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CORAL REEFS MONITORING PROJECT 2005:
TURTLE ISLANDS PARK

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ABSTRACT

The coral reefs monitoring project at Turtle Islands Park (TIP) has been carried out from 7 – 16 September 2005 and our unit have managed to cover a total of 5 surveying sites. The average percentage of coral cover at TIP was 50.5%, with a total of 335 individuals of fish and 124 of invertebrates are recorded during Reef Check survey.

INTRODUCTION

TIP, with total area of 1,740 ha, was gazetted in 1977 in order to protect the major nesting habitat of two species of sea turtles; Green and Hawksbill. It is located about 40 km to the North of Sandakan on the edge of the Malaysia-Philippines international border. The Park consists of three beautiful islands, namely Selingaan (P. Selingaan), Bakkungan Kechil (P. Bakkungan Kechil)) and Gulisaan (P. Gulisaan). The Park lies between N 06°09´ to N 06° 11´ latitude and E 118° 03´ to E 118° 06´ longitude on the Sulu Sea.
The Park provides nesting habitats to one of the largest aggregations of Green Turtle and the largest remaining Hawksbill Turtle populations in the entire South-East Asian region

(Chan & Liew, 1996). Unlike in other turtle nesting beaches in the world, the Turtle Islands Park is unique for its all-year-round nesting of both species.

Based on the importance of the park, we believe that monitoring of this marine park is extremely important as it can be useful tools to measure how our park functions and to sustain in this era, and hopefully for the future generation. Since the most ongoing or outgoing research is turtle base research either by outsider researchers or by the park's marine Unit. There is no long term intensive research has been carried within our marine park that concentrated to the coral reef ecosystems itself.

Although our Unit has done some coral reefs survey back in 1998, a lot of effort and focus has been concentrated towards the coral reefs monitoring within TARP alone, and the monitoring at TIP area has not been continued after 1998. So, we believe it is the right time for us to continue and expend our capability, and effort towards the monitoring to all marine parks under the Sabah Park jurisdiction as well.

This report is our final report of Coral Reefs Monitoring Project 2005 exclusive for Turtle Islands Parks that has been carried out from 7 -16 September 2005.

OBJECTIVES OF THE SURVEY

a. To collected data on hard coral, fish and invertebrates using the Reef Check and Manta tow methods,

b. To check on the status of the coral reefs within the Parks as a long terms monitoring program,

c. To do some assessments on the function of our marine parks (MPAs) in terms of enforcement and the conservation for the long terms monitoring,

d. To give any recommendation and suggestion to Park management when necessary.

TEAM MEMBERS

During the implementation of the project, our unit had enormous support from the management of Sabah Parks, Park Managers, Rangers and others staff on each and every marine park we carried out the survey. Nevertheless, we feel very fortunate enough to have these team members in our survey project at TIP as shows at Table 1 below;

Table 1: List of team members during TIP Coral Reefs Monitoring Project 2005

Staff	Remarks
1. Irwan Isnain	Team Leader /Invertebrate
2. Koichi Sakamoto	Marine Biologist (JICA/JOCV)/Fish/Underwater photo
3. Mohd Nara Ahmad	Substrate/Invertebrate
4. Oktovorino Benedick	Substrate/Manta Tow

5. Roslee Karim	Manta Tow/Transect
6. Johny Buis	Research Assistant (TIP)
7. Mohd Kassim Karim	Fish survey (TIP)

SURVEY SITES

The selection of survey sites for TIP is base on the 'best live coral cover' from the manta tow survey results as well as sites representations for each area in these particular parks. Survey areas for TIP are concentrated mostly on the coral reefs area off three islands and one sub-merge reef which named as Mid Reef located between P. Selingaan and P. Bakkungan Kechil (Figure 1). Manta tow survey was carried out a day earlier before the sites were surveyed using the diving equipments for further details.

METHODS & TECHNIQUEs

A. Manta Tow Survey

Manta tow technique described in the Survey Manual for Tropical Marine Resource from Australian Institute of Marine Science (2nd edition) is used for the first part of the study to recorded the general status of coral cover of study area. This technique involves towing an observer, using a rope and manta board behind a small boat. Each tows will carried out at a constant speed (1 – 1.5 knots) around the reef slope and for 2 minutes duration (Figure 2).

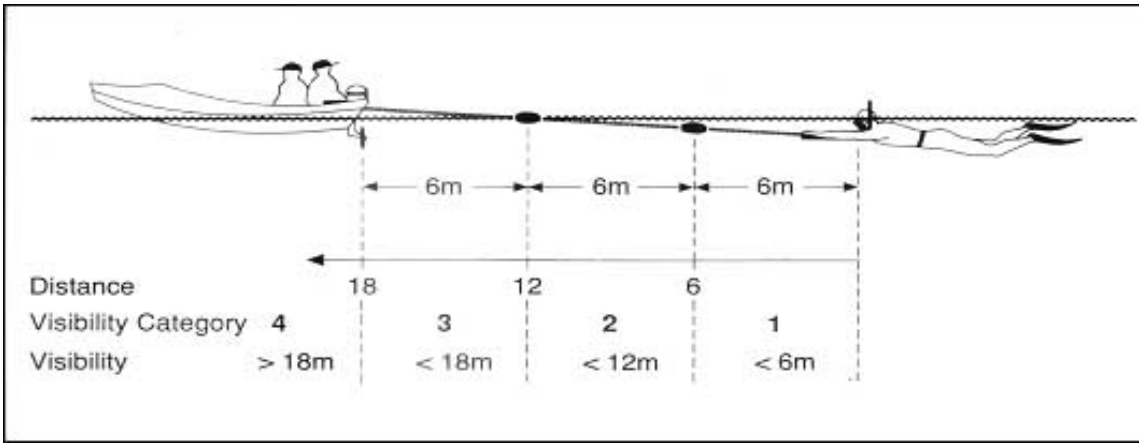
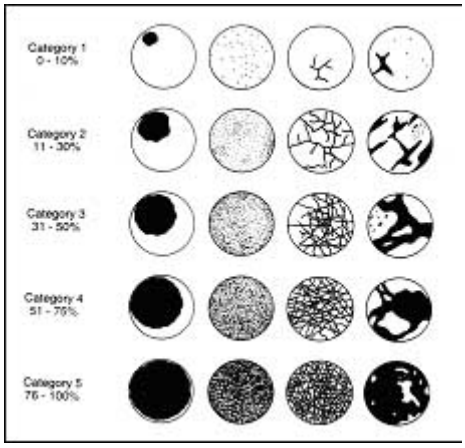


Figure 2: The Manta Tow technique showing the observer being towed along the surface of water behind a small boat (English et al., 1997).

During each 2 minutes tow, the observer will make an observation and record the percentage of live coral, dead coral, soft coral, sand and rubbles or even possible damage of the reef by fish booming activities or the COT on the water prove data sheets using categories (Figure 3). This special design manta board is about 40cm x 60cm in size with 17 meters tow rope connecting the board to the boat (Figure 4). Tow buoys are placed on the rope, one at 6 meters from the manta board and another at 12 meters. These buoys

allow the observer to estimate visibility in a standard manner. Manta tow surveys are conducted by team of one or more pairs.



