



DEPARTMENT OF FISHERIES MALAYSIA
MINISTRY OF AGRICULTURE AND FOOD INDUSTRY

STATUS OF CORAL REEFS IN MALAYSIA

2020

Status of Coral Reefs in Malaysia 2020

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Executive Summary

1. This report presents data from coral reef surveys conducted in Malaysia during 2020 using the Reef Check survey protocol. Reef Check is a coral reef monitoring methodology used to assess the health of coral reefs in over 95 countries and territories worldwide, and in Malaysia since 2001.
2. A total of 201 sites were surveyed in 2020 (2019: 180): 84 in Sunda Shelf eco-region; 15 in Malacca Strait eco-region; and 102 in North Borneo eco-region. The surveys are a continuation of a successful National Coral Reef Survey Programme that has now run for fourteen years.
3. The surveys were carried out by trained government officials from Department of Fisheries Malaysia (DOFM) and Sabah Parks, reflecting commitment from the Government in further improving management of Malaysia's coral reefs and as well as volunteers. Surveys were carried out on several islands, covering both established Marine Protected Areas (MPAs) and non-protected areas.
4. The results indicate that, on average, the Malaysian coral reefs surveyed have fair level of living coral, at 41.32%. While the average masks a wide range, the average data continue to show a slow decline in average coral reef health since 2015.
5. Abundance of most indicator fish and invertebrates remains low. Historical over-harvesting and low natural populations might be the reason for this, but many of the sites surveyed, particularly in Peninsular Malaysia, are in marine protected areas, where protection might be expected to encourage populations to grow.
6. Indicators of disturbance and pollution have increased in many reef areas. These result from human activities and there is a need to address these local impacts to protect reefs from development and tourism.
7. The report recommends taking action to improve management of marine resources by addressing local impacts and introducing participatory management. This gives local stakeholders a stronger voice in decisions that affect their livelihoods, and significant literature exists to suggest that this can lead to improved conservation outcomes.
8. Particular emphasis is given to building resilience – both ecological and economic. Resilient reefs are more likely to withstand or bounce back from the growing threats of climate change. Resilient communities have diversified economies and do not rely entirely on coral reefs for their livelihoods. This reduces human pressures on reefs, particularly from tourism.
9. The government is asked to consider introducing a more sustainable tourism model, moving away from the “mass” tourism model of the last 20-30 years. There is an opportunity to establish a more environmentally friendly tourism industry while “building back better” in the aftermath of the covid pandemic. Tourism trends suggest tourists are looking for a different experience – more authentic, less crowded. Developing high value, low volume destinations will allow local communities to maintain the livelihoods while dramatically reducing pressure on ecosystems.

1. Introduction

Coral reefs are an important ecological and economic resource in many countries around the world, providing a range of valuable ecosystem services to millions of people. Coral reefs provide jobs, food and coastal protection, among other benefits, to over 100 million people in South East Asia. They are the most diverse marine ecosystems on earth. Despite being recognised for their economic and aesthetic value, coral reefs are being damaged by a variety of both local and global threats.

- The world has lost 19% of the original area of coral reefs, 15% are seriously threatened with loss in the next 10-20 years and 20% under threat of loss in the next 20-40 years (Status of Coral Reefs of the World, 2008).
- Over 60% of the world's reefs are under immediate and direct threat from one or more local sources (Reefs at Risk Revisited, 2011).

These threats arise largely as a result of human activities and land use changes along coastlines adjacent to coral reefs. Local threats to coral reefs are many, and are reasonably well understood. They include:

- Over-fishing
- Destructive fishing
- Coastal development
- Pollution
- Physical impacts

In Malaysia, the Department of Fisheries Malaysia (DOFM), Sabah Parks and Sarawak Forestry are tasked with managing these local threats to their protected reef areas. Meanwhile, Reef Check Malaysia (RCM) works with various stakeholders to conserve coral reefs. Since it was registered in 2007, RCM has established an annual, national coral reef monitoring programme. This report presents the results of coral reef surveys conducted in Malaysia during 2020, the fourteenth year of surveys.

Due to Covid-19 pandemic, surveys at some permanent sites are not able to be conducted or completed. They are Miri, Kapalai, Labuan, Mabul and Matakong.

2.

Methodology

Survey Sites

A total of 201 sites were surveyed, 84 of which were in Sunda Shelf region, 15 in Malacca Strait region and 102 in North Borneo region. As far as possible, the same sites are visited each year to provide consistent data over time. In Sunda Shelf and Malacca Strait regions, a large percentage of the surveys were conducted by RCM together with DOFM and RCM's volunteers. In North Borneo region, a large percentage of the surveys were conducted by RCM together with Sabah Parks and a number of dive operators, notably Lankayan, Mabul and Kapalai. This is one of the success stories of getting local stakeholders to be involved in monitoring and management of their own local reefs. The list of sites surveyed is shown in appendix 1.

Methodology

Reef Check surveys are based on the philosophy of "Indicator Species". These are marine organisms that:

- are widely distributed on coral reefs
- are easy for non-scientists to identify
- provide information about the health of a coral reef

Using a standardized methodology, data from surveys in different sites can be compared, whether it be on an island, regional, national or international basis (see www.reefcheck.org for more details).

The Reef Check monitoring methodology allows scientists and managers to track changes to coral reefs over time. By surveying reefs on a regular basis, deleterious changes can be highlighted early, before they become problems. This gives managers the opportunity to intervene, carry out additional more detailed studies and/or initiate management actions to try to reverse the change before permanent damage is done to the reef.

A 100 m transect line is deployed and along it four 20 m transects are surveyed, each separated by 5 m, which provides four replicates per transect (8 per complete survey) for statistical analysis (see figure below).

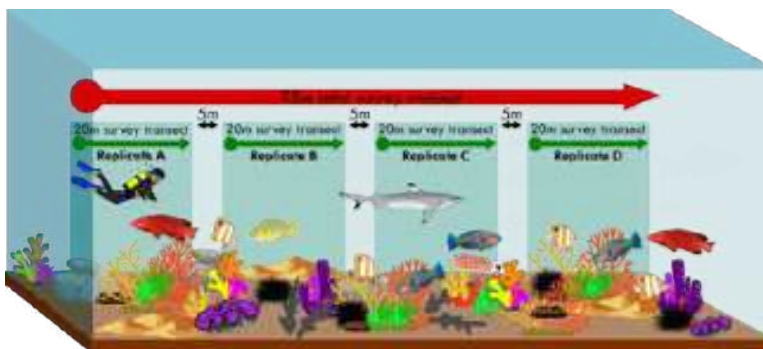


Figure showing the transect – the basic idea of the Reef Check protocol is to swim along a 100m measuring tape (transect) and count organisms in four 20m long transect.

Four types of data are collected:



Fish

Divers count the indicator fish along the four 20m long x 5m wide x 5m high corridors by swimming slowly.

Reef Check indicator fish species were chosen on the basis of targeted demand for:

- Aquarium trade: Butterflyfish (BF)
- Food fish: Sweetlips (SL), Snapper (SN), Barramundi Cod (BC), Parrotfish (PF), Moray Eel (ME), Grouper (GR)
- Live-food fish trade: Humphead Wrasse (HW), Bumphead Parrotfish (BP)

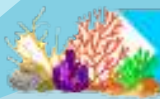


Invertebrate

Divers count the indicator invertebrates along the four 20m x 5m belts.

The invertebrate indicators are targeted for different reasons:

- Collected for Curio trade: Banded Coral Shrimp (BCS), Pencil Urchin (PU), Triton Shell (TR)
- Collected for Food: Collector Urchin (CU), Sea Cucumber (SC), Lobster (LO), Giant Clam (GC)
- Ecological Imbalance/Predator Outbreaks: *Diadema* Urchin (DU), Crown of Thorns (COT)



Substrate

Using Point Intercept method, substrate category is noted at every 0.5m.

The categories are: hard coral (HC), soft coral (SC), sponge (SP), nutrient indicator algae (NIA), recently killed coral (RKC), coral rubble (RB), rock (RC), sand (SD), silt (SI) and other (OT). These are divided into categories that reflect their impact on reef health:

Live Coral Cover: HC + SC

Other: OT

Available Substrate: RC

Sand: SD

Disturbance Indicators: RKC + RB + SI

Pollution Indicators: NIA + SP



Impact

Assess the damage to coral from bleaching, anchoring, destructive fishing, corallivores (such as *Drupella* snail or Crown-of-Thorns starfish), and trash.

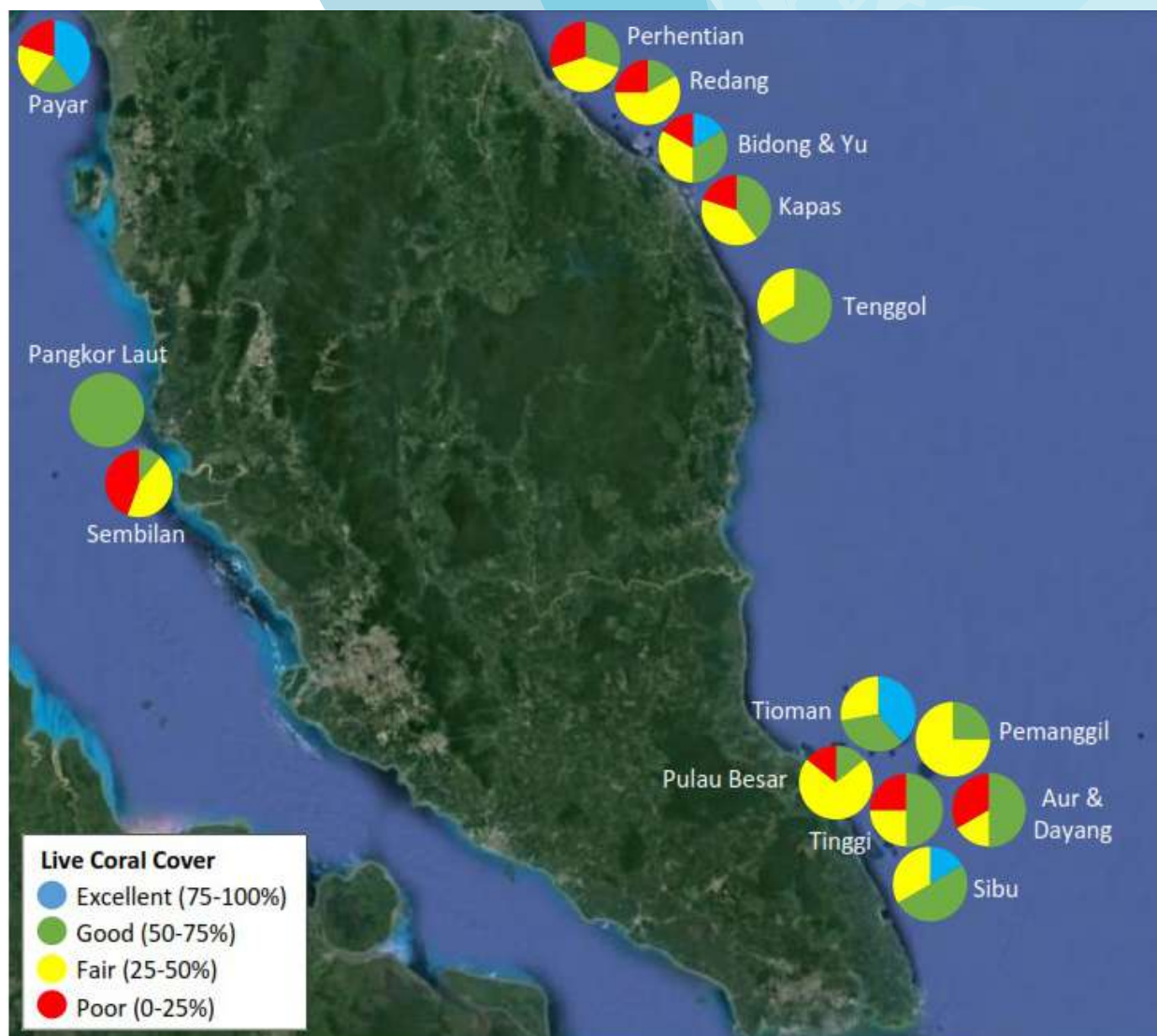
3.

Survey Results & Analysis

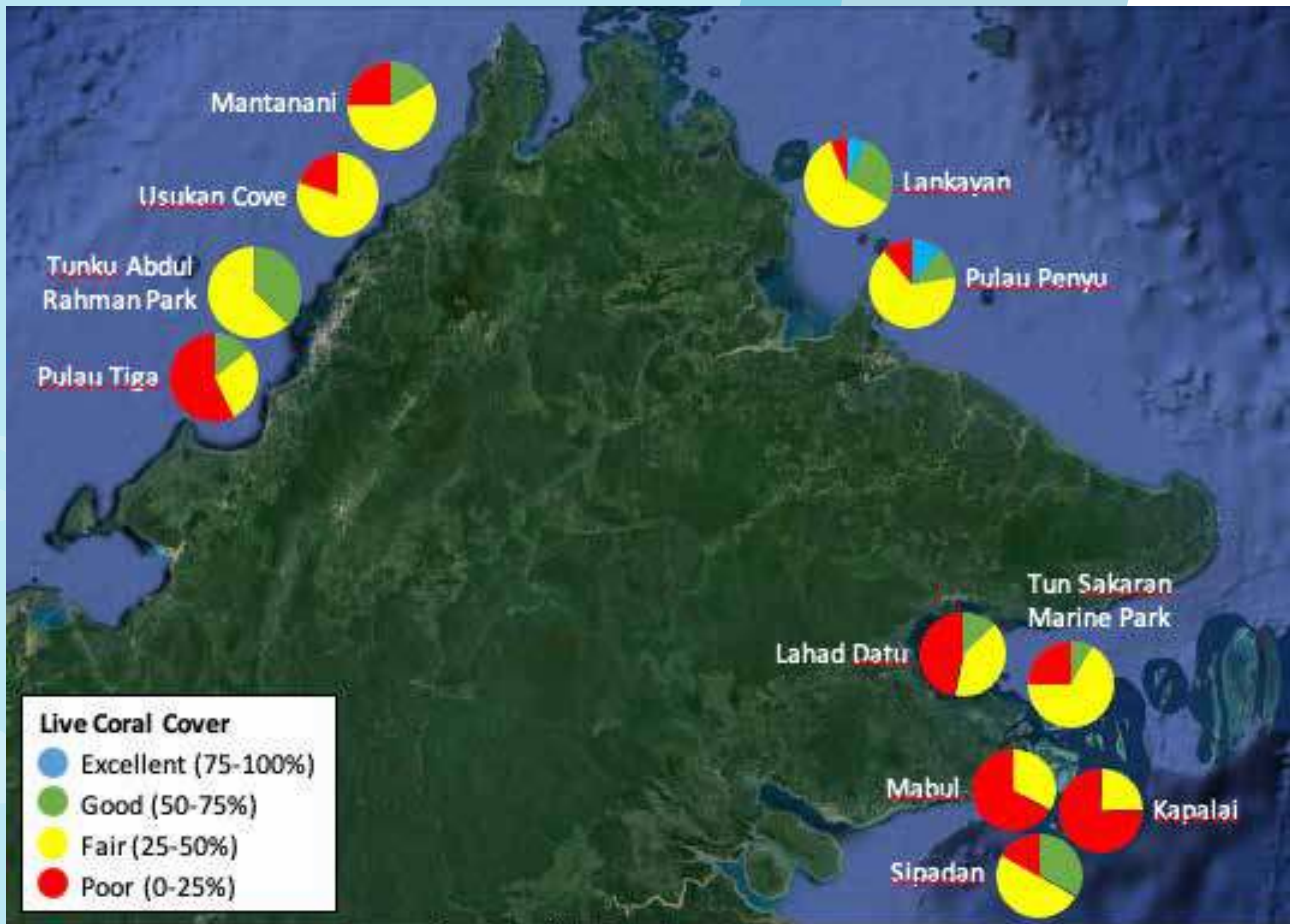
This section presents the results from surveys conducted in 2020, providing an overview of the condition of coral reefs in Malaysia as a whole, and a detailed analysis of the health of reefs in surveyed reef areas.

Malaysia

The results from all 201 surveys were compiled to provide an overview of the status of coral reefs around Malaysia. Sites surveyed off Peninsular Malaysia are mostly islands which are important tourist destinations while the islands and reefs off Sabah are less frequently visited but face other problems such as destructive fishing practices.



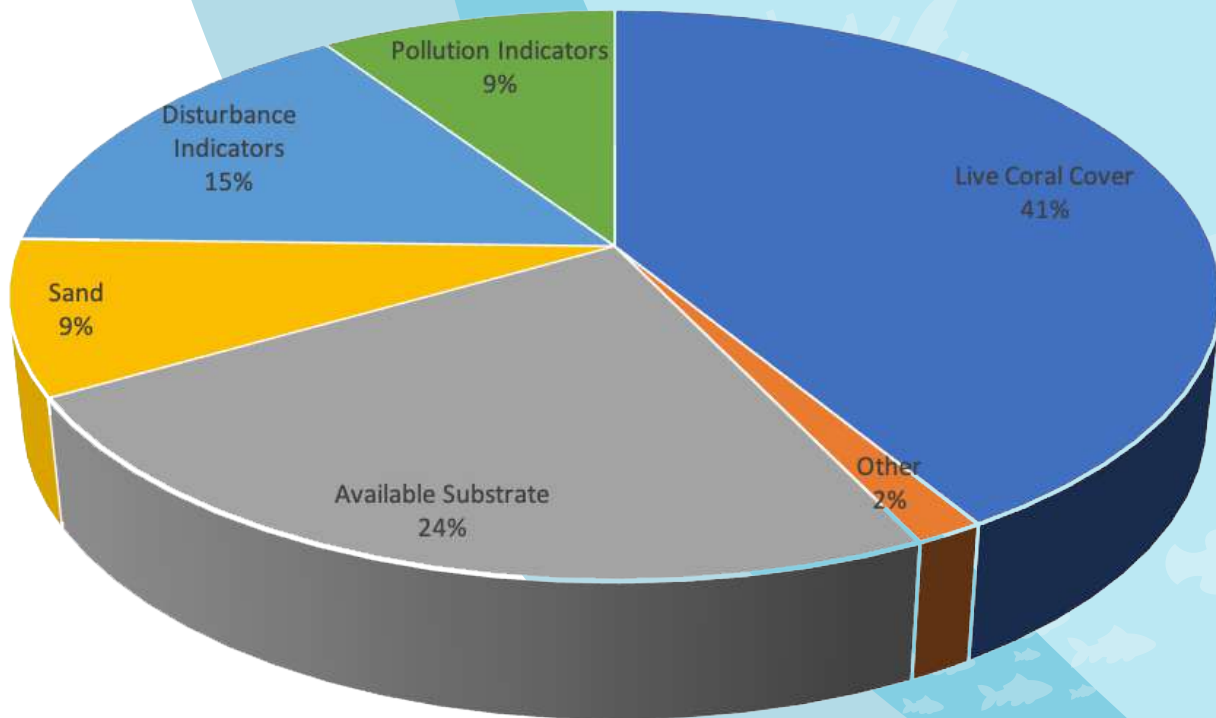
Map showing the reef health composition of each survey islands in Peninsular Malaysia based on their live coral cover.



Map showing the reef health composition of each survey islands in Sabah based on their live coral cover.

Coral Cover and Health

Substrate Composition in Malaysia



- Malaysian reefs are in 'Fair' condition.
- Mean hard coral, reef builder, cover is 37.15%.
- Available substrate for new coral recruits to attach is very high.
- Indicators for disturbance and pollution are high.

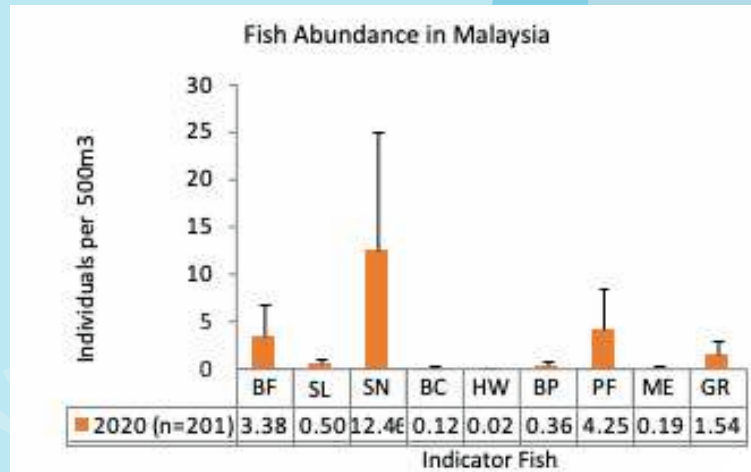
INDICATORS FOR DISTURBANCE

- Mainly in North Borneo region.
- Over 30% of Kapalai, Mabul and Usukan Cove reefs consist of indicators for disturbance.
- 20-30% of Pangkor Laut, Lahad Datu, Mantanani, Pulau Tiga, Tun Sakaran Marine Park reefs consist of indicators for disturbance.

INDICATORS FOR POLLUTION

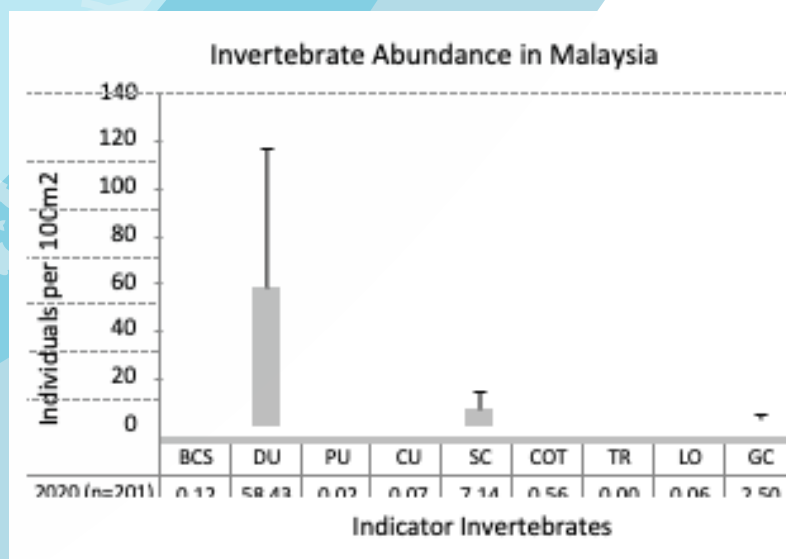
- Mainly in Sunda Shelf region.
- Over 30% of Bidong & Yu, Perhentian and Usukan Cove reefs consist of indicators for pollution.
- 20-30% of Aur & Dayang reefs consists of indicators for pollution.

Fish and Invertebrates



Very low abundance of indicators targeted for live-food fish trade.

- Low abundance of fish targeted for food, except for Snapper and Parrotfish.
- This would suggest that populations of fish targeted for food is heavily harvested.



- Diadema urchin abundance is high.
- Very low abundance of indicators targeted for curio trade.
- Low abundance of indicators targeted for food, except for Sea cucumber.
- COT is an issue in Malaysia.
- A healthy coral reef can support a population of 0.2-0.3 individuals per 100m².

CROWN-OF-THORNS

- COT issue in Malaysia is confined solely to Sunda Shelf region.
- Tioman, Bidong, Yu, Perhentian, Redang, Tenggol, Aur and Dayang are facing COT outbreaks.

Eco-regions in Malaysia

The data below provide an overview of the health of coral reefs surveyed in three Eco-regions in Malaysia. An Eco-region is defined as an area of relatively identical species composition, clearly distinct from adjacent regions. The marine eco-regions relevant to Malaysia are based on the "Marine Eco-regions of the World" system (Spalding et al, 2007). They are:

- Sunda Shelf (East coast of Peninsular Malaysia and Sarawak, Eco-region 117)
- Malacca Strait (West coast of Peninsular Malaysia, Eco-region 118)
- North Borneo (Sabah, Eco-region 126)

Focusing management efforts at an eco-region level can provide benefits as reefs in a given region are similar; therefore, the results of this report have been delineated into these three eco-regions. The results highlight the different problems each island/area is facing. Islands/regions covered in each eco-region are shown in table below.



Eco-regions of Malaysia; 117 = Sunda Shelf, 118 = Malacca Strait and 126 = North Borneo

Site Coverage by Ecoregion

Eco-region	Islands/Areas	No. of sites	Protection Status	LCC (%)	Average (%)
Sunda Shelf	Tioman	18	Marine Park, Pahang	63.68	47.28
	Bidong & Yu	6	Marine Park, Terengganu	46.67	
	Kapas	5	Marine Park, Terengganu	44.50	
	Perhentian	10	Marine Park, Terengganu	38.13	
	Redang	12	Marine Park, Terengganu	35.47	
	Tenggol	6	Marine Park, Terengganu	52.40	
	Aur & Dayang	6	Marine Park, Johor	36.56	
	Pemanggil	4	Marine Park, Johor	49.84	
	Pulau Besar	7	Marine Park, Johor	35.18	
	Sibu	6	Marine Park, Johor	59.38	
Malacca Strait	Tinggi	4	Marine Park, Johor	45.16	41.21
	Pangkor Laut	1	No protection	60.63	
	Sembilan	9	No protection	28.33	
North Borneo	Payar	5	Marine Park, Kedah	60.50	36.42
	Kapalai	4	No protection	17.19	
	Lahad Datu	15	No protection	29.13	
	Lankayan	15	SIMCA	46.54	
	Mabul	3	No protection	21.88	
	Mantanani	12	No protection	34.43	
	Pulau Penyu	9	Sabah Parks	44.44	
	Pulau Tiga	7	Sabah Parks	28.93	
	Sipadan	12	Sabah Parks	40.05	
	TARP	8	Sabah Parks	46.72	
	TSMP	12	Sabah Parks	33.33	
	Usukan Cove	5	No protection	35.00	

Sunda Shelf – Tioman

Tioman Island is located some 50km from Mersing, off the East coast of Pahang. It is the largest island off the East coast of Peninsular Malaysia. The island has seven villages, with a total population of approximately 3,700 most of whom work in the tourism industry, the main industry on the island. The island has been gazetted as a Marine Park since 1994. Reefs are mainly fringing off-shore reefs with some submerged reefs.

Diving and snorkelling are the main tourist activities. The island has long been a popular tourist destination, though at one point it was eclipsed by other destinations (particularly Redang and Perhentian). However, in recent years, tourism on Tioman Island has picked up again and now there are over 70 resorts and 40 dive operators on the island.

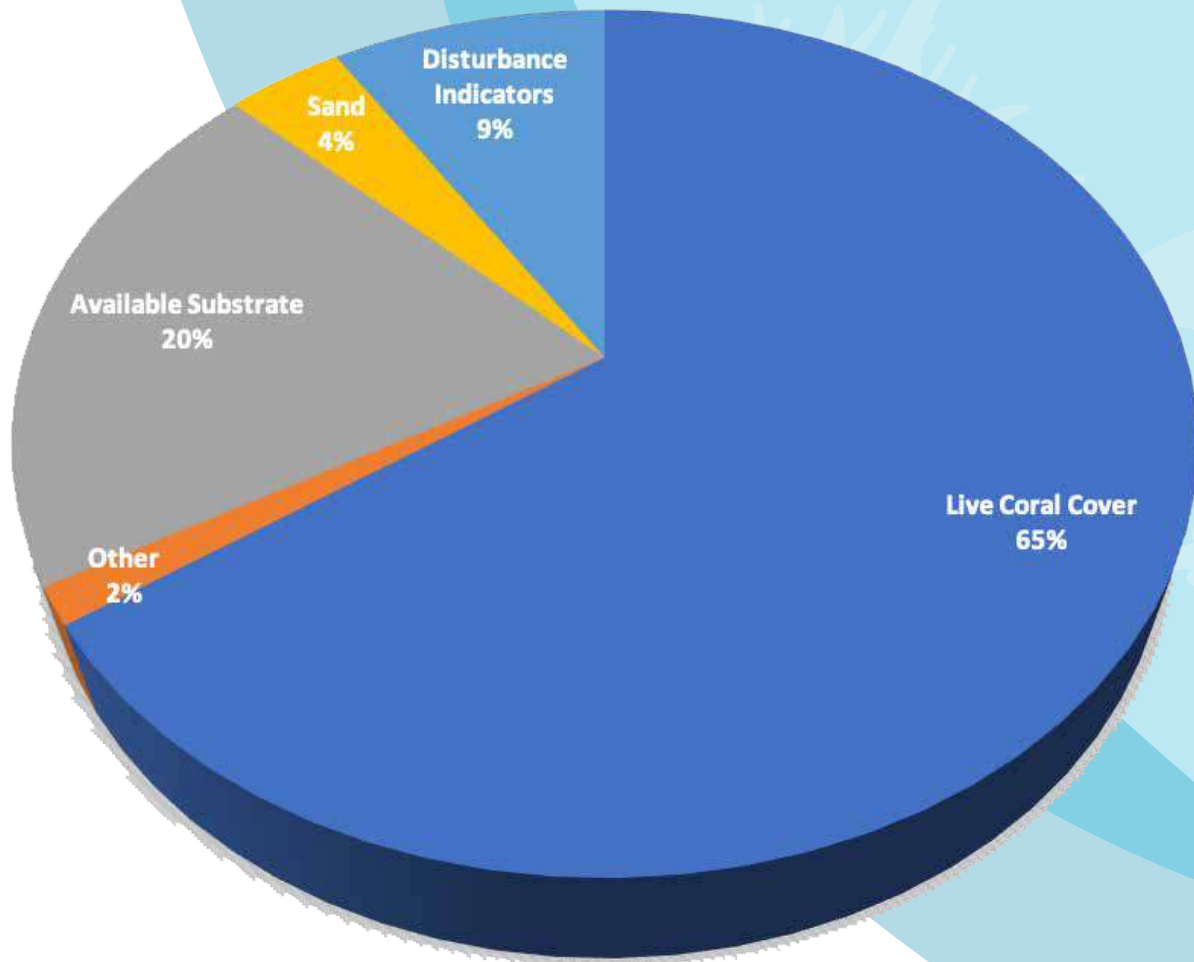
There is a small power generation station on the island, supplying electricity to all areas. Freshwater on the island depends mainly on several river systems coming from the hilly forested areas. A municipal incinerator was constructed some years ago. The island is served by an airport as well as ferry services.



Map showing the health categories of each survey site based on their live coral cover: 7 sites have 'Excellent' coral cover, 6 are in 'Good' condition, and 5 show 'Fair' health.

