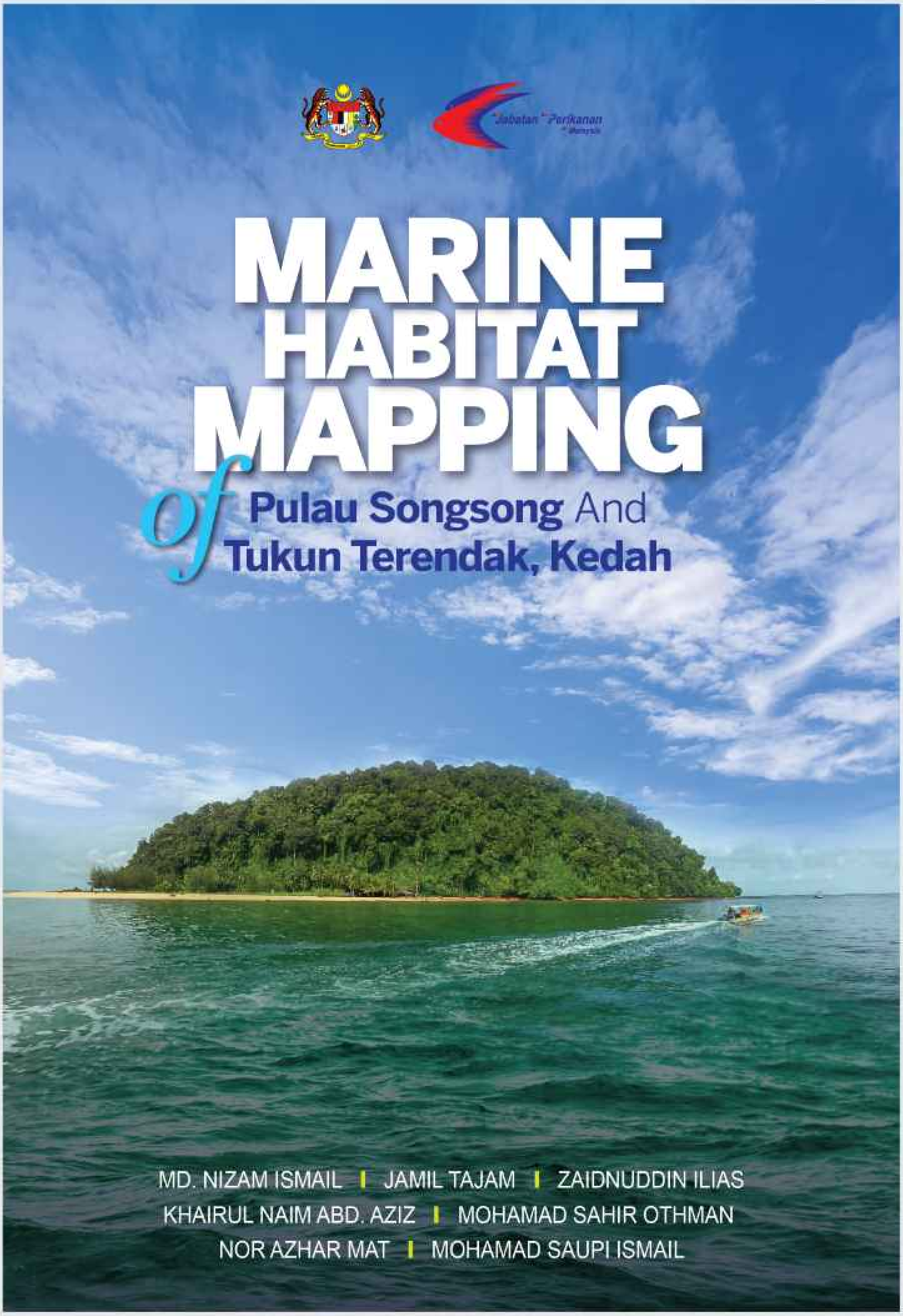

MARINE HABITAT MAPPING

of Pulau Songsong And Tukun Terendak, Kedah

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Contents

PREFACE

Assalamualaikum W.B.T and Salam Keluarga Malaysia.

Marine Protected Areas (MPAs) playing an important rules in protecting our food security. Its provide protection to the habitats of marine life including commercial fishes. To date, total of 42 islands were gazette as Marine Park in Malaysia, under Fisheries Act 1985. Malaysia has an obligation in SDG 14 where the country requires protecting and managing at least 10% of the country's waters as MPA by 2030.

From 2021 to 2022, a scientific expedition was carried out in the waters of Songsong Island and Tukun Terendak, Yan, Kedah by researchers from the National Marine Park Research Center (PPTLN) and Universiti Teknologi Mara (UiTM) Perlis. The objective of this expedition was to identify the coral reef distribution and its areas. The spatial data generated from this study will become as baseline data and supporting document for a new MPAs to fulfill our country commitment to the SDG Goal 14 (Life Below Water).

With that, I would like to express my deepest appreciation to each member of the research team who together contributed towards the production of this report. Hopefully this published information can help the Malaysian Fisheries Department and the Kedah State Government in their efforts to protect marine biodiversity in the Songsong Islands and Tukun Terendak Yan, Kedah.

Mohamad Saupi Ismail
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National Marine Park Research Centre
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1.0 INTRODUCTION

In general, the use of hydro acoustic signals as a remote sensing tool is capable of determining the distribution of coral habitats and categories within a coral reef by measuring different hardness and roughness of the substrate. With this special advantage, a few studies have been carried out effectively on marine habitat mapping, especially on coral reefs in the tropical region. Such studies were carried out by Hamilton *et al.* (1999), where he made a comparative study between the two different acoustic classification systems under the Great Barrier Reef, and Murphy *et al* (1995) where he conducted a wide-scale mapping that projected off the coast of Florida. Furthermore, the acoustic remote sensing has been used more successfully in temperate waters such as for the broad-scale mapping of sublittoral habitats and biota (Foster-Smith et al. 1998; Sotheran et al. 1997), mapping of kelp bed distributions (Foster-Smith et al. 2000) and the distribution of horse mussel beds (Magorrian et al. 1995). However, in Malaysia, the usefulness of this system has not been fully utilized for the mapping of marine habitat.

Spatial patterns of marine physical, biological and geographical landscapes are of essential information in understanding and investigating habitat-species distributions linkage (Jordan et al. 2005; Poulos et al. 2015)and is used to evaluate the effectiveness of management strategies, particularly in regards to marine protected areas. This study explored the observed and predicted distribution of an uncommon soft coral species, Dendronephthya australis within the Port Stephens–Great Lakes Marine Park. Dendronephthya australis was mapped by video operated by a SCUBA diver towing a time synchronised GPS. A species distribution model was created to explore the possible occurrence of D. australis outside of the mapped area, using four environmental parameters: bathymetry, slope of seabed, velocity of tidal currents, and distance from estuary mouth. Dendronephthya australis colonies occurred along the southern shoreline in the Port Stephens estuary between Fly Point and Corlette Point, but no colonies were found within sanctuary (no-take. Marine habitat maps can provide information on species diversity patterns, marine habitat types, spawning aggregation sites, and ultimately become a scientific basis for conserving biodiversity and aid the selection of protected areas, thus allowing managers to meet the goals adopted under the Convention on Biological Diversity (CBD) as well as enhancing Marine Protected Area (MPA) planning (Cogan et al. 2009; Copeland et al. 2013; Foley et al. 2010). Therefore, due to the diversification scale of marine habitat mapping, it clearly shows that this technique plays a significant role for the MPA manager to identify suitable areas for protection by examining the distribution and structure of ecosystems (Jordan et al. 2005; Poulos et al. 2015)and is used to evaluate the

1.0 INTRODUCTION

effectiveness of management strategies, particularly in regards to marine protected areas. This study explored the observed and predicted distribution of an uncommon soft coral species, Dendronephthya australis within the Port Stephens–Great Lakes Marine Park. Dendronephthya australis was mapped by video operated by a SCUBA diver towing a time synchronised GPS. A species distribution model was created to explore the possible occurrence of D. australis outside of the mapped area, using four environmental parameters: bathymetry, slope of seabed, velocity of tidal currents, and distance from estuary mouth. Dendronephthya australis colonies occurred along the southern shoreline in the Port Stephens estuary between Fly Point and Corlette Point, but no colonies were found within sanctuary (no-take. On the other hand, marine habitat maps are considered an important tool to support the decision making process in key areas such as biodiversity conservation, fisheries management and coastal development planning (Edinger & Risk 2000).

The overall aim of this study is to discriminate and map the seabed features and marine habitat at the Pulau Songsong and Tukun Terendak, Yan, Kedah. Furthermore, this report will analyze the changes in the diversity of different substrate classes, as a way to measure habitat heterogeneity in these islands. Finally, the implications of this research will be addressed in terms of the future planning, design, protection and management of these areas for an ecologically sustainable development while at the same time preserving the livelihoods of local fishermen.

2.0 METHODOLOGY

2.1 Acoustic Ground Discriminating System (AGDS)

RoxAnn is one of the state of the art AGDS that is commonly used as a remote sensing tool for marine survey. The system is based on a single beam echosounder and works by integrating the components of the returned echoes to provide information on the acoustic characteristics of the seabed (Foster-Smith & Sotheran 2003)the marine environment imposes limitations on the way that ground sampling can be undertaken and the spatial extent of information that can be obtained. In summary, the main issues that contribute to variability and uncertainty of biotope maps based on AGDS-based methodology are: (1. In addition to the seabed's depth, the characteristics extracted by the system include a measure of the seabed's roughness (E1) derived from the tail of the first echo, and a measure of the seabed's hardness (E2) derived from the entire second echo. The second echo refers to the echoes which are reflected twice before returning to the transducer as seen in Figure 1 (White et al. 2003)AGDS is rarely used in tropical environments but is easy to operate and produces a modest amount of digital data. This study aimed to assess acoustic surveys of coral reef benthic classes using a RoxAnn(TM.

The shape and strength of the returning echoes depend on features or characteristics of the seafloor under the survey vessel and this provides the basis for data processing and habitat discrimination. For example, reefs produce high E1 and E2 values. The rough substrate creates significant backscatter and reflects more sound towards the transducer, creating a more significant tail on the first echo. The hard nature of the reef substrate also absorbs less sound, thus returning a stronger second echo. The E1, E2 and depth data along with the vessel's position (from a GPS) are logged, saved and exported as a text file for post processing. The data extracted is essentially a point data that is centered on the survey vessel, and the acoustic footprint of each point depends on the angle of the echo-sounder beam and the depth of the water. An acoustic 'picture' of the seabed is gradually built up by tracking back and forth over the seabed.

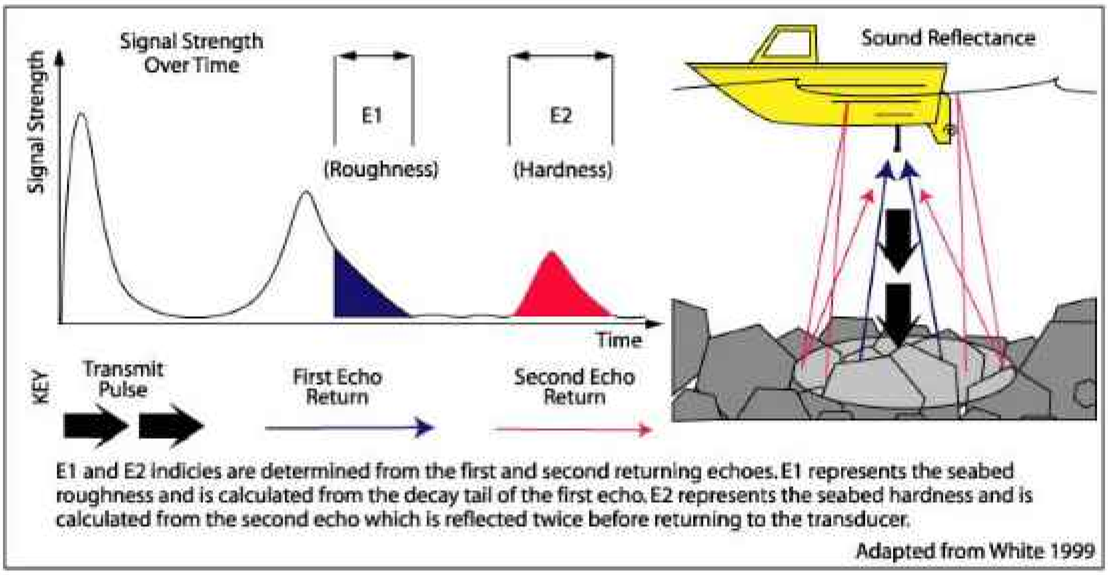

Figure 1: A diagram describing the acoustic variables recorded by a RoxAnn acoustic ground discrimination system

2.2 RoxAnn AGDS Survey Setting and Procedure

The equipment used for survey consists of a RoxAnn signal processor combined with a Furuno single beam echosounder. A Garmin GPS (without differential correction) was interfaced with the system and the recorded data was plotted using microplot before being exported as raw text file data. For accurate positioning, the GPS aerial was fixed at the highest point on the vessel on a scaffold pole above the position of the echosounder's transducer