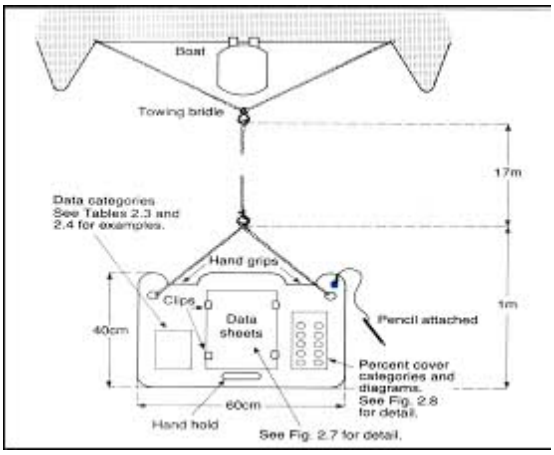


Figure 3 & 4: Left picture show schematic representations of percent cover and right picture show detail of the manta board and associated equipment (English *et al*., 1997).

B. Reef Check Survey

The second and final stage of the monitoring is underwater study using SCUBA equipment. The underwater monitoring follows the guideline in the Reef Check Instruction Manual, A guide to Reef Check Coral Reef monitoring (2004 edition). As describe in the manual, single 100 meters or two 50 meters fibreglass measuring tape or transect are deployed on two depth contours, between 2 – 6 meters (shallow) and between >6 - 10 meters (deep) as the depth during the lowers low tide. These transect are placed seaward of the reef crest on the outer slope, parallel to shore (Figure 5). However the deployment of two transects is not a compulsory as it all depending on the reefs suitability and if the reefs areas are not suitable, surveying one contour depth is enough.

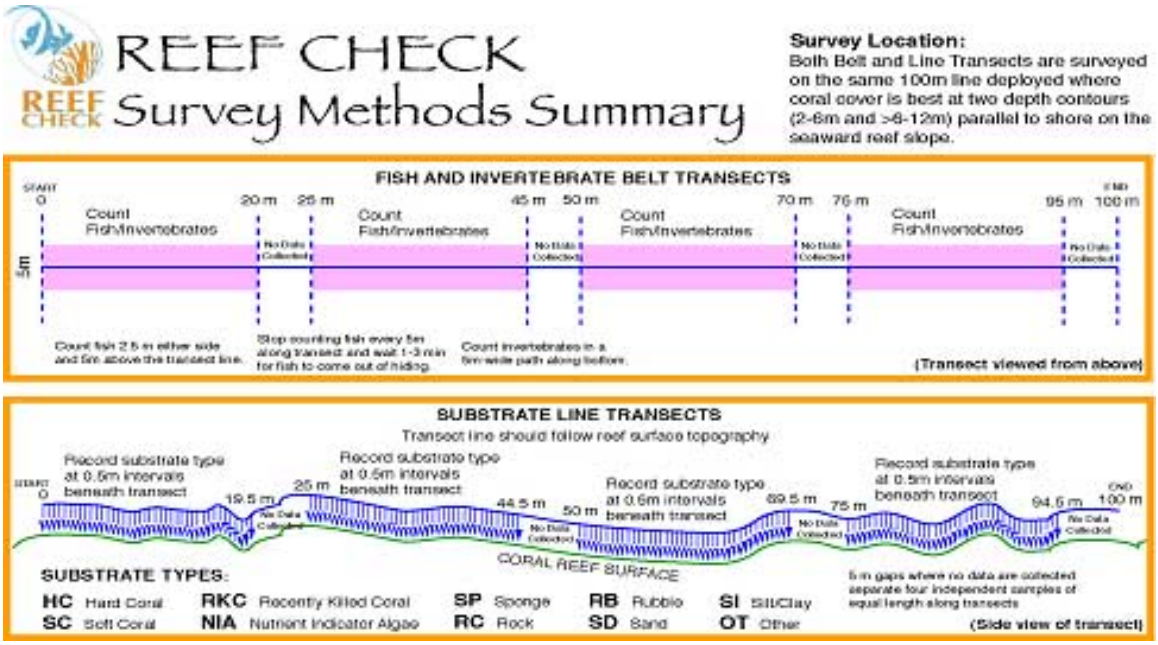


Figure 5: The diagram of transect (www.reefcheck.org)

One buddy pair needed to lay out a 100 meters transect line on each specific depth contour and it should goes through the areas of high coral cover as possible. After deployment, the entire length of the transect line should be examined to ensure it is not snagged or floating more than 1 meter off the bottom. Small temporary floats should be attached to the both starting and ending points of each transect for easy to find. And as our long time monitoring purpose, at the starting point of each transects, an angel bar with buoys is hammered as permanent site marker for the future references and survey.

The Reef check survey are divided into 3 types of data recoding. These are;

i. Fish Belt Transect

About 15 minutes after the transect deployment, the Fish Belt Transect survey is carry out. This 'resting' periods are important to allow fish to resume their normal behaviors after been disturbed by the divers deploying the transect line. The fish belt survey only counted and recorded indicator fish; fish species typically targeted by fisherman, aquarium collectors and others. However, for our Unit purpose some fish species also added into our data and some underwater pictures are taken as a record. Diver will count fish while swim slowly along the transect counting the indicators fish (See Appendix i). The indicators fish are counted each 2.5 meters left and right from the centered on the transect line (5 meters wide) by 20 meters long segments, and fish seen up to 5 meters above the water column are counted as well. The diver will stop every 5 meters, and wait one to three minutes for the indicators fish come out of hiding before proceed the next

stopping point. Each 100 meter transect are divided into 4 segments of 20 meters long with 5 meters gaps where no data are collected. Overall there are 400 m2 combined timed and area restricted survey on each transects (four segments x 20 m long x 5 m wide= 400 m2). An additional data of any sightings of what are now becoming rare animals such as manta rays, sharks, turtles, Humphead Wrasse and Bumphead Parrotfish are also recorded.

ii. Invertebrate Belt Transect

When the fish belt transect survey is complete, the Invertebrate Belt Transect team can then carry out the invertebrates survey using the same belt transect as was used for the fish survey earlier. The invertebrate's survey is similar to the fish survey, however in this survey the diver does not stop at every 5 meters. For the invertebrate survey, it is extremely important to look into cracks, under large coral heads and overhangs to search for cryptic species such as lobster and banded coral shrimp (See Appendix ii).
At all sites, estimating coral damage are made with focus on the damage made by the boat or anchoring, dynamite, COT and Others. Bleaching coral population and colonies for each site and sighted of any trash including fish nets are also made into the record. Estimating is made with rating from none=0, low=1, medium=2, and high=3.

iii. Substrate Line Transect

When the invertebrate belt transects is almost complete, the next designated buddy pair can begin the Substrate Line Transect survey. This sampling is base on 'point sampling' because it is least ambiguous and faster method of survey, plus easy to learn by non-scientists. The diver will simply look at a series of points where transect tape lies above the reef and note down what lies under those points. Substrate type will be recorded at 0.5 meters intervals along the line (Figure 6). There will be 40 data points will be recorded for every 20 meters transect segment (See Appendix iii).

Figure 6: A pair of buddy doing the Substrate line transects data collection

To minimize bias, plum line or pointer is used. The plum line or pointer is a 0.5 mm diameter metal rod (stainless steel) and about 15 cm in length will be used. Divers will recorded every substrate type on every point along the transect line.