Coral Cover and Health

Substrate Composition at Tioman

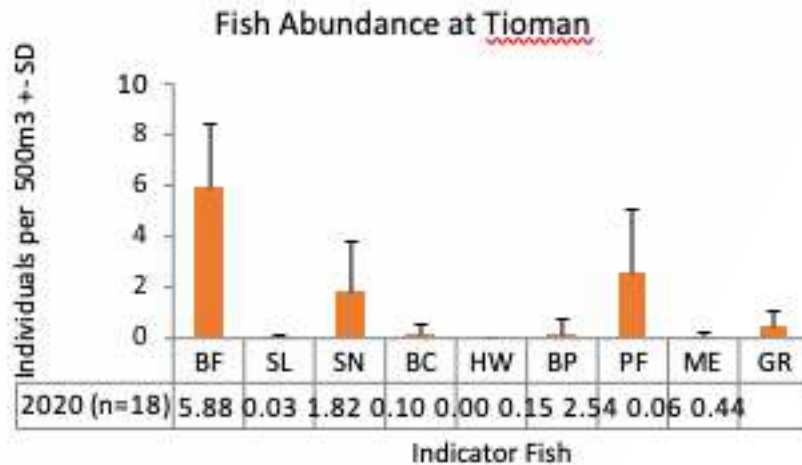


- Tioman is dominated by live coral cover, which is mainly hard coral. This is considered a sign of healthy reefs.
- Mean hard coral, reef builder, cover is 59.93%.
- In 'Good' condition and above the Sunda Shelf region average (47.28%).
- Available substrate for coral recruits to attach to is high.
- Disturbance indicators are slightly high.
- Rubble level is especially high at Labas, Salang, Soyak South and Tekek House Reef.

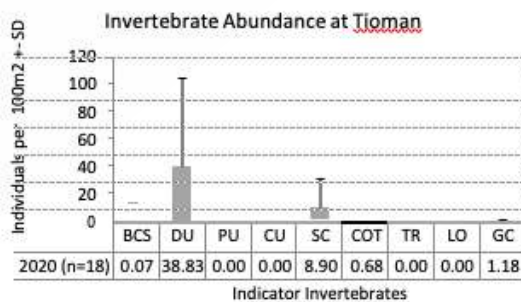
CORAL IMPACTS

- Boat anchor damage, discarded fishing nets and trash are recorded at some sites.
- One site is impacted by bleaching.
- Many sites are damaged by COT predation.

Fish and Invertebrate



- Butterflyfish abundance is the highest.
- Absent (Humphead wrasse) or very low abundance (Bumphead parrotfish) of indicators targeted for live-food fish trade.
- Fish targeted for food are low in abundance.
- This suggest that fish targeted for food are heavily harvested.



- Diadema urchin abundance is the highest.
- Invertebrates targeted for food are low in abundance, except for Sea cucumber.
- Indicators for curio trade are absent or very low in abundance.
- COT is an issue in Tioman.
- A healthy coral reef can support a population of 0.2-0.3 individuals per 100m².

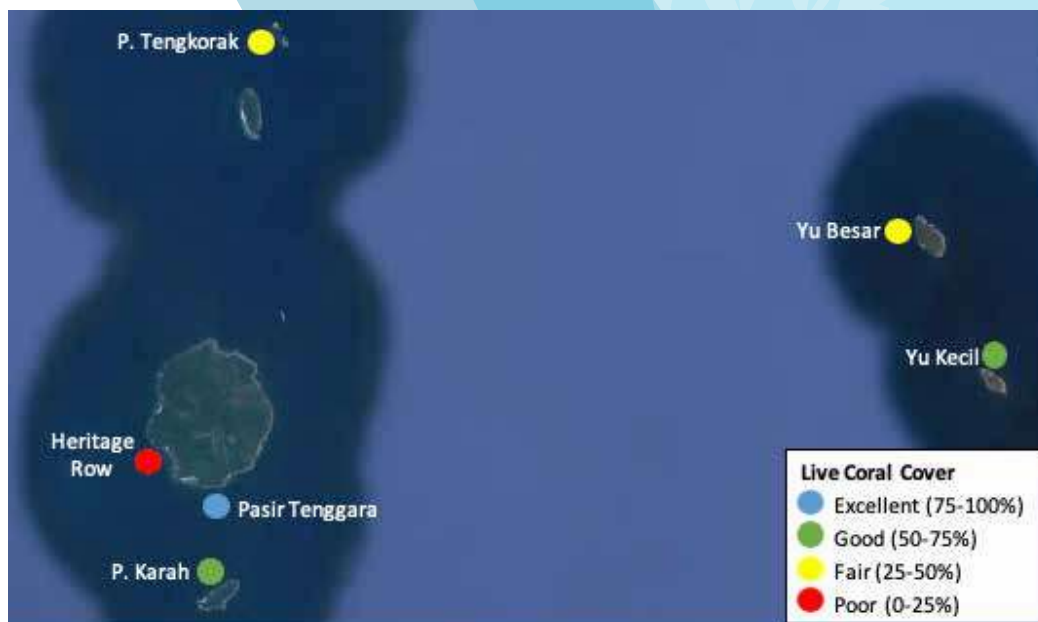
RARE ANIMALS

- Blacktip shark and Green turtle were recorded at many sites.

Sunda Shelf – Bidong & Yu

The Bidong and Yu archipelago comprises several small islands, located 15-25km from Marang, off the East coast of Terengganu, Malaysia. The islands are unpopulated, though from 1978 to 1991 Bidong was a centre for Vietnamese refugees. Yu islands are now gazetted as a Marine Park.

Bidong has mainly been used as a research base for University Malaysia Terengganu but has recently grown in popularity as a diving destination. Bidong has some sandy beaches and fringing reefs while Pulau Yu Besar and Kecil are mainly small rocky islands, with boulder slopes dropping to 25-30m, with some coral reef areas.



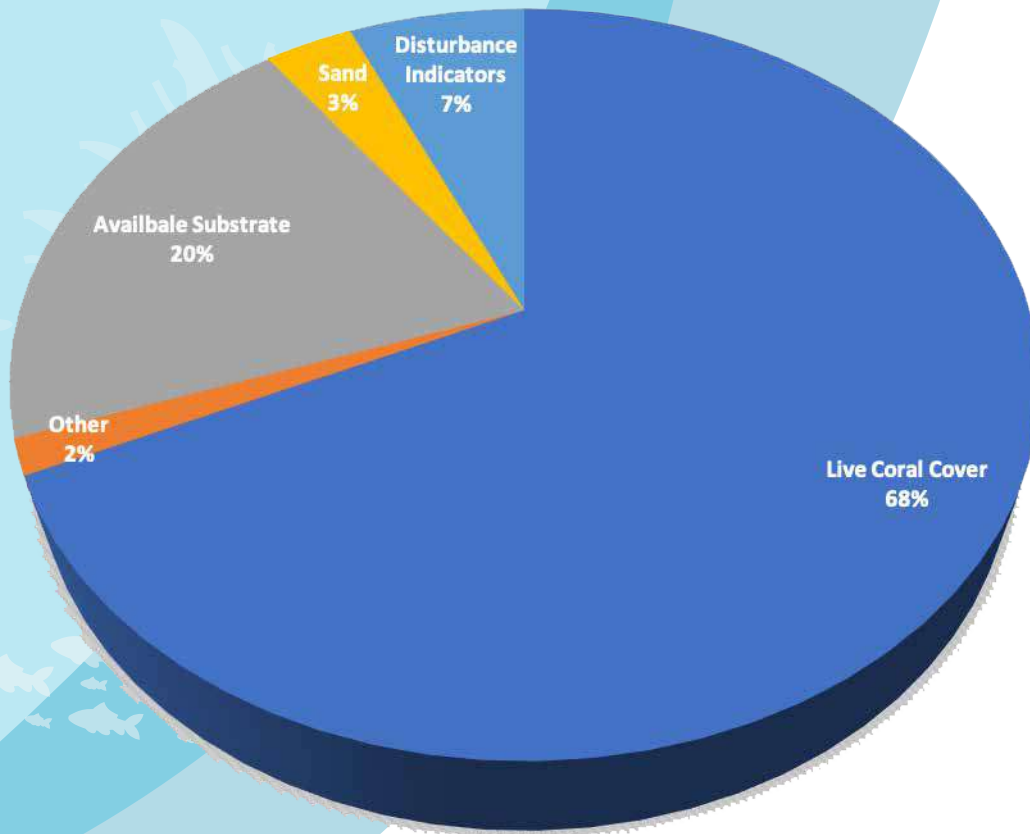
Map showing the health categories of each survey site based on their live coral cover: 1 site have 'Excellent' coral cover, 2 are in 'Good' condition, 2 show 'Fair' health and 1 is in 'Poor' state.



Reef at Pulau Bidong

Coral Cover and Health

Substrate Composition at Bidong & Yu

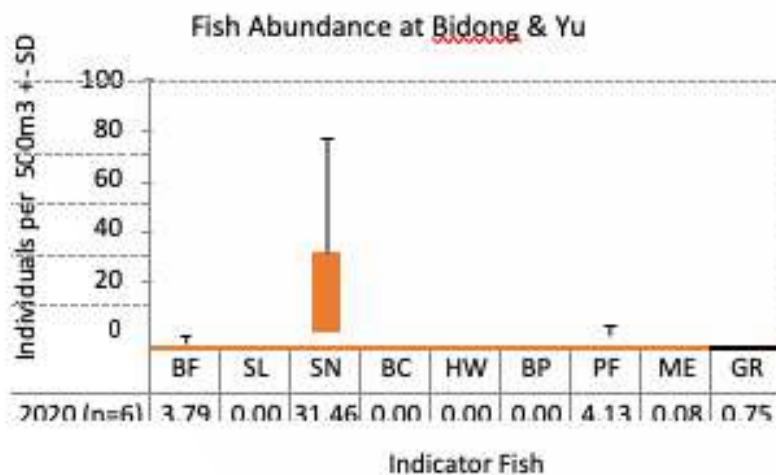


- Bidong and Yu are dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 31.35%.
- In 'Fair' condition and below the Sunda Shelf region average (47.28%).
- Available substrate for coral recruits to attach to is high.
- Pollution indicators are extremely high.
- Nutrient indicator algae level is very high at all sites except for Pasir Tenggara. The level is especially high at Heritage Row and Pasir Tengkorak.
- Although Pasir Tenggara has 'Excellent' coral cover, the high percentage of live coral cover is mainly attributed by soft coral (Zoanthid), which recorded 89.38%. Hard coral cover is only 2.50%. Zoanthid appears to colonise the whole reef. While the category appears "healthy", the reef is actually undergoing a significant shift to a potentially less stable state.

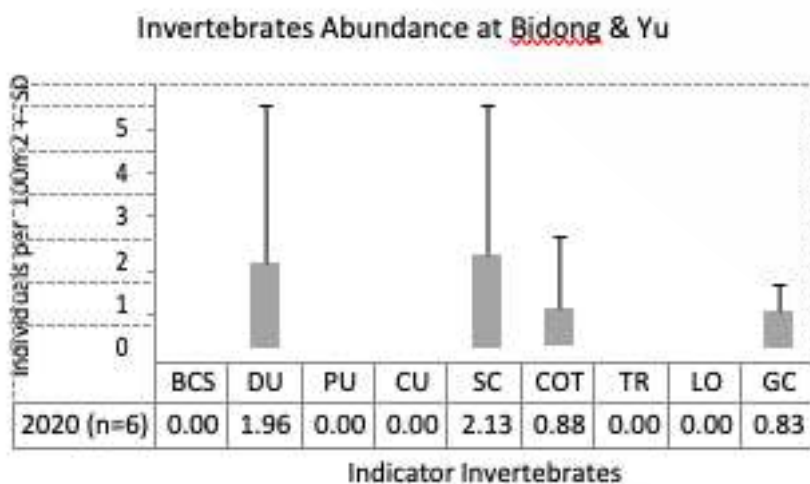
CORAL IMPACTS

- Discarded fishing nets are recorded at some sites.
- One site is impacted by warm water bleaching.
- Damages due to COT and Drupella predations are recorded.

Fish and Invertebrate



- Snapper abundance is high.
- Indicators targeted for live-food fish trade are absent.
- Fish targeted for food are very low in abundance, except for Snapper.
- This suggest that fish targeted for food are heavily harvested.



- Invertebrates targeted for food are very low in abundance.
- Indicators for curio trade are absent.
- COT is an issue in Bidong and Yu.
- A healthy coral reef can support a population of 0.2-0.3 individuals per 100m2.

Sunda Shelf – Kapas

Kapas is a small island located just 6km from Marang, off the East coast of Terengganu, Malaysia. There is no resident local population but several resorts provide accommodation for tourists. The island is gazetted as a Marine Park (since 1994).

The island is not a major tourism destination due to its small size, but does have an established tourist market, with less than ten resorts and one dive operator. Diving and snorkelling are the main tourist activities. There is no centralised electricity supply, resorts operate their own generators for power. Groundwater supplies are limited and there is no centralised sewage treatment, each resort having its own sewage treatment facilities.

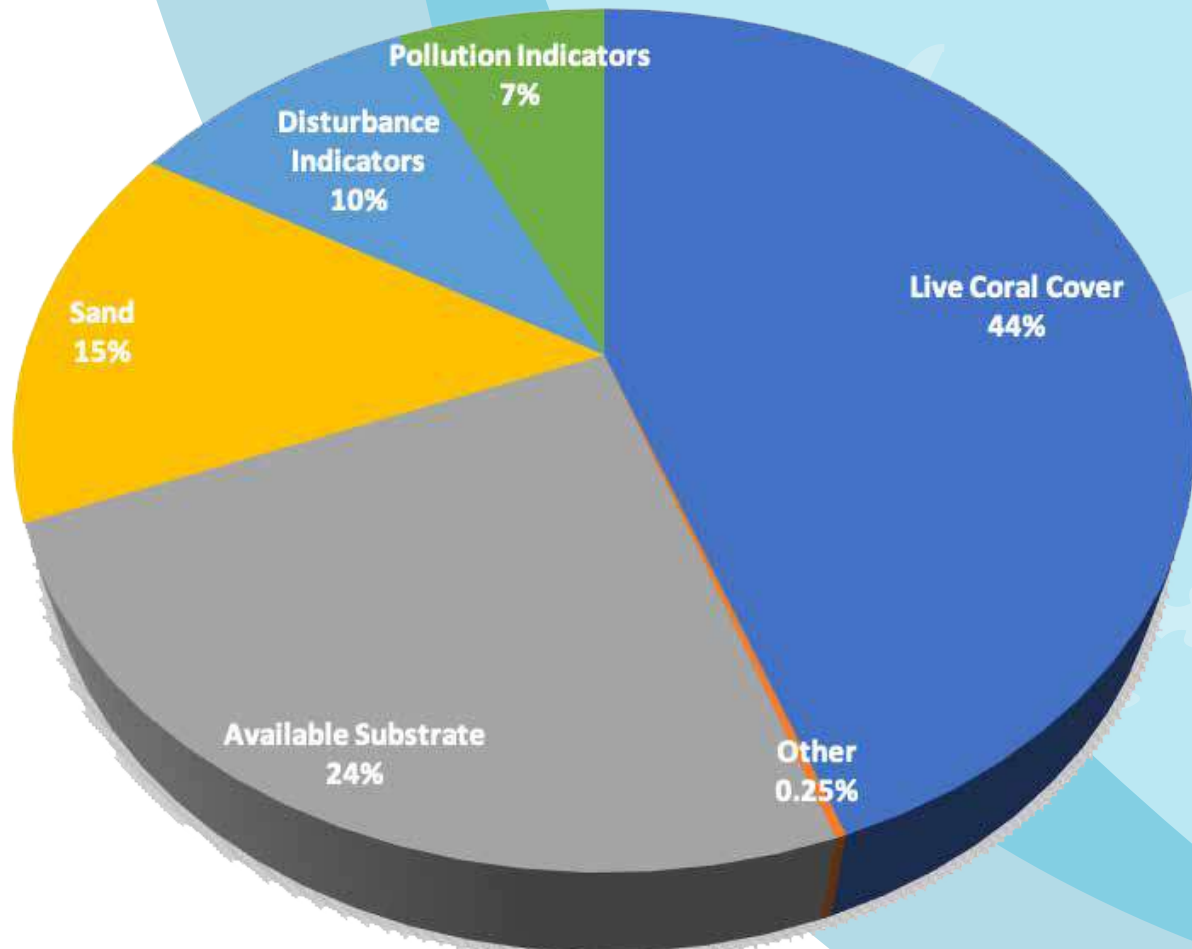
Reefs are mainly fringing off-shore reefs, with some submerged reefs.



Map showing the health categories of each survey site based on their live coral cover: 2 sites have 'Good' coral cover, 2 are in 'Fair' condition, and 1 shows 'Poor' health.

Coral Cover and Health

Substrate Composition at Kapas

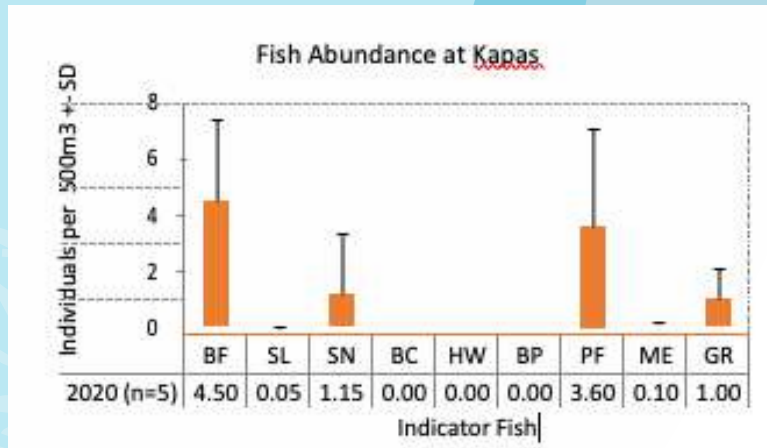


- Kapas is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 41.13%.
- In 'Fair' condition, below the Sunda Shelf region average (47.28%).
- Available substrate for coral recruits to attach is very high.
- Sand level is high.
- Disturbance indicators are slightly high.
- Rubble level is especially high at Coral Garden 1 and Coral Garden 3.
- Silt level is especially high at Silent Reef.

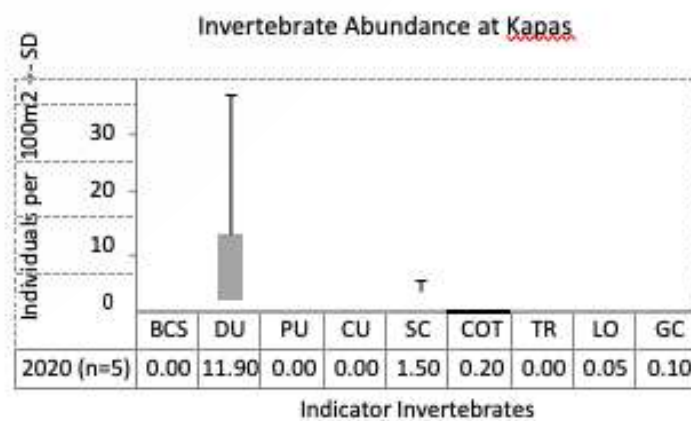
CORAL IMPACTS

- Discarded fishing nets and trash are recorded at some sites.
- Some reefs are impacted by warm water bleaching.

Fish and Invertebrate



- Butterflyfish abundance is the highest.
- Indicators targeted for live-food fish trade are absent.
- Fish targeted for food are low in abundance.
- This suggest that fish targeted for food are heavily harvested.



- Diadema urchin abundance is the highest.
- Invertebrates targeted for food are very low in abundance.
- Indicators for curio trade are absent.

Sunda Shelf – Perhentian

The Perhentian islands are located some 20km from Kuala Besut off the East coast of Terengganu, Malaysia. The islands have one village with a population of approximately 2,300, most of whom work in tourism, the main industry on the islands. The islands are gazetted as a Marine Park (since 1994).

A popular tourist destination, particularly among backpackers, there are over 40 resorts, mainly small, family run chalets with a growing number of large resorts to cater for a changing tourist market. There are now over 20 dive operators, spread around the two main islands. Diving and snorkelling are the main tourist activities.

Growth in tourism has been rapid on the islands, and resort development continues. There is no grid-supplied electricity, nor centralised sewage treatment; groundwater supplies are limited in Perhentian and fresh water is supplied from the mainland.

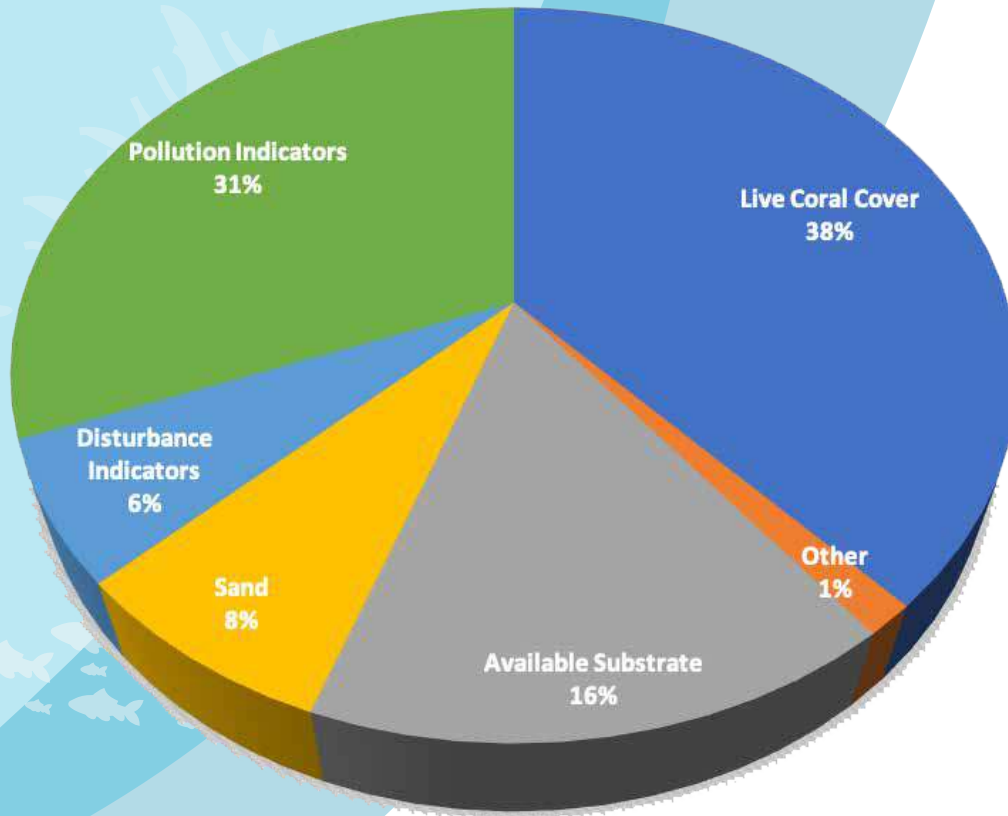
Reefs are mainly fringing off-shore reefs, with some submerged reefs.



Map showing the health categories of each survey site based on their live coral cover: 3 sites have 'Good' coral cover, 4 are in 'Fair' condition, and 3 show 'Poor' health.

Coral Cover and Health

Substrate Composition at Perhentian

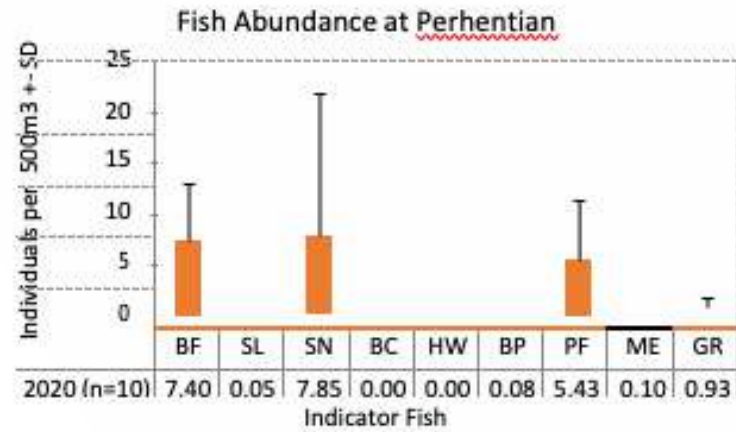


- Perhentian is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 35.50%.
- In 'Fair' condition, below the Sunda Shelf region average (47.28%).
- Available substrate for coral recruits to attach is high.
- Pollution indicators are extremely high.
- Nutrient indicator algae level is very high at all sites.
- Over 65% of Pulau Rawa and Seabell reefs consist of nutrient indicator algae.

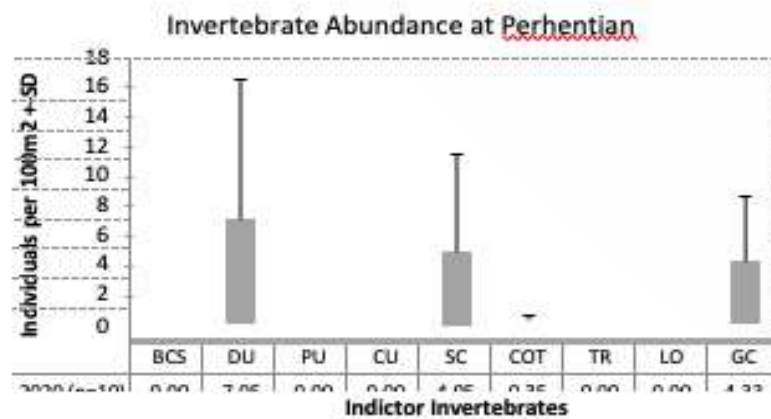
CORAL IMPACTS

- Discarded fishing nets and trash are recorded at some sites.
- All reefs are impacted by warm water bleaching.
- Many sites are damaged by Terpios sponge infection, and COT and Drupella predations.

Fish and Invertebrate



- Snapper abundance is the highest.
- Absent (Humphead wrasse) or very low abundance (Bumphead parrotfish) of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance, except for Snapper and Parrotfish.
- This suggest that fish targeted for food are heavily harvested.



- Diadema urchin abundance is the highest.
- Invertebrates targeted for food are low in abundance.
- Indicators for curio trade are absent.
- COT is an issue in Perhentian.
- A healthy coral reef can support a population of 0.2-0.3 individuals per 100m2.

RARE ANIMALS

- Shark and turtle were recorded.

Sunda Shelf – Redang

Redang Island is located some 25km from Merang, off the East coast of Terengganu, Malaysia. The island has a population of approximately 1,500, only a small proportion of whom work in tourism, the main industry on the islands. The islands are gazetted as a Marine Park (since 1994).

The island is a popular resort destination, with a more upmarket image than nearby Perhentian. Diving and snorkelling are the main tourist activities. There are 10 medium-large size resorts, mainly on Pasir Panjang. Most resorts have an in-house dive operator. There is no centralised electricity supply, resorts operate their own generators for power. Water is supplied by pipeline from the mainland and each resort has its own sewage treatment facilities. The island is served by an airport (flights to KL and Singapore) as well as boat services from the mainland.

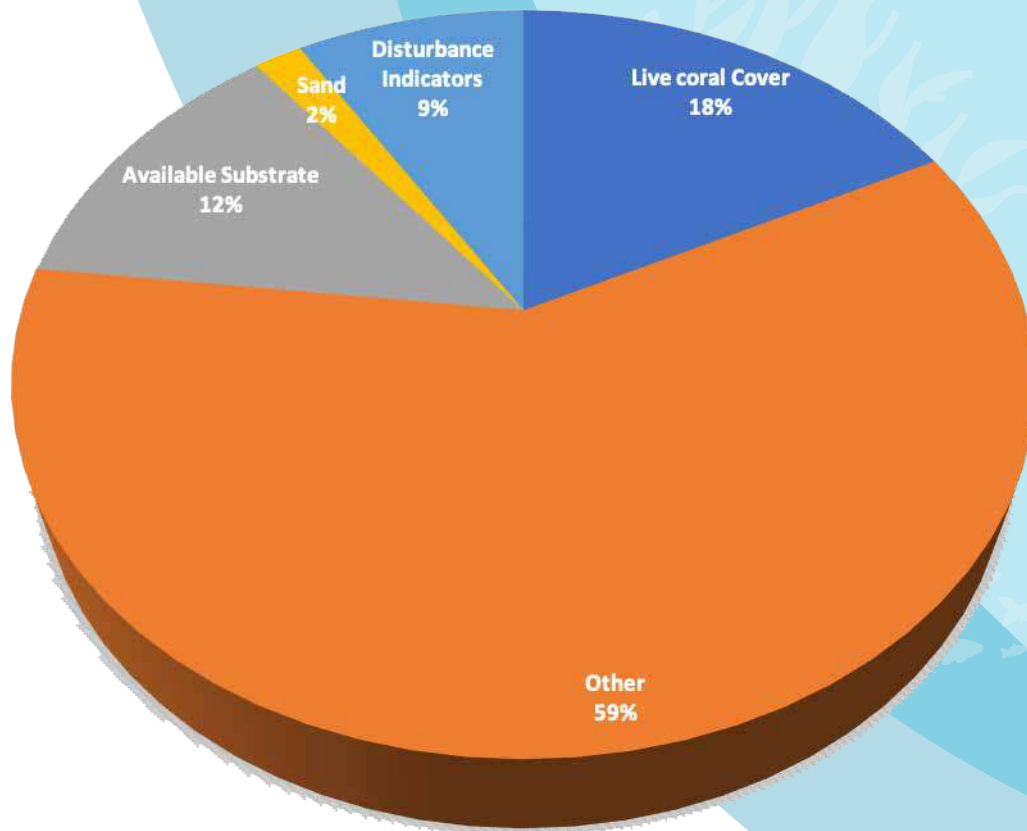
Both fringing off-shore reefs and submerged reefs can be found in the area.



Map showing the health categories of each survey site based on their live coral cover: 2 sites have 'Good' coral cover, 7 are in 'Fair' condition, and 3 show 'Poor' health.

Coral Cover and Health

Substrate Composition at Redang

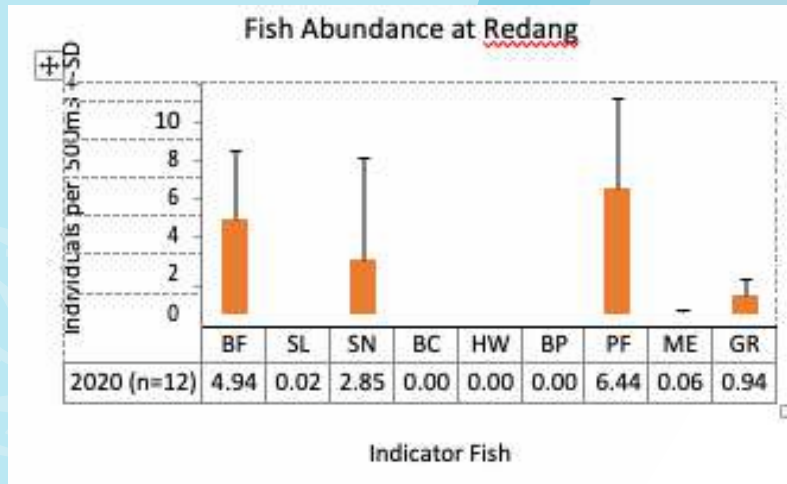


- Redang is dominated by live coral cover, which is mainly coral.
- Mean hard coral, reef builder, cover is 30.78%.
- In 'Fair' condition, below the Sunda Shelf region average (47.28%).
- Available substrate for coral recruits to attach is very high.
- Disturbance indicators are high.
- Rubble level is especially high at Pulau Pinang Marine Park and Pulau Paku Besar.
- Pollution indicators are high.
- Nutrient indicator algae level is especially high at Chagar Hutang East.

