

THE CONDITION OF CORAL REEFS IN WEST BANGKA WATER

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ABSTRACT

Bangka Island is well known as the world's largest tin producer. The inland and offshore tin mining has profound effects on the coastal environment, resulting in the high sedimentation in the water. Many corals suffered physiological damage due to low light intensity. The distribution of stony corals and the status of coral reefs was surveyed at 6 sites in West Bangka waters in October 2012. A total of 72 species of corals belonging to 33 genera and 12 families were found, and 4 species were distributed at all research sites. The live coral coverage was 36% on average and was categorized as being in fair condition. The coverage was 0% at Kamboja Island where the corals were the most affected by tin mining. The sediment flowed out from tin mining, blocked the light, and settled on the corals' surface. Consequently, many corals were buried and the live corals decreased. It is obviously necessary to reduce and control the tin mining.

Keywords: tin mining, coral reefs, sedimentation, West Bangka Water

INTRODUCTION

Coral reefs are highly complex ecosystems with high biodiversity (Medrizam *et al.*, 2004) and play vital ecological and economic roles. The ecological role of coral reefs are as a landscape barrier which can protect the coastline from degradation and provide a “home” for plenty of marine biota. Economically, coral reefs provide a source of income, particularly in fisheries, pharmaceutical and ecotourism sectors, and can be used as a natural laboratory for education (Burke *et al.*, 2002).

Unfortunately, coral reefs are also among the most vulnerable ecosystems in the world (Grimsditch and Salm, 2006). Coral reefs are generally found in areas close to the land which are of shallow depth, making their existence vulnerable to climate change and human activities as well (Buddemeier *et al.*, 2004). (Burke *et al.*, 2002) and Kunzmann (2002), state that 85% of coral reefs in Indonesia had experienced an adverse

effect resulting from human activities and 70% of them were seriously damaged.

Similarly, the condition of coral reefs in West Bangka waters is highly affected by human activities. Tin mining occurring both on the land and offshore influences the water quality, causing the turbidity to be higher. Consequently, the sedimentation is very high, covering the corals' surface and reducing light intensity. The excavation, transportation and disposal of soft-bottom material may lead to various adverse impacts on the marine environment (PIANC, 2010).

Several studies of coral reefs in Bangka waters have been carried out since 2005. Generally, the eastern part of Bangka Island, or around Ketawai Island, has coral reefs in better condition compared to the western part (Universitas Negeri Bangka Belitung, 2013) In the southern part, particularly around Lepar Pongok Island, the condition is categorized as “good” (Muhajir *et al.*, 2010; Siringoringo *et al.*, 2006).

The aim of this study was to obtain general information on both the distribution of stony corals and the status of coral reefs in West Bangka waters. Hence, it is expected that the results will be the basis for Bangka's coastal zone development. The present development programs occurring in Bangka's coastal areas are not supposed to bring more negative impacts to its coastal marine life.

MATERIALS AND METHODS

The field surveys were carried out in October 2012 at six sites, Tanjung Ular (Site 1), Karang

Berang-Berang (Site 2), Karang Haji (Site 3), Teluk Limau (Site 4), Kamboja Island (Site 5) and Pantai Tungau (Site 6). During the investigation, we were using a local boat which was driven by local fisherman (Fig. 1). The observation was conducted at a range of depths between 3 and 14 meters. The corals were monitored with Line Intersect Transect (LIT) (English *et. al.*, 1994) and random sampling methods.

LIT was utilized because of its accuracy up to a centimeter, enabling us to represent the community structure in the terms of percentages of live corals, dead corals, types of the substrates