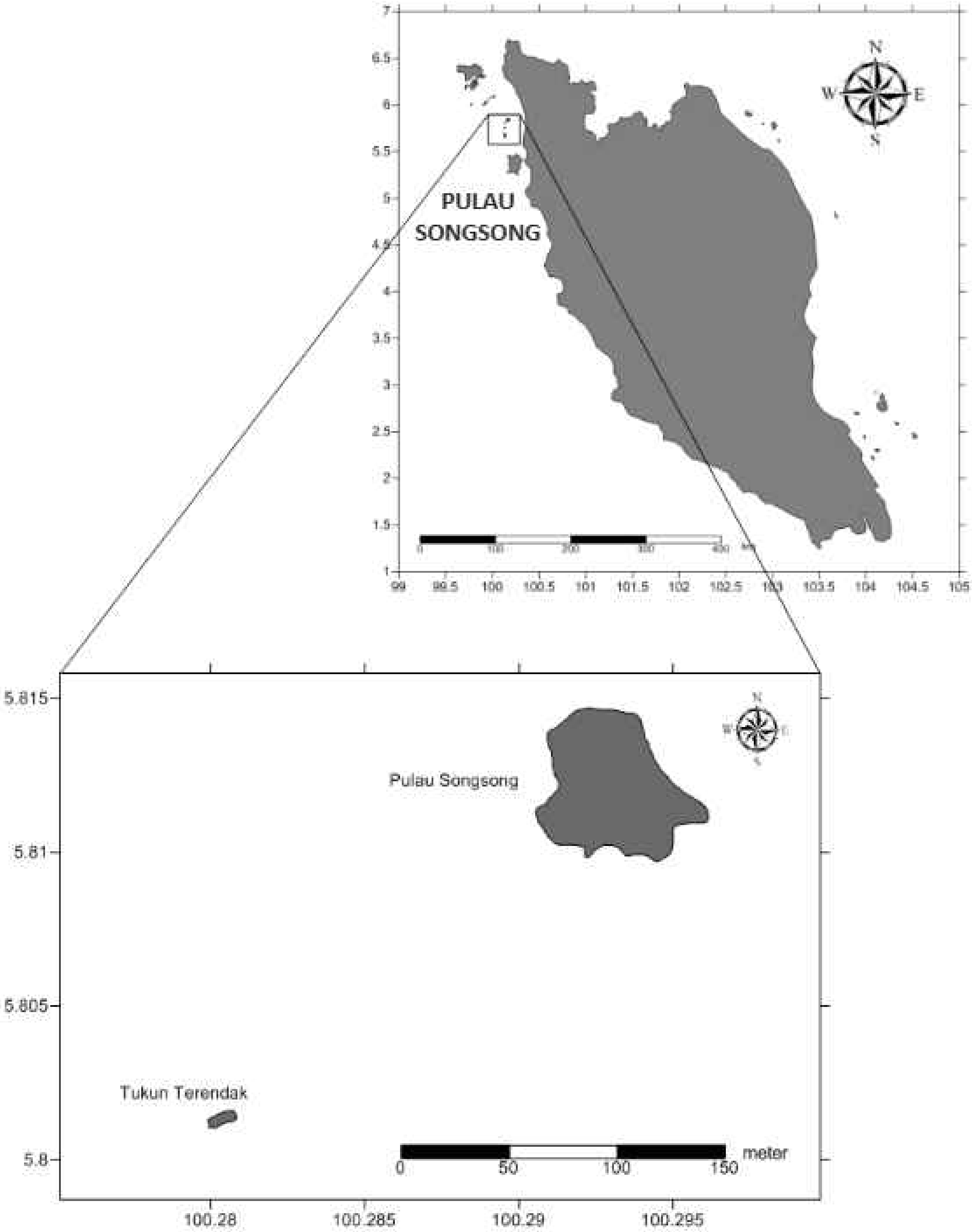

Figure 2: Coral Survey Area

(fixed to the starboard side of the boat). The vessel ran at an average speed of 3 to 4 knots, forming a continuous 'U' transect at 50 meter surface intervals, perpendicular to each island. This allows the seabed ranging in depths between 3m to 25m (± 2m tidal variations) where most live corals and other important habitats are found to be surveyed. The survey area was shown in Figure 2. During the survey, the output signals (position, depth, E1 and E2) were monitored and areas of interest (with high E1 and E2 values and variable depth) were noted, along with any potential erroneous data points. All of the data collected in ASCII form were processed using ArcGIS Desktop 9.3 and Surfer 13.0 software for thematic maps.

AGDS is more likely to be able to discriminate between habitats established on different substrates because of their differing acoustic properties. Grouping these habitats was therefore likely to the acoustic classification. For example, mud and sand have very different acoustic properties. Sand has quite a distinct acoustic property because of its high profile. While roughness and hardness of rubble substrates produce high E1 and E2 values, mud absorbs sounds, producing very low hardness (E2) and very low roughness (E1) values due to its flatness. Prior to the survey, the system was calibrated against the initially identified seabed substrate Figure 3. Table 1 displays the substrates which have been divided into four (4) clusters.

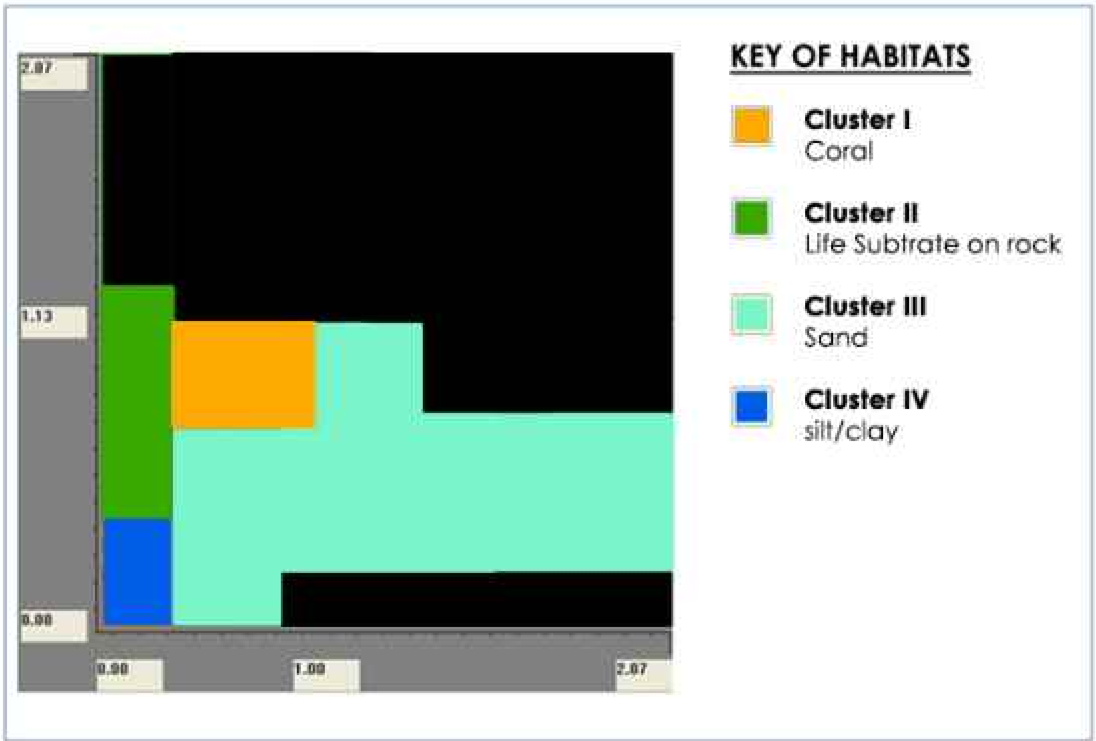

Figure 3: Calibration Box for AGDS

Table 1: Shows the validation of each cluster

CLUSTER	CLASSIFICATION	IMAGE
Cluster I	Coral	
Cluster II	Life Substrate on Rock	
Cluster III	Sand	
Cluster IV	Silt/Clay	

3.0 PROJECT FINDINGS

3.1 Substrate distribution

A total of 21,405 points were successfully recorded using AGDS around Pulau Songsong (14,199 points) and Tukun Terendak (7,206 points), Yan, Kedah during the survey period on 14 – 16 October 2021. This survey line consisted of both parallel and perpendicular with a total area approximately was 685,983 m². To interpret the depths on each island, the 'kriging' model method was used to produce depth contour maps in the study area (Figures 4 & 5). According to Greenstreet et al. (1997), the contour map that has been produced will help and be able to distinguish the depth and will be used to determine the type of substrate overflow in the study area. Overall, the average depth for Pulau Songsong and Tukun Terendak were at 7.72±4.08 meters and 11.01± 4.23 meters, respectively.

Parts from that, the individual points were analyzed by using ArcGIS Desktop 9.3 and Surfer 13.0 software after the survey. In this study, four (4) clusters have been identified, among them are; Cluster I for group of coral, , Cluster II for rock, Cluster III for group of sand and Cluster IV for group of silt/clay. Table 2 shows how cluster groups represent a difference in the percentage of distribution and wideness of each cluster at the proposed airport development area. It can be clearly seen that the cluster groups of bottom substrate compositions varied considerably across the criteria of roughness (E1) and hardness (E2) of each point within the depth.