C. Basic Water Quality

For each diving site (reef check survey), a four basic water qualities such as Secchi Disc, temperature, Salinity and Conductivity as well as the GPS (Global Positioning System) reading are also recorded for future references and study.

EQUIPMENTS AND LOGISTIC

Below is some of the equipments and logistic which is used during the study;

a. Research vessel, Diving & Research equipments,
b. At least 2 unit 100 meters fiberglass transect tape, 20 lb hammer, angels bars, buoys and rope,
c. Underwater date sheets, slid board, underwater digital cameras and laminating underwater pictures (references),
d. Manta board, aerial maps, and coral reef maps,
e. GPS and references.

FIELD WORK SCHEDULE

Date	Field Works/Notes
7 – 16 September 2005	Field works at TIP: -Manta tow & Reef Check

RESULT

a. Manta Tow

Manta tow survey at TIP carried out during the second week of September 2005. A total of 90 tows were completed in order to cover the whole park. The details are shown as at Table 2 & 3 and on the Figure 7.

Table 2: Numbers of tows completed during Manta tow survey at TIP.

Sites	Sites Name	Number of tows
1	Pulau Gulisan	29
2	Mid Reef	18
3	Pulau Selingan	22
4	Pulau Bakungan Kechill	20
Total:		**89 tow**

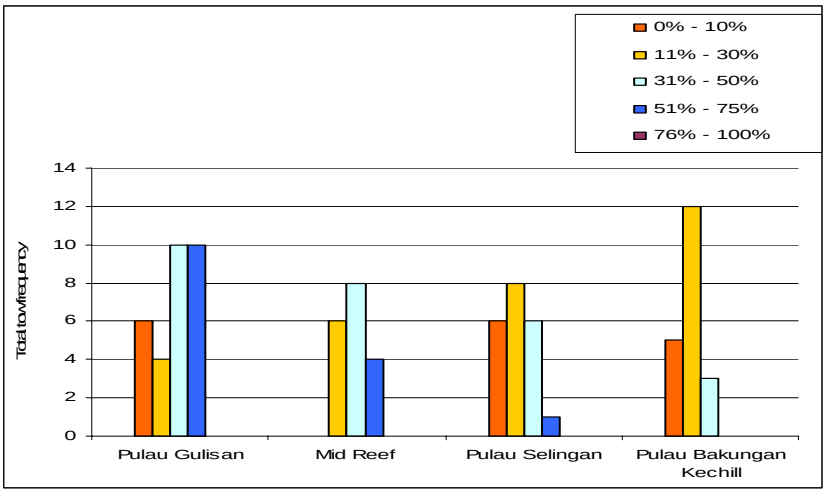


Figure 7: The graph above show the frequency of total tows.

Table 3: The number of tows completed under each category during Manta tow survey at TIP

Category*		Pulau Gulisan	Mid Reef	Pulau Selingan	Pulau Bakungan Kechill
1	0% - 10%	6	0	6	5
2	11% - 30%	4	6	8	12
3	31% - 50%	10	8	6	3
4	51% - 75%	10	4	1	0
5	76% - 100%	0	0	0	0
Total:		30	18	22	20

** Category 0: Poor, Category 1: Fair, Category 2: Moderate, Category 3: Good, Category 4: Very Good, Category 5: Excellent*

b. Reef Check

A Total of 5 reef check sites were completed during this survey at TIP. Two sites were carried out at P. Selingaan reef area namely P. Selingan 1 and P. Selingaan 2, while one site were deployed each at P. Gulisaan reef flat, at the reef slope of Mid Reef and P. Bakkungan Kechil, respectively. Three sites were completed with 2 depth contour (3-4 meters for the shallow and 8-10 meters for the deep) while the rest of the sites were only cover with one depth contour at 3 - 4 meters. The details of the data are as shows at Table 4 – Table 7, below;

i. Substrate line transect

Table 4: The percentage of substrates recorded for each sites and depth contour at TIP.

Site	Depth	HC %	SC %	RKC %	NIA %	SP %	RC %	RB %	SD %	SI %	OT %
Mid Reef	3m	71.3	0.0	0.0	1.3	0.0	15.6	10.0	1.9	0.0	0.0
	8m	30.0	0.0	0.0	0.0	0.0	17.5	27.5	25.0	0.0	0.0
PGL	2.5m	66.9	2.5	0.0	3.1	0.0	10.0	5.6	1.9	0.0	10.0
PSL1	3m	50.6	0.6	0.0	0.0	1.3	31.9	11.9	3.8	0.0	0.0
PSL2	5m	69.4	1.9	0.0	0.0	0.0	18.8	3.1	6.9	0.0	0.0
	10m	43.1	1.3	0.0	1.3	0.6	18.1	11.9	23.1	0.0	0.6
PBK	3m	46.9	3.1	0.0	0.0	0.0	22.5	16.3	8.8	0.0	2.5
	8m	25.6	1.9	0.0	0.0	0.6	27.5	34.4	7.5	0.0	2.5
Average		**50.5**	**1.4**	**0.0**	**0.7**	**0.3**	**20.2**	**15.1**	**9.9**	**0.0**	**2.0**

ii. Fish Belt Transect

Table 5: Numbers of targeted fish recorded for each sites and depth contour at TIP.

Site	Depth	Butterfly fish	Sweetlips	Snapper	Barramundi Cod	Grouper (>30cm)	Humphead wrasse	Bumphead parrot	Parrotfish	Moray eel	Total
Mid Reef	3m	4	0	0	0	2	0	0	0	0	6
	8m	18	0	10	0	0	0	0	9	0	37
PGL	2.5m	10	0	0	0	1	0	0	4	0	15
PSL1	3m	24	0	11	1	8	0	0	7	0	51
PSL2	5m	23	0	8	0	7	0	0	0	0	38
	10m	23	6	25	0	10	0	0	5	0	69
PBK	3m	13	0	15	0	9	0	0	5	0	42
	8m	28	2	24	0	13	0	0	10	0	77
Total:		143	8	93	1	50	0	0	40	0	**335**

iii. Invertebrate belt transect

Table 6: Numbers of invertebrates recorded for each sites and depth contour at TIP.

Site	Depth	Banded coral shrimp	Diadema urchin	Pencil urchin	Tripneustes	Sea cucumber	Crown of Thorns	Giant clam	Triton shell	Lobster	Total
Mid Reef	3m	0	28	0	0	0	0	2	0	0	30
	8m	0	10	0	0	1	0	0	0	0	11
PGL	2.5m	0	2	0	0	0	0	0	0	0	2
PSL1	3m	0	9	0	0	0	0	2	0	5	16
PSL2	5m	0	1	0	0	0	0	0	0	0	1
	10m	0	4	0	0	0	0	0	0	3	7
PBK	3m	0	18	0	0	21	0	0	0	0	39
	8m	0	7	0	0	11	0	0	0	0	18
Total:		0	79	0	0	33	0	4	0	8	124

c. Water Quality

At every surveys site, basic water quality data also taken and recorded as show at Table 7 below;

Table 7: The average of basic water quality recorded for each sites at TIP

Site	Salinity (ppt)	Secchi disc (meter)	Conductivity (μs)	Temperature (Average) ºC
P. Gulisaan	35	6	53.4	30.2
PSL1	35	7	54	30.6
PSL2	35	8	54.1	30
Mid reef	35	6	53.6	30.3
PBK	35	10	52.8	30

Average	35	7.4	53.58	30.22

DISCUSSION

a. Manta tow:

Figure 1 and Table 3 shows that over **46.6%** (42 tows, n=90) of total tows were categories under good coral cover. Sites at P. Gulisaan and Mid Reef recorded the highest tows with 66.6% (20 tows, n=30) and 66.7% (12 tows, n=18), which categories as good coral cover. However, P. Bakkungan Kechil and P. Selingaan site recorded the lowers among all sites with 15% (3 tows, n=20) and 31.8% (7 tows, n=22), respectively.