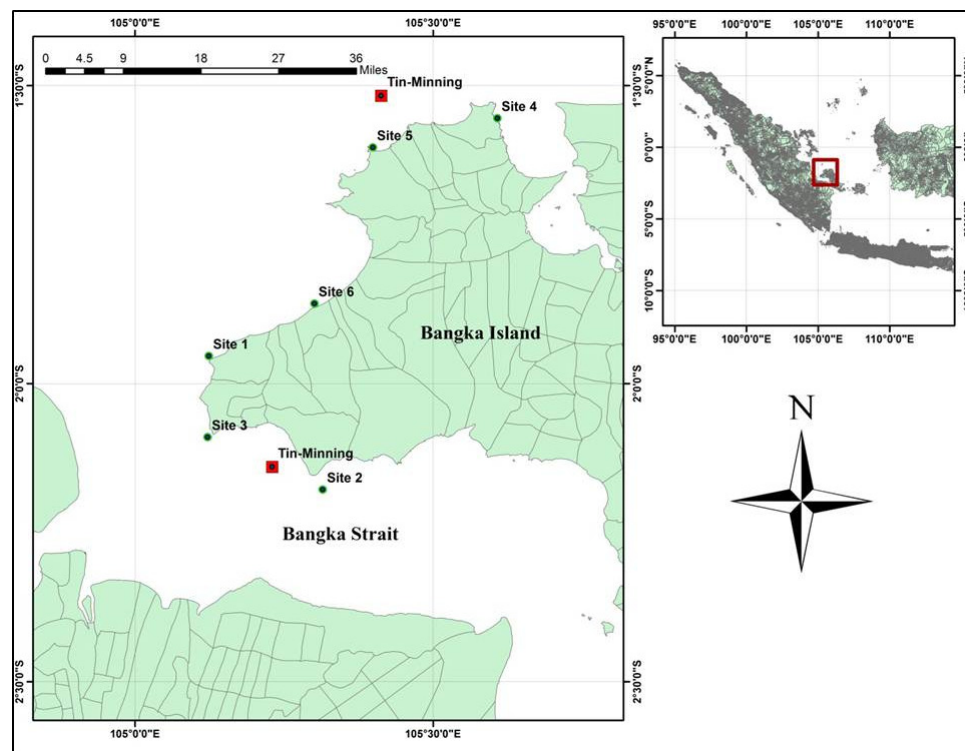


Figure 1. The research sites in West Bangka Waters.

Table 1. Covering percentage of each benthic category and substrate at each research site..

Substratum	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Total live coral	28.7	14.8	33.3	46.0	0.0	21.6
<i>Acropora</i>	1.0	1.0	0.3	2.3	0.0	0.3
Non <i>Acropora</i>	27.7	13.8	32.9	43.9	0.0	21.3
Dead coralline algae	0.0	0.0	0.0	0.5	0.0	0.0
Macroalgae	3.6	3.2	6.0	4.0	0.0	0.0
Soft coral	0.0	2.0	1.0	0.0	0.0	0.0
Sponge	7.9	0.3	1.6	0.0	0.0	5.2
Turf algae	39.9	33.2	42.1	34.1	60.0	42.2
Other organisms	0.0	0.8	2.0	0.0	0.0	0.8
Rubble	0.5	0.0	0.0	0.0	0.0	0.0
Sand	15.4	36.9	13.7	15.2	30.0	28.4
Silt	4.00	8.8	0.4	0.0	10.0	1.7

and the presence of other organisms (English *et. al.*, 1994). The transect was 70 meters in length parallel to the coast line at 5–10 meters in depth. All biota and substrates exactly beneath the line were recorded at 0–10 meters, 30–40 meters and 60–70 meters of the transect. Based on these data, the covering percentage of corals and other benthic categories were evaluated. Moreover, the values of coral diversity index (H') and evenness (J') were calculated based on the LIT data by a program “Primer 5” (Clarke & Warwick, 2001).

Random sampling was also conducted to observe the coastal conditions, such as the vegetation, the length of reef flat, visibility, depth, substrates, the slope angle, general reef condition, other organisms which dominate and associate with corals, and other phenomena.

RESULTS

Environment

The turbidity of the water was very high with visibility ranging from 0.5 to 3 meters. It was higher at sites closer to the river mouths. The beach areas were slightly sloped, mostly covered by white sands, and dominated by coastal vegetations.



a

At Site 4, there were big rocks on the beach, while at the other sites, many patch reefs were found.

Substrates and covering of live corals

LIT showed the covering of live corals ranged from 15% to 46%, with the average at 36% (Table 1) categorized as being in fair condition (Gomez and Yap, 1988). The highest percentage of corals was observed at Site 4, while in contrast hardly any live corals were found at Site 5. Acropora was rare, 0.8% on average. Sponges and macro algae occurred only at some sites and with small percentages. The substrate was mostly dominated by sands and silts, averaging at 23% and 4 %, respectively.