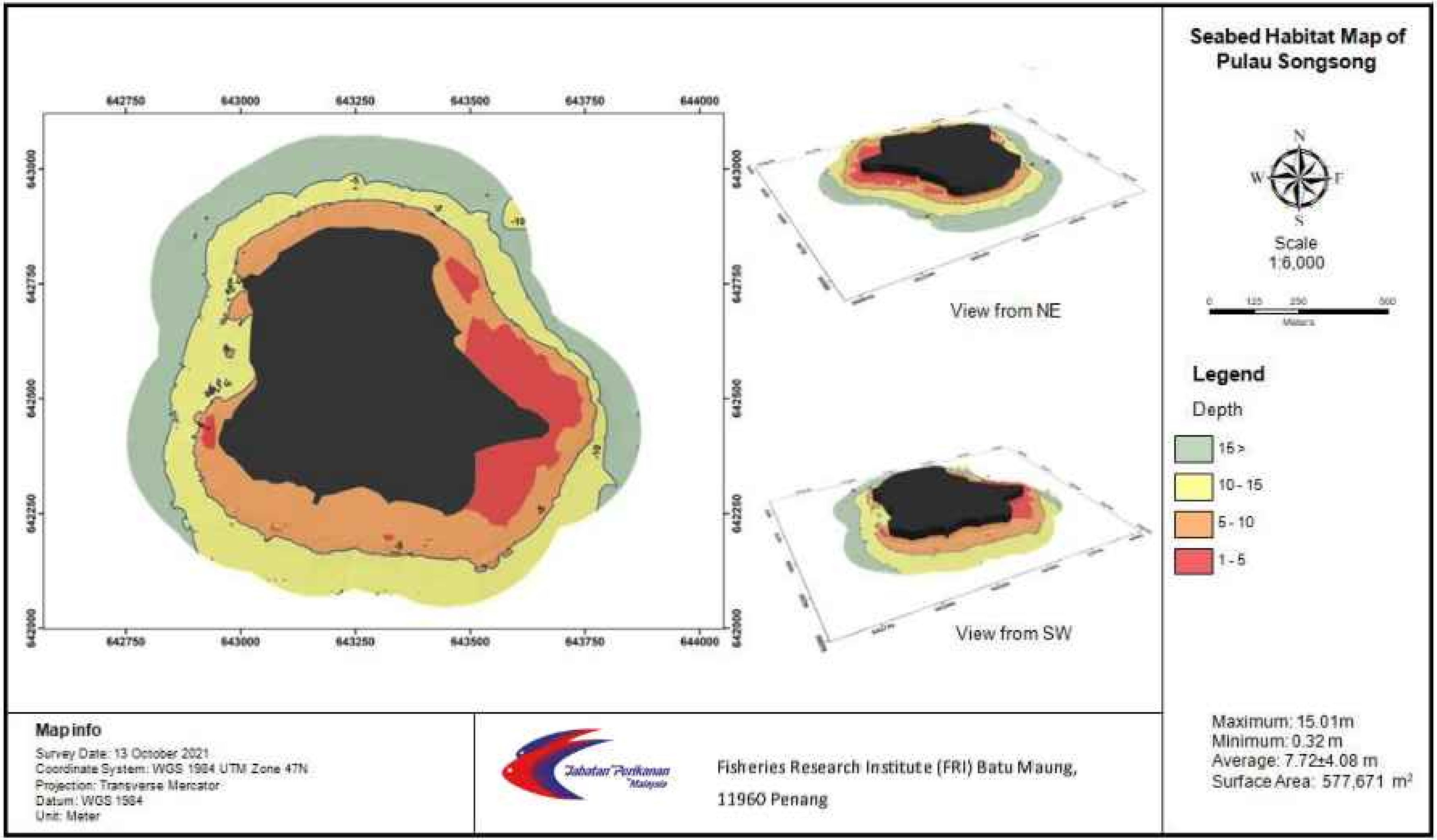

Figure 4 : Bathymetric interpolation map for Pulau Songsong, Yan, Kedah

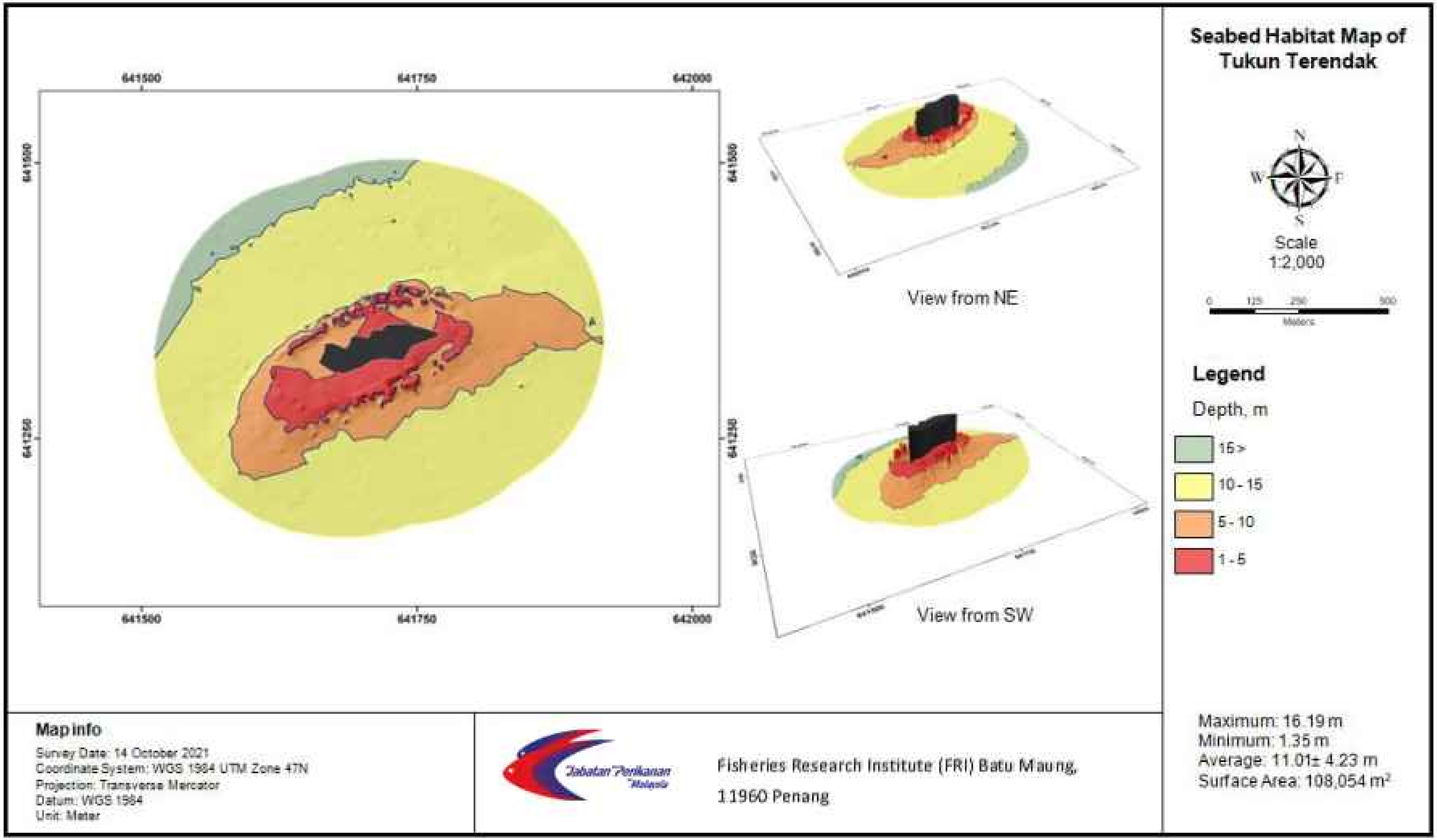

Figure 5 : Bathymetric interpolation map for Tukun Terendak, Yan, Kedah

Table 2 Substrate composition for Pulau Songsong & Tukun Terendak, Yan, Kedah

Cluster	PULAU SONGSONG		TUKUN TERENDAK	
	(%)	Area (m^2)	(%)	Area (m^2)
Cluster I - Coral	3.85%	22,272	1.96%	2,116
Cluster II – Life Subtrate on Rock	4.53%	26,196	6.92%	7,479
Cluster III - Sand	91.45%	528,529	89.19%	96,377
Cluster IV – Silt/Clay	0.16%	932	1.93%	2,082
TOTAL	**100**	**577,929**	**100**	**108,054**

According to Table 2, the results indicate Pulau Songsong and Tukun Terendak were dominated by sand (Cluster III) which recorded the highest percentage among the cluster with the value of 91.45% and 89.19%, respectively. Further, each location was recorded with an area of 528,529 m^2 for Pulau Songsong and 96,377 m^2 for Tukun Terendak. Meanwhile, life substrate on rock (Cluster II) at Pulau Songsong and Tukun Terendak were recorded the second highest percentage at 4.53 % (26,196 m^2) and 6.92% (7,479 m^2), respectively. Then, followed by the coral (Cluster I) with obtain the total area of 22,272 m^2 (Pulau Songsong) and 2,116 m^2 (Tukun Terendak). Figure 6 and Figure 7 show the results of interpolation mapping for the bottom substrate around Pulau Songsong and Tukun Terendak

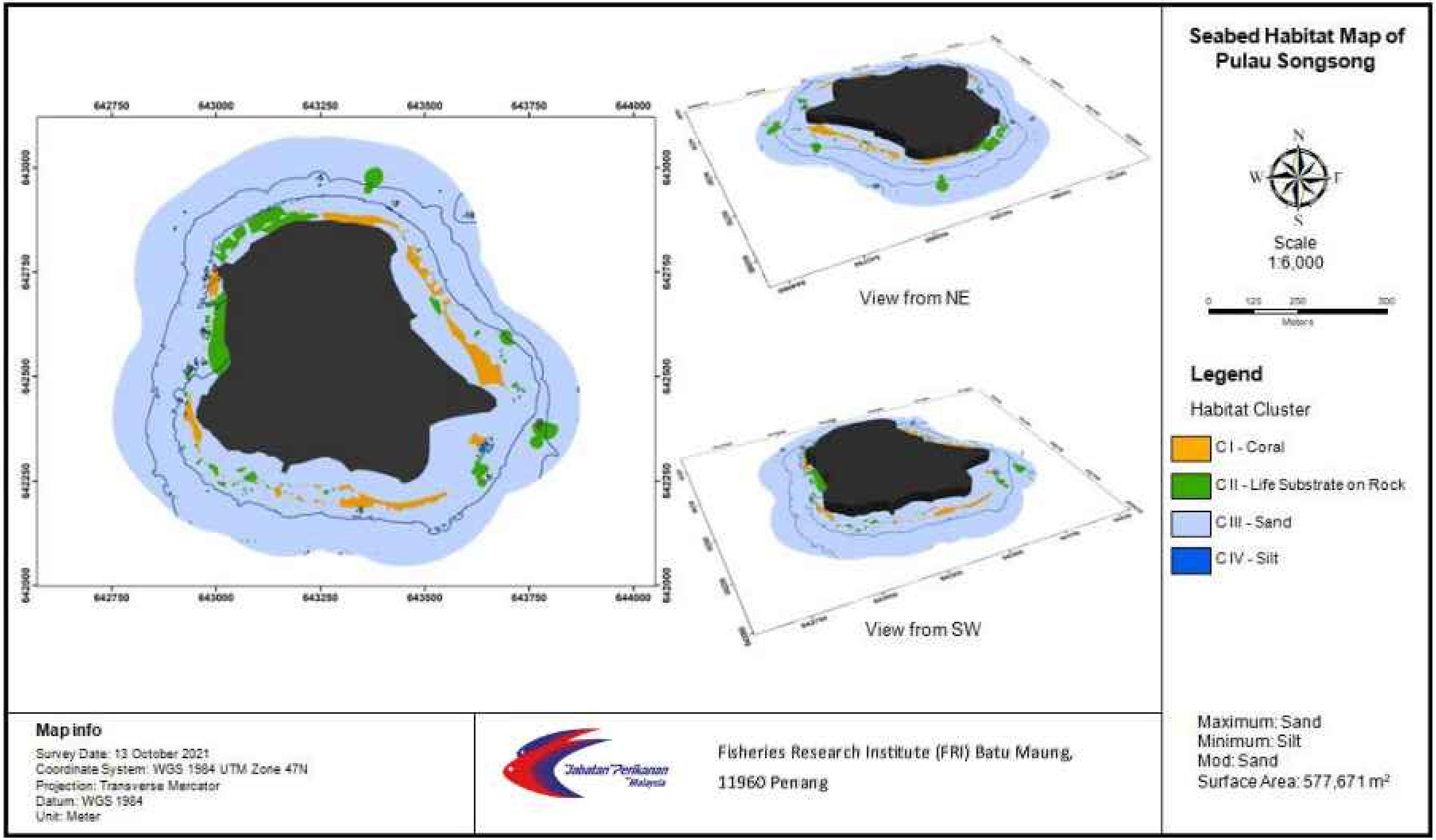

Figure 6 : The distribution of marine habitats for Pulau Songsong, Yan, Kedah

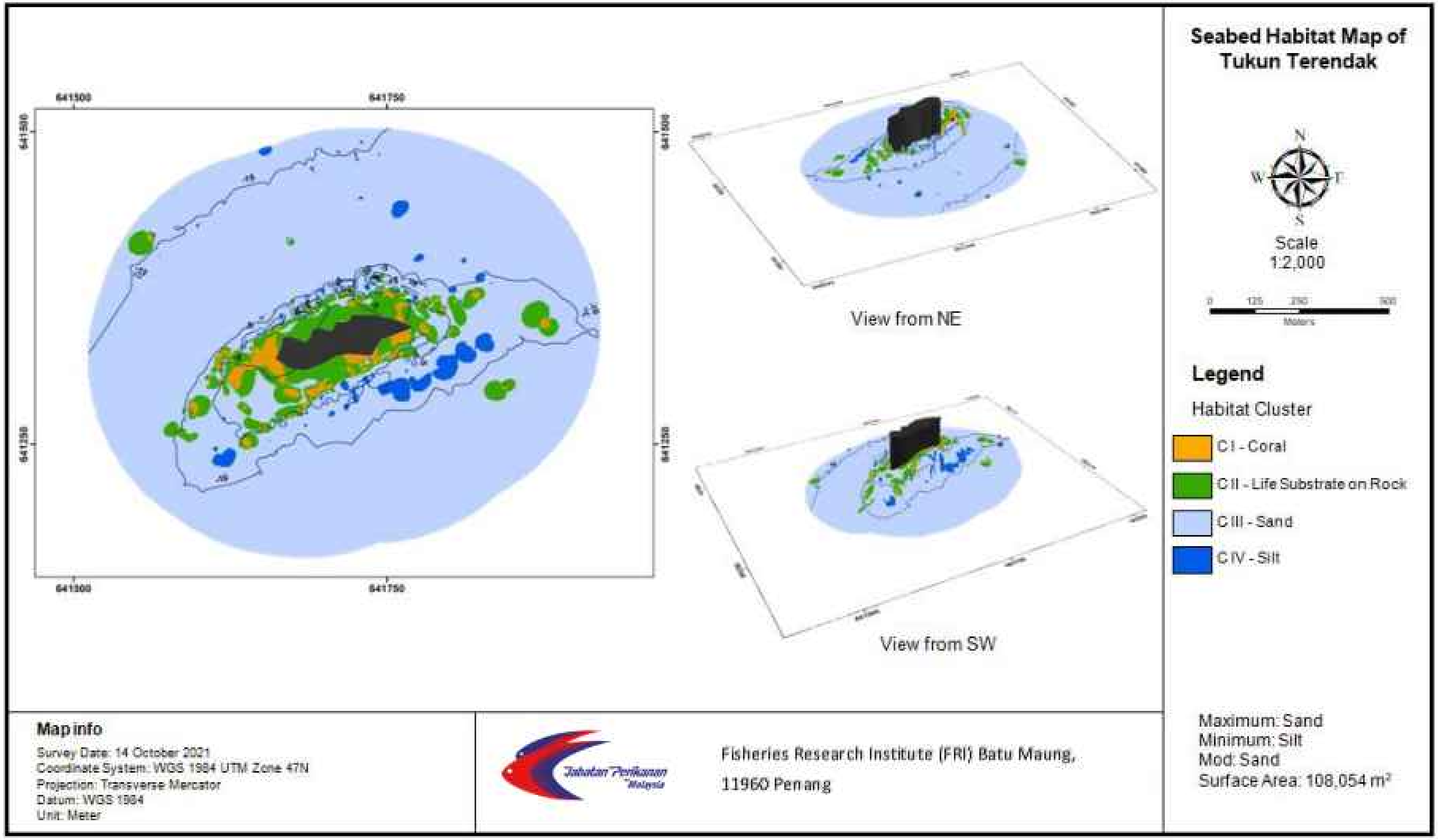

Figure 7 : The distribution of marine habitats for Tukun Terendak, Yan, Kedah

3.2 Geographical Tagging

Geographical tagging (also written as GeoTagging) is the process of adding geographical identification data to various media such as a geotagged photograph or video, websites, SMS messages, QR Codes or RSS feeds. This data consists of latitude and longitude coordinates, though they can also include altitude, distance, and place names. Geotagging can help users find a variety of location-specific information from a device. For instance, someone can find images taken near a given location by entering latitude and longitude coordinates into a suitable image search engine. Geotagging Photographs -there are two main options for geotagging photos; capturing GPS information at the time the photo is taken or "attaching" the photograph to a map after the picture is taken. Geographical Tagging as a Monitoring Tool in Coral Mapping Projects While Geotag provides the user with the ability to capture the location on the mobile device it also allows users to read this location for varied purposes. Figure 8 show the image with the coordinate information on the image details properties.