From data analysis and general observation of TIP revealed that most "good coral cover" were limited to shallow areas, it is believed that if the surveys were carried out on the reef slope the result might be much lower. In addition, some un-experienced observer may have resulted an error during the surveys.

However, as mentioned in methods that manta tow surveys were carried out as general base-line data collection, the main study of the programme will be the Reef Check surveys.

b. Reef Check

i. Substrate

<u>P. Gulisaan</u>
(2.5m transect)

Reef flat at P. Gulisaan were among the largest at TIP, but the visibility was extremely low. That forced us to deploy only one permanent transect on the shallow reef flat at the depth of 2.5m.

The percentage cover of 'hard coral' was 66.9%, followed by 'rock' with 10% and 'rubble' with 5.6%. This value of hard coral cover was the third highest among sites of TIP. The dominant genera of hard coral consisted of *Acropora*, *Montipora* and *Seriatopora* (Figure 8 & 9).

Figure 8 & 9: Dominant genera of hard coral in this transect were *Acropora*, *Montipora* and *Seriatopora* recorded at P. Gulisaan site at the depth 2.5 meter.

What came to our concern was that we found a few colonies of green algae, *Halimeda sp*., which spreading large area and, in some places, covering over hard corals (Figure 10 & 11). Besides, filamentous algae were observed breeding over that *Halimeda* partly and smothering some hard corals as shown at Figure 12 & 13.


Figure 10 & 11: large colony of *Halimeda sp.*, which is one of the green algae and some of *Halimeda sp*. was covering over hard corals


Figure 12 & 13: Filamentous algae was breeding on the *Halimeda* and smothering some hard corals

Damage caused by "anchor", "dynamite" and "COT" was not observed, while "other" damage was regarded as low on 1st to 3rd segment, medium on 4th segment with the filamentous algae aggression.

Although coral bleaching was found in 1st segment, it was estimated less than 1% of the total coral population.

P. Selingaan 1

(3m transect)

Even though the visibility at this site was a little bit better than P. Gulisaan, deeper transect could not be set up because the visibility became worse at the deeper depth. Only one permanent transect was deployed at the shallow depth of 3 meter.

The percentage cover of 'hard coral' was 50.6%, followed by 'rock' with 31.9% and 'rubble' with 11.9%. Tabular and branching *Acropora* was dominant (Figure 14). We witnessed one large tabular *Acropora* in 2nd transect, which was over two meter in maximum diameter (Figure 15).

Figure 14 & 15: Large tabular and branching *Acropora*, and over 2 meter large tabular *Acropora* on the right picture.

On the other hand, many dead *Acropora* covered with algae caught our eyes. The reason was not clear, however what we can say that the disturbance which had caused such situation seemed to happen recently as we still can observed the structures were still remained (Figure 16 & 17).

Figure 16 & 17: Dead algae covering some *Acropora* plates, and some branching Acropora were dead and become rubbles.

Though damage caused by "anchor", "dynamite" and "COT" was not observed, damage by "other" was regarded as medium on the 2nd, 3rd and 4th segment with dead algae covered *Acropora* mentioned above.

<u>P. Selingaan 2</u>
(5m transect)

The percentage cover of 'hard coral' was 64.9%, followed by 'rock' with 18.8% and 'sand' with 6.9%. This value of hard coral cover was the second highest among sites of TIP. With reference to coral composition, there was not dominant species and rather were various kinds of corals (Figure 18), except the extensive tract of *Milepora* on the third segment (Figure 19).

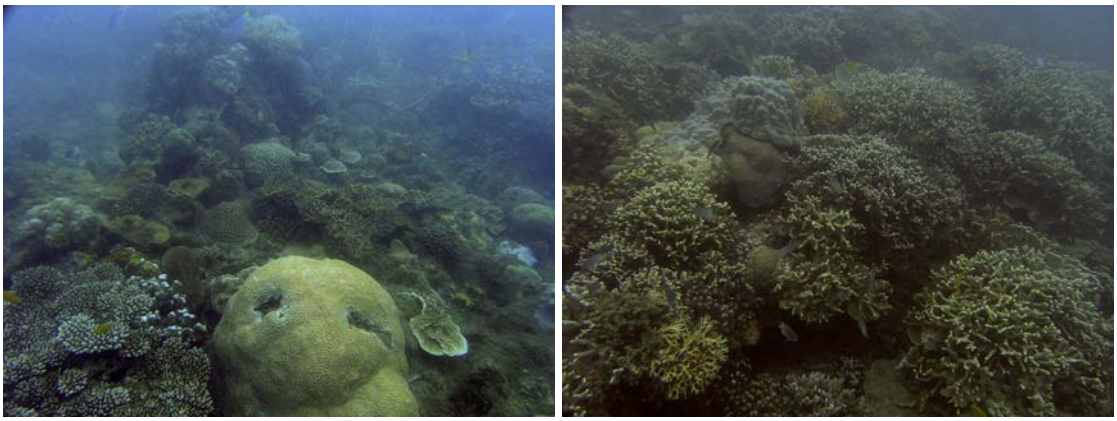


Figure 18 & 19: There was no dominant species and rather various kinds of corals were observed. Large colony of *Milepora* recorded on the third segment of transects.

Damage caused by "anchor", "dynamite" and "COT" was not observed, damage by "other" was regarded as low from 1st to 4th segment some algae covered corals.

(10m transect)

At the deeper contour, the percentage cover of 'hard coral' was 43.1%, followed by 'sand' with 23.1% and 'rock' with 18.1%. Foliose, encrusting and massive forms of corals were common at this site. *Montipora, Pacyseris, Echinopora, Diploastrea, Oxypora, Mycedium, Pectinia, Porites* and *Faviidae* were some of the various species of corals observed at this site (Figure 20& 21).