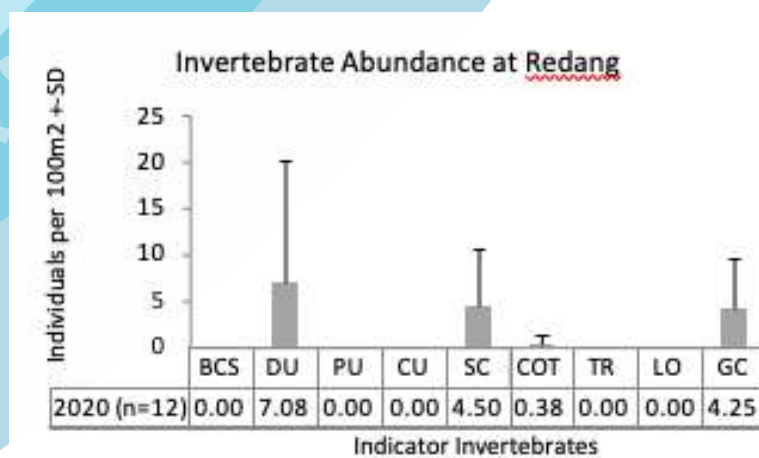
CORAL IMPACTS

- Boat anchor damage and trash are recorded at some sites.
- A few reefs are impacted by warm water bleaching.
- Some sites are damaged by Terpios sponge infection, and COT and Drupella predations.

Fish and Invertebrate



- Parrotfish abundance is the highest.
- Indicators targeted for live-food fish trade are absent.
- Fish targeted for food are low in abundance, except for Parrotfish.
- This suggest that fish targeted for food are heavily harvested.



- Diadema urchin abundance is the highest.
- Invertebrates targeted for food are low in abundance.
- Indicators for curio trade are absent.
- COT is an issue in Redang.
- A healthy coral reef can support a population of 0.2-0.3 individuals per 100m2

RARE ANIMALS

- Blacktip shark and Hawksbill turtle were recorded.

Sunda Shelf – Tenggol

Tenggol Island is located approximately 30km from Dungun, off the East coast of Terengganu, Malaysia. This small island has no local population. The island is gazetted as a Marine Park (since 1994).

The island is a popular diving destination due to the surrounding deep water which attracts more mega fauna than other islands (whale sharks are common around the island). There are four resorts on the island, each with its own dive operator. There is no centralised electricity supply, resorts operate their own generators for power. Groundwater supplies are limited and there is no centralised sewage treatment, each resort having its own sewage treatment facility.

Tenggol Island has gained in popularity over the last few years and a number of dive and snorkel operators have started to operate from Dungun, the nearest town on the mainland, offering day trip packages to divers and snorkelers alike.

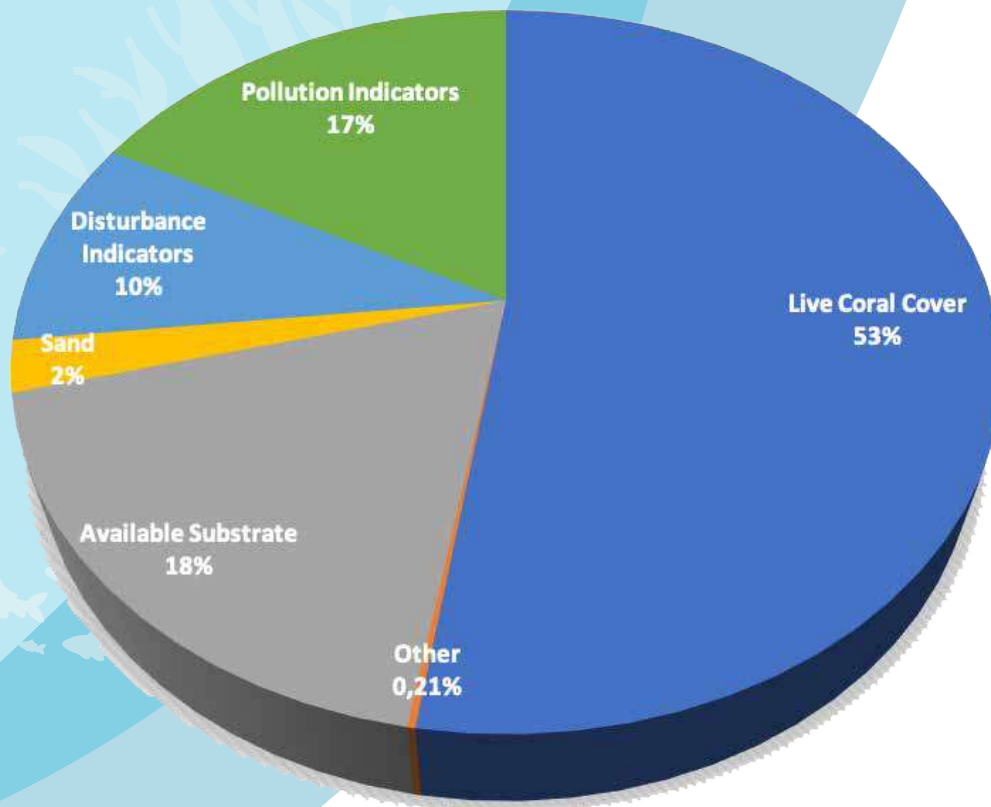
Much of the island's coastline is rocky, besides a couple of sandy beaches. The reefs are mainly fringing reefs and rocky reefs.



Map showing the health categories of each survey site based on their live coral cover: 4 sites have 'Good' coral cover and 2 are in 'Fair' condition.

Coral Cover and Health

Substrate Composition at Tenggol

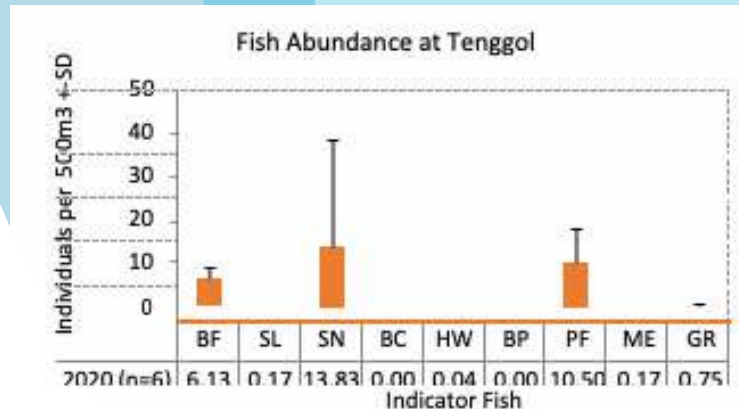


- Tenggol is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 42.50%.
- In 'Good' condition and above the Sunda Shelf region average (47.28%).
- Available substrate for coral recruits to attach is high.
- Disturbance indicators are slightly high.
- Rubble level is especially high at Pasir Tenggara.
- Pollution indicators are high.
- Nutrient indicator algae are especially high at Freshwater Bay and Gua Rajawali.

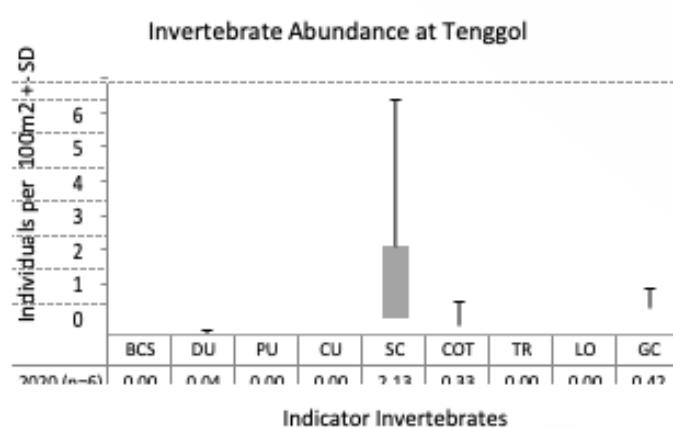
CORAL IMPACTS

- Discarded fishing nets and trash are recorded at almost all sites.

Fish and Invertebrate



- Snapper abundance is the highest.
- Absent (Bumphead parrotfish) or very low abundance (Humphead wrasse) of indicators targeted for live-food fish trade.
- Fish targeted for food are low in abundance, except for Snapper and Parrotfish.
- This suggest that fish targeted for food are heavily harvested.
- Snapper abundance is the highest.
- Absent (Bumphead parrotfish) or very low abundance (Humphead wrasse) of indicators targeted for live-food fish trade.
- Fish targeted for food are low in abundance, except for Snapper and Parrotfish.
- This suggest that fish targeted for food are heavily harvested.



- Invertebrates targeted for food are low in abundance.
- Indicators for curio trade are absent.
- COT is an issue in Tenggol.
- A healthy coral reef can support a population of 0.2-0.3 individuals per 100m2.

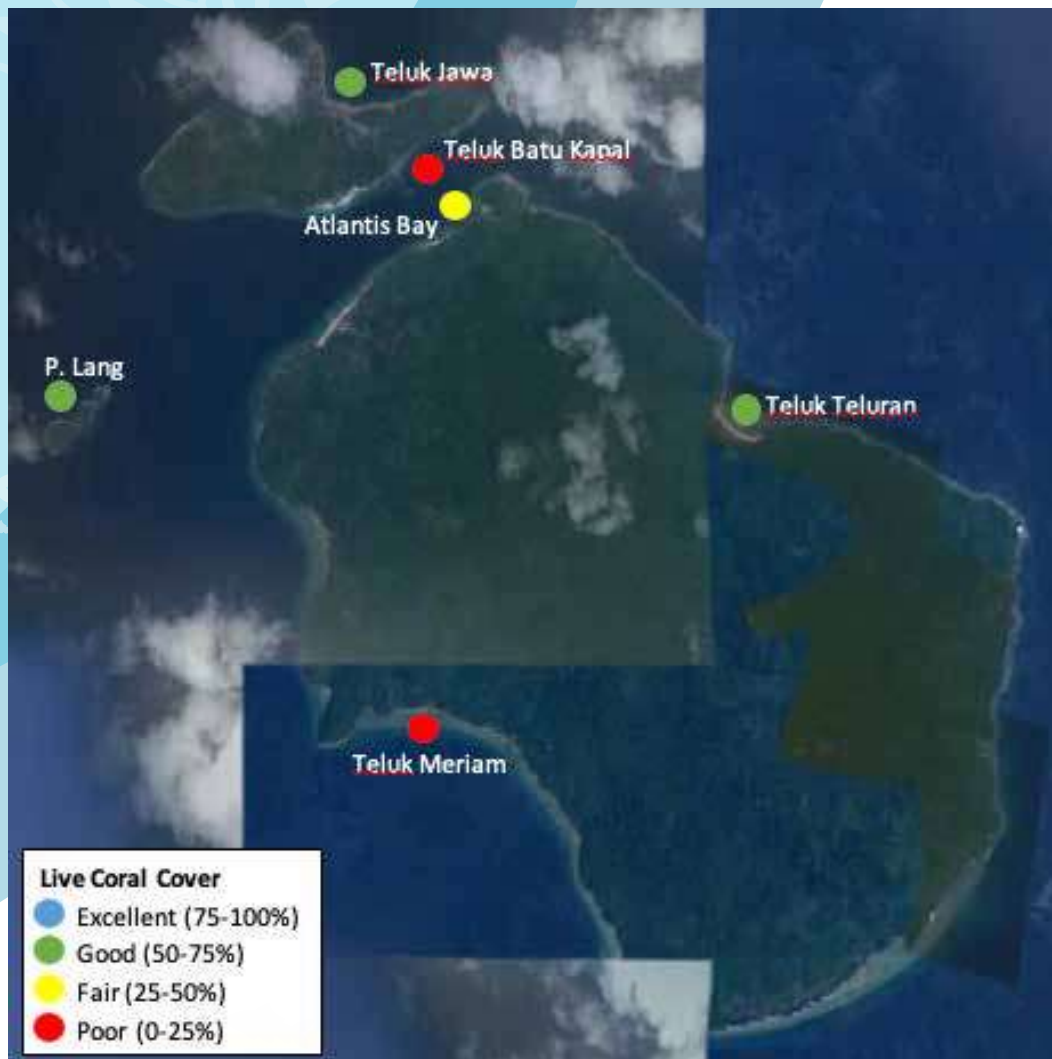
RARE ANIMALS

- Blacktip shark, Hawksbill turtle and Morbula ray were recorded.

Sunda Shelf – Aur & Dayang

Pulau Aur and Pulau Dayang are adjacent islands in Mersing District, Johor. They lie about 76km east of Mersing off the East coast of Peninsular Malaysia and were gazetted as a Marine Park in 1994 under the Fisheries Act 1985 (Amended 1993).

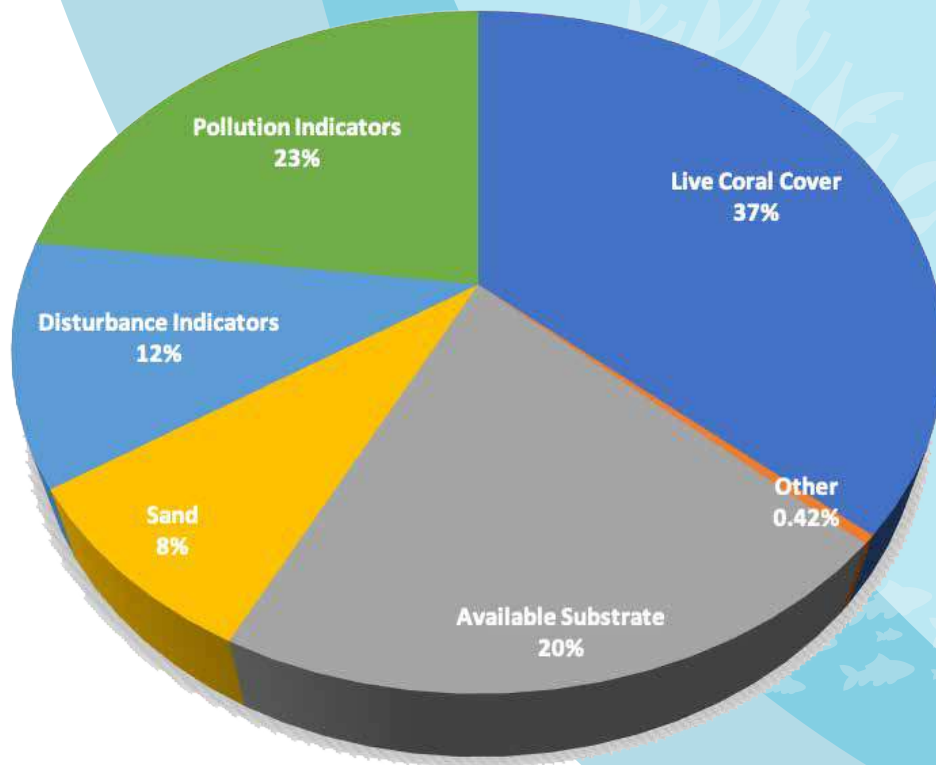
Their corals, lagoons and offshore pools make these islands a tourist attraction. The islands are sparsely populated with few villages and have for many years been a frequent stopover point for fishermen. Pulau Aur and Pulau Dayang used to be a popular diving destination among tourists from Singapore.



Map showing the health categories of each survey site based on their live coral cover: 3 sites have 'Good' coral cover, 1 is in 'Fair' condition, and 2 show 'Poor' health.

Coral Cover and Health

Substrate Composition at Aur & Dayang

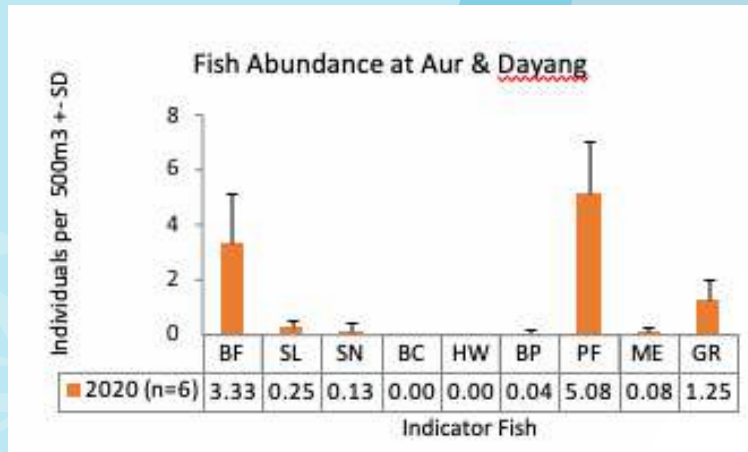


- Aur and Dayang is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 33.33%.
- In 'Fair' condition, below the Sunda Shelf region average (47.28%).
- Available substrate for coral recruits to attach is very high.
- Disturbance indicators are high.
- Rubble level is especially high at Atlantis Bay, Teluk Batu Kapal and Teluk Meriam.
- Pollution indicators are very high.
- Nutrient indicator algae level is especially high at Atlantis Bay, Teluk Batu Kapal and Teluk Teluran.

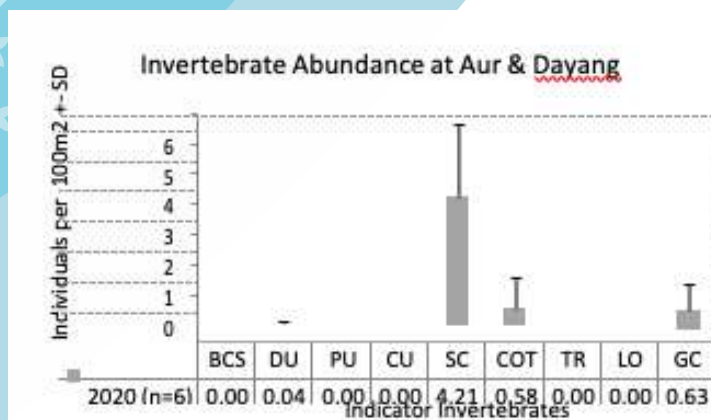
CORAL IMPACTS

- Discarded fishing nets and trash are recorded.
- Most reefs are impacted by warm water bleaching.
- Many sites are damaged by *Terpios* sponge infection, and COT and *Drupella* predations.

Fish and Invertebrate



- Parrotfish abundance is the highest.
- Absent (Humphead wrasse) or very low abundance (Bumphead parrotfish) of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance, except for Parrotfish.
- This suggest that fish targeted for food are heavily harvested.



- Sea cucumber abundance is the highest.
- Invertebrates targeted for food are very low in abundance, except for Sea cucumber.
- Indicators for curio trade are absent.
- COT is an issue in Aur and Dayang.
- A healthy coral reef can support a population of 0.2-0.3 individuals per 100m2.

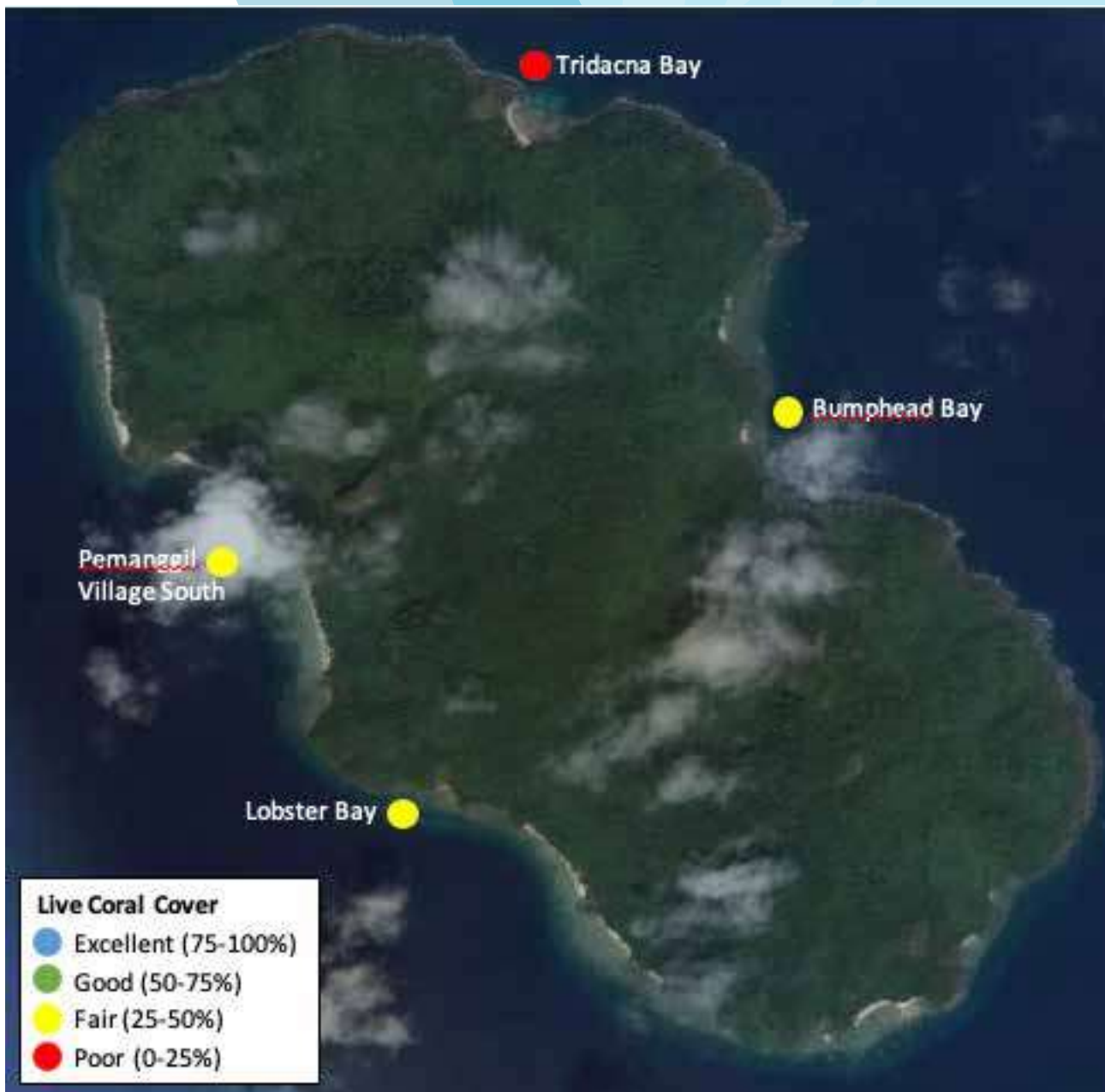
RARE ANIMALS

- Hawksbill turtle was recorded.

Sunda Shelf – Pemanggil

Pemanggil Island is approximately 45km east of Mersing off the East coast of Peninsular Malaysia. The island and its surrounding waters were gazetted as a Marine Park in 1994 under the Fisheries Act 1985 (Amended 1993).

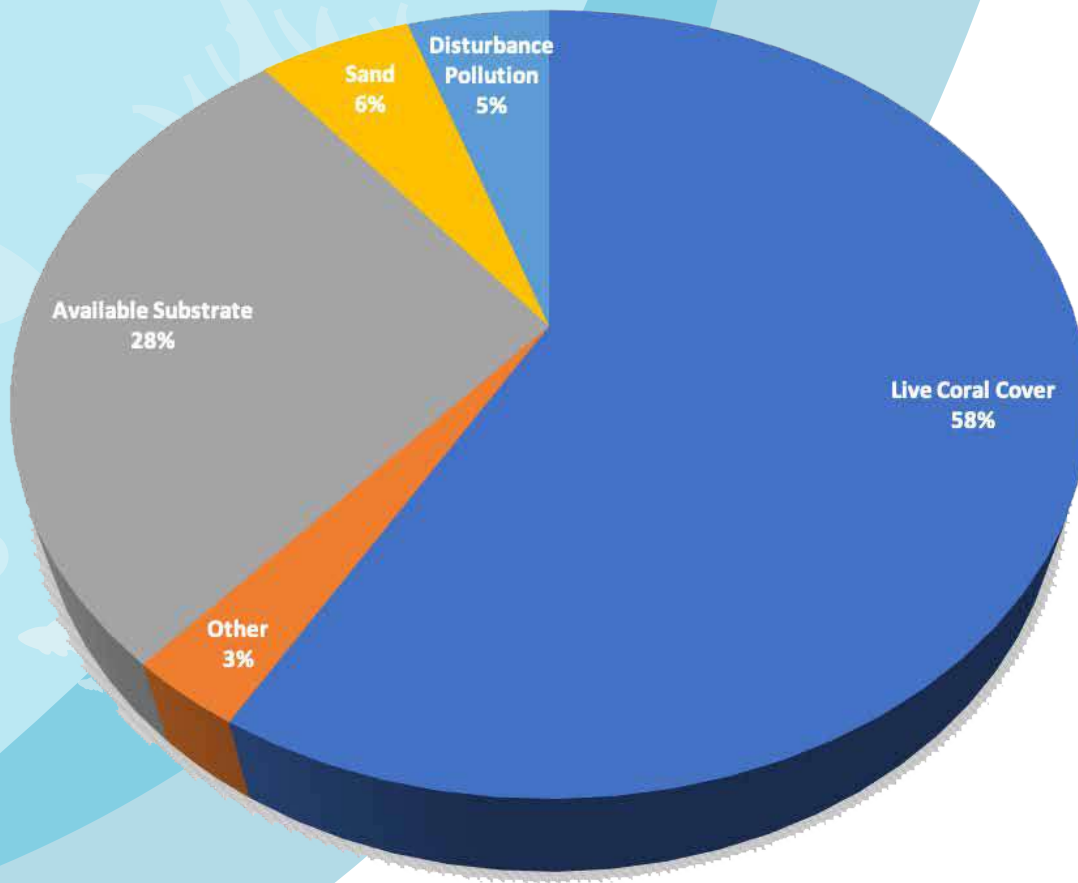
The island is sparsely populated and has for many years been a frequent stopover point for fishermen.



Map showing the health categories of each survey site based on their live coral cover: 3 sites have 'Fair' coral cover and 1 is in 'Poor' condition

Coral Cover and Health

Substrate Composition at Pemanggil

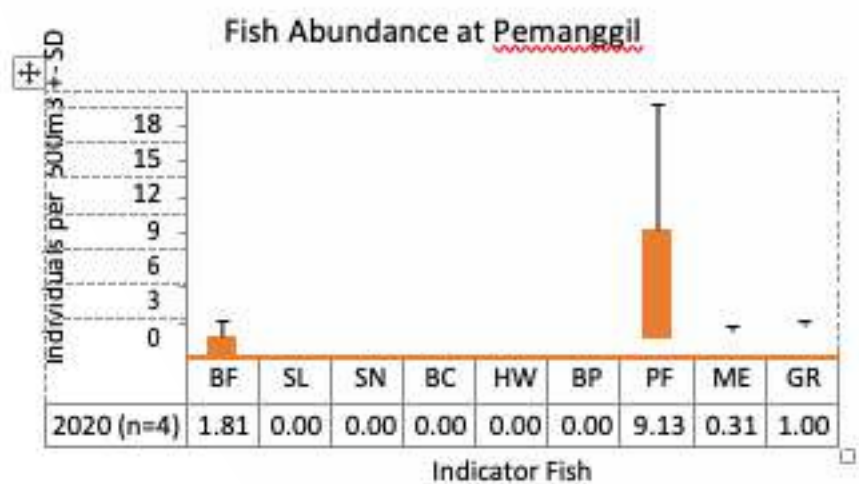


- Pemanggil is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 44.69%.
- In 'Fair' condition, above the Sunda Shelf region average (47.28%).
- Available substrate for coral recruits to attach is very high.
- Pollution indicators are high.
- Nutrient indicator algae level is especially high at Bumphead Bay and Pemanggil Village South.

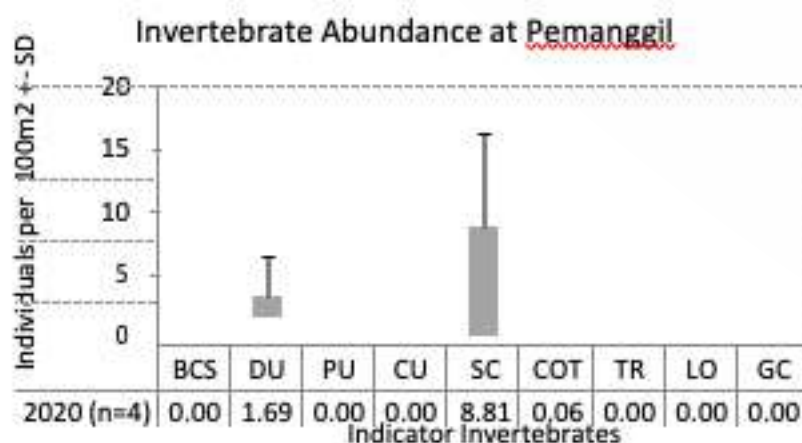
CORAL IMPACTS

- Fish trap and trash are recorded.
- One site is impacted by warm water bleaching.
- Damage by Terpios sponge infection is recorded.

Fish and Invertebrate



- Parrotfish abundance is the highest.
- Indicators targeted for live-food fish trade are absent.
- Fish targeted for food are very low in abundance, except for Parrotfish.
- This suggest that fish targeted for food are heavily harvested.



- Sea cucumber abundance is the highest.
- Invertebrates targeted for curio trade are absent.
- Indicators targeted for food are very low in abundance, except for Sea cucumber.

Sunda Shelf – Pulau Besar

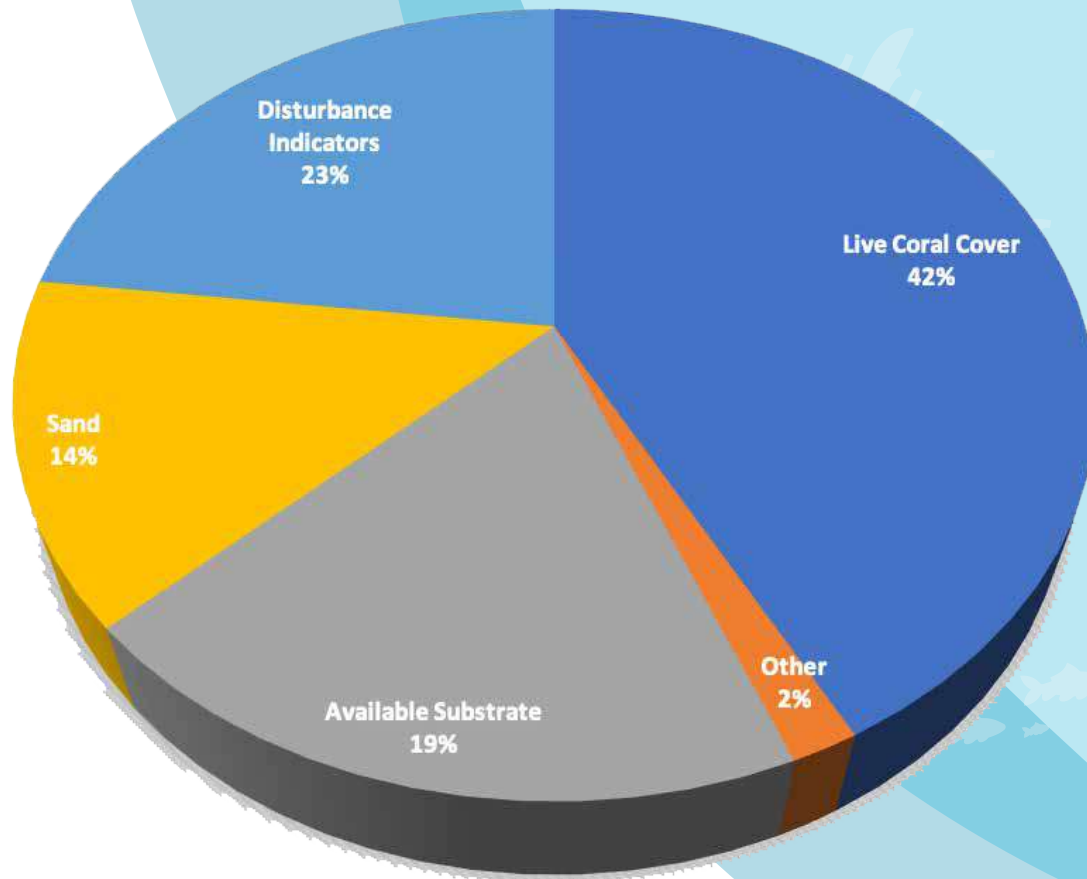
Pulau Besar is an island in Mersing District, Johor. The island is surrounded by Pulau Rawa, Pulau Sibul and Pulau Tinggi. The waters surrounding the island group were gazetted as a Marine Park in 1994 under the Fisheries Act 1985 (Amended 1993).