Species composition and diversity of stony corals

There were 71 species of stony corals of 33 genera and 12 families (Table 2). Massive coral were dominant in West Bangka waters. Poritidae, Oculinidae, and Faviidae were abundant and the most diverse families. Nine species of Acroporidae were found (Photo 1a), but they were relatively scarce. Dendrophyllidae is also an abundant family, and, in particular, *Turbinaria peltata* was very abundant (Photo 1b).



b

Photo 1. a. *Acropora* sp., Site 2; b. *Tubastrea faulkneri*, Site 3

Table 2. List of stony coral species at each research site. (+ : Present, - : Absent)

No	Species	Site 1	Site 2	Site 3	Site 4	Site 5
	Number of species	31	17	30	40	24
I	ACROPORIDAE					
1	<i>Acropora humilis</i>	+			+	+
2	<i>Acropora gemmifera</i>	+	+		+	
3	<i>Acropora millepora</i>			+		
4	<i>Acropora tenuis</i>				+	
5	<i>Acropora</i> sp.		+	+	+	
6	<i>Astreopora myriophthalma</i>			+		
7	<i>Montipora</i> sp.			+	+	+
8	<i>Montipora incrassata</i>					+
9	<i>Montipora informis</i>	+				
II	AGRICIIDAE					
10	<i>Pavona decussata</i>	+				
11	<i>Pavona</i> sp.	+	+	+		
12	<i>Pavona decussata</i>			+	+	
13	<i>Pavona frondifera</i>				+	
14	<i>Pavona varians</i>	+				
III	PORITIDAE					
15	<i>Porites australiensis</i>				+	
16	<i>Porites cylindrica</i>					+
17	<i>Porites lobata</i>	+	+	+	+	+
18	<i>Porites lutea</i>	+	+	+	+	+
19	<i>Porites nigrescen</i>		+			+
20	<i>Porites rus</i>			+	+	
21	<i>Porites</i> sp.	+	+			+
22	<i>Goniopora lobata</i>			+		
23	<i>Goniopora</i> sp.					+
IV	FUNGIIDAE					
24	<i>Ctenactis echinata</i>			+		
25	<i>Fungia repanda</i>				+	
26	<i>Fungia horrida</i>			+		
V	OCULINIDAE					
27	<i>Galaxea fascicularis</i>	+	+	+	+	+
VI	PECTINIIDAE					
28	<i>Echinophyllia aspera</i>	+				
29	<i>Mycedium elephantotus</i>			+		
30	<i>Pectinia lactuca</i>	+	+		+	+
31	<i>Pectinia paeonia</i>	+				+
VII	MUSSIDAE					
32	<i>Lobophyllia hemprichii</i>				+	
33	<i>Symphyllia radians</i>	+			+	+
34	<i>Symphyllia valenciennesii</i>	+		+		+

VIII	MERULINIDAE					
35	<i>Hydnopora microconos</i>			+		
36	<i>Merulina ampliata</i>	+				+
IX	FAVIIDAE					
37	<i>Cyphastrea serailia</i>	+		+		
38	<i>Cyphastrea chalcidicum</i>					+
39	<i>Diploastrea heliopora</i>		+			+
40	<i>Echinopora lamellosa</i>					+
41	<i>Echinopora</i> sp.					+
42	<i>Favia fавus</i>	+				+
43	<i>Favia pallida</i>					+
44	<i>Favia speciosa</i>	+	+	+	+	+
45	<i>Favia danae</i>	+	+	+	+	+
46	<i>Favia matthaii</i>	+			+	
47	<i>Favia</i> sp.	+				
48	<i>Favites abdita</i>			+	+	+
49	<i>Favites halicora</i>				+	
50	<i>Favitespentagona</i>				+	+
51	<i>Favites flexuosa</i>	+		+	+	
52	<i>Favites</i> sp.1	+		+	+	
53	<i>Favites</i> sp.2	+			+	
54	<i>Goniastrea minuta</i>	+	+	+		
55	<i>Goniastrea retiformis</i>		+		+	+
56	<i>Goniastrea edwardsi</i>			+	+	+
57	<i>Leptastrea purpurea</i>	+				
58	<i>Leptastrea transversa</i>	+		+		
59	<i>Leptoriap hyrygya</i>					
60	<i>Montastrea curta</i>	+				
61	<i>Montastrea</i> sp.			+		
62	<i>Platygyra lamellina</i>	+			+	
63	<i>Platygyra</i> sp.	+	+	+		+
64	<i>Plesiastrea fersipora</i>				+	
65	<i>Oulastrea crispata</i>	+		+		
66	<i>Oulophylli abennetae</i>				+	+
67	<i>Oulophyllia</i> sp.				+	+
X	EUPHYLLIDAE					
68	<i>Euphyllia glabrescens</i>		+		+	
XI	DENDROPHYLLIDAE					
69	<i>Tubastrea faulkneri</i>			+		
70	<i>Turbinaria peltata</i>	+	+	+		+
XII	HELIOPORIDAE					
71	<i>Heliopora coerulea</i>				+	