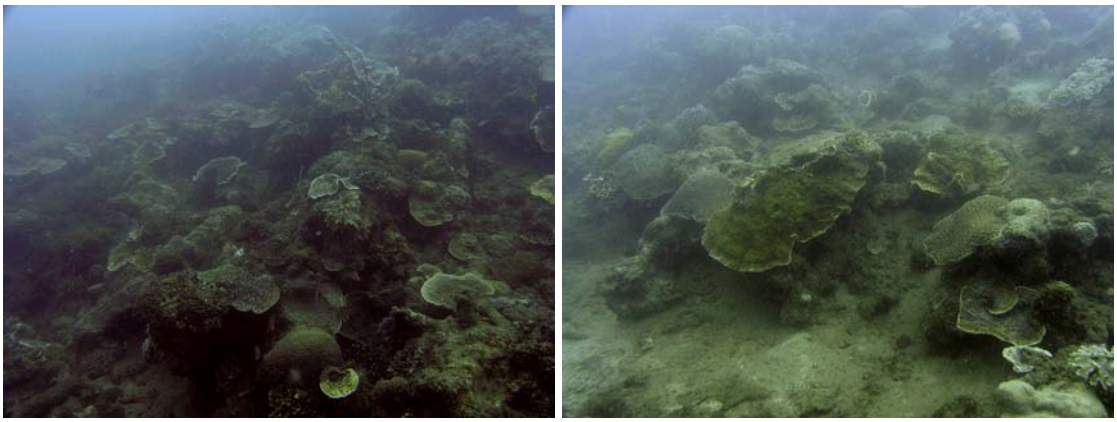


Figure 20 & 21: Some of the various species of corals observed at this site

The damage caused by "anchoring", "COT" or "dynamite" was not observed. On the other hand, we observed some area which sediment accumulating on corals (Figure 22), and algae growing and covering corals. The "other damage" was rated as medium from the 1st to 4th segments. While "general trash" was not recorded, abandoned fish net was observed on the 4th segment of transect (Figure 23).

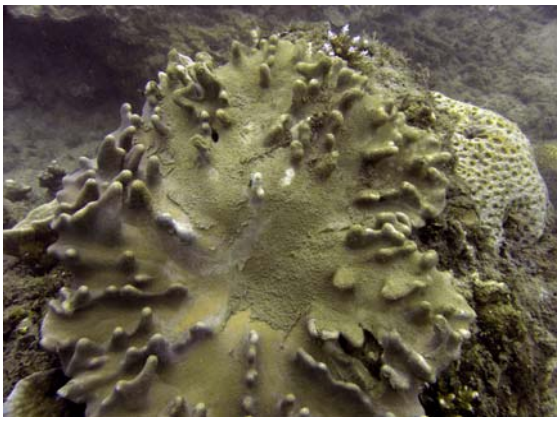
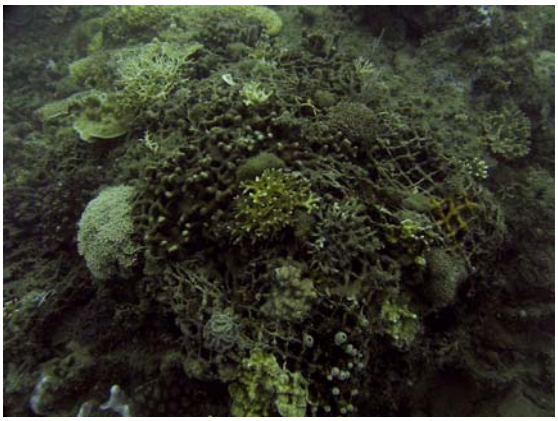



Figure 22: High sediment also observes covered hard and soft coral.
Figure 23: Fish net, which was probably left for a long time also observed.

Mid Reef
(3 meter)

The percentage cover of 'hard coral' was 71.3%, followed by 'rock' with 15.6% and 'rubble' with 10%. This value of hard coral cover was the highest among sites of TIP. At this site, *Acropora* was the dominant corals (Figure 24), however at some points, a tract of *Pocillopora*, *Millepora*, *Porites* and *Montipora* were also observed (Figure 25).

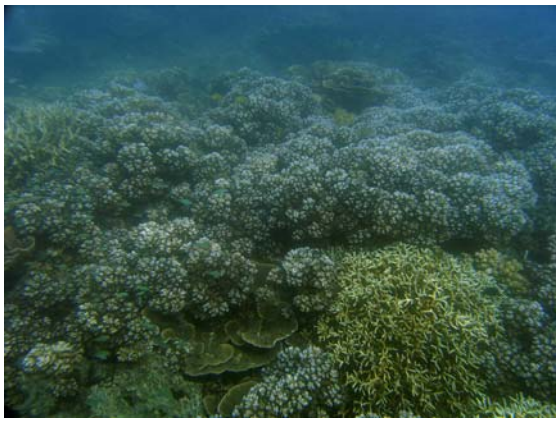



Figure 24: *Acropora* rather dominant at this site.
Figure 25: A tract of *Pocillopora* also observed.

Coral cover from the first to the third segment of transect was generally high. However, at the 4th segment the percentage of coral had suddenly declined to just at 42.5%, instead dead coral stood out (Figure 26).


Figure 26: Dead coral are more stood out at the 4th segment.
Figure 27: Typical sheltered corals were dominant on the poor visibility and high sediments area.

Damage caused by "dynamite" and "COT" was not observed. However, a crack/hole about a meter in diameter was observed in the colony of branching *Acropora* few meters from transect at the shallow depth. This damage appeared to have been caused by boat anchoring (Figure 28). "Others damage" were recorded at low level from 1st to 4th segment with some algae covered dead corals.

Figure 28: A large hole was observed in this colony of *Acropora*, believed have been caused by anchoring.

(8 meter)

The percentage of 'hard corals' was 30.0%, followed by 'rubble' with 27.5% and 'rock' with 17.5%. The values of hard coral were significantly lower then the shallow transect (3m). Visibility is very poor and conspicuous sediments seemed to be one of the reasons which caused such condition. The dominant corals at this transect were rather the typical sheltered corals such as *Montipora, Pacyceris, Echinopora, Mycedium* and *Turbinaria* (Figure 27). Sponge, feather star, soft coral and sea fan were also observed in great number within the transect area (Figure 29 & 30)


Figure 29 & 30: Plenty of sponge, feather star, soft coral and sea fan at this site, with some low visibility as the back ground.

Coral damage causes by “anchoring”, “COT” and “dynamite” not been recorded. “Others” damage were recorded at medium level from 1st to 4th segment. No “general trash” or “fish net” recorded.

P. Bakkungaan Kechil

(3 meter)

The percentage of ‘hard coral’ cover was 46.9% on average, followed by ‘rock’ with 22.5% and ‘rubble’ with 16.3%. This hard coral percentage was the lowest value among the shallower transect of TIP. *Porites* was slightly outstanding (Figure 31), while soft coral rather abundant (Figure 32).

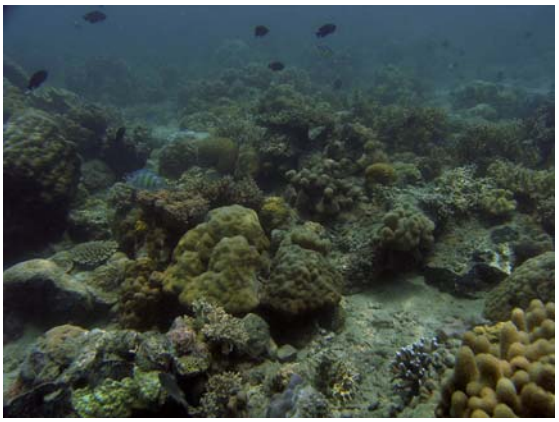
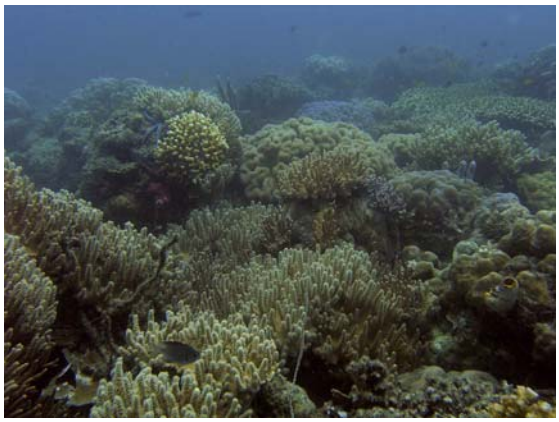



Figure 31 & 32: Left picture show that *Porites* was slightly outstanding with abundant soft coral on the right.