Map showing the health categories of each survey site based on their live coral cover: 1 site has 'Good' coral cover, 5 are in 'Fair' condition, and 1 shows 'Poor' health.

Coral Cover and Health

Substrate Composition at Pulau Besar

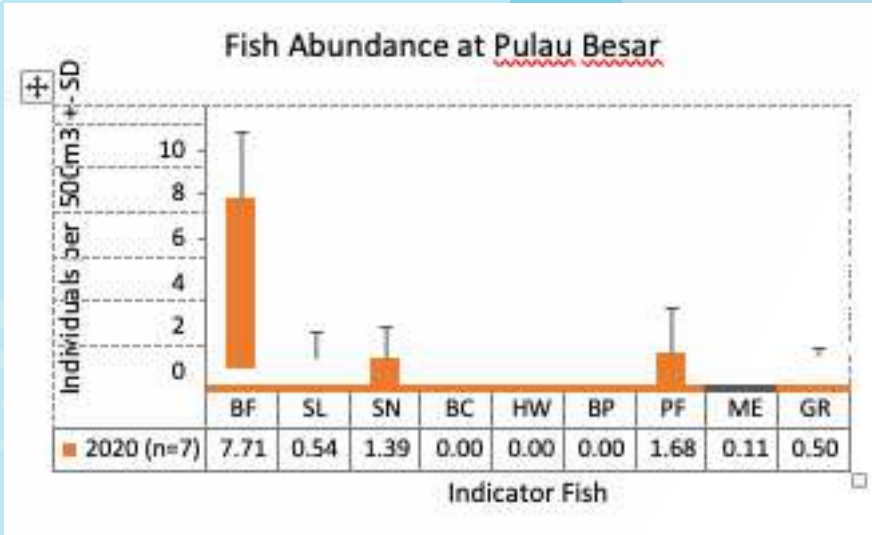


- Pulau Besar is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 33.57%.
- In 'Fair' condition, below the Sunda Shelf region average (47.28%).
- Available substrate for coral recruits to attach is high.
- Disturbance indicators are high.
- Rubble level is especially high at Rapang.
- Silt level is especially high at Palenting and Teluk Buluh.
- Pollution indicators are high.
- Nutrient indicator algae level is especially high at Mirage and Teluk Meriam South.

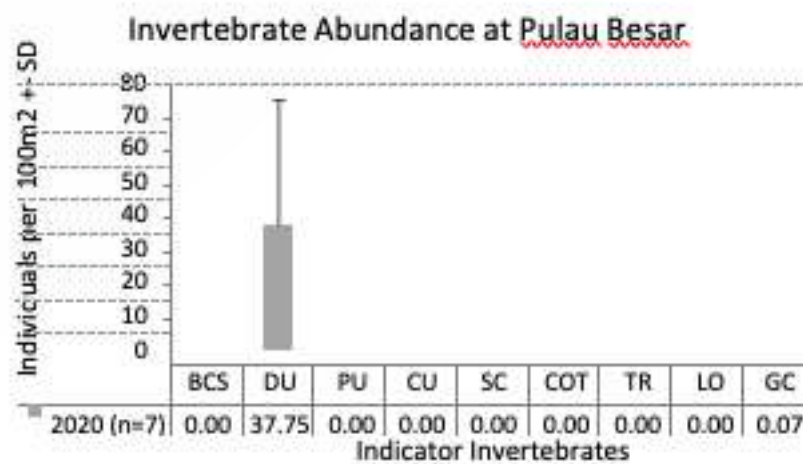
CORAL IMPACTS

- Boat anchor damage and trash are recorded at some sites.
- Discarded fishing nets are recorded at many sites.
- Almost all reefs are impacted by warm water bleaching.
- Many sites are damaged by Terpios sponge infection, sedimentation and/or fish bite.

Fish and Invertebrate



- Butterflyfish abundance is the highest.
- Indicators targeted for live-food fish trade are absent.
- Fish targeted for food are very low in abundance.
- This suggest that fish targeted for food are heavily harvested



- Diadema urchin abundance is high.
- Invertebrates targeted for food are absent except for Giant clam which is very low in abundance.
- Indicators for curio trade are absent.

RARE ANIMALS

- Shark and turtle were recorded.

Sunda Shelf – Sibul

The Sibul archipelago, known locally by the name of the largest island, Sibul, is located less than 10km off the East coast of mainland Peninsular Malaysia. The waters surrounding the island group were gazetted as a Marine Park in 1994 under the Fisheries Act 1985 (Amended 1993).

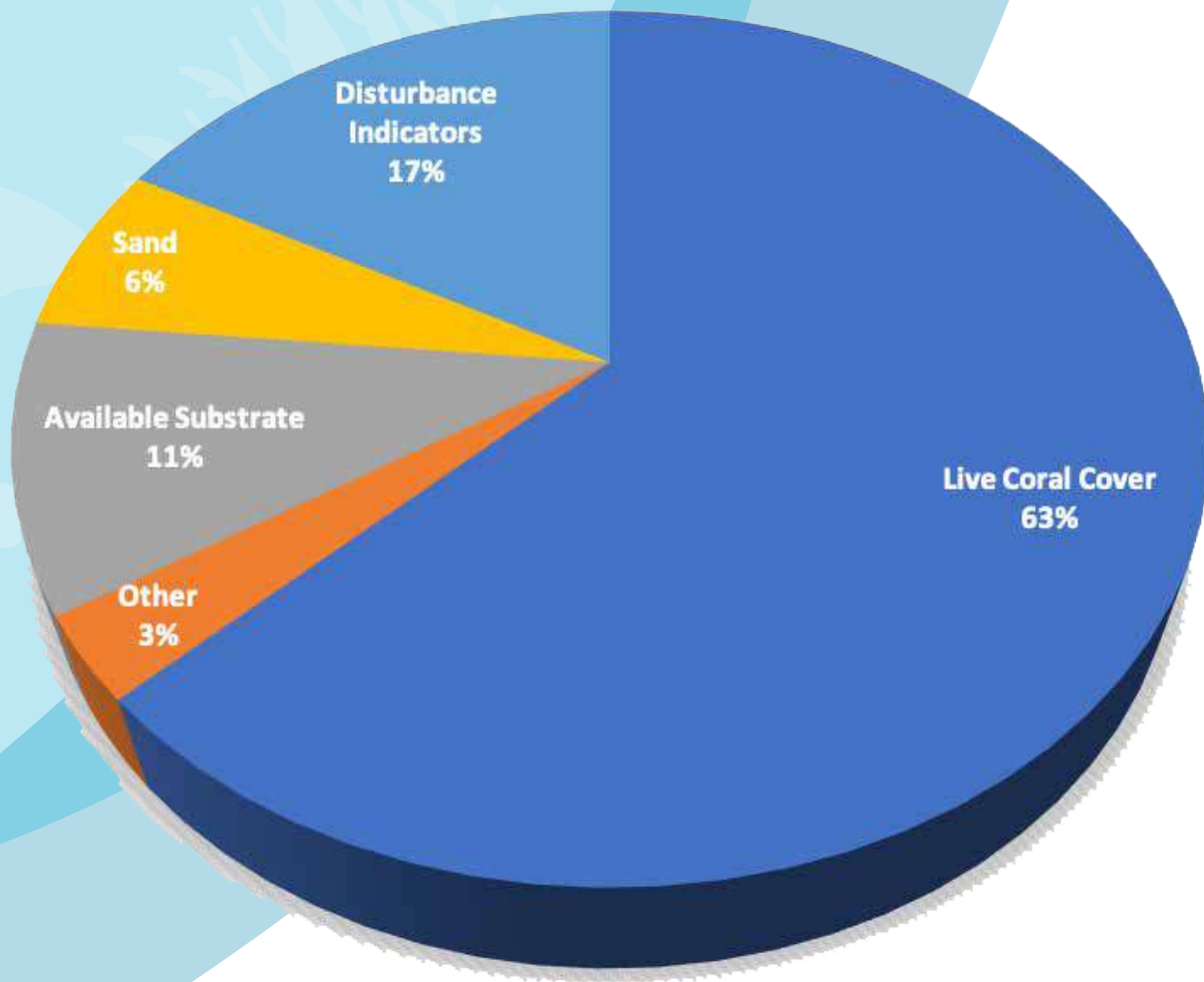
Sibul island is not as popular among tourists as other islands off the East coast, but the tourism industry here is growing. The island is sparsely populated with few villages and a number of small resorts.



Map showing the health categories of each survey site based on their live coral cover: 1 site has 'Excellent' coral cover, 3 are in 'Good' condition, and 2 show 'Fair' health.

Coral Cover and Health

Substrate Composition at Sibü

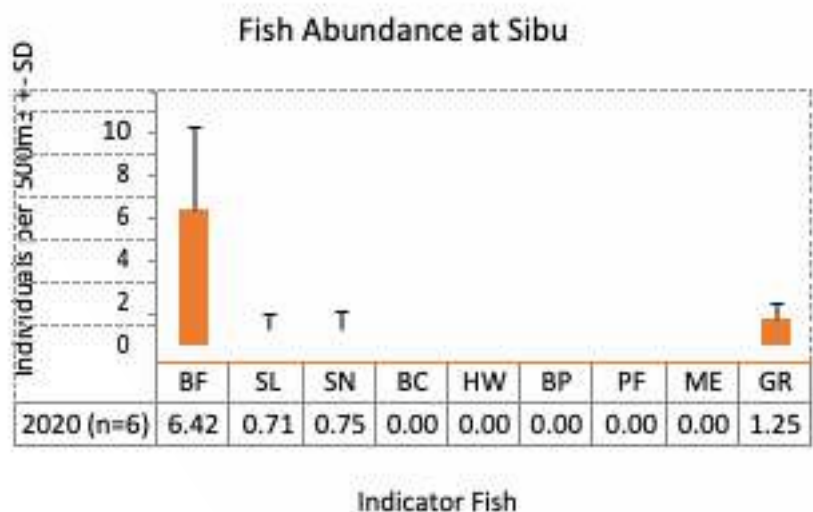


- Sibü is dominated by live coral cover, which is mainly hard coral.
- In 'Good' condition, above the Sunda Shelf region average (47.28%).
- Available substrate for coral recruits to attach is high.
- Disturbance indicators are high.
- Silt level is especially high at Buntut Meriam and Sibü Hujung.

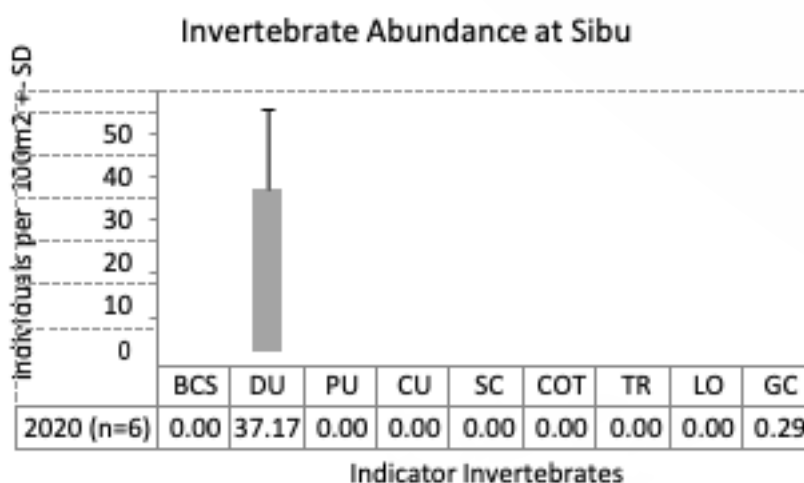
CORAL IMPACTS

- Discarded fishing net and trash are recorded.
- Most reefs are impacted by warm water bleaching.

Fish and Invertebrate



- Butterfly abundance is the highest.
- Absent of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance.
- Parrotfish, an important algae grazer, is absent.
- This suggest that fish targeted for food are heavily harvested.



- Diadema urchin abundance is high.
- Invertebrates targeted for food are absent except for Giant clam which is very low in abundance.
- Indicators for curio trade are absent.

Sunda Shelf – Tinggi

Tinggi Island is located less than 15km off the East coast of mainland Peninsular Malaysia. The island and its surrounding waters were gazetted as a Marine Park in 1994 under the Fisheries Act 1985 (Amended 1993).

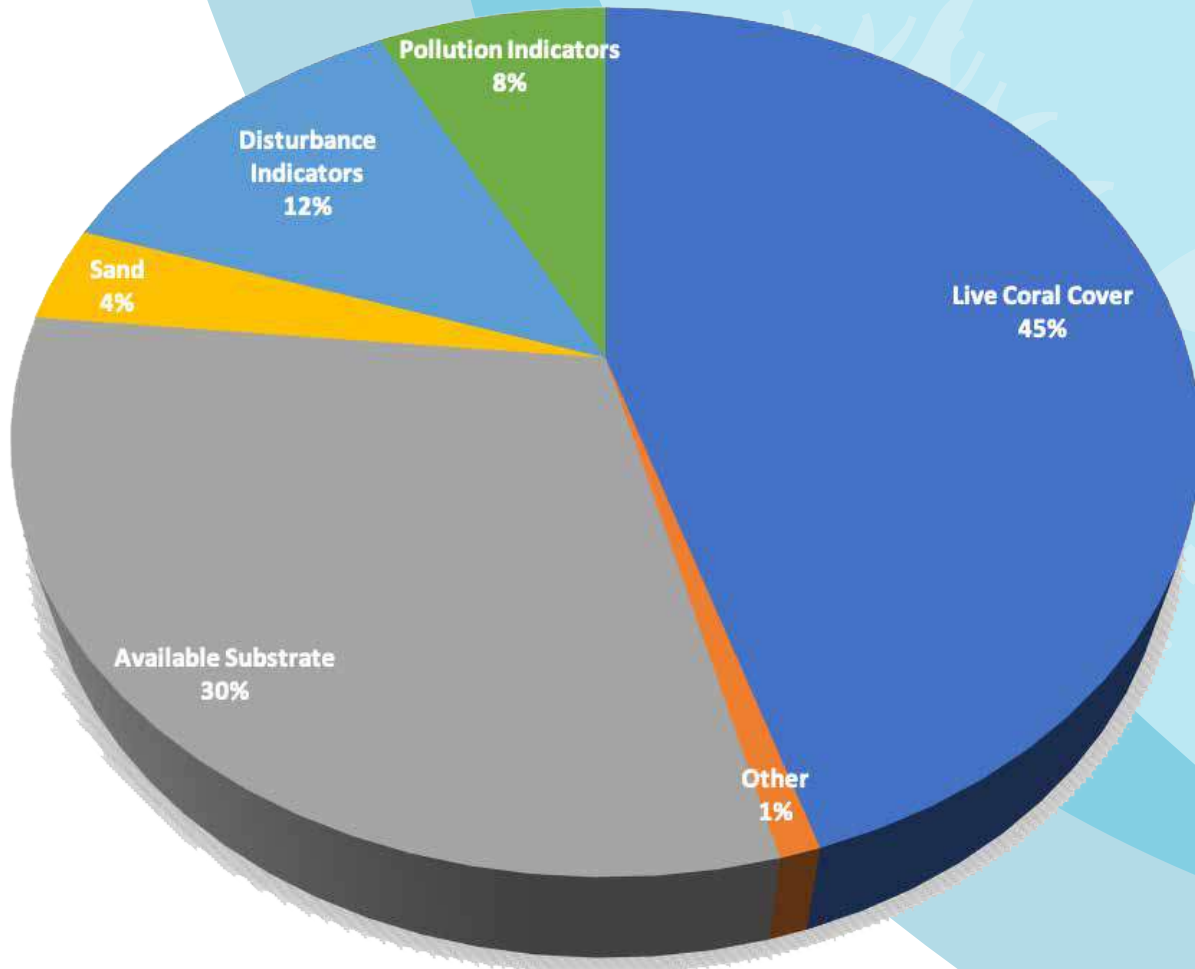
The island is not as popular among tourists as other islands off the East coast, but the tourism industry here is growing. There is no dive operator on Tinggi Island.



Map showing the health categories of each survey site based on their live coral cover: 2 sites have 'Good' coral cover, 1 is in 'Good' condition, and 1 shows 'Fair' health.

Coral Cover and Health

Substrate Composition at Tinggi

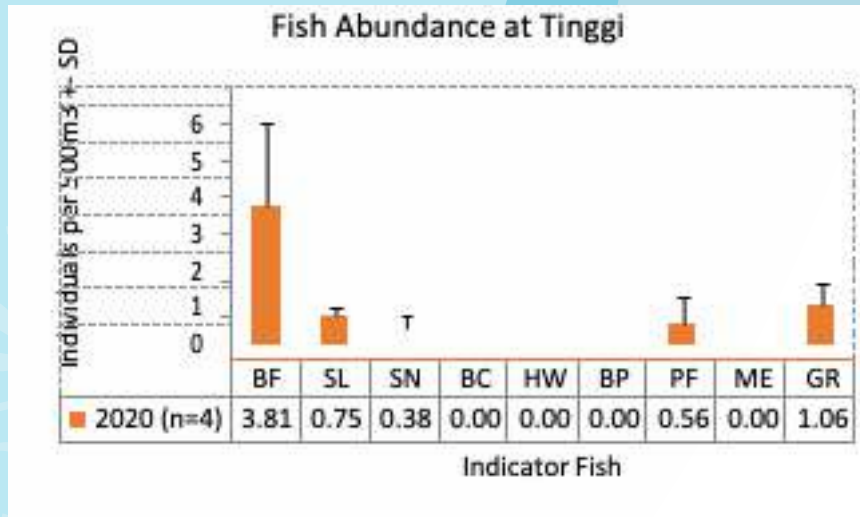


- Tinggi is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 38.13%.
- In 'Fair' condition, below the Sunda Shelf region average (47.28%).
- Available substrate for coral recruits to attach is extremely high.
- Disturbance indicators are high.
- Silt level is especially high at Pulau Nanga and Tanjung Gua Subang.
- Pollution indicators are slightly high.
- Nutrient indicator algae level at Tanjung Gua Subang is high.
- Sponge level at Pulau Ibol and Pulau Mentinggi is high.

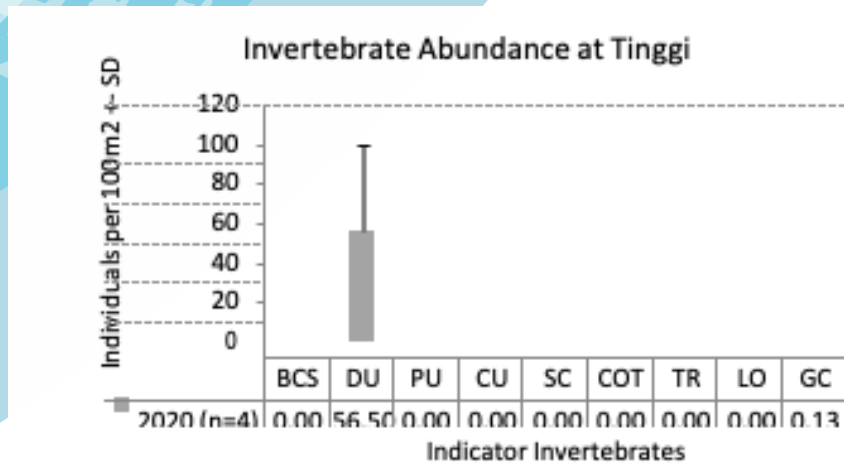
CORAL IMPACTS

- Ghost net, discarded fishing net and trash are recorded.
- Most reefs are impacted by warm water bleaching

Fish and Invertebrate



- Butterfly abundance is the highest.
- Absent of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance.
- This suggest that fish targeted for food are heavily harvested.



- Diadema urchin abundance is high.
- Invertebrates targeted for food are absent except for Giant clam which is very low in abundance.
- Absent of indicators for curio trade.

RARE ANIMALS

- While no rare animals are recorded, about 30 Snappers spotted off survey transect.

Malacca Strait – Pangkor Laut

Pangkor Laut Island is a small island, privately owned and located 3 miles off the coast of Perak, along the Straits of Malacca. Of the island's 300 acres, a fraction has been developed to house a premier resort.

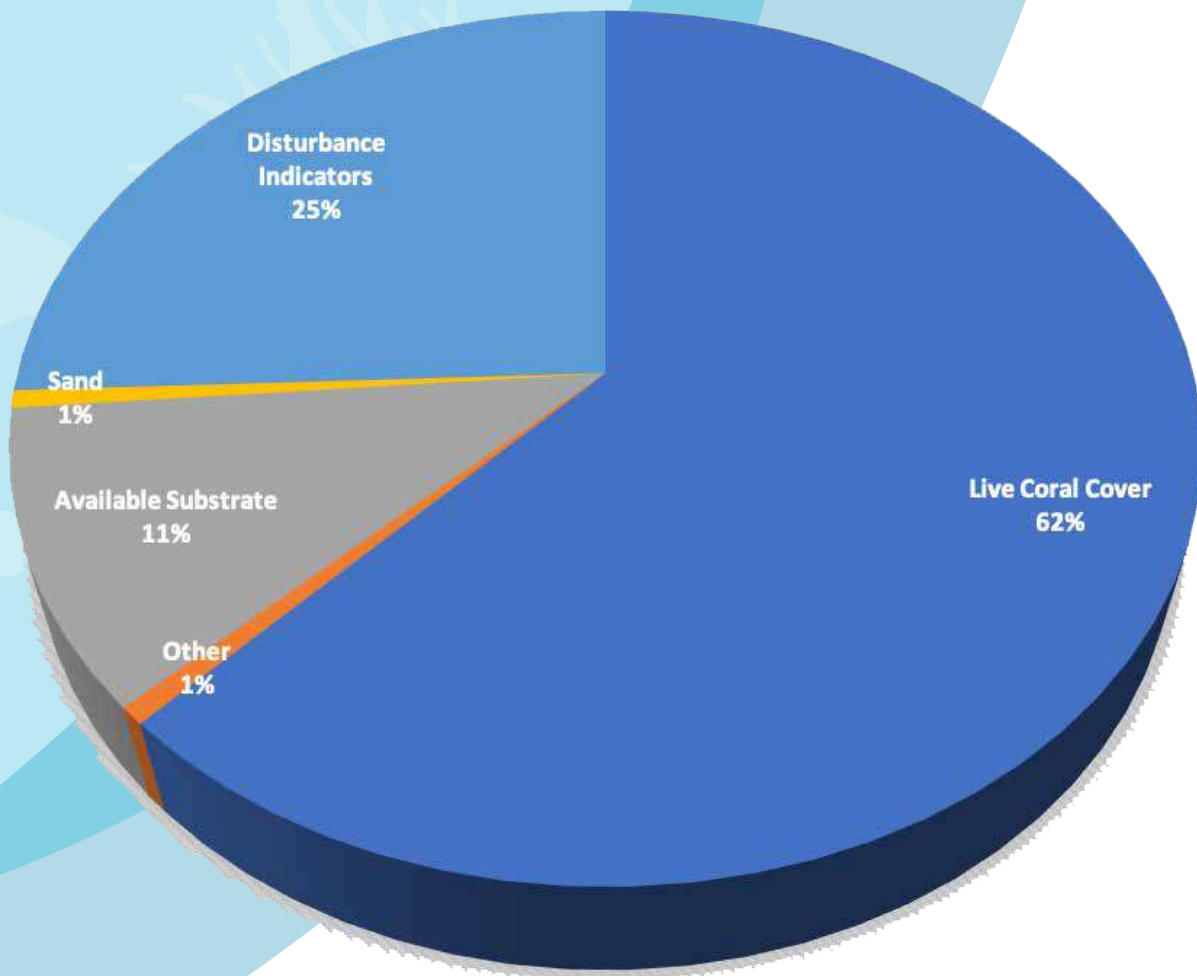
Only one site has been surveyed at Pulau Pangkor Laut, a very limited sample.



Map showing the health categories of each survey site based on their live coral cover: the site has 'Good' coral cover.

Coral Cover and Health

Substrate Composition at Pangkor Laut

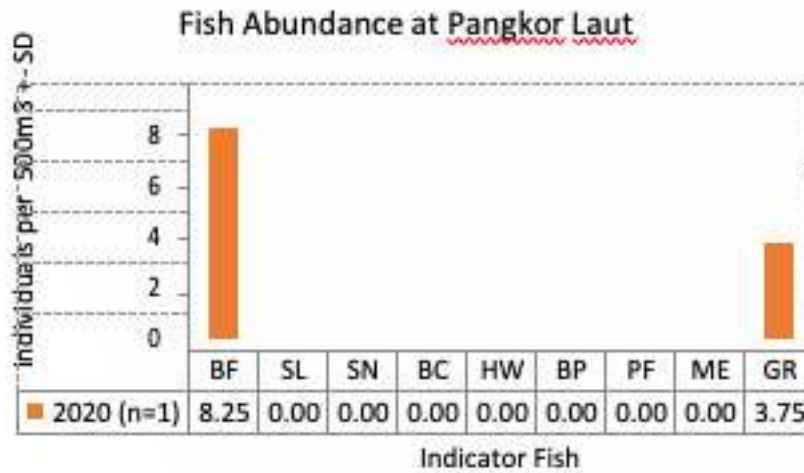


- Pangkor Laut is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 60.63%.
- In 'Good' condition, above the Malacca Strait region average (41.21%).
- Available substrate for coral recruits to attach is high.
- Disturbance indicators are very high.
- Rubble level is very high at 23.13%.

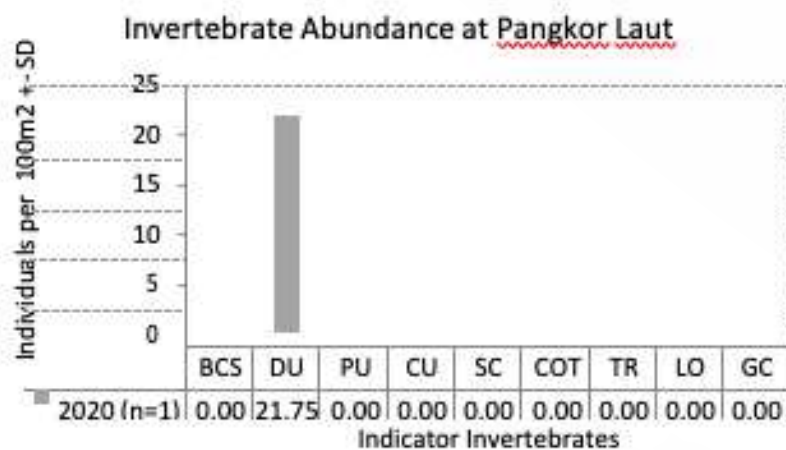
CORAL IMPACTS

- Discarded fishing net is recorded

Fish and Invertebrate



- Butterflyfish abundance is the highest.
- Absent of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance, except for Grouper.
- Parrotfish, an important algae grazer, is absent.
- This suggest that fish targeted for food are heavily harvested.



- Only Diadema urchin is recorded.
- Indicators for curio trade and invertebrates targeted for food are absent.

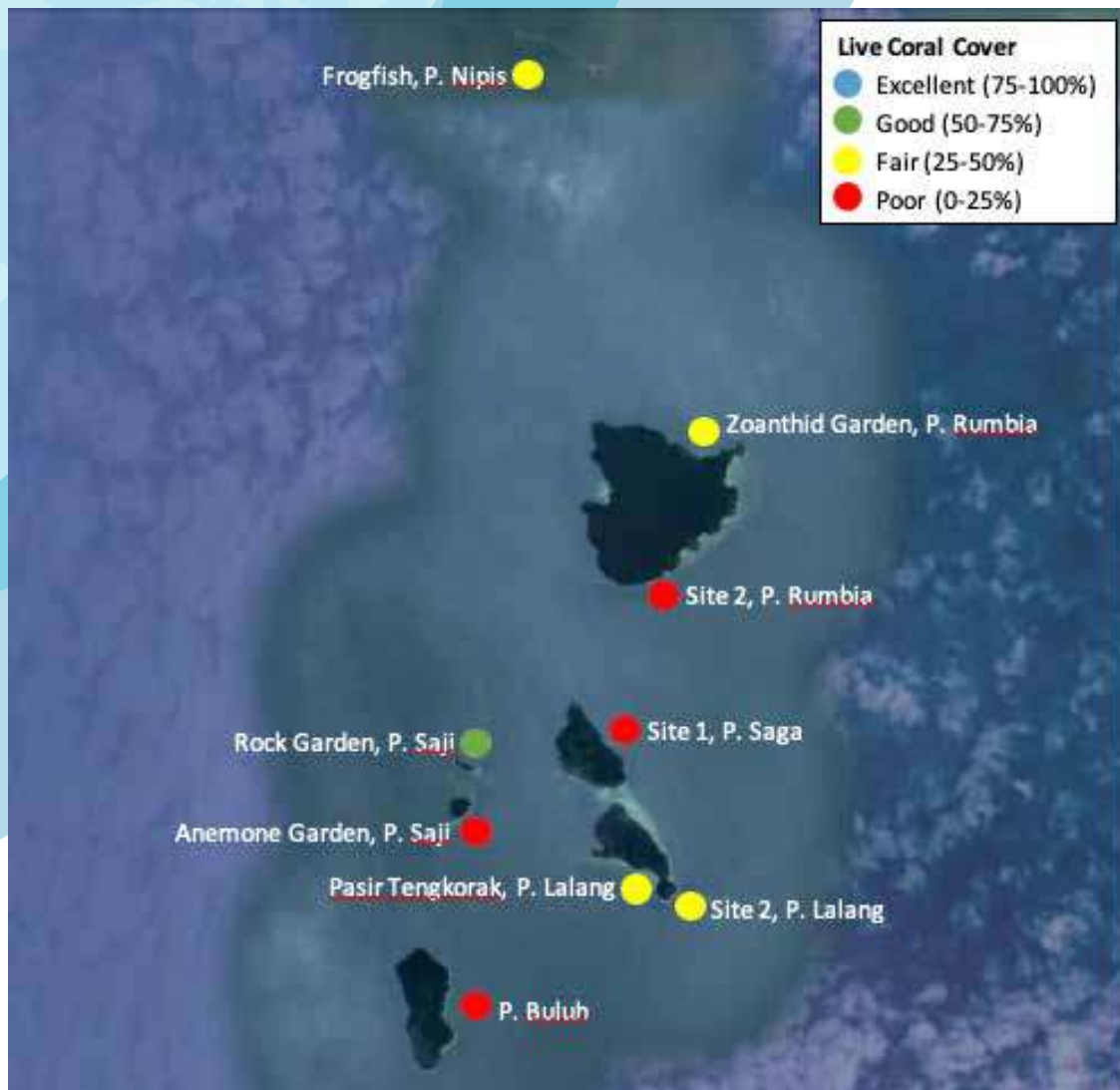
RARE ANIMALS

- Seahorse was recorded

Malacca Strait – Sembilan

The Sembilan Islands consist of a cluster of nine islands (Pulau Agas, Pulau Payong, Pulau Nipis, Pulau Rumbia, Pulau Lalang, Pulau Saga, Pulau Buluh, Black Rock and White Rock) which are located some 20km from the coast of Perak (Lumut), off the west coast of Peninsular Malaysia, in the Straits of Malacca.