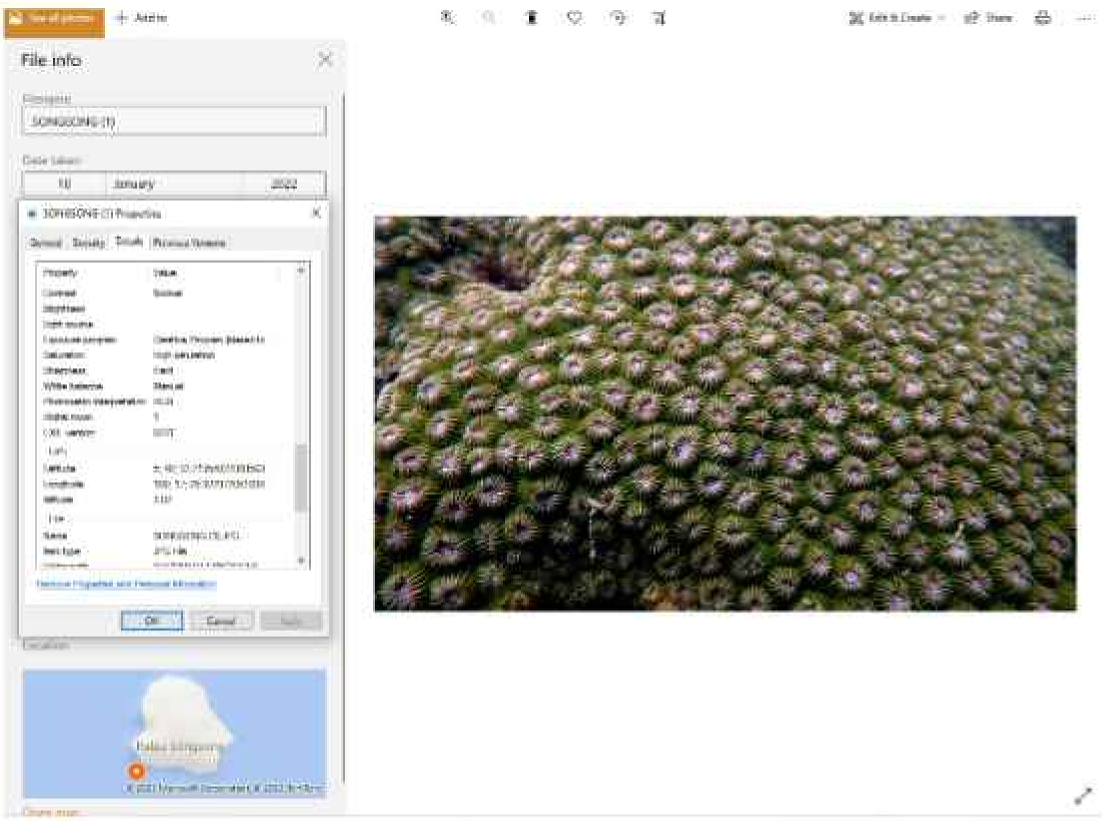

Figure 8 : GPS information from image properties

After the process of geatagging finished, then GeoSetter will used to convert image with geotag info to other metadata such as .kmz file. KMZ is a file extension for a placemark file used by Google Earth (Figure 9) and stands for Keyhole Markup language Zipped. KMZ files can contain placemarks featuring a custom name; the latitudinal and longitudinal coordinates for the location, and 3D model data. KMZ files can be opened by Google Earth. This report is also included the **TERENDAK_2022.kmz & SONGSONG_2022.kmz** file to determine the exact location of the photo. Meanwhile, Table 3 was show the photo coordinates for Pulau Songsong and Tukun Terendak

Figure 9 : The actual position of geotagged image in Google Earth software

Table 3 : Coral photo ID and coordinates for Pulau Songsong and Tukun Terendak

NO.	LATITUDE	LONGITUDE	PHOTO ID	SPECIES
1	5.800198	100.2796	TERENDAK (1)	*Heteractis* sp.
2	5.80017	100.2796	TERENDAK (2)	*Heteractis* sp.
3	5.800149	100.2796	TERENDAK (3)	*Rhodactis* sp.
4	5.800156	100.2796	TERENDAK (4)	*Heteractis* sp.
5	5.80018	100.2797	TERENDAK (5)	*Porites* sp.
6	5.800181	100.2797	TERENDAK (6)	*Turbinaria* sp.
7	5.800242	100.2797	TERENDAK (7)	*Turbinaria* sp.
8	5.800273	100.2797	TERENDAK (8)	*Turbinaria* sp.
9	5.800334	100.2798	TERENDAK (9)	*Heteractis* sp.
10	5.800356	100.2798	TERENDAK (10)	*Turbinaria* sp.
11	5.800394	100.2799	TERENDAK (11)	*Turbinaria* sp.
12	5.800444	100.28	TERENDAK (12)	*Acropora* sp.
13	5.800447	100.28	TERENDAK (13)	*Acropora* sp.
14	5.800492	100.2801	TERENDAK (14)	*Turbinaria* sp.
15	5.800571	100.2803	TERENDAK (15)	*Turbinaria* sp.
16	5.800593	100.2804	TERENDAK (16)	*Dipsastraea* sp.
17	5.800721	100.2807	TERENDAK (17)	*Turbinaria* sp.
18	5.800767	100.2807	TERENDAK (18)	*Turbinaria* sp.
19	5.800943	100.2808	TERENDAK (19)	*Dipsastraea* sp.
20	5.800969	100.2808	TERENDAK (20)	*Rhodactis* sp.
21	5.800976	100.2808	TERENDAK (21)	*Turbinaria* sp.
22	5.800977	100.2806	TERENDAK (22)	*Turbinaria* sp.
23	5.800968	100.2806	TERENDAK (23)	*Rhodactis* sp.
24	5.800974	100.2806	TERENDAK (24)	*Turbinaria* sp.
25	5.800965	100.2805	TERENDAK (25)	*Heteractis* sp.
26	5.800961	100.2805	TERENDAK (26)	*Turbinaria* sp.
27	5.800959	100.2805	TERENDAK (27)	*Turbinaria* sp.
28	5.800957	100.2804	TERENDAK (28)	*Heteractis* sp.
29	5.80096	100.2804	TERENDAK (29)	*Heteractis* sp.
30	5.80096	100.2804	TERENDAK (30)	*Turbinaria* sp.
31	5.800973	100.2804	TERENDAK (31)	*Heteractis* sp.
32	5.800977	100.2804	TERENDAK (32)	*Turbinaria* sp.
33	5.800975	100.2799	TERENDAK (33)	*Rhodactis* sp.
34	5.800787	100.2795	TERENDAK (34)	*Turbinaria* sp.
35	5.800782	100.2795	TERENDAK (35)	*Turbinaria* sp.
36	5.800763	100.2795	TERENDAK (36)	*Dipsastraea* sp.

NO.	LATITUDE	LONGITUDE	PHOTO ID	SPECIES
37	5.800707	100.2794	TERENDAK (37)	*Dipsastraea* sp.
38	5.800653	100.2794	TERENDAK (38)	*Heteractis* sp.
39	5.800613	100.2793	TERENDAK (39)	*Cyphastrea* sp.
40	5.800586	100.2793	TERENDAK (40)	*Turbinaria* sp.
41	5.800567	100.2793	TERENDAK (41)	*Rhodactis* sp.
42	5.800345	100.2791	TERENDAK (42)	*Palythoa* sp.
43	5.800393	100.2791	TERENDAK (43)	*Turbinaria* sp.
44	5.800377	100.2792	TERENDAK (44)	*Porites* sp.
45	5.800217	100.2792	TERENDAK (45)	*Acropora* sp.
46	5.80006	100.2794	TERENDAK (46)	*Diploastrea heliopora*
47	5.800278	100.2797	TERENDAK (47)	*Heteractis* sp.
48	5.800327	100.2798	TERENDAK (48)	*Heteractis* sp.
49	5.800354	100.2798	TERENDAK (49)	*Turbinaria* sp.
50	5.800358	100.2799	TERENDAK (50)	*Turbinaria* sp.
51	5.809228	100.2916	SONGSONG (1)	*Diploastrea heliopora*
52	5.809218	100.2916	SONGSONG (2)	*Porites* sp.
53	5.809211	100.2916	SONGSONG (3)	*Isopora* sp.
54	5.809204	100.2916	SONGSONG (4)	*Isopora* sp.
55	5.809196	100.2916	SONGSONG (5)	*Isopora* sp.
56	5.809118	100.2916	SONGSONG (6)	*Diploastrea heliopora*
57	5.809085	100.2916	SONGSONG (7)	*Platygyra* sp.
58	5.809077	100.2916	SONGSONG (8)	*Dipsastraea* sp.
59	5.809061	100.2916	SONGSONG (9)	*Platygyra* sp.
60	5.809046	100.2916	SONGSONG (10)	*Platygyra* sp.
61	5.808991	100.2916	SONGSONG (11)	*Platygyra* sp.
62	5.808976	100.2916	SONGSONG (12)	*Porites sp.*
63	5.80896	100.2916	SONGSONG (13)	*Dipsastraea* sp.
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69	5.808835	100.2918	SONGSONG (19)	*Turbinaria* sp.
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73	5.809122	100.2922	SONGSONG (23)	*Porites* sp.
74	5.809165	100.2922	SONGSONG (24)	*Porites* sp.
75	5.80926	100.2923	SONGSONG (25)	*Porites* sp.

NO.	LATITUDE	LONGITUDE	PHOTO ID	SPECIES
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88	5.808852	100.2934	SONGSONG (38)	*Porites* sp.
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100	5.808579	100.2947	SONGSONG (50)	*Pavona* sp.
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103	5.812022	100.2915	SONGSONG (53)	*Turbinaria* sp.
104	5.812029	100.2915	SONGSONG (54)	*Dipsastraea* sp.
105	5.81203	100.2915	SONGSONG (55)	*Acropora* sp.
106	5.81203	100.2915	SONGSONG (56)	*Rhodactis* sp.
107	5.812047	100.2915	SONGSONG (57)	*Platygyra* sp.
108	5.81208	100.2915	SONGSONG (58)	*Turbinaria sp.*
109	5.812085	100.2915	SONGSONG (59)	*Diploastrea heliopora*
110	5.812232	100.2913	SONGSONG (60)	*Turbinaria sp.*
111	5.812275	100.2914	SONGSONG (61)	*Lobophyllia* sp.
112	5.812275	100.2914	SONGSONG (62)	*Lobophyllia* sp.
113	5.812325	100.2915	SONGSONG (63)	*Platygyra* sp.
114	5.812354	100.2915	SONGSONG (64)	*Lobophyllia* sp.