Coral damage causes by “anchoring”, “COT” and “dynamite” not been recorded. “Others” damage was recorded at low level from 1st to 4th segment. No “general trash” or “fish net” recorded.

(8 meter)

The percentage of ‘hard corals’ was 25.6%”, followed by ‘rubble’ with 34.4% and ‘rock’ with 27.5%. The hard coral value was the lowers among the deeper transect of TIP. Visibility is very poor and noticeable sediments seemed to be one of the reasons which caused such condition. There are no dominant corals at this transect, and it were rather consist of some typical sheltered corals as what can be observed at deeper transects

on other sites of TIP (Figure 33). Hydroid and soft corals were abundant with some gorgonian (Figure 34 & Figure 35).

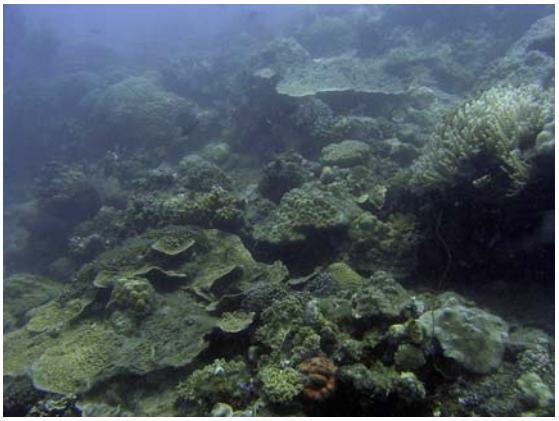
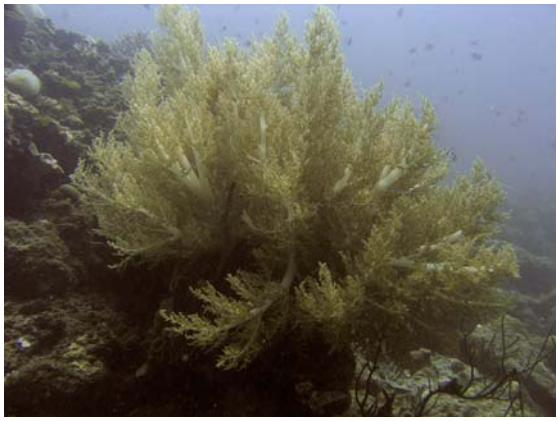



Figure 33 & 34: Left picture show a typical sheltered coral were among that can be observe at the deeper depth contour, while at right picture show some of the Soft coral at this site.

Coral damage causes by “anchoring”, “COT” and “dynamite” not been recorded. “other” causes damage were recorded at low level from 1st to 4th segment of transect.

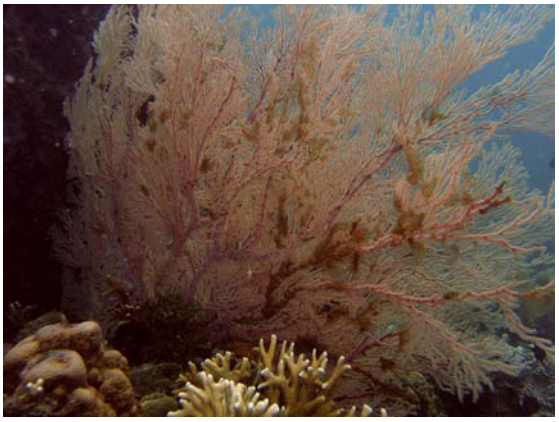


Figure 35: Some magnificent sea fan at P. Bakkungan Kechil site.

Overall Discussion of Substrates at TIP

The average percentage of “hard coral” was 50.5%. On the shallow depth contours, the percentage of hard coral cover were between 46.9% - 71.3% with an average of 61.0%, while at the deeper depth contours those were between 25.6% - 43.1% with an average of 32.9%. These indicate that most “good coral cover” was limited to shallow area compared to deeper one.

As we trying to answer the question of why those shallow transect recorded more good coral cover compared to deeper one, we assume that it might have some connection with the poor visibility during this surveys.

Theoretically the suspended sediment are believed to be carried from rivers of mainland and stirred up by water movement and current, which might bring about such a typical characteristic to a considerable area.

It is a fact that suspended sediment will prevent sun light, which is necessary for coral growing, from penetrating and reaching toward deeper area. Besides, suspended

sediment supposedly accumulates on corals easier in deeper area than shallower one because of the expected low water movement. The sediment on corals will give a lot of stress and sometimes will let it dies with smothering.

Estimating for coral damage and trash mass was made at all sites. Though none of the damage by "COT" or "dynamite" was recorded, one damaged spot by anchoring was recorded just on the shallow transect at Mid Reef. "Other" damage was recorded at all sites rated as low or medium level, mainly caused by sediment, overgrowth of algae, or occurrence of many dead corals. No "general trash" was recorded at all sites, while fish-net was found at P.Selingaan 2.

However, despite the damage caused by fish-net and anchoring were recorded only one time each, it was shocking that those were recorded just on our 100m transects line. Judging from this finding, it will not surprise us if there were more damage within this park. Regular observations on these matters are crucial.

Bleaching coral at TIP sites recorded in very low percentage, which is less then 1% of the coral population. Coral diseases are not been recorded during the survey. However, we sighted a kind of sponge, *Terpios sp.*, which covered and kill hard corals (Figure 36)

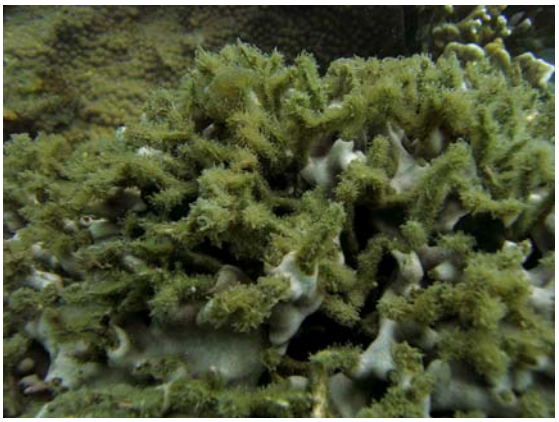


Figure 36: A kind of sponge, *Terpios sp*., which is likely to cover and kill hard corals, was observed at Pulau Selingaan 2 site.

ii. Fish

P. Gulisaan
(2.5 meter)

At this site, a total of 15 individuals of fish recorded and was the second lowers among all sites of TIP. The common fish are butterflyfish from *Chaetodon octofasciatus* species with 10 individuals, followed by the family of other parrotfish, *Scarus spp.* with 4 and grouper, *Epinephelus fasciatus* with 1.

P. Selingaan 1
(3 meter)

A total of 51 individuals of fish from 5 groups recorded. Butterflyfish are common with 24 individuals, followed by snapper with 11, grouper with 8, other parrotfish, *Scarus spp.* with 7 and Baramudi cod, *Cromileptes altivelis* with 1.