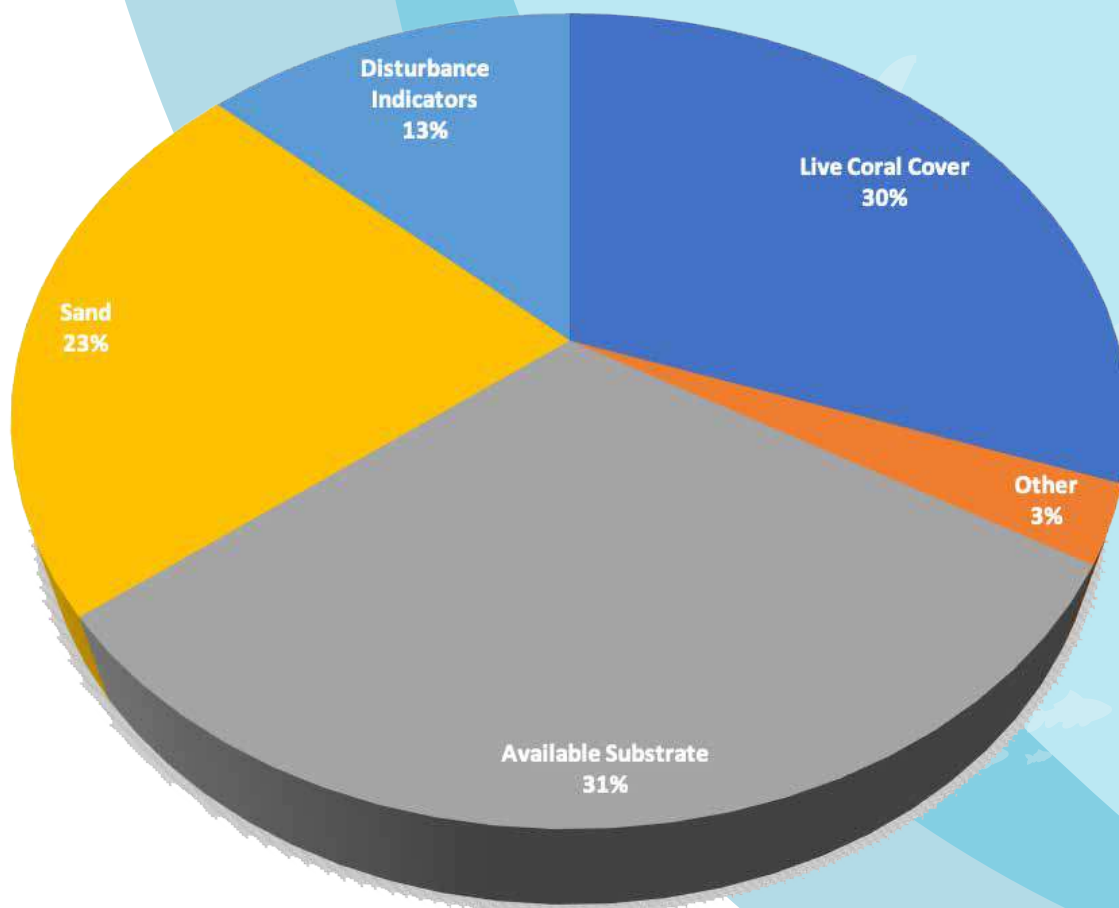
The islands are uninhabited and the only structures on the islands are small rest areas on Pulau Saga, constructed for the use of tourists and fishermen. The islands are a favourite fishing spot among sport and commercial fishermen. They are also occasionally visited by snorkelers and divers from Pangkor and Lumut. They have no protected status; hence tourism and fishing pressure are neither controlled nor monitored.



Map showing the health categories of each survey site based on their live coral cover: 1 site has 'Good' coral cover, 4 are in 'Fair' condition, and 4 show 'Poor' health.

Coral Cover and Health

Substrate Composition at Sembilan

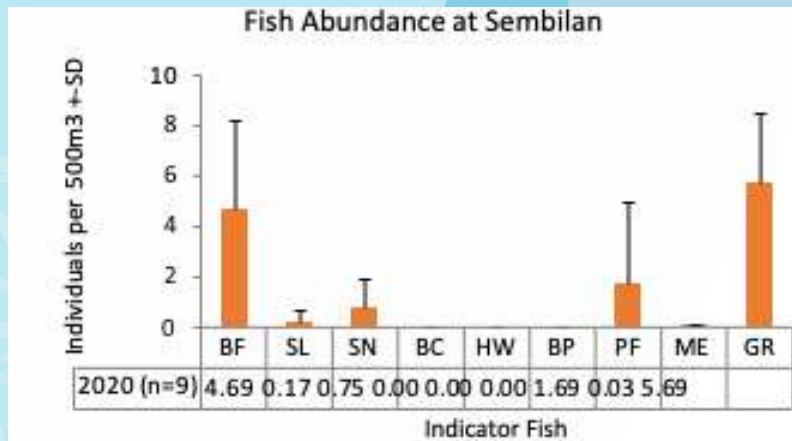


- Sembilan is dominated by available substrate, which is rock, for coral recruits to attach on.
- Mean hard coral, reef builder, cover is 25.35%.
- In 'Fair' condition, below the Malacca Strait region average (41.21%).
- Sand level is very high.
- Disturbance indicators are high.
- Rubble level is especially high at Site 2, Pulau Rumbia and Zoanthid Garden.
- Pollution indicators are slightly high.
- All sites, except for Zoanthid Garden recorded considerable amount of sponge.
- All the above are considered signs of unhealthy reefs. While available substrate for coral recruits to attach to is high, high amount of sand, disturbance and pollution indicators may deter coral growth if they are not deal with.

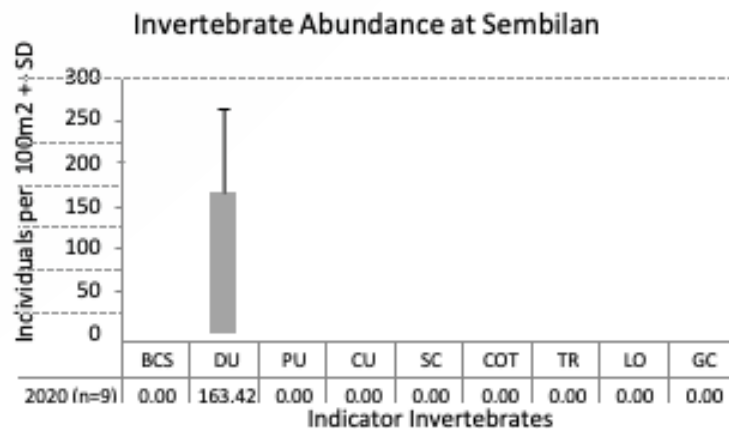
CORAL IMPACTS

- Discarded fishing net and trash are recorded at many sites.
- Damage by Drupella predation is recorded.

Fish and Invertebrate



- Grouper abundance is the highest.
- Absent of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance, except for Grouper.
- This suggest that fish targeted for food are heavily harvested.



- Only Diadema urchin is recorded.
- Indicators for curio trade and invertebrates targeted for food are absent.

RARE ANIMALS

- Seahorses were observed at 2 sites.
- A pair of cuttlefish was also observed during surveys.

Malacca Strait – Payar

Payar is one of many islands off the West coast of mainland Kedah. It is situated 35km south of Langkawi, 59km north of Penang and 28km west of Kuala Kedah. It was gazetted as a Marine Park in 1994 under the Fisheries Act 1985 (Amended 1991).

The island is a popular destination for tourists (mainly from Langkawi) famous for its corals and reef fishes. Measuring 2km long and 0.25km wide, its sheltered waters are ideal for snorkelling, diving and swimming.

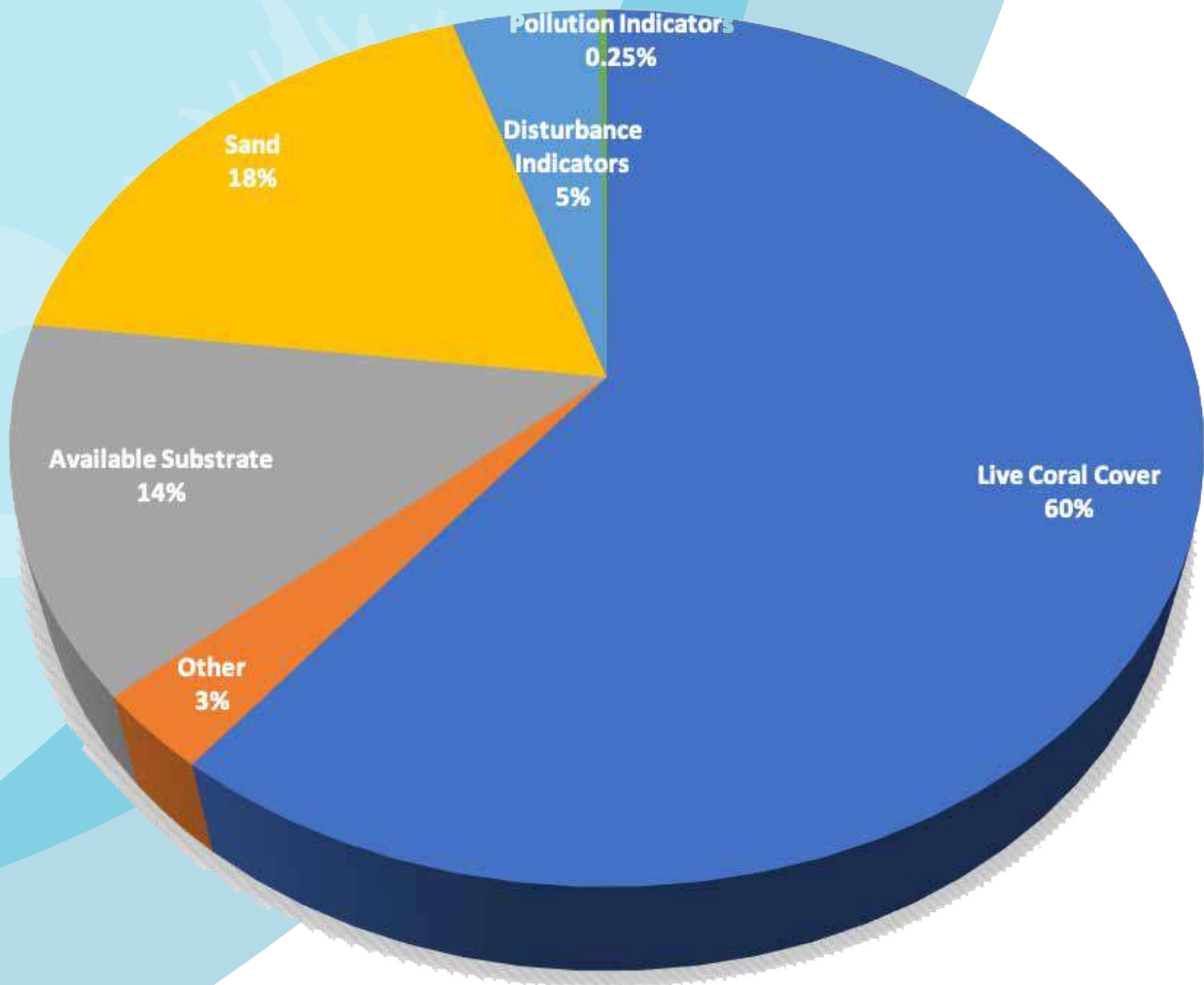
The island is uninhabited and the only operating structures on the island are the Marine Park centre with facilities for day trip visitors such as gazebos, picnic tables and restroom facilities at selected areas. There is also an old abandoned resort. A floating platform moored just off Payar serves as a restaurant and dive platform for tourists.



Map showing the health categories of each survey site based on their live coral cover: 2 sites have 'Excellent' coral cover, 1 is in 'Good' condition, 1 shows 'Fair' health and 1 is in 'Poor' state.

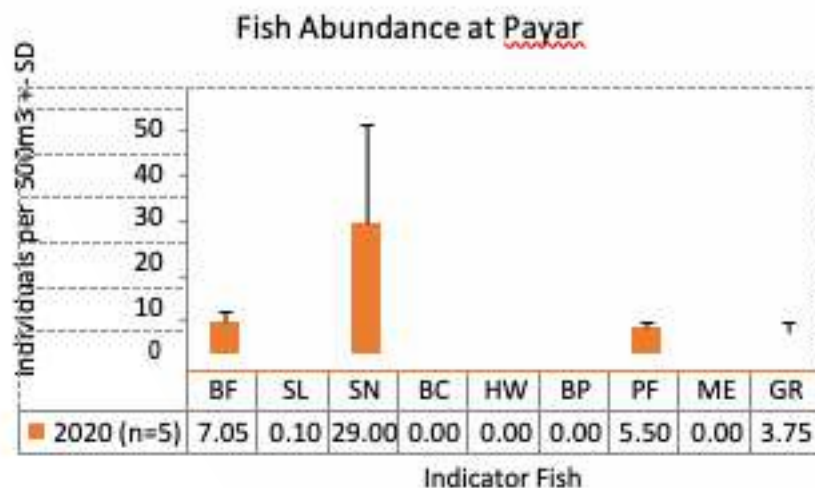
Coral Cover and Health

Substrate Composition at Payar

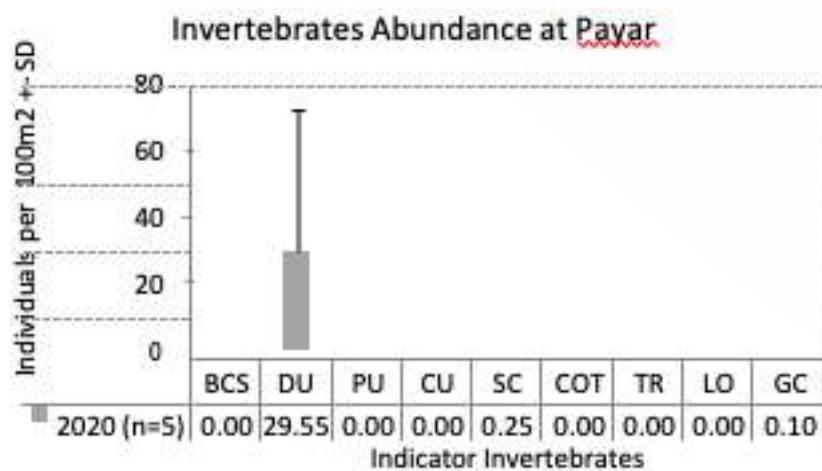


- Payar is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 60.50%.
- In 'Good' condition, above the Malacca Strait region average (41.21%).
- Available substrate for coral recruits to attach to is high.
- Sand level is high.

Fish and Invertebrate



- Snapper abundance is the high.
- Absent of indicators targeted for live-food fish trade.



- Diadema urchin abundance is high.
- Invertebrates targeted for food are very low in abundance.
- Indicators for curio trade are absent.

RARE ANIMALS

- Blacktip shark was recorded.

North Borneo – Kapalai

Kapalai Island is located near Semporna, Sabah and is 15 kilometres from Sipadan Island. Though it is called an island, it is actually a sandbar situated on Ligitan Reef. Kapalai used to be a real island with vegetation but erosion over the last few hundred years has reduced the island to sea level. All of the buildings are on stilts resting on the reef.

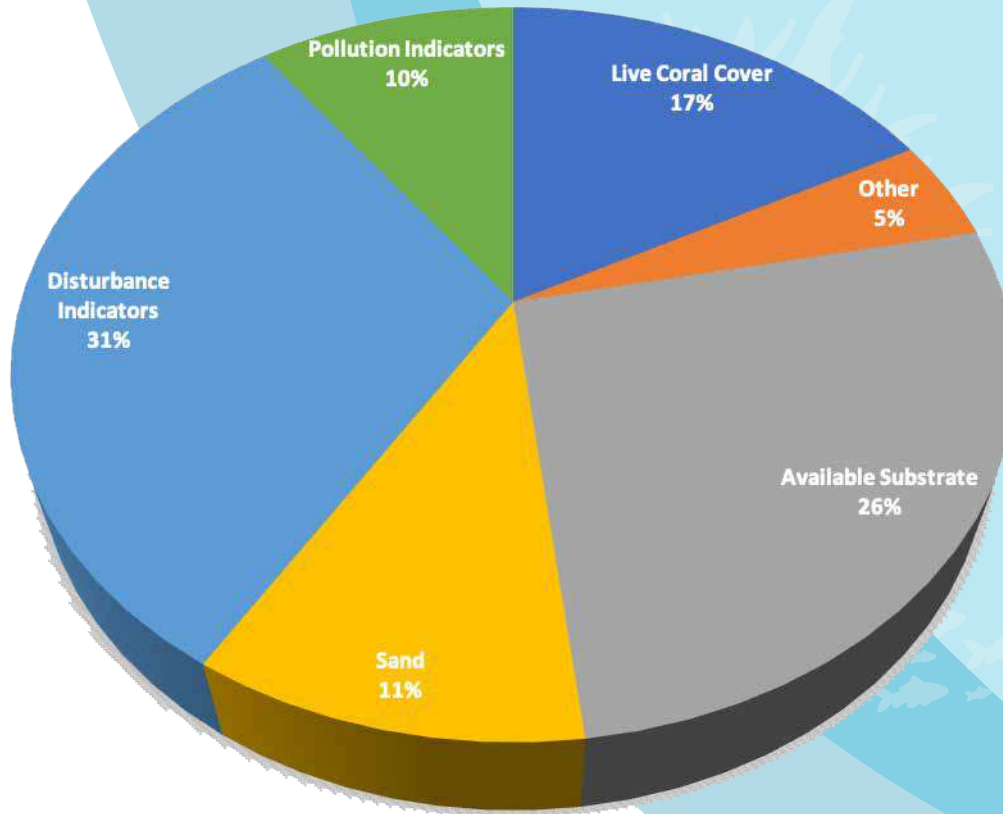
Kapalai is mostly known for its scuba diving. There is only one private resort on the island while the rest of the island is uninhabited.



Map showing the health categories of each survey site based on their live coral cover: 1 site has 'Fair' coral cover and 3 are in 'Poor' condition.

Coral Cover and Health

Substrate Composition at Kapalai

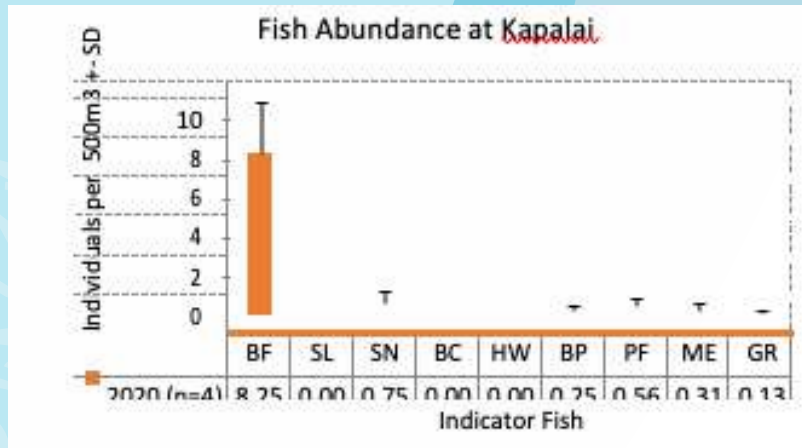


- Kapalai is dominated by disturbance indicators.
- Rubble level is very high at all sites.
- 41.25% of Great Wall reefs consist of rubble.
- Kapalai mean hard coral, reef builder, cover is 14.38%.
- In 'Poor' condition, below the North Borneo region average (36.42%).
- Available substrate for coral recruits to attach is very high.
- Pollution indicators are high.
- Sponge level is especially high at Lost World.
- All the above are considered signs of unhealthy reefs. While available substrate for coral recruits to attach to is very high, high level of disturbance and pollution indicators may deter corals growth if they are not deal with.

CORAL IMPACTS

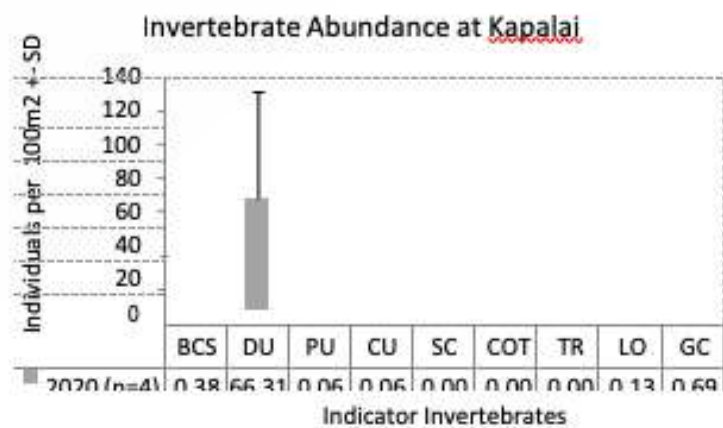
- Boat anchor damage, discarded fishing net and trash are recorded at many sites.
- All sites are impacted by warm water bleaching.

Fish and Invertebrate



Butterflyfish abundance is the highest.

- Absent (Humphead wrasse) or low abundance (Bumphead parrotfish) of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance.
- This suggest that fish targeted for food are heavily harvested.



Invertebrate Abundance at Kapalai:

- Diadema urchin abundance is high.
- Indicators for curio trade are very low in abundance.
- Invertebrates targeted for food is also very low in abundance.

RARE ANIMALS

- Shark and turtle were recorded.

North Borneo – Lahad Datu

Lahad Datu is a town located in the east of Sabah, Malaysia, on the island of Borneo. It occupies the peninsula on the north side of Darvel Bay – the largest semi-enclosed bay on the east coast of Borneo islands. Administratively, it falls within the Tawau Division and is estimated to have a population of over 156,000 (2000 census).

Currently, there is little development along the coastal areas of Lahad Datu. In Lahad Datu itself, tourism is still limited, though Sabah Urban Development Corporation is trying to promote greater investment in infrastructure. There are two well-known nature-based tourism attractions near to Lahad Datu: Tabin Wildlife Reserve and the Danum Valley Conservation Area, and the wider Kinabatangan river basin is also nearby.

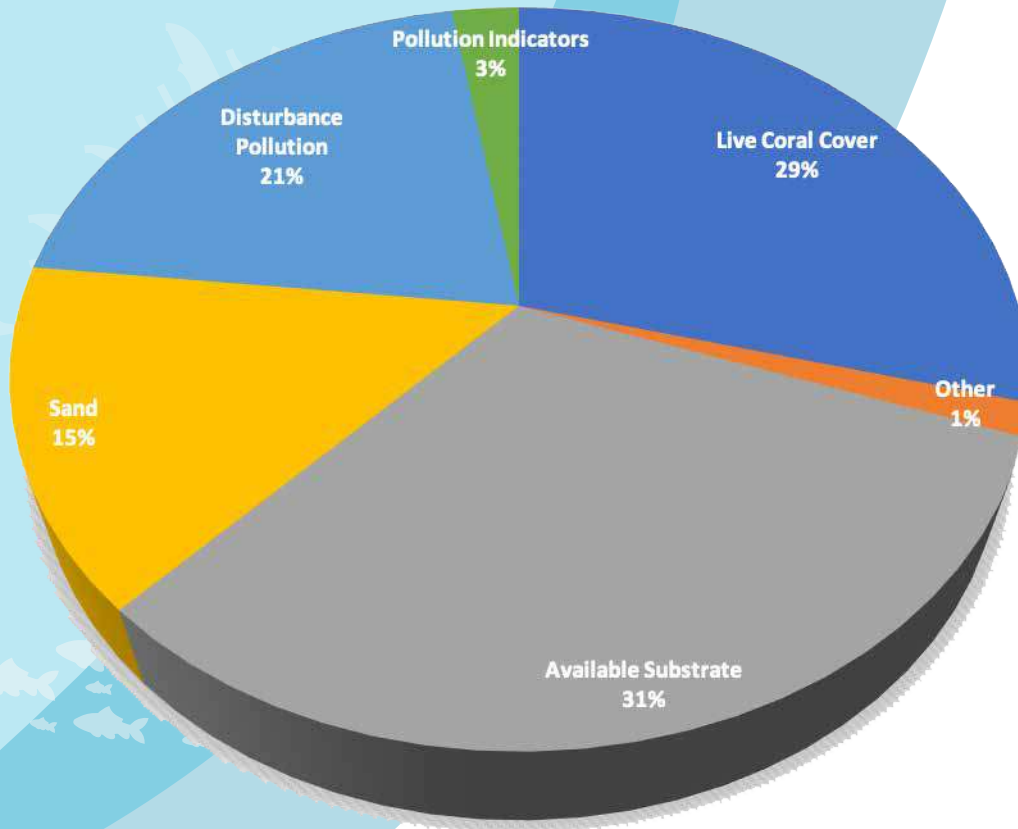
Darvel Bay has yet to become established as a popular diving destination. The area includes both fringing and submerged reefs.



Map showing the health categories of each survey site based on their live coral cover: 2 sites have 'Good' coral cover, 6 are in 'Fair' condition, and 7 show 'Poor' health.

Coral Cover and Health

Substrate Composition at Lahad Datu

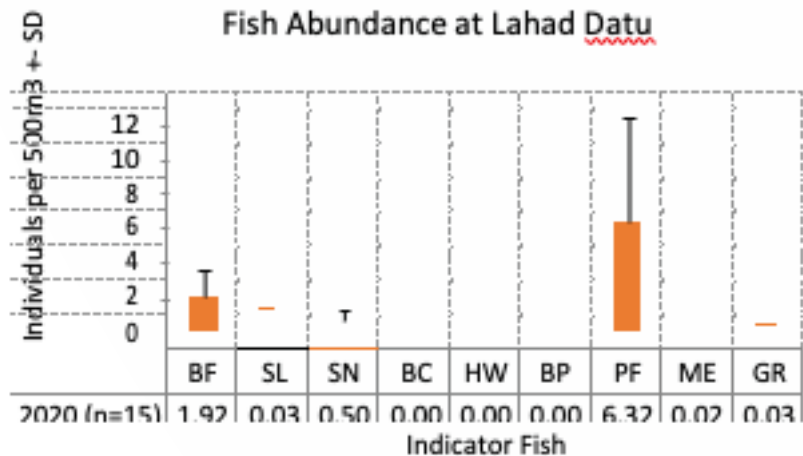


- Lahad Datu is dominated by available substrate, which is rock, for coral recruits to attach to.
- Mean hard coral, reef builder, cover is 28.13%.
- In 'Fair' condition, below the North Borneo region average (36.42%).
- Sand level is high.
- Disturbance indicators are very high.
- Rubble level is especially high at Ira's Reef, Small Reef, Lam's Point, Pulau Burung and Fish Eyes.
- 53.13% of Ira's Reef consists of rubble.
- Silt level is especially high at Tumunong Hallo.
- All the above are considered signs of unhealthy reefs. While available substrate for coral recruits to attach to is extremely high, high amount of sand and disturbance indicators may deter coral growth if they are not deal with.

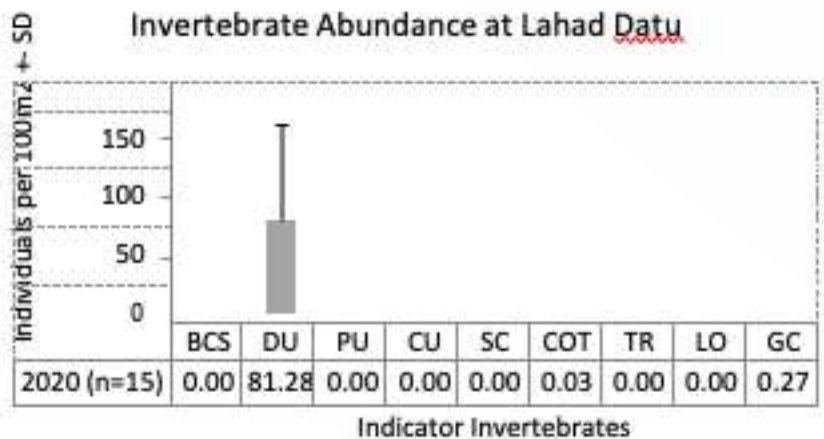
CORAL IMPACTS

- Discarded fishing net and trash are recorded at many sites.
- Sedimentation is recorded at some sites.

Fish and Invertebrate



- Parrotfish abundance is the highest.
- Absent of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance, except for Parrotfish.
- This suggest that fish targeted for food are heavily harvested.



- Diadema urchin abundance is high.
- Indicators for curio trade are absent.
- Invertebrates targeted for food is also very low in abundance.

North Borneo – Lankayan

Lankayan is a small island in the Sulu Sea, a 1.5-hour boat ride north of Sandakan. A resort island, Lankayan is part of the Sugud Islands Marine Conservation Area (SIMCA), a large, privately managed MPA off the East coast of Sabah.

SIMCA is remote and distant from populated areas and no communities exist on the islands within the protected area. However, the SIMCA area is known to be a traditional fishing ground and is fished by both artisanal and commercial fishers from Sandakan, Kudat and the Philippines.