NO.	LATITUDE	LONGITUDE	PHOTO ID	SPECIES
115	5.812354	100.2915	SONGSONG (65)	*Dipsastraea* sp.
116	5.812361	100.2915	SONGSONG (66)	*Dipsastraea* sp.
117	5.812369	100.2915	SONGSONG (67)	*Lobophyllia* sp.
118	5.812377	100.2915	SONGSONG (68)	*Diploastrea heliopora*
119	5.812441	100.2915	SONGSONG (69)	*Turbinaria* sp.
120	5.812459	100.2915	SONGSONG (70)	*Dipsastraea* sp.
121	5.812463	100.2915	SONGSONG (71)	*Turbinaria* sp.
122	5.812498	100.2915	SONGSONG (72)	*Turbinaria* sp.
123	5.812504	100.2915	SONGSONG (73)	*Turbinaria* sp.
124	5.812516	100.2915	SONGSONG (74)	*Lobophyllia* sp.
125	5.812516	100.2915	SONGSONG (75)	*Dipsastraea* sp.
126	5.812614	100.2915	SONGSONG (76)	*Diploastrea heliopora*
127	5.812644	100.2915	SONGSONG (77)	*Diploastrea heliopora*
128	5.812684	100.2915	SONGSONG (78)	*Turbinaria* sp.
129	5.812689	100.2915	SONGSONG (79)	*Turbinaria* sp.
130	5.812698	100.2915	SONGSONG (80)	*Rhodactis* sp.
131	5.812716	100.2915	SONGSONG (81)	*Diploastrea heliopora*
132	5.812848	100.2915	SONGSONG (82)	*Dipsastraea* sp.
133	5.812863	100.2915	SONGSONG (83)	*Favites* sp.
134	5.812863	100.2915	SONGSONG (84)	*Lobophyllia* sp.
135	5.812886	100.2915	SONGSONG (85)	*Dipsastraea* sp.
136	5.812899	100.2915	SONGSONG (86)	*Diploastrea heliopora*
137	5.812909	100.2915	SONGSONG (87)	*Diploastrea heliopora*
138	5.812959	100.2914	SONGSONG (88)	*Favites* sp.
139	5.813057	100.2914	SONGSONG (89)	*Turbinaria* sp.
140	5.813136	100.2914	SONGSONG (90)	*Lobophyllia* sp.
141	5.81318	100.2914	SONGSONG (91)	*Lobophyllia* sp.
142	5.813261	100.2914	SONGSONG (92)	*Diploastrea heliopora*
143	5.813268	100.2914	SONGSONG (93)	*Coelastrea* sp.
144	5.813331	100.2914	SONGSONG (94)	*Turbinaria* sp.
145	5.813329	100.2914	SONGSONG (95)	*Turbinaria* sp.
146	5.813368	100.2913	SONGSONG (96)	*Turbinaria* sp.
147	5.813368	100.2913	SONGSONG (97)	*Turbinaria* sp.
148	5.813402	100.2914	SONGSONG (98)	*Turbinaria* sp.
149	5.813404	100.2914	SONGSONG (99)	*Turbinaria* sp.
150	5.813656	100.2914	SONGSONG (100)	*Turbinaria* sp.
151	5.813859	100.2915	SONGSONG (101)	*Turbinaria* sp.
152	5.813867	100.2915	SONGSONG (102)	*Turbinaria* sp.
153	5.813899	100.2915	SONGSONG (103)	*Turbinaria* sp.

NO.	LATITUDE	LONGITUDE	PHOTO ID	SPECIES
154	5.813903	100.2915	SONGSONG (104)	*Rhodactis* sp.
155	5.813905	100.2916	SONGSONG (105)	*Turbinaria* sp.
156	5.813943	100.2916	SONGSONG (106)	*Goniopora* sp.
157	5.813958	100.2916	SONGSONG (107)	*Lobophyllia* sp.
158	5.813969	100.2916	SONGSONG (108)	*Sinularia* sp.
159	5.81398	100.2916	SONGSONG (109)	*Sinularia* sp.
160	5.814028	100.2916	SONGSONG (110)	*Sinularia* sp.
161	5.811698	100.2978	SONGSONG (111)	*Porites* sp.
162	5.812009	100.2976	SONGSONG (112)	*Porites* sp.
163	5.812057	100.2976	SONGSONG (113)	*Porites* sp.
164	5.81226	100.2974	SONGSONG (114)	*Porites* sp.
165	5.8124	100.2972	SONGSONG (115)	*Dipsastraea* sp.
166	5.812422	100.2972	SONGSONG (116)	*Hydnophora* sp.
167	5.812424	100.2972	SONGSONG (117)	*Dipsastraea* sp.
168	5.812465	100.2972	SONGSONG (118)	*Heteractis* sp.
169	5.812468	100.2972	SONGSONG (119)	*Dipsastraea* sp.
170	5.812544	100.2971	SONGSONG (120)	*Acropora* sp.
171	5.812592	100.297	SONGSONG (121)	*Favites* sp.
172	5.812605	100.297	SONGSONG (122)	*Porites* sp.
173	5.812619	100.297	SONGSONG (123)	*Dipsastraea* sp.
174	5.812718	100.2969	SONGSONG (124)	*Pavona* sp.
175	5.812724	100.2968	SONGSONG (125)	*Lobophyllia* sp.
176	5.812727	100.2968	SONGSONG (126)	*Porites* sp.
177	5.812726	100.2968	SONGSONG (127)	*Dipsastraea* sp.
178	5.812754	100.2968	SONGSONG (128)	*Porites* sp.
179	5.812761	100.2968	SONGSONG (129)	*Porites* sp.
180	5.812762	100.2968	SONGSONG (130)	*Dipsastraea* sp.
181	5.812771	100.2968	SONGSONG (131)	*Porites* sp.
182	5.812776	100.2968	SONGSONG (132)	*Porites* sp.
183	5.81285	100.2967	SONGSONG (133)	*Porites* sp.
184	5.812883	100.2967	SONGSONG (134)	*Acropora* sp.
185	5.812978	100.2966	SONGSONG (135)	*Porites* sp.
186	5.812981	100.2966	SONGSONG (136)	*Porites* sp.
187	5.813001	100.2966	SONGSONG (137)	*Porites* sp.
188	5.813013	100.2966	SONGSONG (138)	*Porites* sp.
189	5.81307	100.2965	SONGSONG (139)	*Porites* sp.
190	5.813109	100.2965	SONGSONG (140)	*Porites* sp.
191	5.813133	100.2964	SONGSONG (141)	*Porites* sp.
192	5.813141	100.2964	SONGSONG (142)	*Porites* sp.

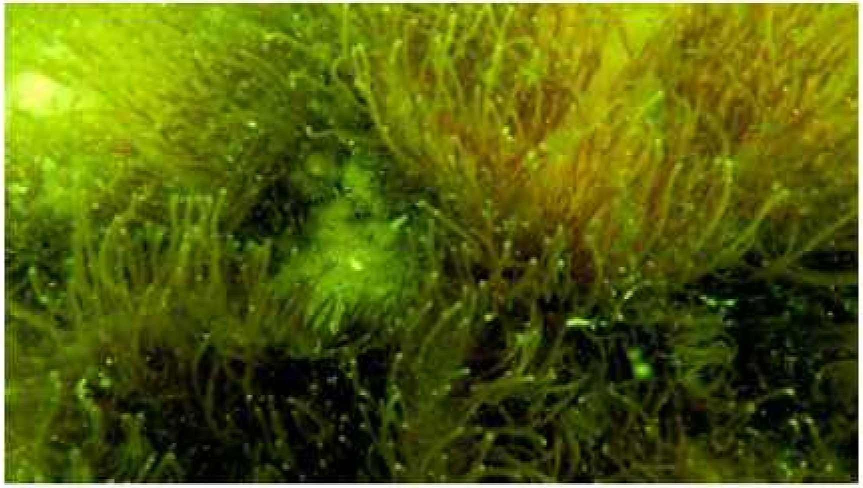
NO.	LATITUDE	LONGITUDE	PHOTO ID	SPECIES
193	5.813184	100.2964	SONGSONG (143)	*Euphyllia* sp.
194	5.81324	100.2963	SONGSONG (144)	*Pavona* sp.
195	5.813277	100.2963	SONGSONG (145)	*Pavona* sp.
196	5.813282	100.2963	SONGSONG (146)	*Porites* sp.
197	5.813354	100.2963	SONGSONG (147)	*Porites* sp.
198	5.813396	100.2963	SONGSONG (148)	*Porites* sp.
199	5.813423	100.2963	SONGSONG (149)	*Pavona* sp.
200	5.81347	100.2963	SONGSONG (150)	*Acropora* sp.
201	5.813591	100.2963	SONGSONG (151)	*Dipsastraea* sp.
202	5.813614	100.2963	SONGSONG (152)	*Pavona* sp.
203	5.813669	100.2962	SONGSONG (153)	*Dipsastraea* sp.
204	5.813272	100.2965	SONGSONG (154)	*Physogyra* sp.
205	5.813263	100.2965	SONGSONG (155)	*Diploastrea heliopora*
206	5.812741	100.2968	SONGSONG (156)	*Acropora* sp.
207	5.812732	100.2968	SONGSONG (157)	*Fungia* sp.
208	5.812733	100.2968	SONGSONG (158)	*Fungia* sp.
209	5.812065	100.2973	SONGSONG (159)	*Acropora* sp.
210	5.812064	100.2973	SONGSONG (160)	*Acropora* sp.

3.3 Geographical Tagging Photo for Tukun Terendak

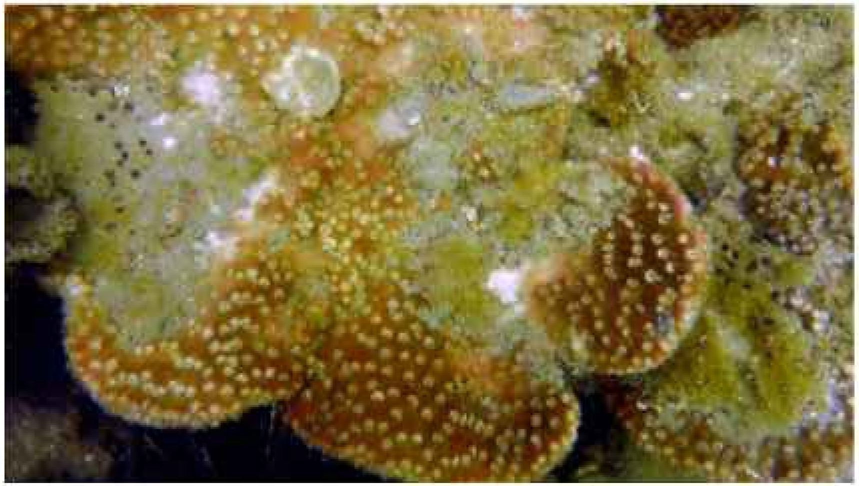
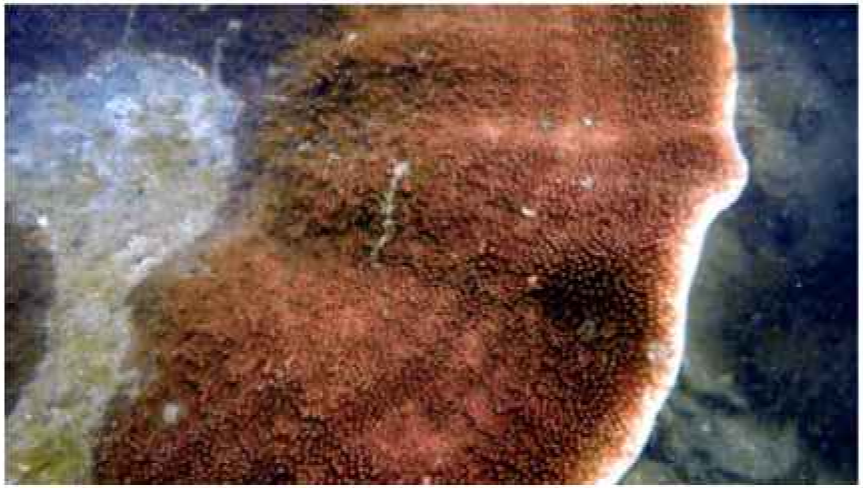
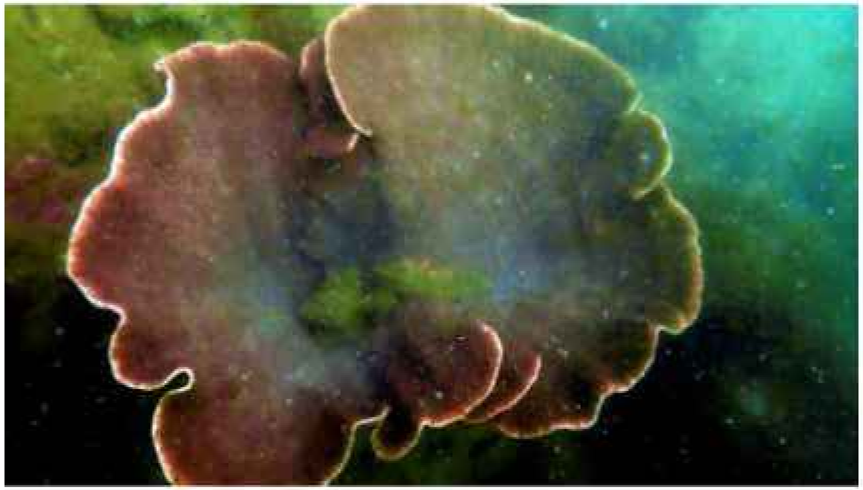
Heteractis sp.
TERENDAK (1)

Heteractis sp.
TERENDAK (2)

Rhodactis sp.
TERENDAK (3)