Diversity and evenness indices were different among the sites, ranging from 2.67–3.30 and 0.88–0.95, respectively (Table 3). Site 4 was the most diverse site with 40 species including 21 species of Faviidae, and the evenness was also high.

DISCUSSION

The condition of the coral reef ecosystems in West Bangka waters was fair viewed from the covering percentage of corals although the sedimentation rate was high resulting mainly from tin mining activities. The substrate was mostly dominated by sands and silts (Table 1). This condition seemed to be mainly caused by over-mining activities. Increasing sediment causes smothering and burial of coral polyps, shading, tissue necrosis and a population explosion of bacteria in coral mucus (Erftemeijer *et al.*, 2012). Moreover, the sediments reduce light availability for photosynthesis or increase the need for active sediment removal (Reigl and Branch, 1995). Offshore mining activities in Bangka continually increase the sedimentation process which is faster than the coral's growth, causing many corals to be buried and dying (Photo 2).

The covering percentage of coral at each site may depend on water current (Figure 2). The suspended sediments settle in places with slow current. All the stations are situated nearby the mainland where the current is quite slow. Site 4, which has less impact from the offshore mining activities, is located in a bay within, and protected, by a gulf (Figure 1) where the current flows southward (Figure 2). Conversely, Sites 5 and Site 2, which are highly affected by the sedimentation, are situated near the center of tin-mining (Figure 1), and the current flows towards to the sites (Figure 2) causing heavy sedimentation.

The corals found at West Bangka waters were mostly massive corals belonging to Poritidae, Oculinidae and Faviidae, and branching-form corals such as *Acropora* were scarce. Branching corals are fast growing, and such corals are generally less resistant to stress (McClanahan, 2004), while massive corals are able to respond to less light intensity by increasing their surface areas (Todd *et al.*, 2004). In addition, Oculinidae and Faviidae have large polyps which can more quickly remove sedimentation on their surface (Todd *et al.*, 2001, Stafford-Smith and Ormond, 1992). Massive

Table 3. The number of species (S), the number of individuals (N), Pielou's evenness index (J') and Shannon's diversity index (H').

Study sites	S	N	J'	H'
Site 1	33	70	0.88	3.08
Site 2	17	30	0.94	2.67
Site 3	30	51	0.95	3.22
Site 4	40	90	0.90	3.30
Site 5	0	0	0.00	0.00
Site 6	24	41	0.95	3.03



A



B

Photo 2. A. *Favites* sp., Site 3; *Favia speciosa*, Site 3.