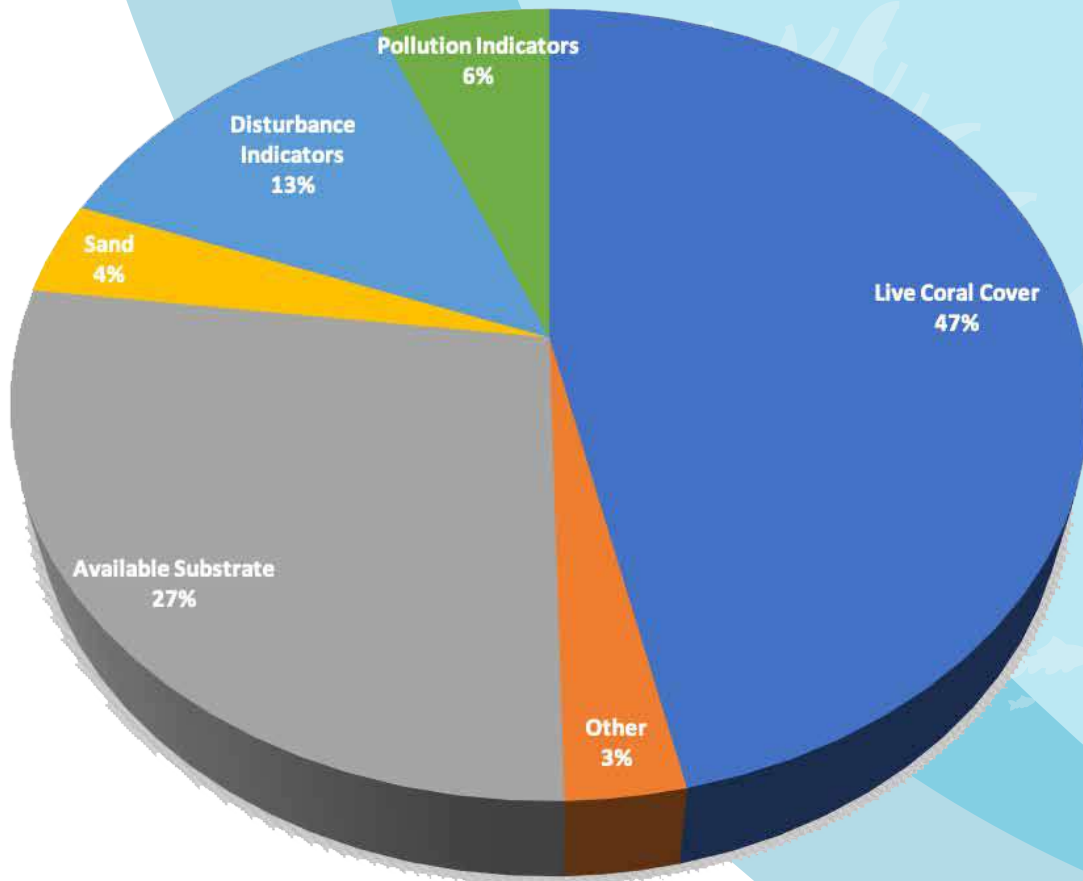
Before the creation of SIMCA, blast fishing was a constant problem, and turtle eggs were poached on a regular basis. Lankayan Island is the only developed island within SIMCA. The 0.05 km² island is the site of the Lankayan Island Dive Resort (LIDR), which is the only structure on the otherwise uninhabited island.



Map showing the health categories of each survey site based on their live coral cover: 1 site have 'Excellent' coral cover, 4 are in 'Good' condition, 9 show 'Fair' health and 1 is in 'Poor' state.

Coral Cover and Health

Substrate Composition at Lankayan

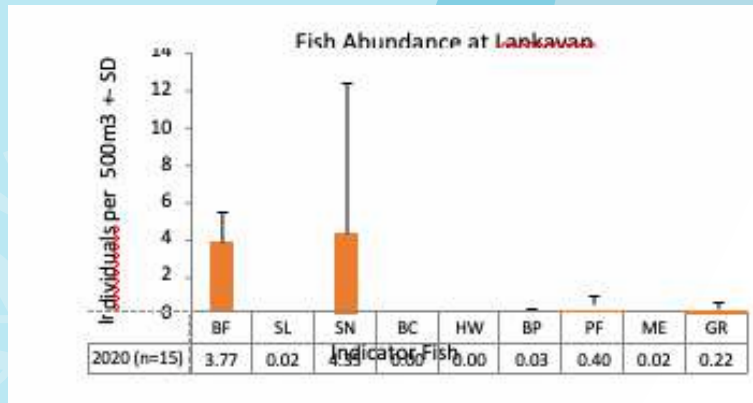


- Lankayan is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 43.29%.
- In 'Fair' condition, above the North Borneo region average (36.42%).
- Available substrate for coral recruits to attach is very high.
- Disturbance indicators are high.
- Rubble level is especially high at Froggie Fort and Sandbar South

CORAL IMPACTS

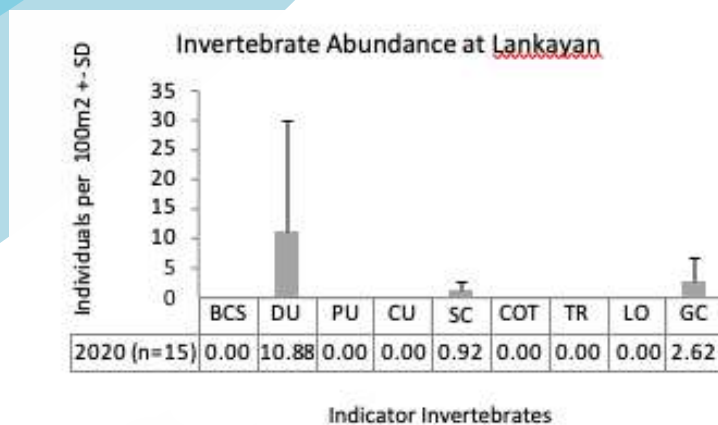
- Discarded fishing nets and trash are recorded at some sites.
- Almost all sites are impacted by warm water bleaching.

Fish and Invertebrate



Snapper abundance is the highest.

- Indicators targeted for live-food fish trade are very low (Bumpheadparrotfish) or absent (HumpheadWrasse).
- Fish targeted for food are very low in abundance, except for Snapper.
- This suggest that fish targeted for food are heavily harvested.



- Indicators for curio trade are absent.
- Very low abundance of invertebrates targeted for food.

RARE ANIMALS

- Shark and turtle were recorded.

North Borneo – Mabul

Mabul is a small island off the south-eastern coast of Sabah. The island has been a fishing village since the 1970s. In the 1990s, it first became popular to divers due to its proximity to Sipadan Island, 15km away. This 20-hectare piece of land surfaces 2–3 m above sea level, consists mostly of flat ground and the aerial view is oval-shaped. Surrounding it are sandy beaches, perched on the northwest corner of a larger 2 km² reef. The reef is on the edge of the continental shelf and the seabed surrounding the reef slopes out to 25 to 30 m deep.

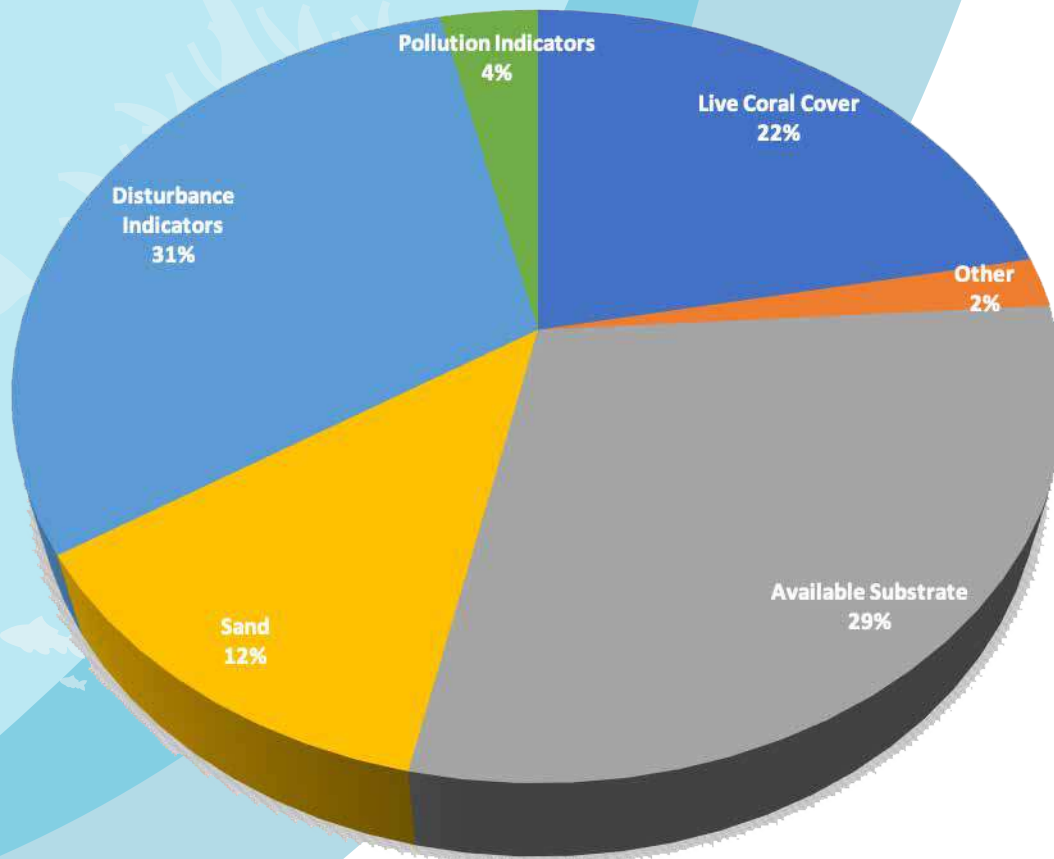
There are several dive resorts operating on Mabul Island, which provide accommodation for scuba divers – most are located on the island or on stilts over the water, while one is on a converted oil platform about 500 meters from the beach. There are also several home stay and backpacker accommodations that also arrange diving trips.



Map showing the health categories of each survey site based on their live coral cover: 1 site has 'Fair' coral cover and 2 are in 'Poor' condition.

Coral Cover and Health

Substrate Composition at Mabul

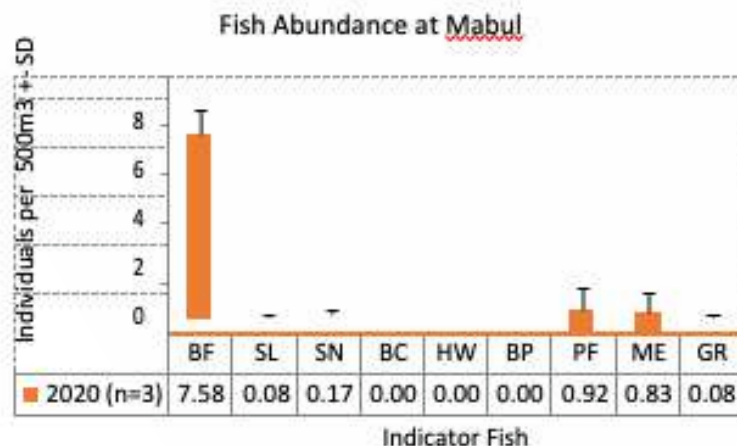


- Mabul is dominated by disturbance indicators.
- Rubble level is very high at all sites.
- 39.38% of Ribbon Valley reef consists of rubble.
- Mabul mean hard coral, reef builder, cover is 13.75%.
- In 'Poor' condition, below the North Borneo region average (36.42%).
- Available substrate for coral recruits to attach to is very high.
- All the above are considered signs of unhealthy reefs. While available substrate for coral recruits to attach to is very high, high level of disturbance and pollution indicators may deter coral growth if they are not deal with.

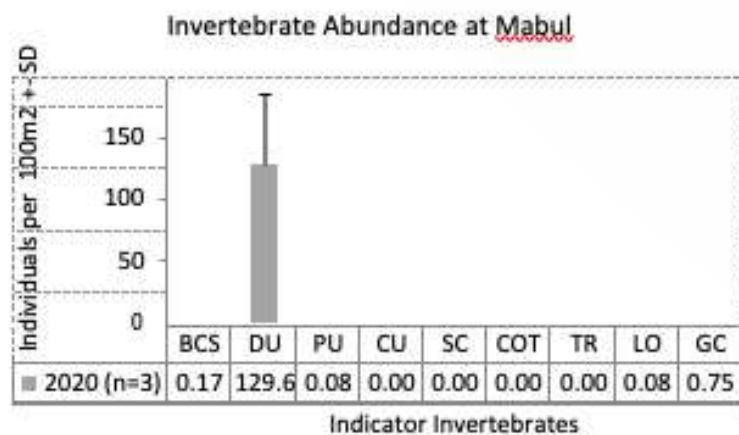
CORAL IMPACTS

- Boat anchor damage, discarded fishing nets and trash are recorded at many sites.
- All sites are impacted by warm water bleaching.

Fish and Invertebrate



- Absent of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance.
- This suggest that fish targeted for food are heavily harvested.



- Diadema urchin abundance is high.
- Very low abundance of indicators for curio trade.
- Invertebrates targeted for food is also very low in abundance.

RARE ANIMALS

- Turtles were recorded at all sites.

North Borneo – Mantanani

The Mantanani archipelago is located some 30km off the north-west coast of Sabah, off the town of Kota Belud. The largest island is Mantanani Besar; the other two are Mantanani Kecil and Linggisan.

Mantanani is mainly populated by Bajau Ubian, with a small population of about 1,000 in two villages. The two main economic activities are fisheries and tourism.

Mantanani is an increasingly popular snorkelling and diving destination, and tourist numbers have grown ten-fold in the last eight years, mainly day trippers from Kota Kinabalu. The number of tourism operators is increasing and there are plans for further development.

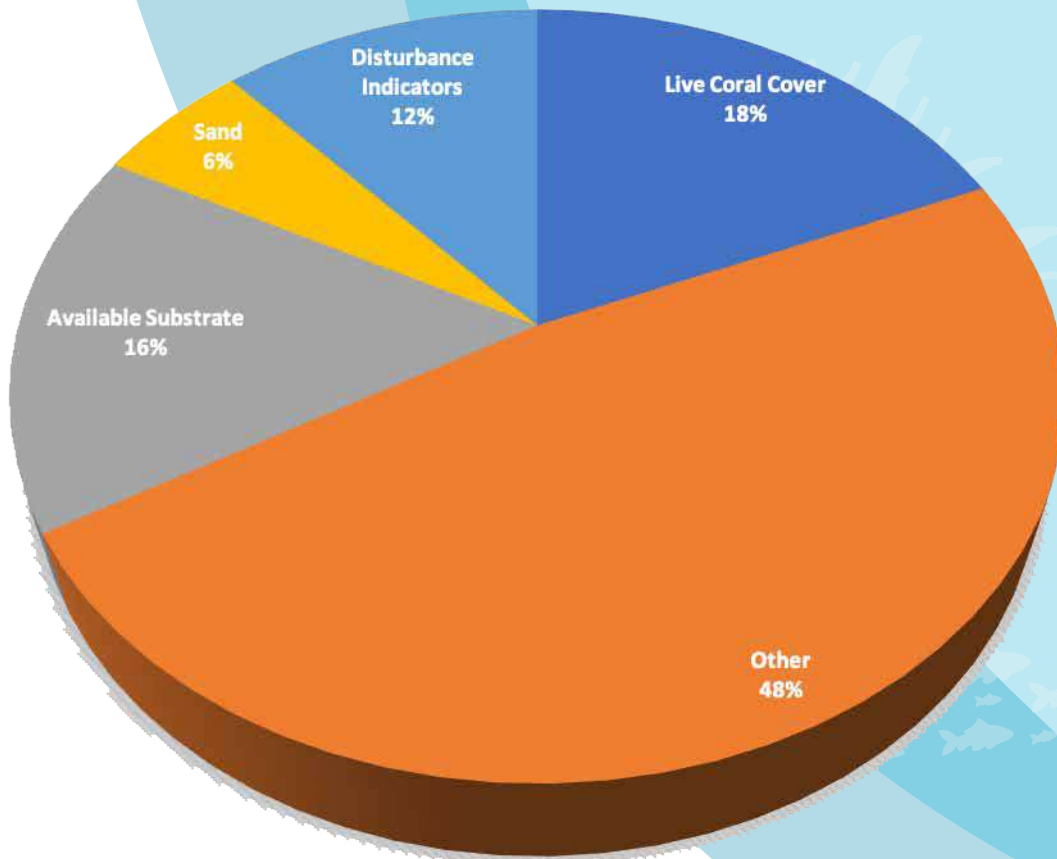
Fish bombing is a major problem in the area. This destructive fishing method has damaged large areas of reef around the islands. Blast detector data showed that a total of 2832 blasts were recorded from June 2014 until February 2020. The blasts were recorded within 5km radius of Mantanani.



Map showing the health categories of each survey site based on their live coral cover: 2 sites have 'Good' coral cover, 7 are in 'Fair' condition, and 3 show 'Poor' health.

Coral Cover and Health

Substrate Composition at Mantanani

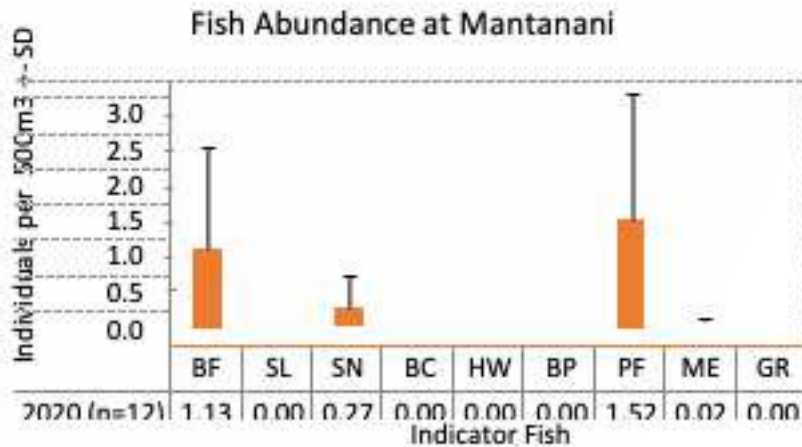


- Mantanani is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 33.33%.
- In 'Fair' condition, below the North Borneo region average (36.42%).
- Available substrate for coral recruits to attach is very high.
- Disturbance indicators are very high.
- Rubble level is high at most sites.
- 50% of South East Point reef consists of rubble.
- Fish bombing is common in Mantanani; this may explain the high level of rubble.

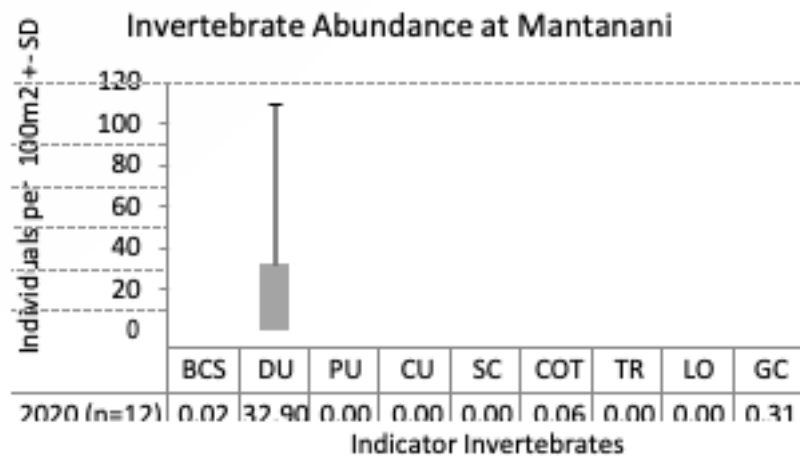
CORAL IMPACTS

- Discarded fishing net and trash are recorded at some sites.
- Coral damage due to fish bombing is recorded, fresh bomb blast craters are observed.
- Many sites are impacted by warm water bleaching.
- At Sahara, many table corals are found to be in upside down position, overturned by abalone collector.

Fish and Invertebrate



- Absent of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance.
- This suggest that fish targeted for food are heavily harvested.



- Diadema urchin abundance is high.
- Indicators for curio trade are very low in abundance.
- Invertebrates targeted for food is also very low in abundance.

RARE ANIMALS

- Shark and turtle were recorded.
- Many juvenile groupers and parrotfish were observed.

North Borneo – Pulau Penyu

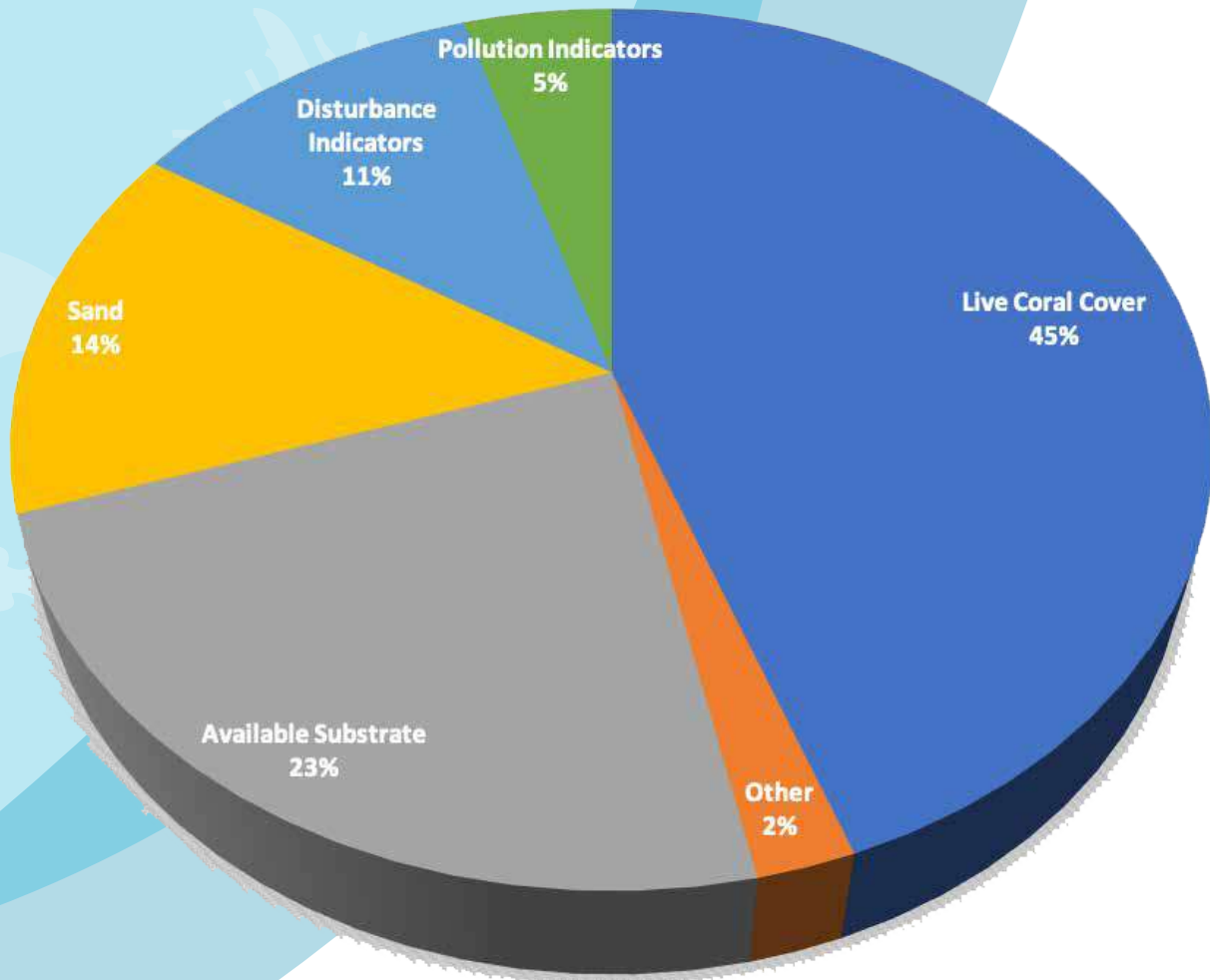
Pulau Penyu lies in the Sulu Sea some 40km north of Sandakan, Sabah. It comprises of three islands; Pulau Selingan, Pulau Bakungan Kecil and Pulau Gulisan. The park gained its popularity from the green and hawksbill turtles which lay their eggs on the beaches of the islands. All the three islands are protected within marine parks on both sides of the Malaysian and Philippine borders. The park covers an area of 17.4km² and administered by Sabah Parks.

Only on Selingan are there chalets for overnight visitors, and those who wish to see the turtles laying egg must stay overnight. However, park rules and regulations are strictly enforced and visitors are not allowed on the beach from sunset to sunrise so as not to disturb the turtles. A ranger will call all visitors to observe only one turtle laying eggs per night.



Map showing the health categories of each survey site based on their live coral cover: 1 site have 'Excellent' coral cover, 1 are in 'Good' condition, 6 show 'Fair' health and 1 is in 'Poor' state.

Coral Cover and Health

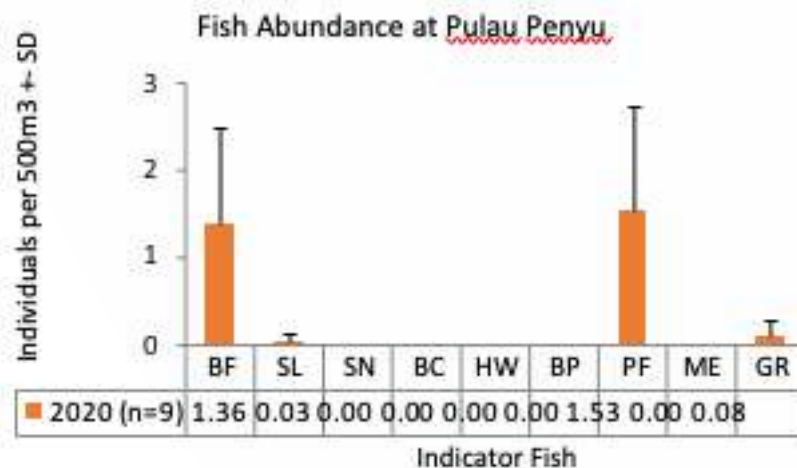


- Pulau Penyu is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 39.72%.
- In 'Fair' condition, above the North Borneo region average (36.42%).
- Available substrate for coral recruits to attach to is very high.
- Sand level is high.
- Disturbance indicators are high.
- Rubble level is especially high at Mid Reef, Pulau Bakungan 1 and Pulau Bakungan 2.

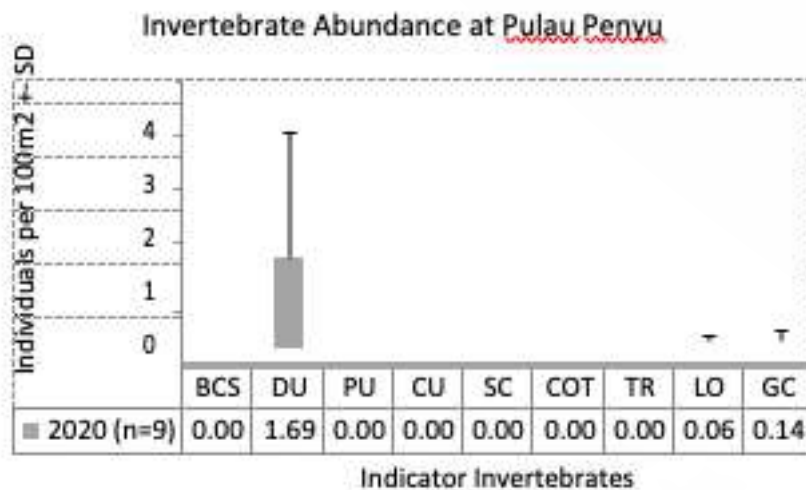
CORAL IMPACTS

- Trash and damage due to flood are recorded.

Fish and Invertebrate



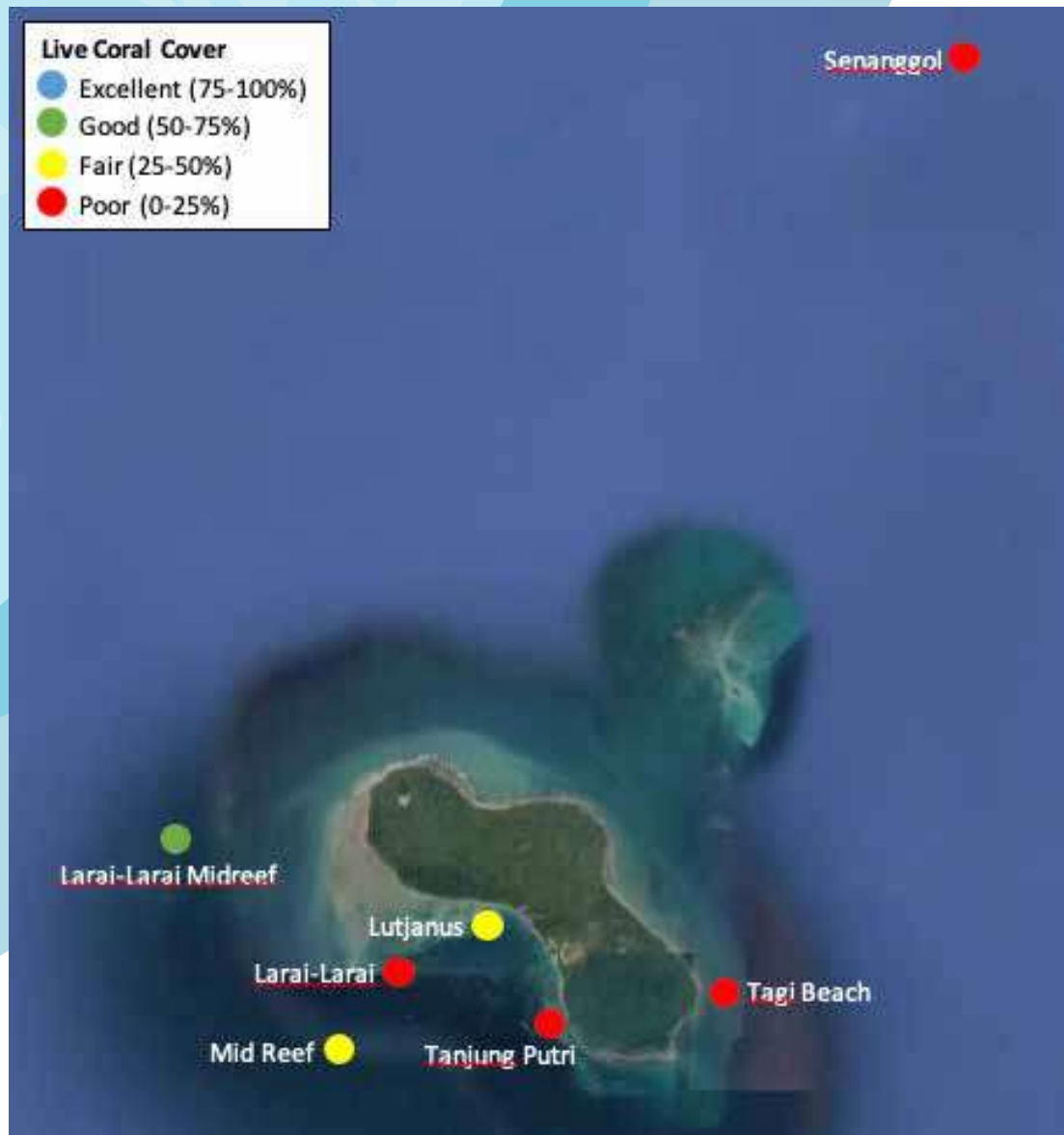
- Absent of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance.
- This suggest that fish targeted for food are heavily harvested.



- Indicators for curio trade are absent.
- Invertebrates targeted for food is very low in abundance.