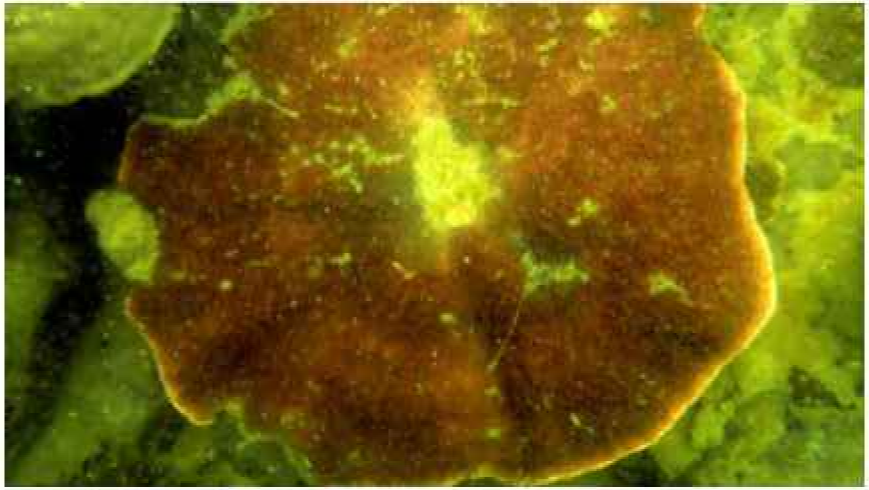


Heteractis sp.
TERENDAK (4)

	
Porites sp. **TERENDAK (5)**	*Turbinaria* sp. **TERENDAK (6)**
	
Turbinaria sp. **TERENDAK (7)**	*Turbinaria* sp. **TERENDAK (8)**

Heteractis sp.
TERENDAK (9)

Turbinaria sp.
TERENDAK (10)



Turbinaria sp.
TERENDAK (11)

Acropora sp.
TERENDAK (12)

Acropora sp.
TERENDAK (13)

Turbinaria sp.
TERENDAK (14)

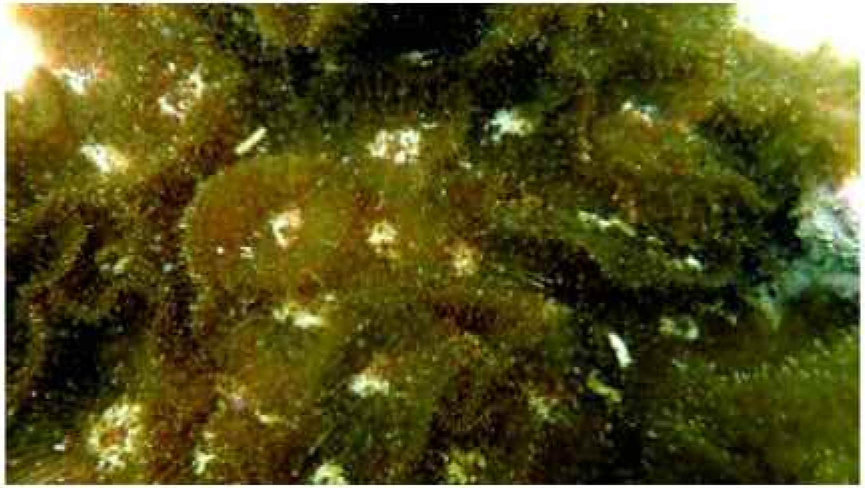
Turbinaria sp.
TERENDAK (15)

Dipsastraea sp.
TERENDAK (16)

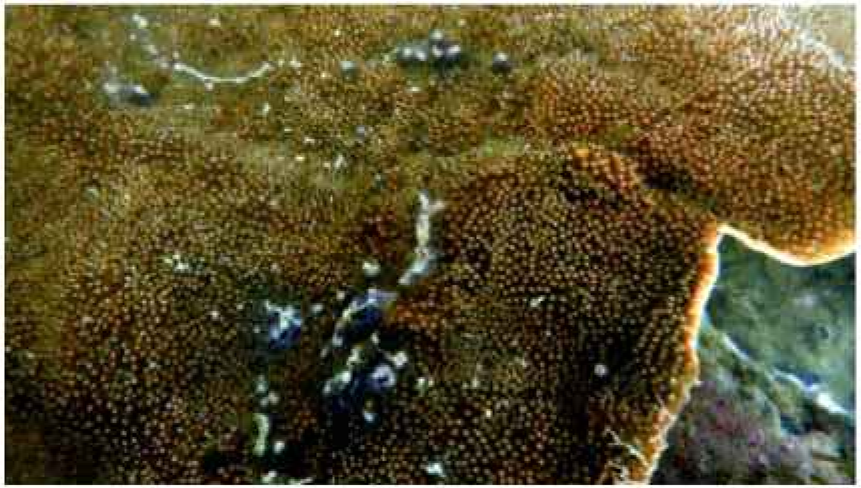
Turbinaria sp.
TERENDAK (17)

Turbinaria sp.
TERENDAK (18)

Dipsastraea sp.
TERENDAK (19)



Rhodactis sp.
TERENDAK (20)



Turbinaria sp.
TERENDAK (21)

Turbinaria sp.
TERENDAK (22)

Rhodactis sp.
TERENDAK (23)

Turbinaria sp.
TERENDAK (24)

Heteractis sp.
TERENDAK (25)

Turbinaria sp.
TERENDAK (26)

Turbinaria sp.
TERENDAK (27)

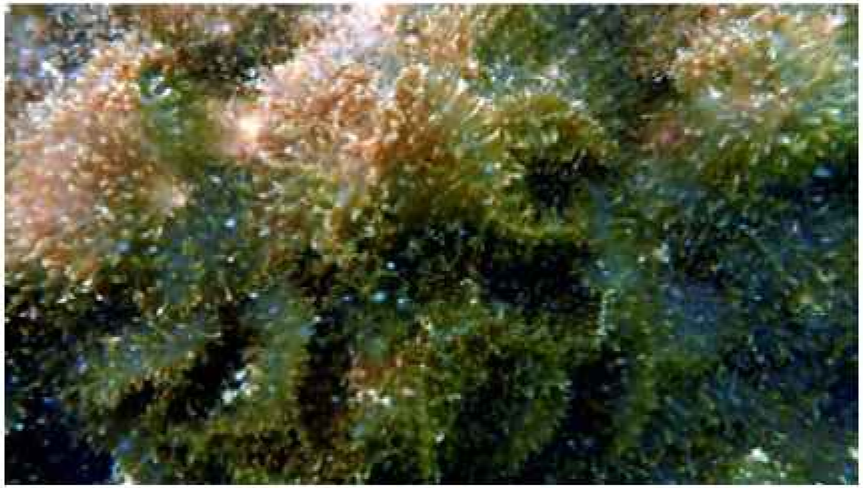
Heteractis sp.
TERENDAK (28)

Heteractis sp.
TERENDAK (29)

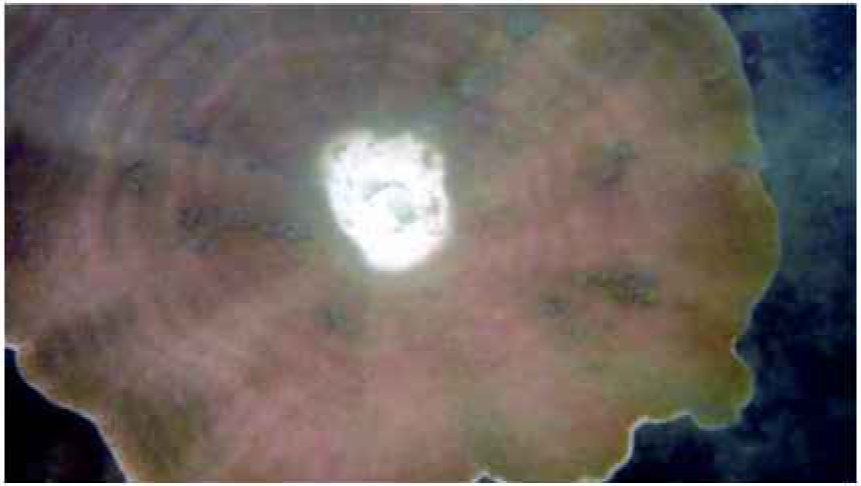
Turbinaria sp.
TERENDAK (30)

Heteractis sp.
TERENDAK (31)

Turbinaria sp.
TERENDAK (32)



Rhodactis sp.
TERENDAK (33)



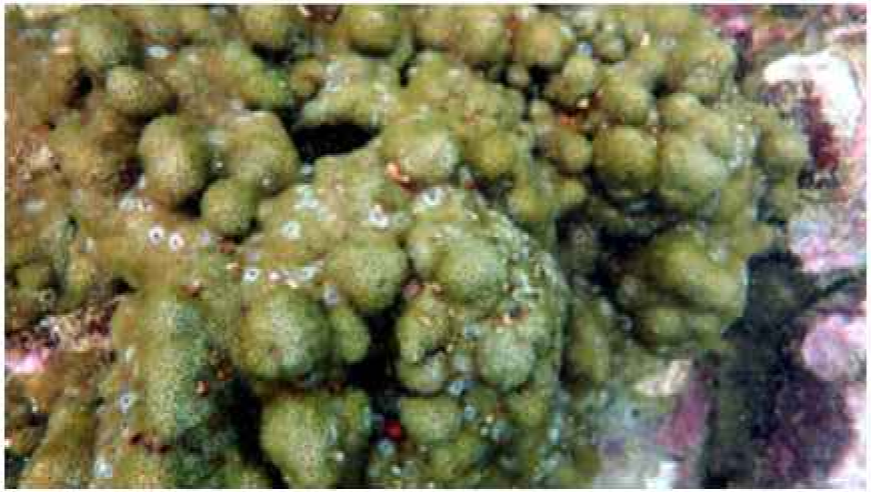
Turbinaria sp.
TERENDAK (34)

Turbinaria sp.
TERENDAK (35)

Dipsastraea sp.
TERENDAK (36)

Dipsastraea sp.
TERENDAK (37)

Heteractis sp.
TERENDAK (38)



Cyphastrea sp.
TERENDAK (39)

Turbinaria sp.
TERENDAK (40)

Rhodactis sp.
TERENDAK (41)

Palythoa sp.
TERENDAK (42)

Turbinaria sp.
TERENDAK (43)

Porites sp.
TERENDAK (44)

	
Acropora sp. **TERENDAK (45)**	*Diploastrea heliopora* **TERENDAK (46)**
	
Heteractis sp. **TERENDAK (47)**	*Heteractis* sp. **TERENDAK (48)**

	
Turbinaria sp. **TERENDAK (49)**	*Turbinaria* sp. **TERENDAK (50)**

3.4 Geographical Tagging Photo for Songsong Island

Diploastrea heliopora
SONGSONG (1)

Porites sp.
SONGSONG (2)

Isopora sp.
SONGSONG (3)

Isopora sp.
SONGSONG (4)

	
Isopora sp. **SONGSONG (5)**	*Diploastrea heliopora* **SONGSONG (6)**
	
Platygyra sp. **SONGSONG (7)**	*Dipsastraea* sp. **SONGSONG (8)**

Platygyra sp.
SONGSONG (9)

Platygyra sp.
SONGSONG (10)

Platygyra sp.
SONGSONG (11)

Porites sp.
SONGSONG (12)

Dipsastraea sp.
SONGSONG (13)

Dipsastraea sp.
SONGSONG (14)

Turbinaria sp.
SONGSONG (15)

Turbinaria sp.
SONGSONG (16)

Turbinaria sp.
SONGSONG (17)

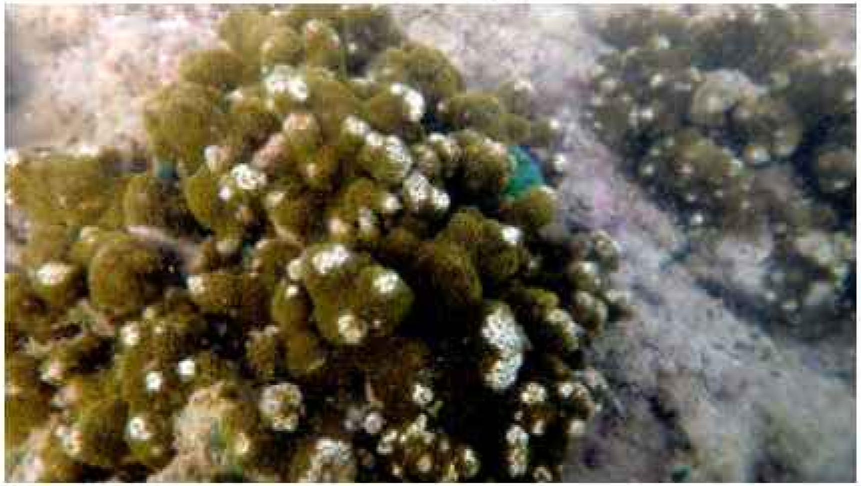
Goniopora sp.
SONGSONG (18)

Turbinaria sp.
SONGSONG (19)