*Chaetodon octofasciatu*s is the major species with 17, follow by the *C. rostratus* with 3, *C. trifascialis* and *Parachaetodon ocellatus* both with 2. The number of butterflyfish recorded at these sites was the highest among the shallow transect of TIP.

The major species of snapper recorded is *Lutjanus carponottatus* with total 5 individuals, followed by *L. decussatus* with 3, *L. fulviflamma* with 2 and *L. quinquelineatus* with 1.

Only two species of grouper recorded; *Epinephelus fasciatus* with 5 individuals and *Cephalopholis formosa* with 3.

P. Selingaan 2

(5 meter)

A total of 38 individuals of fish from 3 groups recorded. Butterflyfish are common sighted with 23 individuals, followed by snapper with 8 and grouper with 7.

*Chaetodon octofasciatu*s is the major species recorded with 17 individuals, follow by the *C. trifascialis* with 3, *C. rostratus* with 2 and *C. trifascialis* with 1.

The major species of snapper recorded is *Lutjanus decussatus* and *L. fulviflamma* with 3 each and *L. carponottatus* with 2.

Two species of grouper recorded; *Epinephelus fasciatus* with 6 individuals and *Cephalopholis formosa* with 1.

Figure 37: Two Harlequin sweetlips, *Plectorhinchus chaetodonoides*, was sighted roaming near a coral head at P. Selingan 2 site.

(10 meter)

A total of 69 individuals of fish from 5 groups recorded. Still, butterflyfish are common sighted with 23 individuals, followed by snapper with 25, grouper with 10, sweetlips with 6 and other parrotfish, *Scarus spp*. with 5.

*Chaetodon octofasciatu*s is still the major species recorded with 13 individuals, followed by the *C. rostratus* with 8 and *C. trifasciatus* with 2.

Three major species of snapper recorded were *Lutjanus decussatus* with 9 individuals, followed by *L. carponottatus* with 8, *L. lutjanus* with 6 and *L. fulviflamma* with 3. The number of snapper recorded at these sites was the highest among the deeper transect of TIP.

Two species of grouper recorded; *Epinephelus fasciatus* with 8 individuals and *Cephalopholis formosa* with 2. The number of grouper recorded at these sites was the second highest among the deeper transect of TIP

Three major species of sweetlips recorded were *Diagramma pictum* with 4 individuals, while *Plectorhinchus gibbosus* and *P. chaetodontoides* both with 1 individual each. The number of sweetlips recorded at these sites was the highest among sites of TIP.

Mid Reef

(3 meter)

A total of 6 individuals of fish from 2 groups recorded. Butterflyfish are the common sighted with 4 individuals, followed by grouper with 2.

*Chaetodon octofasciatu*s is the major species with 4 individuals. While, 2 species of grouper were, *Cephalopholis formosa* and *Epinephelus fasciatus* were both with 1 individual.

(8 meter)

A total of 37 individuals from 3 groups of fish recorded. Butterflyfish are common with 18 individuals, followed by snapper with 10 and other parrotfish, *Scarus spp*. with 9.

Two major species of butterflyfish were *Chaetodon octofasciatu*s with 14 individual and *C. rostratus with* 4 were recorded.

Three species snapper recorded were *Lutjanus decussatus* with 6 individuals, *L. lutjanus* with 3 and *L. carponottatus* with 1.

P. Bakkungan Kechil

(3 meter)

A total of 42 individuals of fish from 4 groups recorded. Butterflyfish are common with 13 individuals, followed by snapper with 15, grouper with 9 and other parrotfish, *Scarus spp.* with 5.

Three major species of butterflyfish recorded were *Chaetodon octofasciatu*s with 9 individuals, followed by the *C. rostratus* and *C. trifasciatus* both with 2 each.

Three species of snapper recorded were *Lutjanus carponottatus* with 9 individuals, followed by *L. decussates* with 4 and *L. fulviflamma* with 3.

Two species of grouper recorded were *Epinephelus fasciatus* with 8 individuals and *Cephalopholis formosa* with 1.

(8 meter)

A total of 77 individuals fish from 5 groups recorded. Butterflyfish still lead with 28 individuals, followed by snapper with 24, grouper with 13, other parrotfish, *Scarus spp.* with 10 and sweetlips with 2. The number of parrotfish recorded at these sites was the highest among the deeper transect of TIP.

Four species of butterflyfish recorded were *Chaetodon octofasciatu*s with 15 individuals, *C. rostratus* with 10 and *C. trifasciatus* with 2, and *Henicohus varius* with 1. The number of butterflyfish recorded at these sites was the highest among the deeper transect of TIP.

Three species of snapper recorded were *Lutjanus carponottatus* with 14 individuals, followed by *L. decussates* with 6 and *L. fulviflamma* with 4. The number of snapper recorded at these sites was the second highest among the deeper transect of TIP.

Two 2 species of grouper recorded were *Epinephelus fasciatus* with 8 individuals and *Cephalopholis formosa* with 5. The number of grouper recorded at these sites was the highest among the deeper transect of TIP.

Overall Discussion of Fish at TIP

A total of 335 individuals of targeted fish were recorded during the survey in all sites. Butterflyfish, Snappers, Groupers and other Parrotfish were commonly sighted and recorded almost at all sites.

Among five surveys sites, only three were set up with two transects (shallow and deep), and recorded more numerous number of individuals at the deep transect than the shallow one. The main reason for this difference between two depths could be attributed to the abundant records of Sweetlips and Snappers at the deep transects. In fact, Sweetlips, Snappers and large-size Grouper, in general, have a tendency to settle in deeper area.

But this did not necessarily mean that the deeper contours were more productive than the shallow ones. Because we observed various kinds and a lot of damselfish, wrasse, cardinalfish, and etc., mainly small and not highly prized in a market, on the shallow transect (Figure 38).

Figure 38: Some of the damselfish among *Acropora* at P.Bakkungan Kechil site (8 m).

Butterflyfish was commonly sighted almost at every dive and recorded at all sites. A total of 143 individuals were recorded. Wood, E., (1986) recorded 15 species of Butterflyfish in Turtle Islands Park, while our surveys recorded a total of 6 species; however this might be fairly attributed to the difference of research method and approach used. Two major species that stood out among the recorded six species were *Chaetodon octofasciatu*s and *Chelmon rostratus* with 89.5% of total number of Butterflyfish recorded at TIP. This fact really got us noticed and concerned whether these two species might adapt to the conditions so well or the biodiversity of this family might be declining.

Snappers were sighted occasionally and were recorded almost at all sites during this survey except at P. Gulisaan. Among five recorded species of Snappers, three major species that more dominant than others were *Lutjanus carponottatus*, *L. decussatus* and *L. fulviflamma* with 89.2% of total number of Snappers recorded at TIP.


Figure 39 & 40: Left picture is an interesting group of Panda Butterflyfish, *Chaetodon adiergastos,* were flocking around P. Selingaan 2 sites, and while on right is a school of Russelli's snapper *Lutjanus russelli* at P. Selingaan 2.

Groupers were sighted occasionally at all sites. However, the numbers of grouper recorded were rather low with just 50 individuals. Only two species of groupers were recorded, *Epinephelus fasciatus* was the major species followed by *Cephalopholis formosa*.