North Borneo – Pulau Tiga

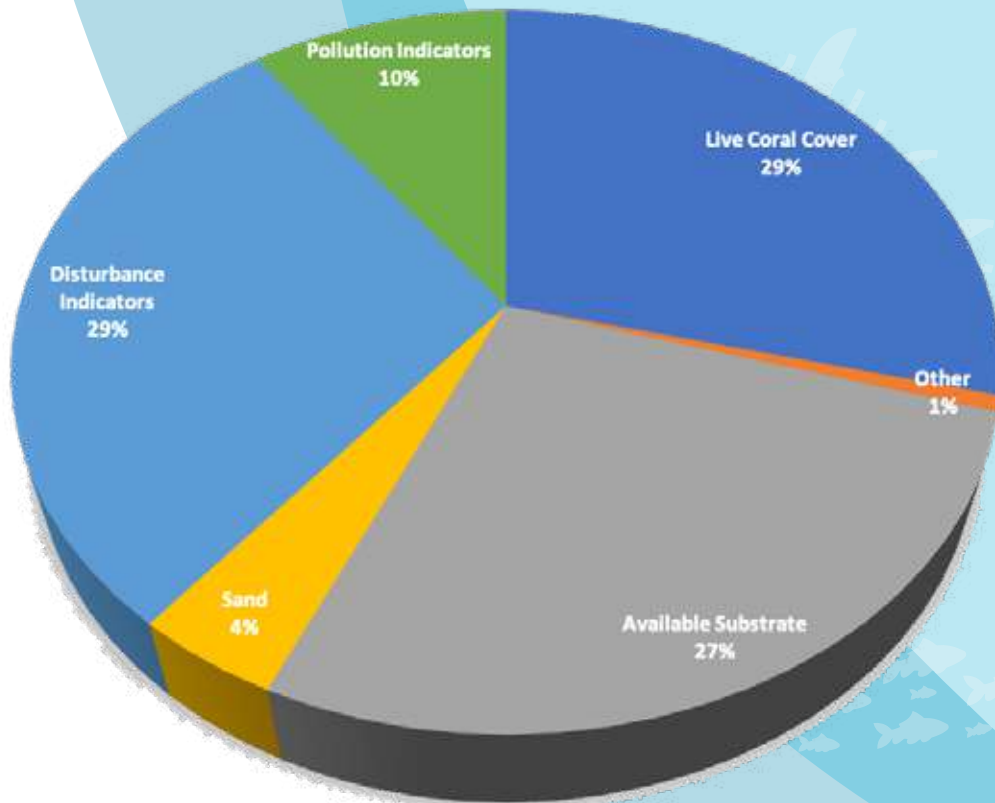
Pulau Tiga is one of a group of small uninhabited islands in Kimanis Bay off the western coast of Sabah. The islands were formed on 21 September 1897, when an earthquake on Mindanao caused a volcanic eruption near Borneo. The island is 607 hectares in size and has a couple of active mud volcanoes at the highest part of the island. Pulau Tiga is one of the three islands that make up Tiga Island National Park. The Park Headquarters are on the island, comprising an office complex and accommodation for the park staff and visiting scientists.



Map showing the health categories of each survey site based on their live coral cover:
1 site has 'Good' coral cover, 2 are in 'Good' condition, and 4 show 'Fair' health.

Coral Cover and Health

Substrate Composition at Pulau Tiga

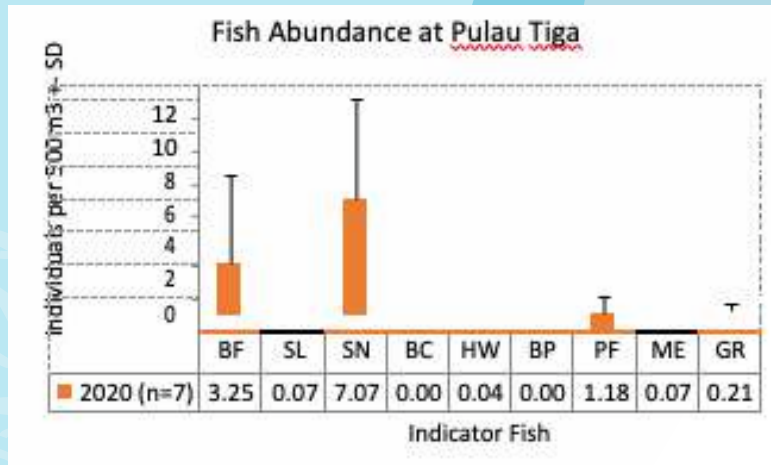


- Pulau Tiga is dominated by disturbance indicators.
- Rubble level is high at most sites.
- 65.63% of Senanggol reefs consist of rubble.
- Pulau Tiga mean hard coral, reef builder, cover is 28.66%.
- In 'Fair' condition and below the North Borneo region average (36.42%).
- Available substrate for coral recruits to attach to is very high.
- Pollution indicators are high.
- Nutrient indicator algae is especially high at Tanjung Putri.
- Sponge level is especially high at Mid Reef.
- All the above are considered signs of unhealthy reefs. While available substrate for coral recruits to attach to is very high, high level of disturbance and pollution indicators may deter corals growth if they are not deal with.

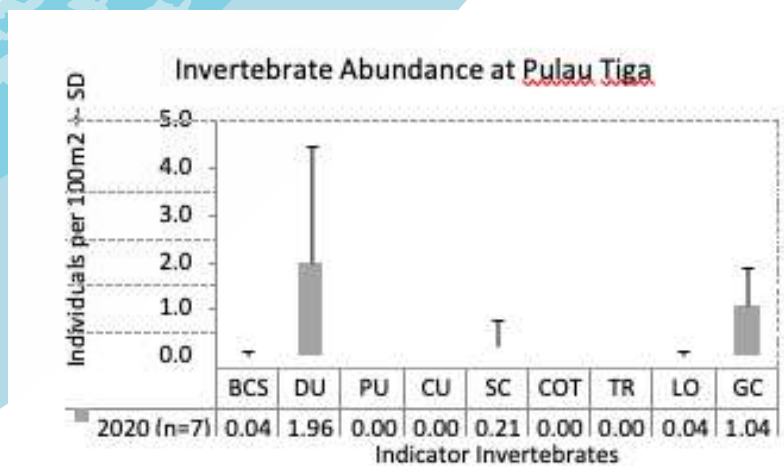
CORAL IMPACTS

- Discarded fishing net and trash are recorded at many sites.
- Many reefs are impacted by warm water bleaching.
- At Mid Reef and Larai-Larai Midreef, table corals are found to be in upside down position, suspected to be overturned by abalone collector.

Fish and Invertebrate



- Snapper abundance is the highest.
- Absent (Bumphead parrotfish) or low abundance (Humphead wrasse) of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance, except for Snapper.
- This suggest that fish targeted for food are heavily harvested.



- Indicators for curio trade are very low in abundance.
- Very low abundance of invertebrates targeted for food.

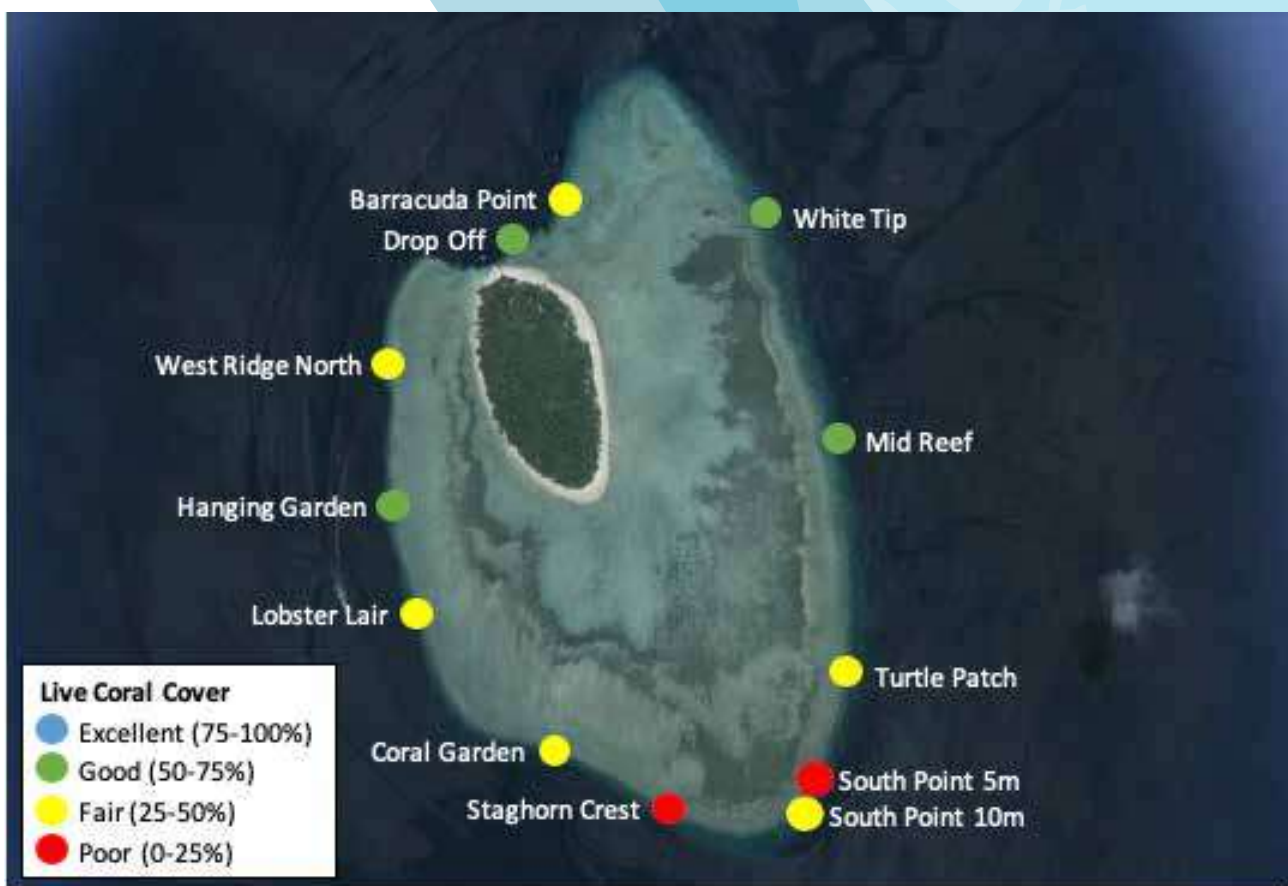
RARE ANIMALS

- Shark and turtle were recorded.
- Many juvenile groupers and parrotfish were observed.

North Borneo – Sipadan

Sipadan is the only oceanic island in Malaysia, rising 600 metres from the seabed and rated by many dive journals as one of the top destinations for diving in the world. Sipadan is located in the Celebes Sea off the east coast of Sabah. It was formed by living corals growing on top of an extinct volcanic cone that took thousands of years to develop.

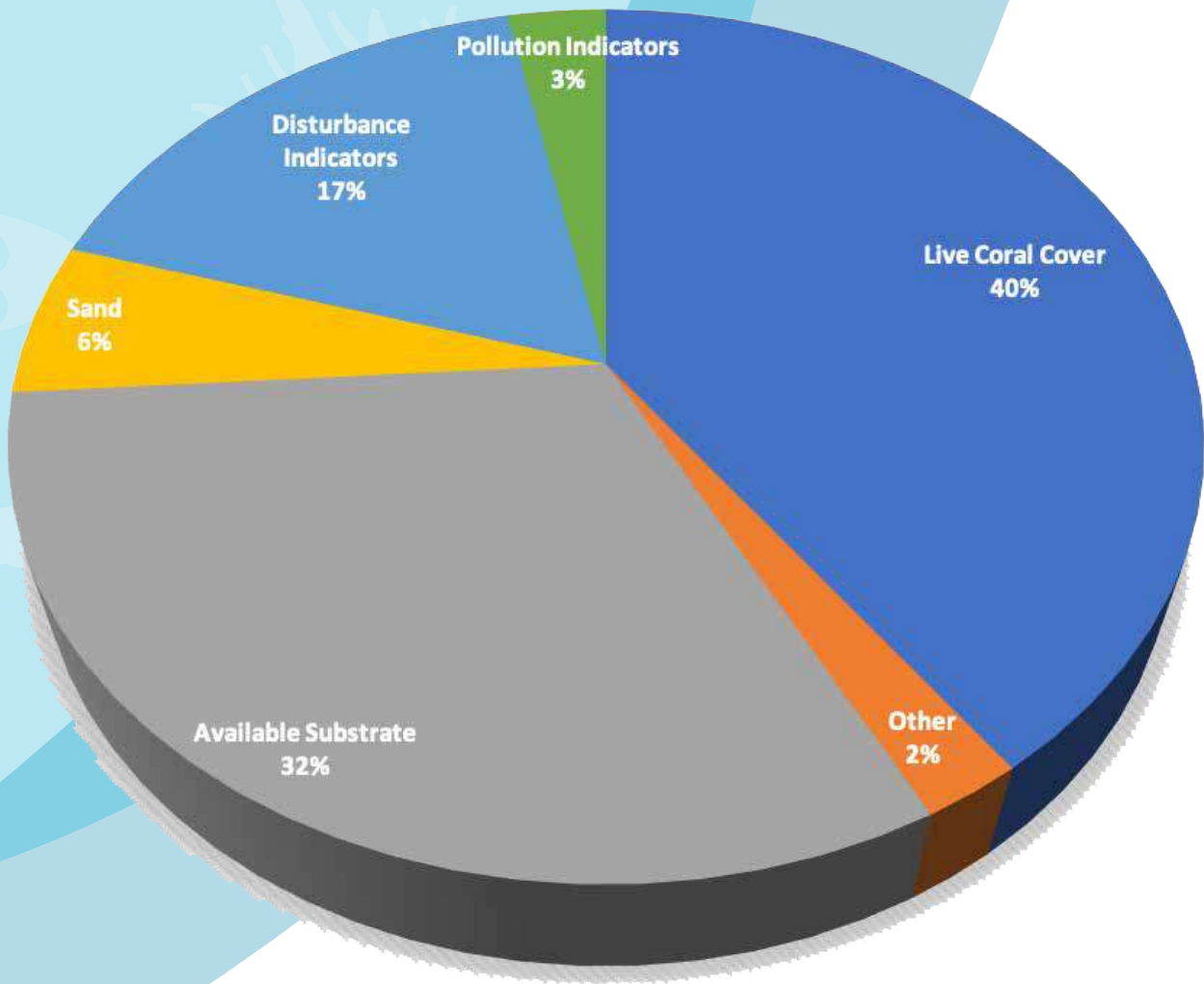
Sipadan is located at the heart of the Indo-Pacific basin, the centre of one of the richest marine habitats in the world. More than 3,000 species of fish and hundreds of coral species have been classified in this ecosystem. Visiting Sipadan requires a permit issued by Sabah Parks. Since 2019, there are 178 permits available each day.



Map showing the health categories of each survey site based on their live coral cover: 4 sites have 'Good' coral cover, 6 are in 'Fair' condition, and 2 show 'Poor' health.

Coral Cover and Health

Substrate Composition at Sipadan

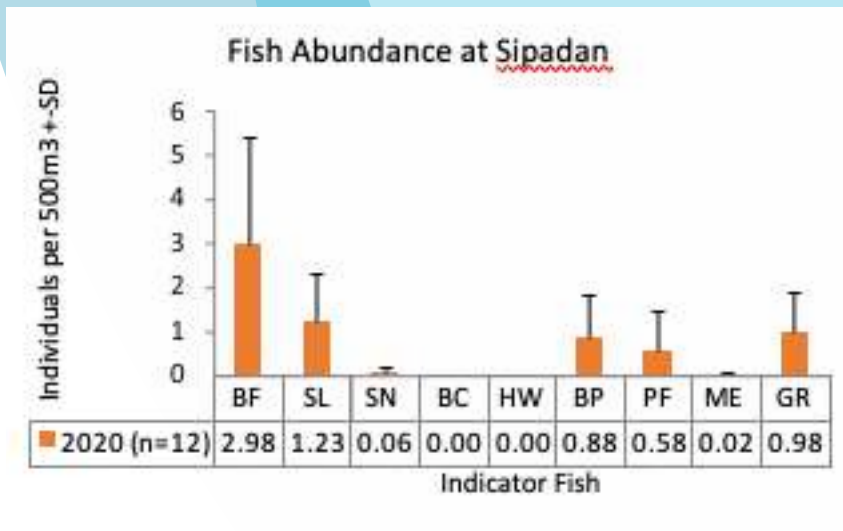


- Sipadan is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 28.65%.
- In 'Fair' condition, above the North Borneo region average (36.42%).
- Available substrate for coral recruits to attach to is extremely high.
- Disturbance indicators are high.
- Rubble level is high at most sites, especially at Turtle Patch, Staghorn Crest and White Tip.

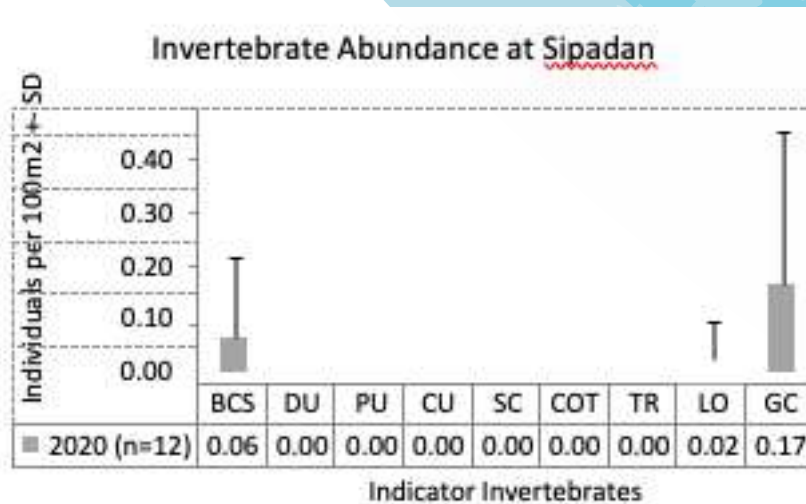
CORAL IMPACTS

- A few reefs are impacted by warm water bleaching.

Fish and Invertebrate



- Absent (Humphead wrasse) or very low abundance (Bumphead parrotfish) of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance.



- Indicators for curio trade are very low in abundance.
- Very low abundance of invertebrates targeted for food.

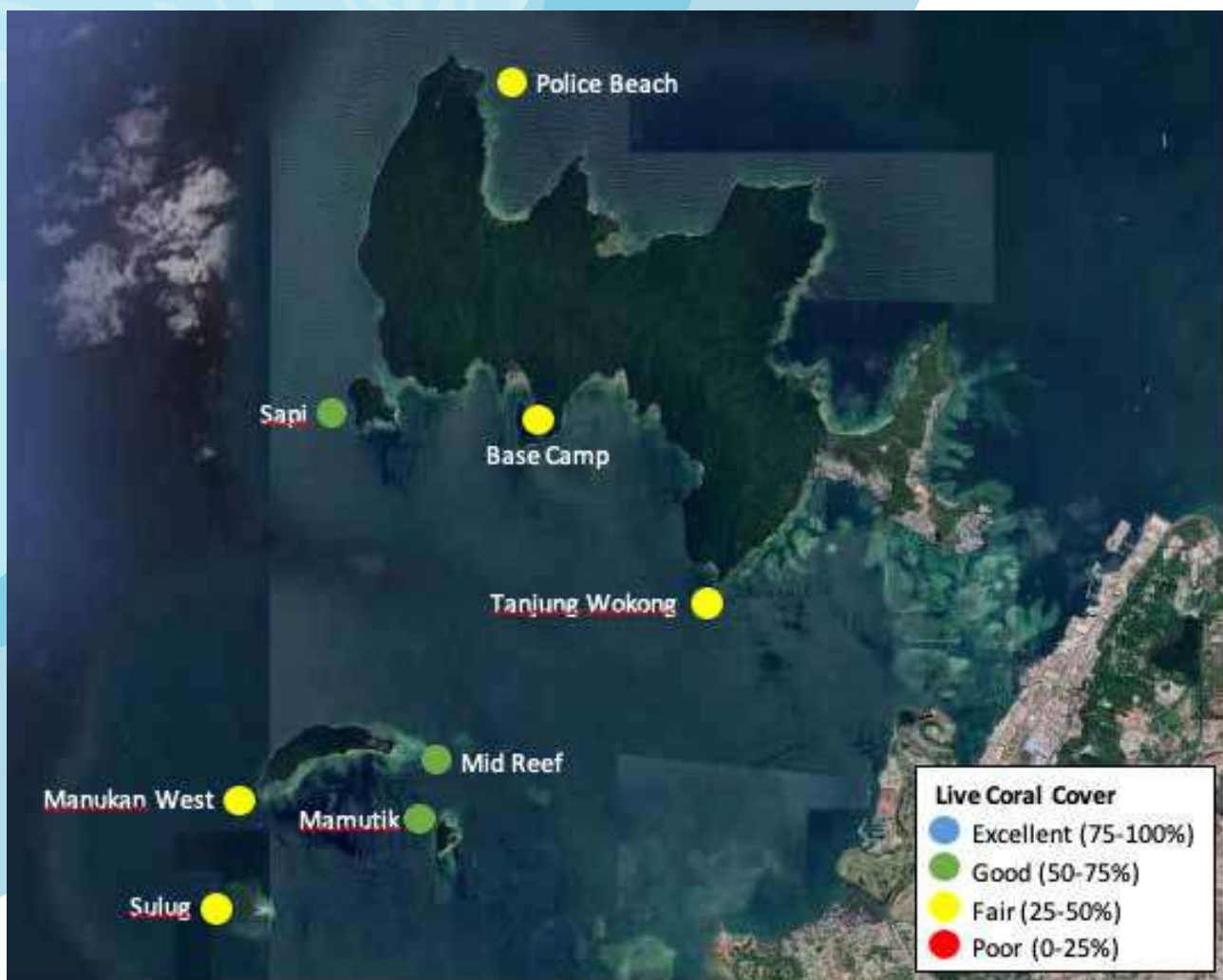
RARE ANIMALS

- Shark and turtle were recorded at all survey sites.

North Borneo – Tunku Abdul Rahman Park

Tunku Abdul Rahman Park is located between 3 to 8 km off Kota Kinabalu, the capital of Sabah, and covers an area over 4,929 hectares, two thirds of which covers the sea. There is a cluster of islands in the Park comprising Pulau Gaya, Pulau Sapi, Pulau Manukan, Pulau Mamutik and Pulau Sulug. The reefs generally lie in shallow water with little current.

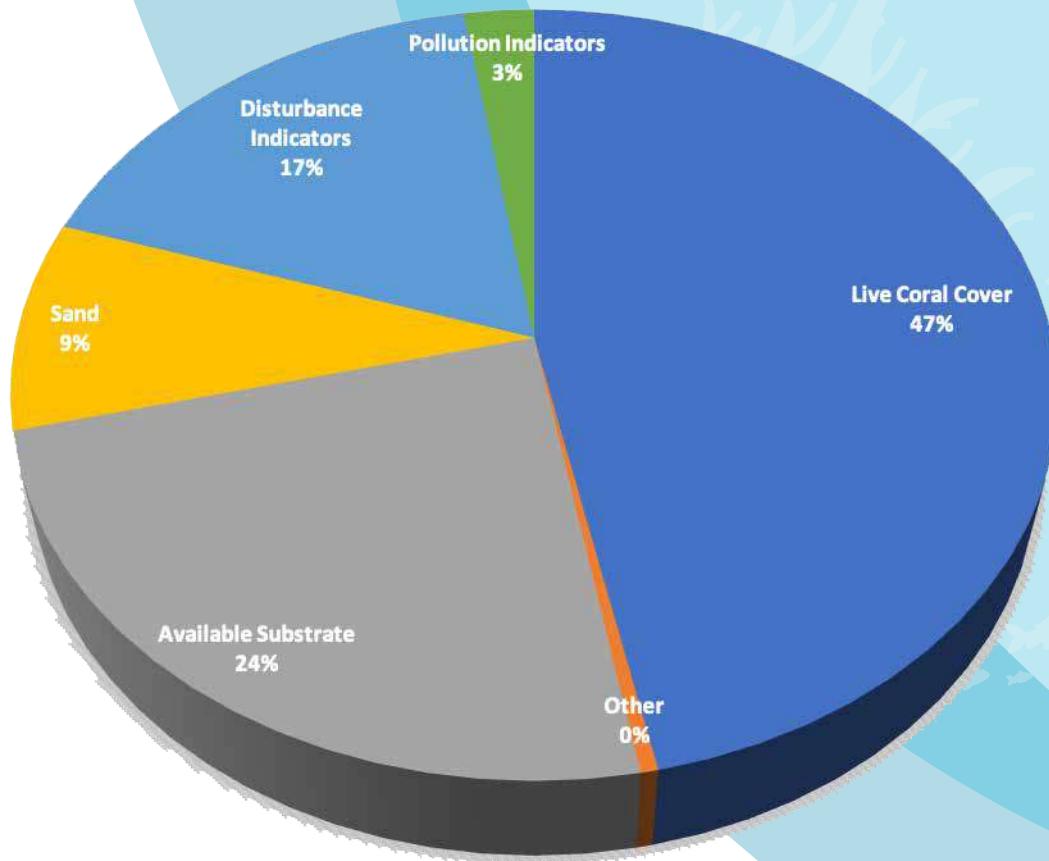
All five islands have tourist facilities such as chalets/rest house, jetty, picnic shelters, barbecue pits, tables, changing rooms and toilets, except for Pulau Sulug which is relatively untouched, remote and undeveloped. The islands receive large numbers of day tourists from Kota Kinabalu.



Map showing the health categories of each survey site based on their live coral cover: 3 sites have 'Good' coral cover and 5 are in 'Fair' condition.

Coral Cover and Health

Substrate Composition at Tunku Abdul Rahman Park

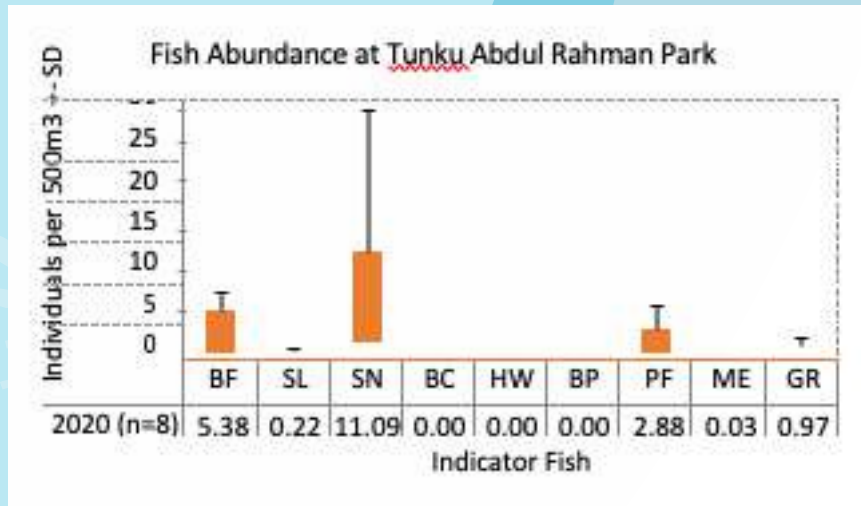


- Tunku Abdul Rahman Park is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 46.25%.
- In 'Fair' condition, above the North Borneo region average (36.42%).
- Available substrate for coral recruits to attach to is very high.
- Disturbance indicators are high.
- Rubble level is very high at most sites, especially high at Base Camp and Manukan West.

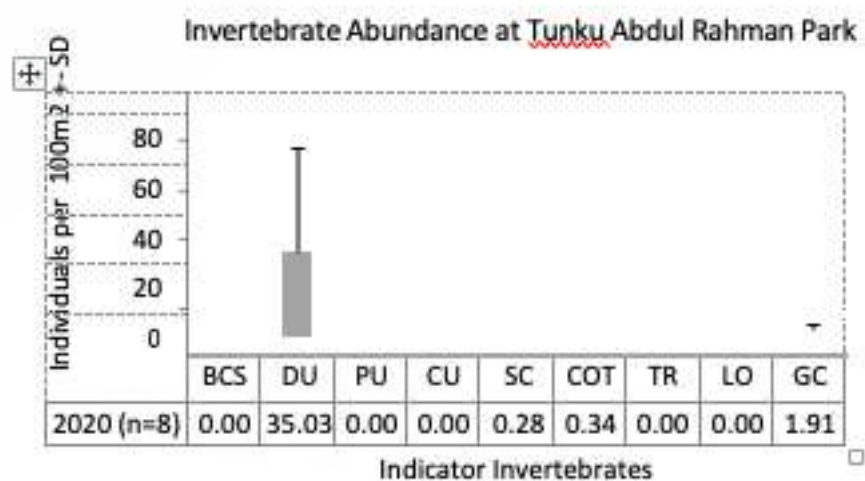
CORAL IMPACTS

- Discarded fishing nets and trash are recorded at some sites.
- One site is impacted by warm water bleaching.
- Damage by Drupella and COT predations are recorded at some sites.

Fish and Invertebrate



- Snapper abundance is the highest.
- Absent of indicators targeted for 30 live-food fish trade.
- Fish targeted for food are very low in abundance, except for Snapper.
- This suggest that fish targeted for food are heavily harvested.



- Diadema urchin abundance is high.
- Indicators for curio trade are absent.
- Very low abundance of invertebrates targeted for food.

North Borneo – Tun Sakaran Marine Park

Tun Sakaran Marine Park is a marine park located off the east coast of the state of Sabah in Malaysia. It consists of the islands of Bodgaya, Boheydulang, Sabangkat, and Salakan, the sand cays of Maiga, Sibuan, and Mantabuan, and the patch reefs of Church and Kapikan.

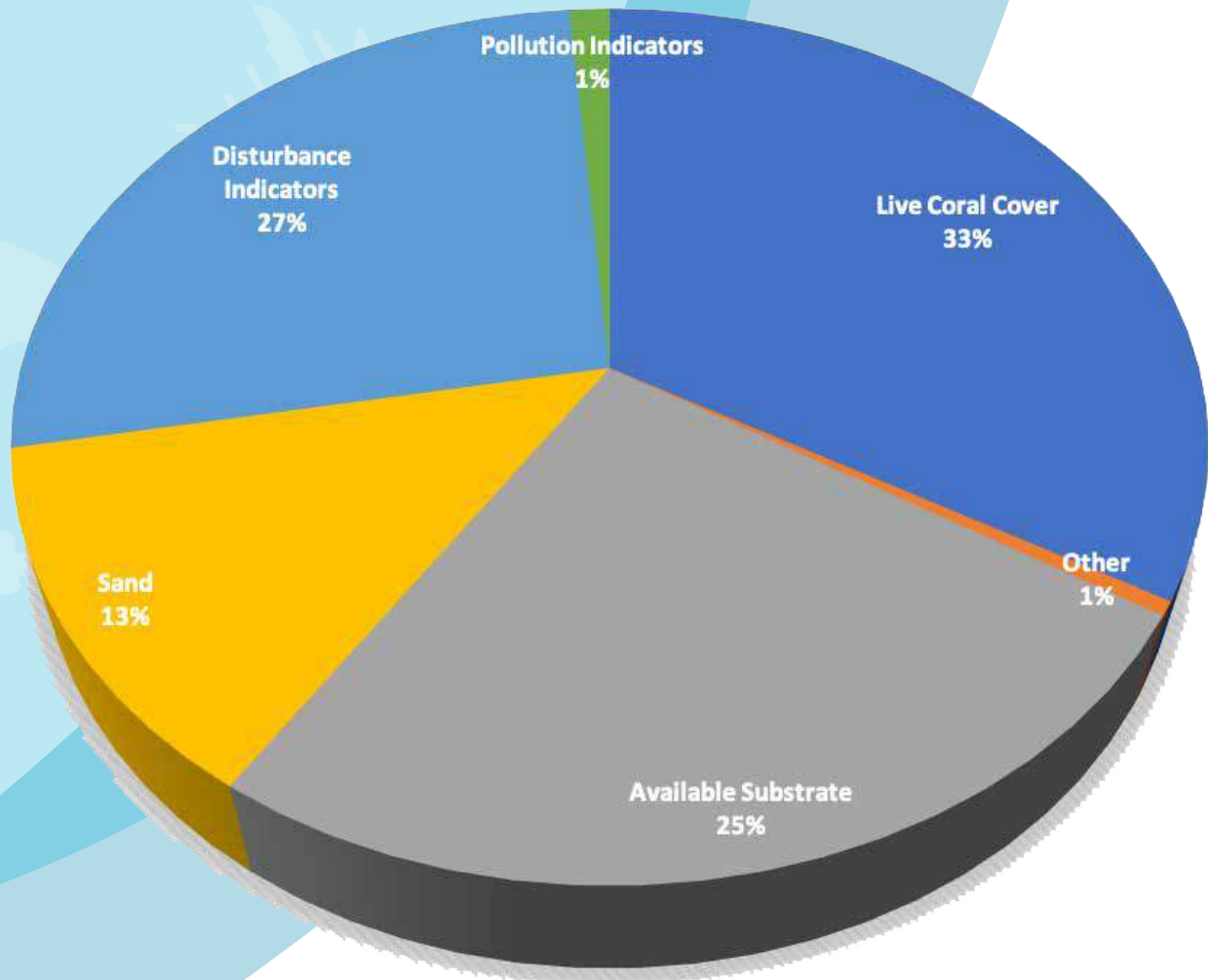
In 2004, the park became the seventh gazetted area under Sabah Parks with a total area of 100.8 km². There are approximately 2,000 people living within the park.