Dipsastraea sp.
SONGSONG (20)

Porites sp.
SONGSONG (21)

Porites sp.
SONGSONG (22)



Porites sp.
SONGSONG (23)

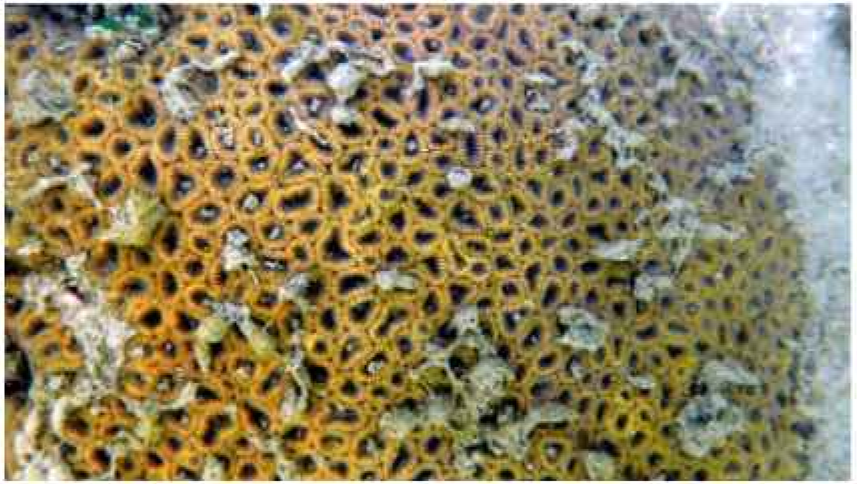
Porites sp.
SONGSONG (24)

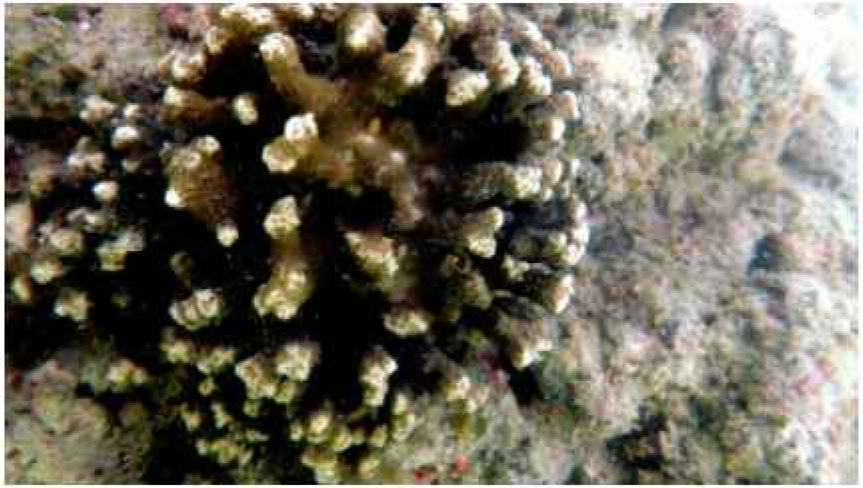
Porites sp.
SONGSONG (25)

Platygyra sp.
SONGSONG (26)

Euphyllia sp.
SONGSONG (27)

Dipsastraea sp.
SONGSONG (28)

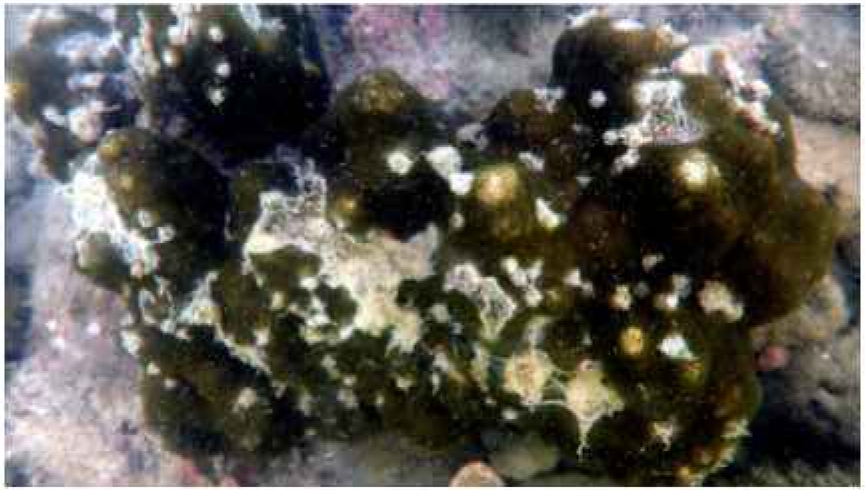
	
Porites sp. **SONGSONG (29)**	*Dipsastraea* sp. **SONGSONG (30)**
	
Porites sp. **SONGSONG (31)**	*Favites* sp. **SONGSONG (32)**

	
Dipsastraea sp. **SONGSONG (33)**	*Dipsastraea* sp. **SONGSONG (34)**
	
Dipsastraea sp. **SONGSONG (35)**	*Porites* sp. **SONGSONG (36)**

Porites sp.
SONGSONG (37)

Porites sp.
SONGSONG (38)

Porites sp.
SONGSONG (39)



Porites sp.
SONGSONG (40)

Pavona sp.
SONGSONG (41)

Porites sp.
SONGSONG (42)

Actiniidae
SONGSONG (43)

Goniastrea sp.
SONGSONG (44)

Porites sp.
SONGSONG (45)

Pavona sp.
SONGSONG (46)

Porites sp.
SONGSONG (47)

Zoanthus sp.
SONGSONG (48)

Dipsastraea sp.
SONGS ONG (49)

Pavona sp.
SONGS ONG (50)

Lobophyllia sp.
SONGS ONG (51)

Diploastrea heliopora
SONGS ONG (52)

Turbinaria sp.
SONGS ONG (53)

Dipsastraea sp.
SONGS ONG (54)

Acropora sp.
SONGS ONG (55)

Rhodactis sp.
SONGS ONG (56)

Platygyra sp.
SONGSONG (57)

Turbinaria sp.
SONGSONG (58)

Diploastrea heliopora
SONGSONG (59)

Turbinaria sp.
SONGSONG (60)

Lobophyllia sp.
SONGSONG (61)

Lobophyllia sp.
SONGSONG (62)

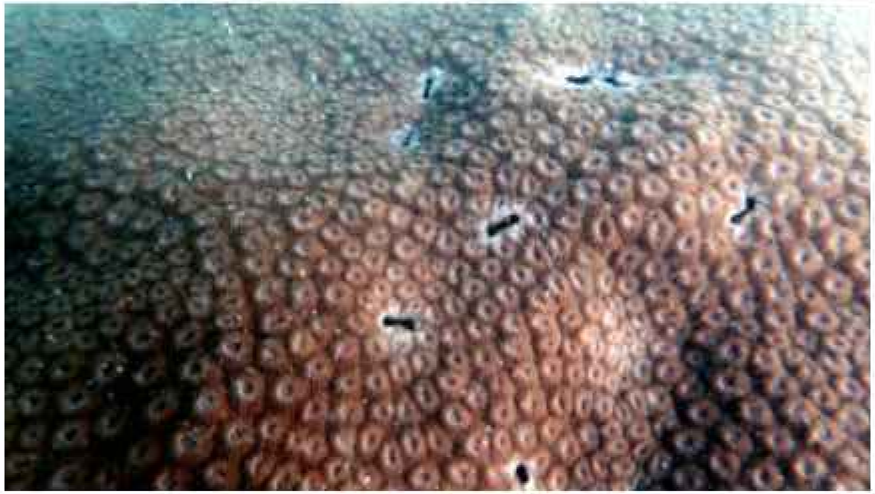
Platygyra sp.
SONGSONG (63)

Lobophyllia sp.
SONGSONG (64)

Dipsastraea sp.
SONGSONG (65)

Dipsastraea sp.
SONGSONG (66)

Lobophyllia sp.
SONGSONG (67)



Diploastrea heliopora
SONGSONG (68)

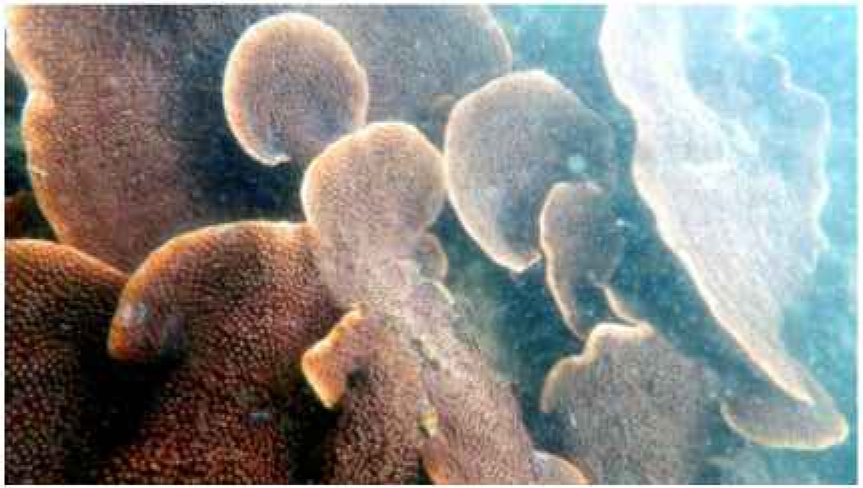
Turbinaria sp.
SONGSONG (73)

Lobophyllia sp.
SONGSONG (74)

Dipsastraea sp.
SONGSONG (75)

Diploastrea heliopora
SONGSONG (76)

Diploastrea heliopora
SONGSONG (77)



Turbinaria sp.
SONGSONG (78)

Turbinaria sp.
SONGSONG (79)

Rhodactis sp
SONGSONG (80)

	
Diploastrea heliopora **SONGSONG (81)**	*Dipsastraea* sp. **SONGSONG (82)**
	
Favites sp. **SONGSONG (83)**	*Lobophyllia* sp. **SONGSONG (84)**

Dipsastraea sp.
SONGSONG (85)

Diploastrea heliopora
SONGSONG (86)

Diploastrea heliopora
SONGSONG (87)

Favites sp.
SONGSONG (88)

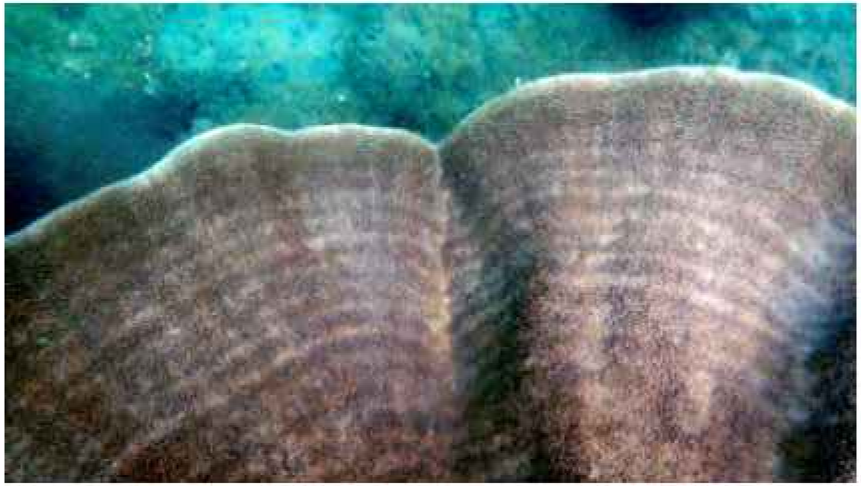
Turbinaria sp.
SONGSONG (89)

Lobophyllia sp.
SONGSONG (90)

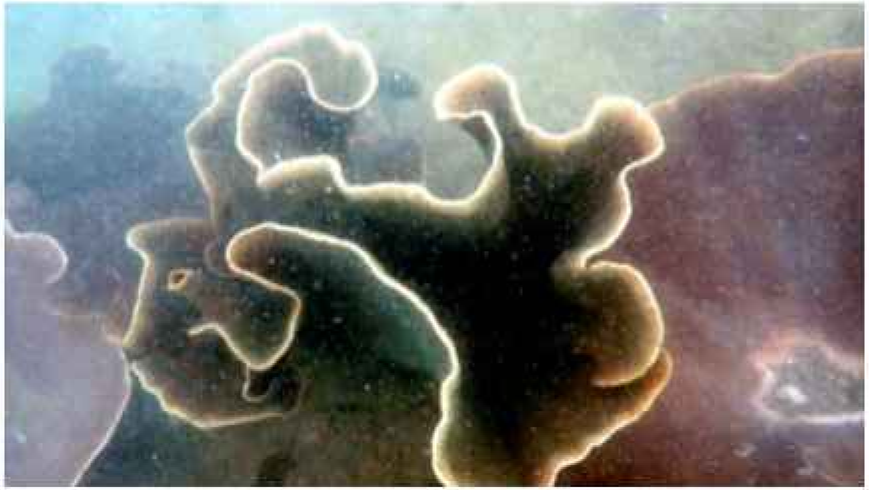
Lobophyllia sp.
SONGSONG (91)

Diploastrea heliopora
SONGSONG (92)

Coelastrea sp.
SONGS ONG (93)



Turbinaria sp.
SONGS ONG (94)



Turbinaria sp.
SONGS ONG (95)

Turbinaria sp.
SONGS ONG (96)

Turbinaria sp.
SONGSONG (97)

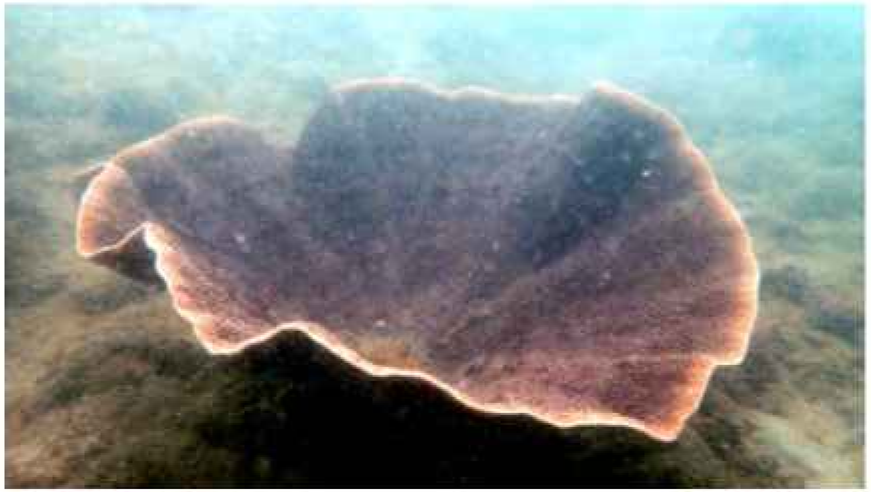
Turbinaria sp
SONGSONG (98).

