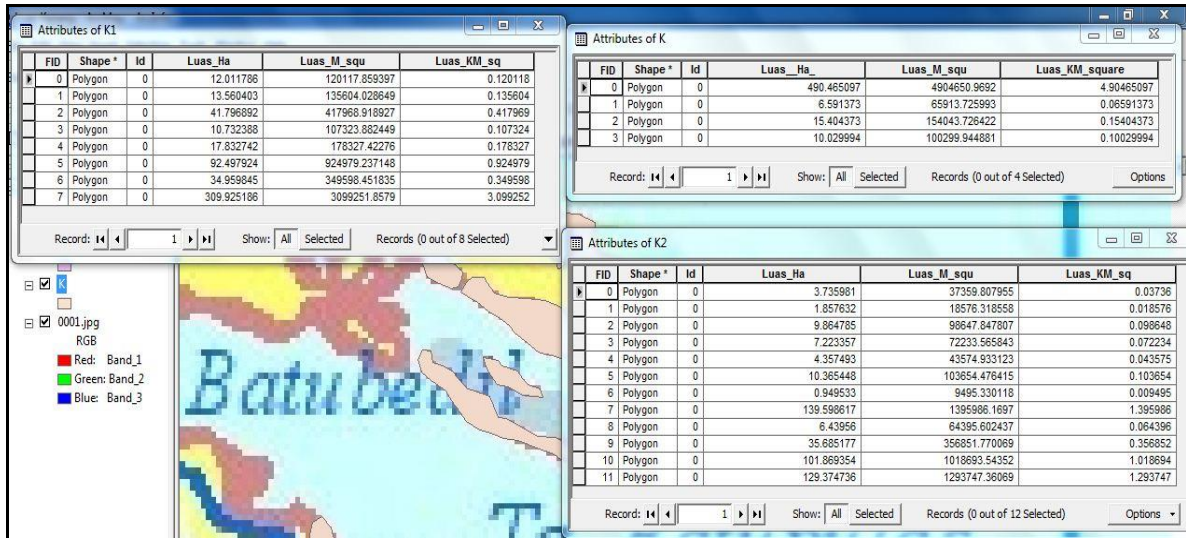


Figure 2. The area of coral reefs using Arc-GIS software.

Table 3  
The extents of coral reef area from GIS analysis in study location

Region	Area of interest	Coral coverage (Ha)
Pekandis Island and surrounding area	Polygon 0	490.4651
	Polygon 1	6.5914
	Polygon 2	15.4044
	Polygon 3	10.0230
	Sum	522.4908
	Gosong Semut and surrounding area	Polygon 0
Polygon 1		13.5604
Polygon 2		41.7969
Polygon 3		10.7324
Polygon 4		17.8327
Polygon 5		92.4979
Polygon 6		34.9598
Polygon 7		309.9252
Sum	533.3172	
Keran Island and surrounding area	Polygon 0	3.7360
	Polygon 1	1.8576
	Polygon 2	9.8648
	Polygon 3	7.2234
	Polygon 4	4.3575
	Polygon 5	10.3564
	Polygon 6	0.9495
	Polygon 7	139.5986
	Polygon 8	6.4396
	Polygon 9	35.6852
	Polygon 10	6.4396
	Polygon 11	129.3747
Sum	451.3127	
Total	1507.1207	

**Conclusions.** The results of this study indicate that the condition of coral reef ecosystems in the study locations is relatively good (at the time of the study). Furthermore, constant monitoring is required to observe the dynamics of the aquatic environment due to anthropogenic activity and new studies are needed.

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