Sweetlips were recorded at two sites with 8 individuals. Only three species of Sweetlips recorded. The dominant species among this three was *Diagramma pictum* with 6 individuals, while the other two species *Plectorhinchus gibbosus* and *P. chaetodonoides* with 1 individual each.

Amazingly, for the first time during our survey within all these three parks we were able to record a single individual of Barramundi cod, *Cromileptes altivelis,* on the shallow depth (3 m) at P. Selingaan 1. It was not only very rare within our parks, but also it was a very interesting finding for our whole study.

A total of 40 individuals of Parrotfish were recorded at all 5 sites during this survey. Unfortunately we could not find any Bumphead parrot, Humphead wrasse and Moray eels. These fish are now very rare and difficult to be seen within our water.

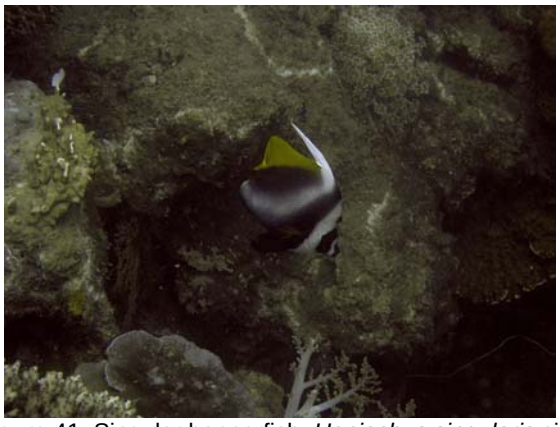


Figure 41: Singular bannerfish, *Heniochus singularis* sighted at P. Bakkungan Kechil.

iii. Invertebrates

P. Gulisaan

A total of 2 invertebrates of long-spined urchin, *Diadema spp*. recorded at P. Gulisaan site.

P. Selingaan 1

At P. Selingaan 1, a total of 16 individuals of invertebrates recorded from 3 groups of animals. Long-spined urchin, *Diadema spp*. are the dominant invertebrates with 9 individuals, followed by Giant clam, *Tridacna spp*. with 2 and lobster, *Panulirus spp*. with 5 individuals recorded.

P. Selingan 2

On the shallow depth of 5 meter, only 1 single individual of *Diadema spp*. recorded. While, at the deep depth of 10 meter, a total of 7 invertebrates recorded from 2 groups of animals. Long-spined urchin, *Diadema spp*. lead with 4 individuals and lobster, *Panulirus spp*. 3 individuals recorded.

Mid Reef

On the shallow depth at 3 meter, 30 individuals of invertebrates recorded from 2 groups of animals. Long-spined urchin, *Diadema spp*. is the major invertebrates recorded with 28 individuals and Giant clam, *Tridacna spp*. with 2.

On the deep depth at 8 meter, a total of 11 individuals of invertebrates from 2 groups recorded consist of long-spined urchin, *Diadema spp* with 10 individuals and sea cucumber, *Holothuria edulis* with 1 individual recorded.

P. Bakkungan Kechil

On the shallow depth at 3 meter, a total of 39 individuals of invertebrates recorded. Long-spined urchin, *Diadema spp*. still the major species of invertebrates recorded with 18 individuals, followed by sea cucumber with 21 individuals. The number sea cucumbers recorded at this site were the highest among sites of TIP.

On the deep depth at 8 meter, a total of 18 individuals of invertebrates recorded. Sea cucumber is the major species recorded with 11 individuals and long-spined urchin, *Diadema spp*. with 7 individuals recorded.

Overall Discussion of Invertebrates at TIP

A total of 124 invertebrates were recorded during the Invertebrate Belt Transect survey. *Diadema* urchin recorded the highest numbers with 79 individuals, followed by sea cucumber with 33, lobster with 8 and giant clam with 4 (Figure 43).

Diadema urchin is an indicator of some overfishing of urchin-feeding fish such as triggerfish, pufferfish and all within particular area. *Diadema* urchin is also an indicator for overgrowth of algae as these animals were major algae grazer or algae feeder. Although the present situation of deadema urchin in TIP seemed not to be serious, the long termed monitoring based on these views is required.

Sea cucumber was particularly abundant in Pulau Bakkungan Kechil, compared to other sites (Figure 42). The reason is not clear now but will be revealed by further monitoring activity.


Figure 42 & 43: Some of the invertebrates recorded at P. Bakkungan Kechil site; Sea cucumber, *Holothuria edulis* and Giant clam, *Tridacna sp*.

Banded coral shrimp, Tripneustes urchin, triton shell and pencil urchin had not recorded during this survey. These animals are all under the threat of overfishing in the Indo-Pacific region. Either this result could be put on overfishing or not, the monitoring on fishing activity within the park is important.

Figure 44: Some of the Lobster, *Panulirus sp.* sighted at P. Bakkungan Kechil.

Lobster and giant clam were recorded 8 and 4 individuals respectively (Figure 44). These highly commercial animals were occurred despite of the supposed threat of overfishing.

There was no data of COT. And moreover we did not see any COT during the whole survey.

c. Water Quality

Four basic water quality parameters were recorded at all 5 sites at TIP (Table 7). Water temperature during the survey at the all sites was established ranged between 30.0 ^{0}C to 30.6 ^{0}C (average at 30.22 ^{0}C). This temperature range is considered as common sea water temperature in tropic region.

Excellent salinity readings are recorded constantly with 35 ppt average at all sites and different depth. Conductivity is considered in the average of it ranged and recorded between 54.8 μs to 54.1 μs.

However, turbidity on each survey sites consider as high as it shows in the secchi disc data. The secchi disc recorded slightly low with ranged between 6 m to 10 m (average at 7.4 m). The deeper the secchi disc can be seen from the surface, less turbid the water.

RECOMMENDATION

a. It is extremely important for the management TIP to continue the regular patrols and enforcement especially at a few interesting coral reef and potential coral recovery area, for example at P. Gulisaan and Mid Reef; avoiding any anchoring and fishing activities.
b. Regular monitoring which focusing on the sediments and algae at a few areas is also very important, since excessive of sediments and algae on the substrates will not only prevent new recruitment of corals, but also cause a various kind of problems, for example space competition, stress and smothering, disease and all.
c. The targeted fish of Reef Check are emphasized on the commercial fish. So, we believed that for more comprehensive understanding of reef conditions, we need to add our own-targeted fish to our checklists.

CONCLUSION

The overall reef check analysis shows that 50.5% of the reefs survey of TIP recorded good live coral cover. However, the best live coral covers with more then 40% were recorded more frequent at the shallow depth compare to the deeper depth contours.

Even though at some part of reef were covered by extensive tracts of algae and sediments, the overall observation shows that the coral reefs at TIP are the most outstanding among others. However, the present situation might not be sustained without serious action to protect this important area initiated.

The numbers of recorded fish are moderate and in some sites rather abundance. However, the decline in biodiversity of butterflyfish might get us concerned. In other hand, the numbers of recorded invertebrates are moderate, however the number of sea cucumbers recorded at TIP is the highest comparing to other surveying locations (TARP& PTP).

Anyway, one of the most important outcomes is to have recorded the present situations as it is necessary to have base-line data for continuous long-term monitoring programme that we have newly established.

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