Turbinaria sp.
SONGSONG (99)

Turbinaria sp.
SONGSONG (100)

Turbinaria sp.
SONGSONG (101)

Turbinaria sp.
SONGSONG (102)



Turbinaria sp.
SONGSONG (103)

Rhodactis sp.
SONGSONG (104)

Turbinaria sp.
SONGSONG (105)

Goniopora sp.
SONGSONG (106)

Lobophyllia sp.
SONGSONG (107)

Sinularia sp.
SONGSONG (108)

Sinularia sp.
SONGSONG (109)

Sinularia sp.
SONGSONG (110)

Porites sp.
SONGSONG (111)

Porites sp.
SONGSONG (112)

Porites sp.
SONGSONG (113)

Porites sp.
SONGSONG (114)

Dipsastraea sp.
SONGSONG (115)

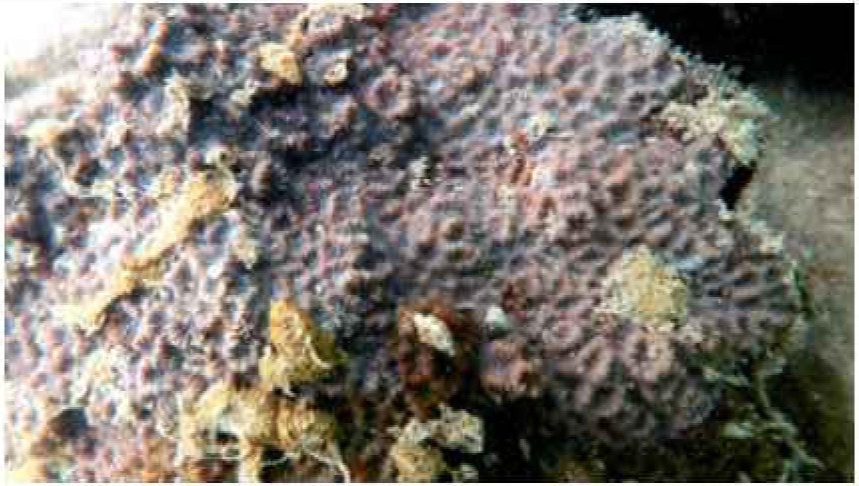
Pavona sp.
SONGSONG (116)

Dipsastraea sp.
SONGSONG (117)

Heteractis sp.
SONGSONG (118)

Dipsastraea sp.
SONGSONG (119)

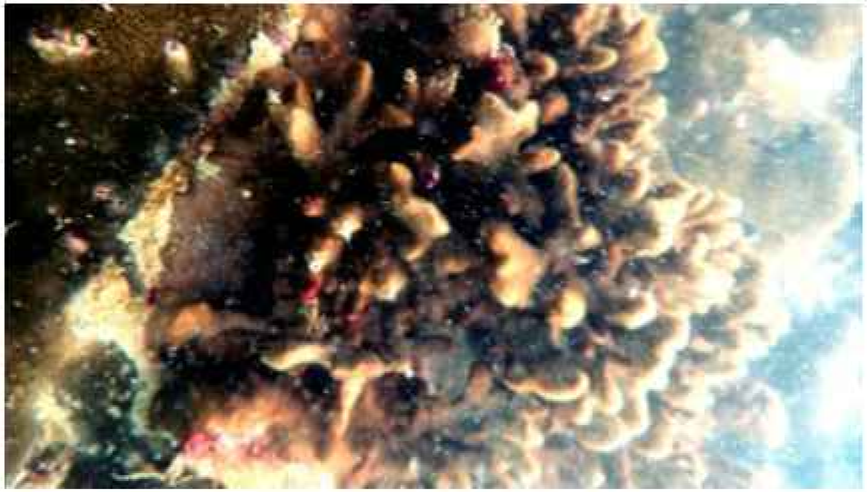
Acropora sp.
SONGSONG (120)



Favites sp.
SONGSONG (121)

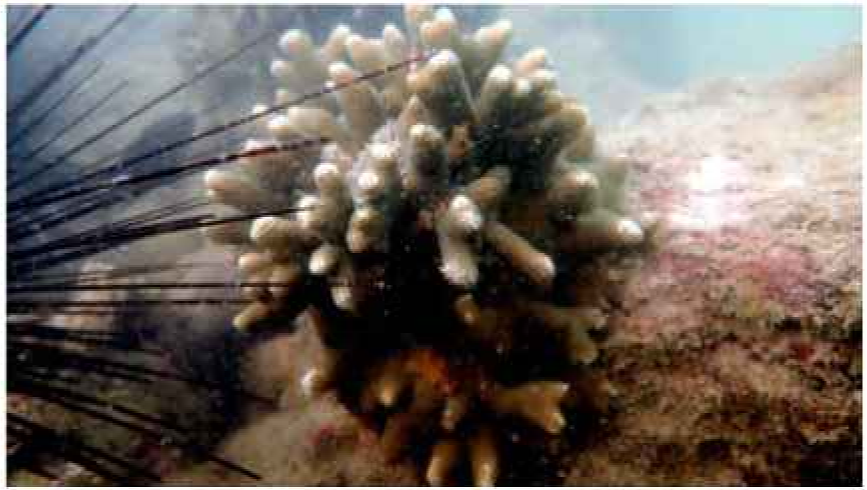
Porites sp.
SONGSONG (122)

Dipsastraea sp.
ONGSONG (123)



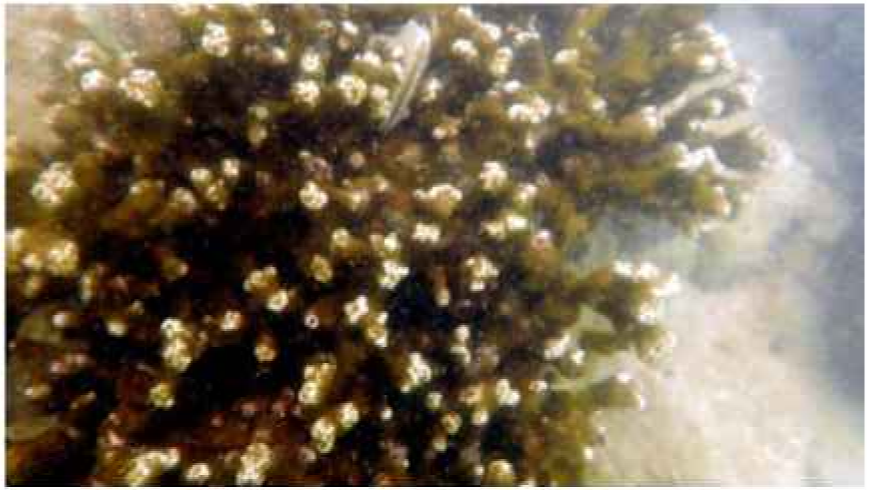
Pavona sp.
SONGSONG (124)

Lobophyllia sp.
SONGSONG (125)



Porites sp.
SONGSONG (126)

Dipsastraea sp.
SONGSONG (127)



Porites sp
SONGSONG (128)

Porites sp.
SONGSONG (129)

Dipsastraea sp.
SONGSONG (130)

Porites sp.
SONGSONG (131)

Porites sp.
SONGSONG (132)

Porites sp.
SONGS ONG (133)

Acropora sp.
SONGS ONG (134)

Porites sp.
SONGS ONG (135)

Porites sp.
SONGS ONG (136)

Porites sp.
SONGS ONG (137)

Porites sp.
SONGS ONG (138)

Porites sp.
SONGS ONG (139)

Porites sp.
SONGS ONG (140)

Porites sp.
SONGSONG (141)

Porites sp.
SONGSONG (142)

Euphyllia sp.
SONGSONG (143)

Pavona sp.
SONGSONG (144)

Pavona sp.
SONGSONG (145)

Porites sp.
SONGSONG (146)

Porites sp.
SONGSONG (147)

Porites sp.
SONGSONG (148)

Pavona sp.
SONGSONG (149)

Acropora sp.
SONGSONG (150)

Dipsastraea sp.
SONGSONG (151)

Pavona sp.
SONGSONG (152)

Dipsastraea sp.
SONGSONG (153)

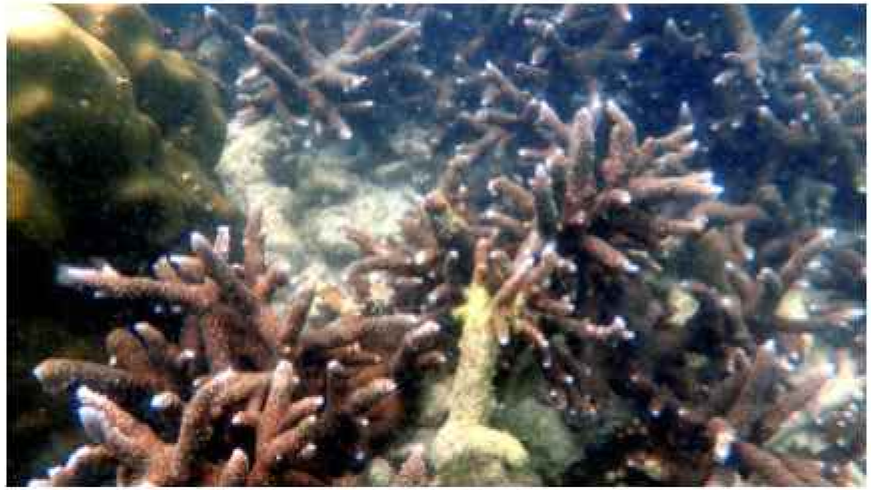
Physogyra sp.
SONGSONG (154)

Diploastrea heliopora
SONGSONG (155)

Acropora sp.
SONGSONG (156)

Fungia sp.
SONGSONG (157)

Fungia sp.
SONGSONG (158)



Acropora sp.
SONGSONG (159)

Acropora sp.
SONGSONG (160)

4.0 CONCLUSION

Most coral reefs at Pulau Songsong and Tukun Terendak have significantly degraded at such a magnitude that recovery may never occur within a human time scale. Stronger efforts are needed to prevent further degradation of remote reefs in Malaysian waters as well as throughout the region. There is an immediate need to implement a management strategy to reduce and/or prevent non-point source pollution impacts on coral reefs before we witness an ecological and socio-economic collapse. In order to ensure the safeguarding of coral diversity within the area for the long-term purpose, rehabilitation and conservation activities such as coral planting and propagation should be strongly emphasized. Furthermore, this study showed that an acoustic approach is particularly suitable for used in waters that have very low visibility. In addition, the data collection using this approach does not depend on the cloud cover, which is known to be a serious problem for satellite imagery. From this study shows that the estimated area of Coral Cover in Pulau Songsong and Tukun Terendak recorded an area of 22,272 m^2 and 2,116 m^2 respectively. Moreover, an acoustic approach will provide detailed information on bathymetry and topography of this area and remains an important tool to be used in addressing a range of key issues relating to Marine Spatial Planning. Once the concept is empowered with policies and good governance, it will play an important role in preserving and conserving fisheries resources. Last but not least, rather than inheriting this earth from our ancestors, we are just merely borrowing it from the future generation.

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