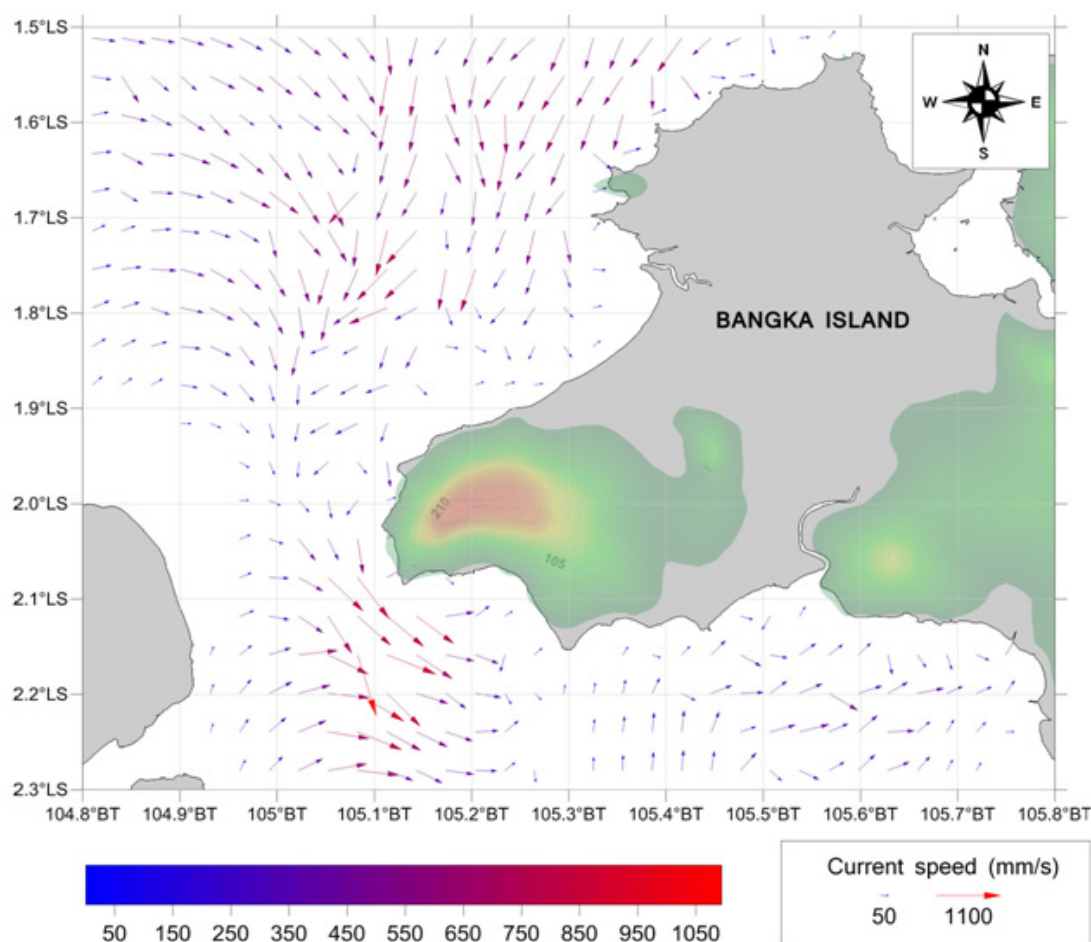


Figure 2. Surface current at high tide, 06 – 10 October 2013, 08 am – 12 pm, 12 pm – 16 pm (Kusmanto, 2013).

corals were dominant in very turbid waters in West Bangka waters. This condition is also similar with the study conducted by Munasik and Siringoringo (2011) in South Kalimantan waters.

There seems strong recruitment for another abundant family Dendrophyllidae, especially *Turbinaria peltata*. Many newly recruited colonies have occurred near adult ones (Photo 1b). The dendrophilid genera, *Dendrophyllia* and *Tubastrea*, have brooding habits and their fertilization occurs in the maternal polyp (Richmond and Hunter, 1990). Brooding corals produce fewer larvae (Fadlallah, 1983). The larvae develop mouths which allow them to feed on particles and ingest zooxanthellae, and they survive for longer periods (Wijgerde, 2009). Due to their high recruitment and high survival, dendrophyllid corals were found at all research sites, other than Site 5.

Site 4 had the highest number of species and a relatively high evenness (Table 3) of abundant faviids which are more resistant to environmental stress. That is partly because this site, situated in the north gulf, is less affected by offshore mining activities. In contrast, Site 5 had almost no corals and is covered by substrates including silt and turf algae (Table 1). This condition is due to high level of environmental stress. Severe and long-lasting stress from sediment disturbances may result in a decrease in coverage, density, diversity of corals (Gilmour *et al.*, 2006).

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