Map showing the health categories of each survey site based on their live coral cover: 1 site have 'Good' coral cover, 8 are in 'Fair' condition, and 3 show 'Poor' health.

Coral Cover and Health

Substrate Composition at Tun Sakaran Marine Park

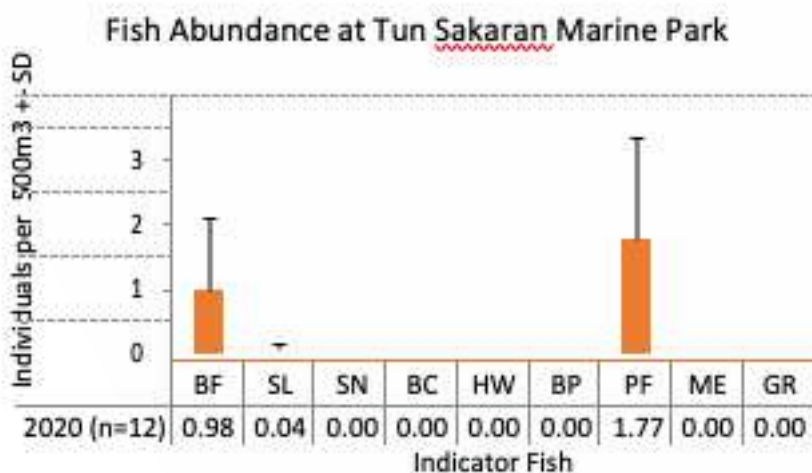


- Tun Sakaran Marine Park is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 26.15%.
- In 'Fair' condition, below the North Borneo region average (36.42%).
- Available substrate for coral recruits to attach to is very high.
- Disturbance indicators are very high.
- Rubble level is very high at most sites, especially at Sibuan and South Rim.
- 63.13% of Sibuan reef (at 5m) consists of rubble.

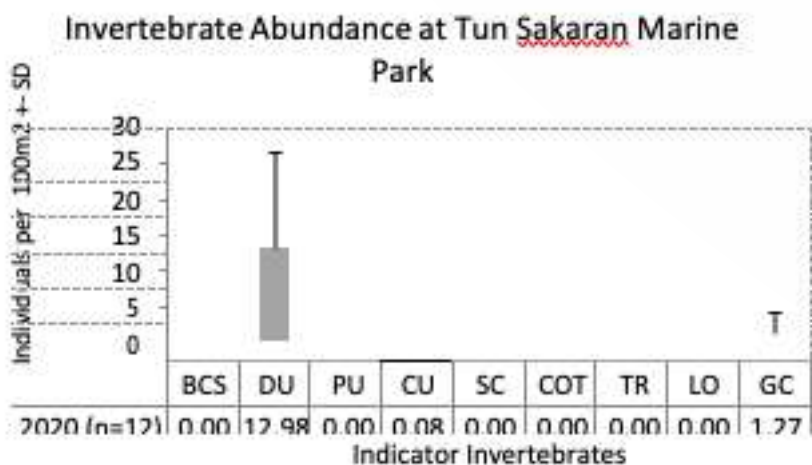
CORAL IMPACTS

- Some reefs are impacted by trash and warm water bleaching.
- Quite a number of sites are impacted by storm damage and sedimentation

Fish and Invertebrate



- Indicators targeted for live-food fish trade are absent.
- Fish targeted for food are very low in abundance.
- This suggest that fish targeted for food are heavily harvested.



- Indicators for curio trade are very low in abundance.
- Very low abundance of invertebrates targeted for food.

RARE ANIMALS

- Turtle was recorded.

North Borneo – Usukan Cove

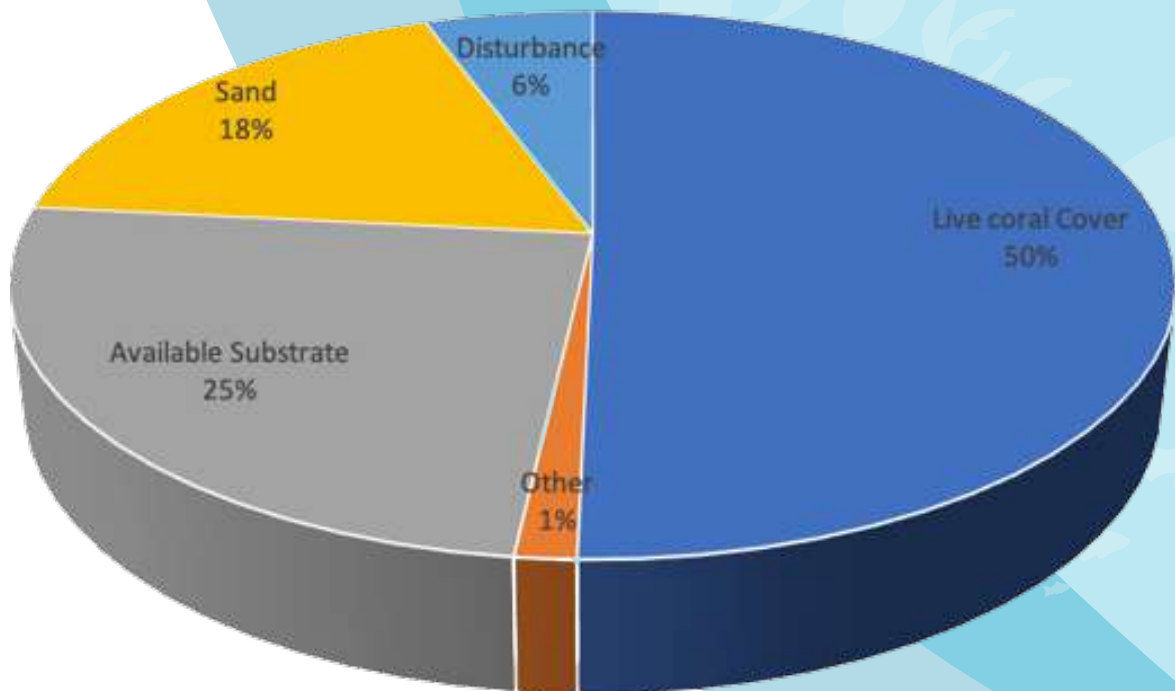
Usukan Cove is located on the North West coast of Sabah approximately half way between Kota Kinabalu and Kudat, in a district called Kota Belud, just beside Kampung Kuala Abai where the jetty to Mantanani Island is situated. Diving and snorkelling as well as fishing are the main activities offered in Usukan Cove.



Map showing the health categories of each survey site based on their live coral cover: 4 sites have 'Fair' coral cover and 1 is in 'Poor' condition.

Coral Cover and Health

Substrate Composition at Usukan Cove

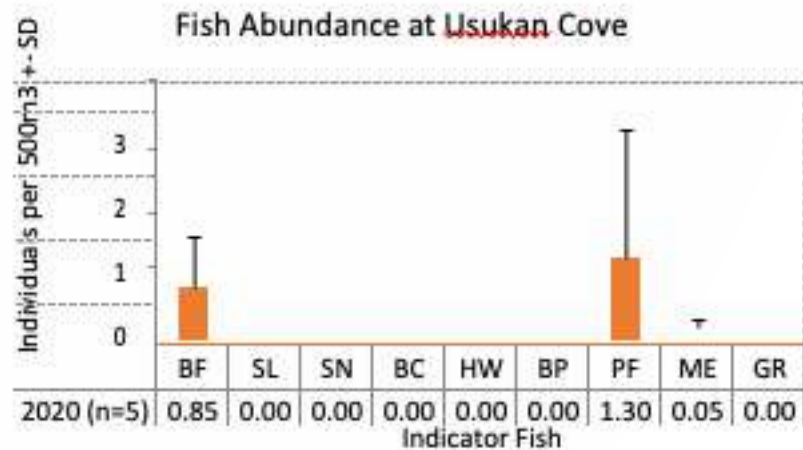


- Usukan Cove is dominated by live coral cover, which is mainly hard coral.
- Mean hard coral, reef builder, cover is 33.63%.
- In 'Fair' condition, below the North Borneo region average (36.42%).
- Available substrate for coral recruits to attach to is high.
- Pollution indicators are extremely high.
- Nutrient indicator algae is very high at all sites.
- 39.38% of Keramat reef consists of nutrient indicator algae.

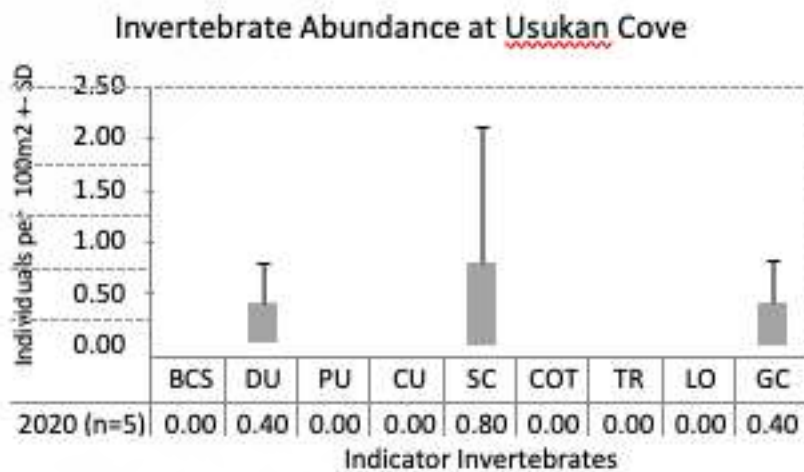
CORAL IMPACTS

- Discarded fishing net is recorded.

Fish and Invertebrate



- Absent of indicators targeted for live-food fish trade.
- Fish targeted for food are very low in abundance.
- This suggest that fish targeted for food are heavily harvested.



- Invertebrates targeted for food are very low in abundance.
- Indicators for curio trade are absent.

4. Reef Check Data Over the Years

Sunda Shelf

Coral Cover and Health

Reef Check data are primarily used for monitoring coral reef health and comparisons of data over time can highlight significant changes and indicate problems and emerging issues. This section reviews data collected over the last fourteen years to assess changes to Malaysia's reefs over the period, separated into three eco- regions: Sunda Shelf, Malacca Strait and North Borneo.



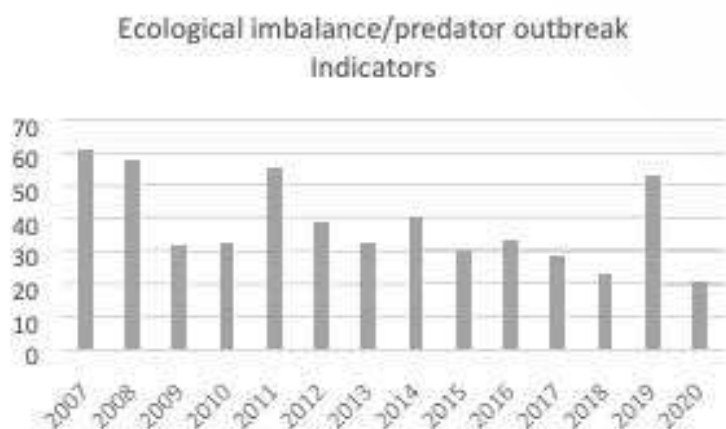
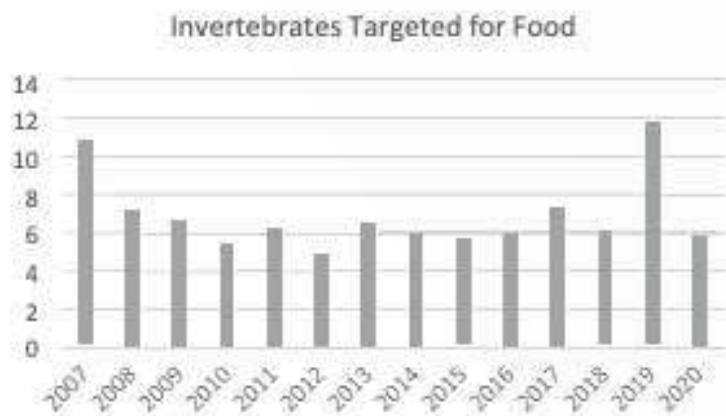
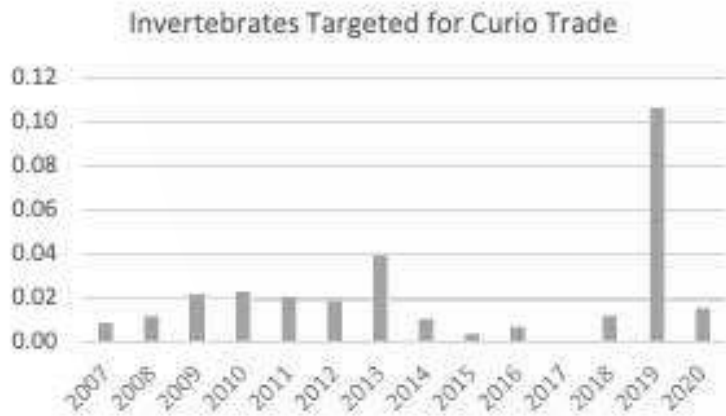
- The reefs in Sunda Shelf have deteriorated in the last 6 years, as reflected by the decrease in live coral cover.
- Pollution indicators have increased in the last 4 years.
- Available substrate for new coral recruits to attach is high, indicating possible recovery if human impacts and Crown-of-thorns population (see invertebrates) are dealt with.

Fish



- The abundance of fish targeted for aquarium trade is more or less the same over the years.
- The abundance of fish targeted for food does not change much. The high abundance from 2008 to 2011 is contributed by Snappers.
- Very low abundance of fish targeted for life-food fish trade, with spikes in 2016 and 2019 which are attributed to non-resident Bumphead parrotfish communities.

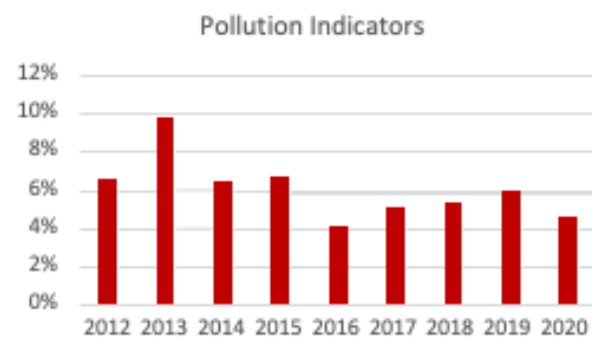
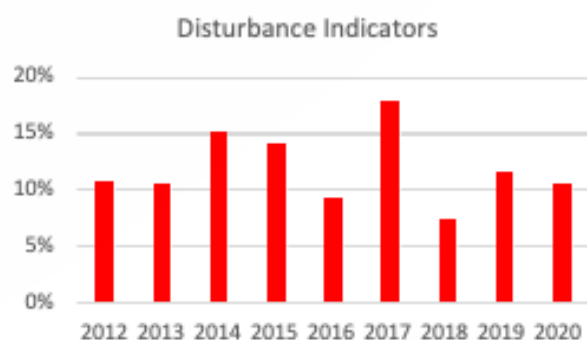
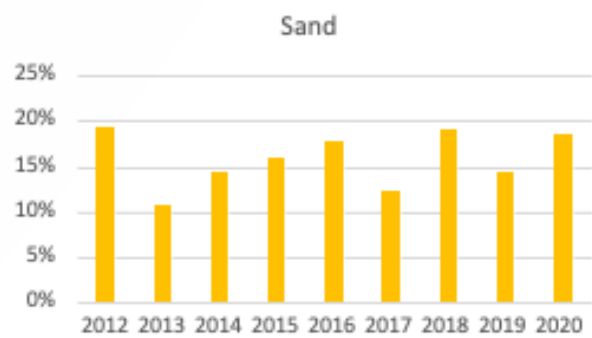
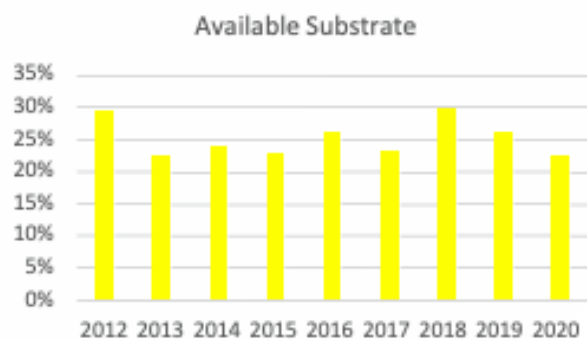
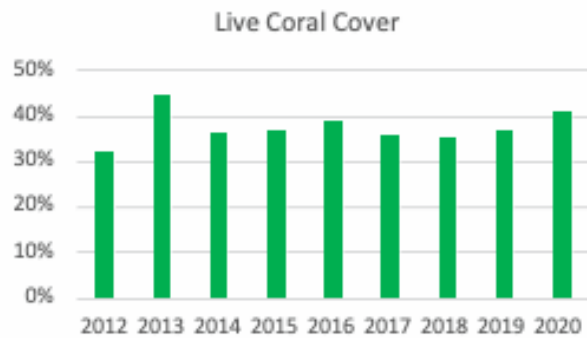
Invertebrate



- Very low abundance of invertebrates targeted for curio trade.
- Indicators targeted for food have maintained more or less the same over the years.
- Indicators for ecological imbalance/predator outbreaks are showing slight decrease in the last 5 years, with a spike in 2019 which is attributed by Diadema urchin.
- High number of Crown-of-thorns and the abundance is showing an increasing trend from 2014 to 2019. In 2020, the number has decreased.
- Crown-of-thorns have always been a threat to Sunda Shelf reefs, with abundance above what a healthy reef can support (0.2-0.3 individual per 100m²).

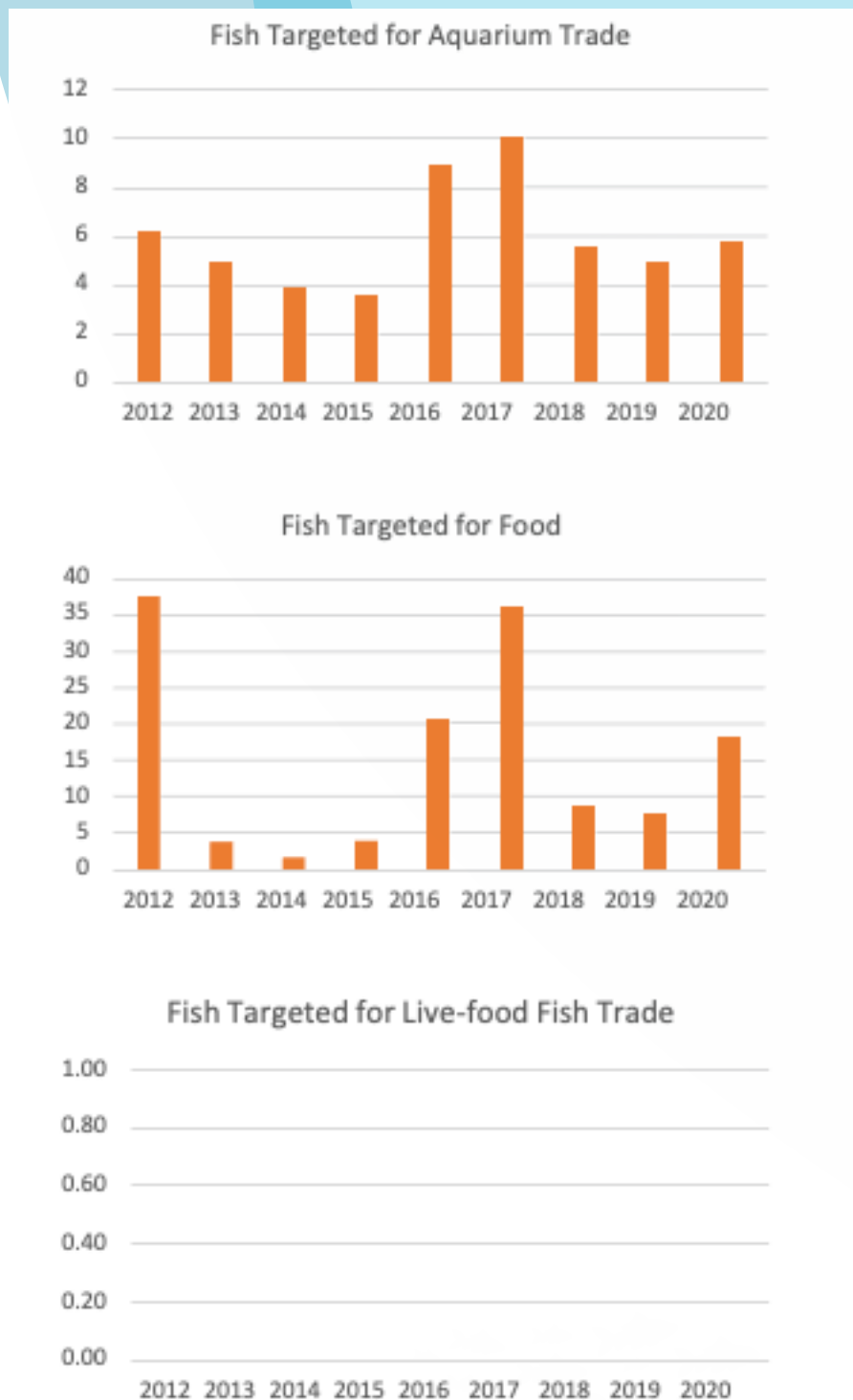
Malacca Strait

Coral Cover and Health



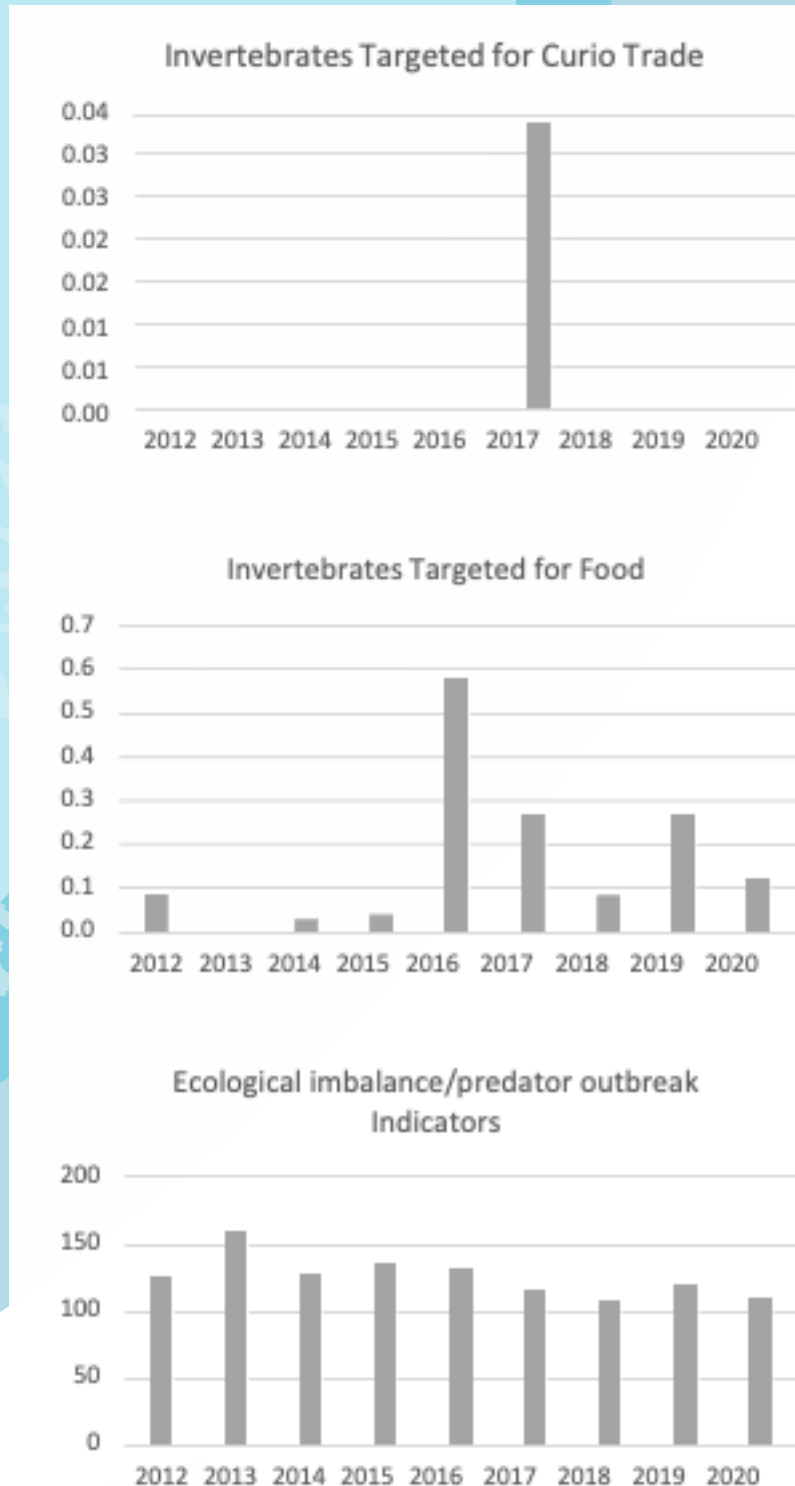
- The reefs in Malacca Strait have maintained more or less the same over the years.
- All substrate categories do not show much changes.

Fish



- Fish targeted for life-food fish trade is never observed and recorded.
- The abundance of fish targeted for aquarium trade is more or less the same over the years.
- Fish targeted for food is mainly attributed by Snappers.
- The abundance of fish targeted for food is inconsistent over the years

Invertebrate



- Invertebrates targeted for curio trade is only observed and recorded once, in 2017.
- Very low abundance of invertebrates targeted for food.
- Ecological imbalance/predator outbreak indicators are attributed solely by *Diadema urchin* and the abundance is more or less the same over the years.

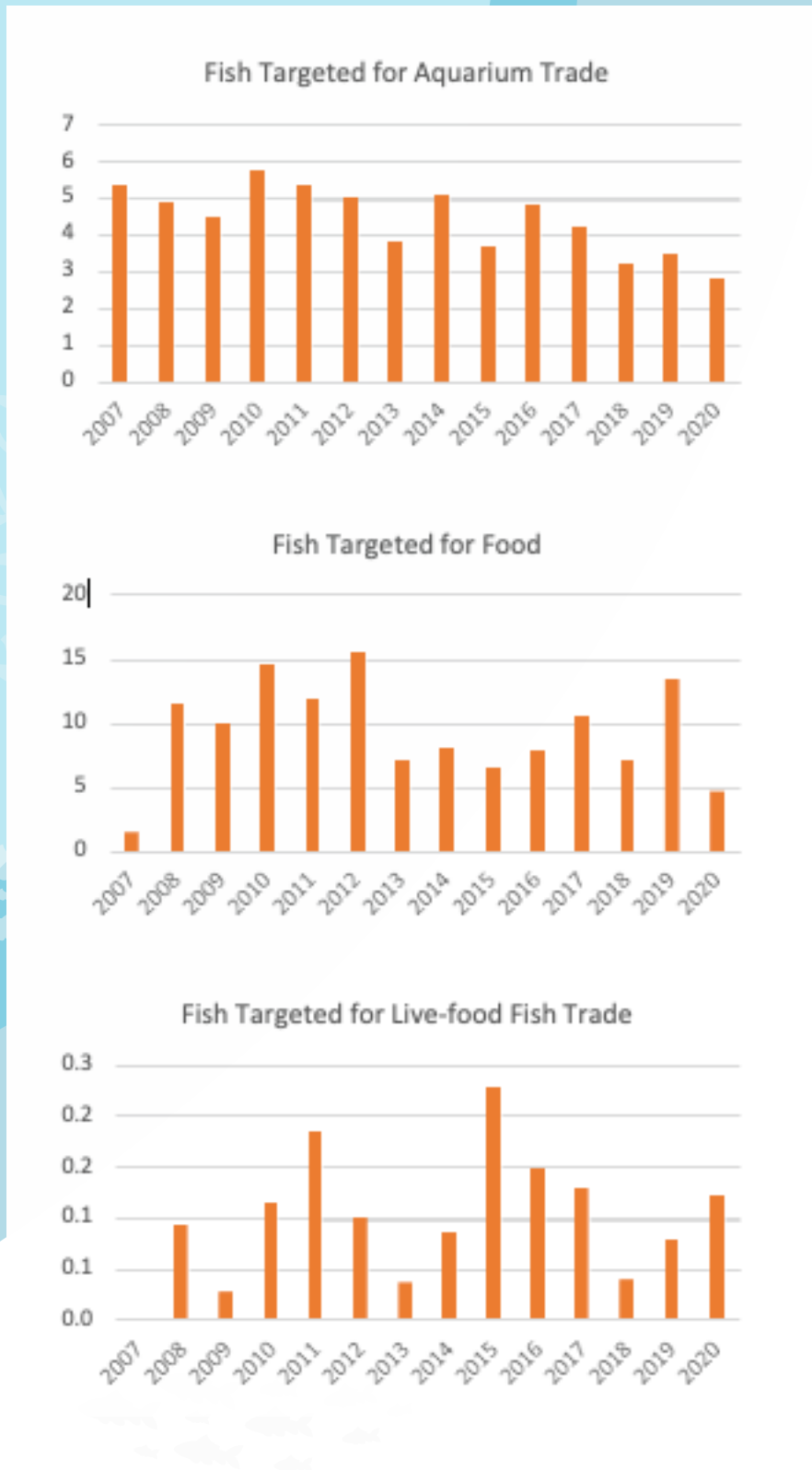
North Borneo

Coral Cover and Health



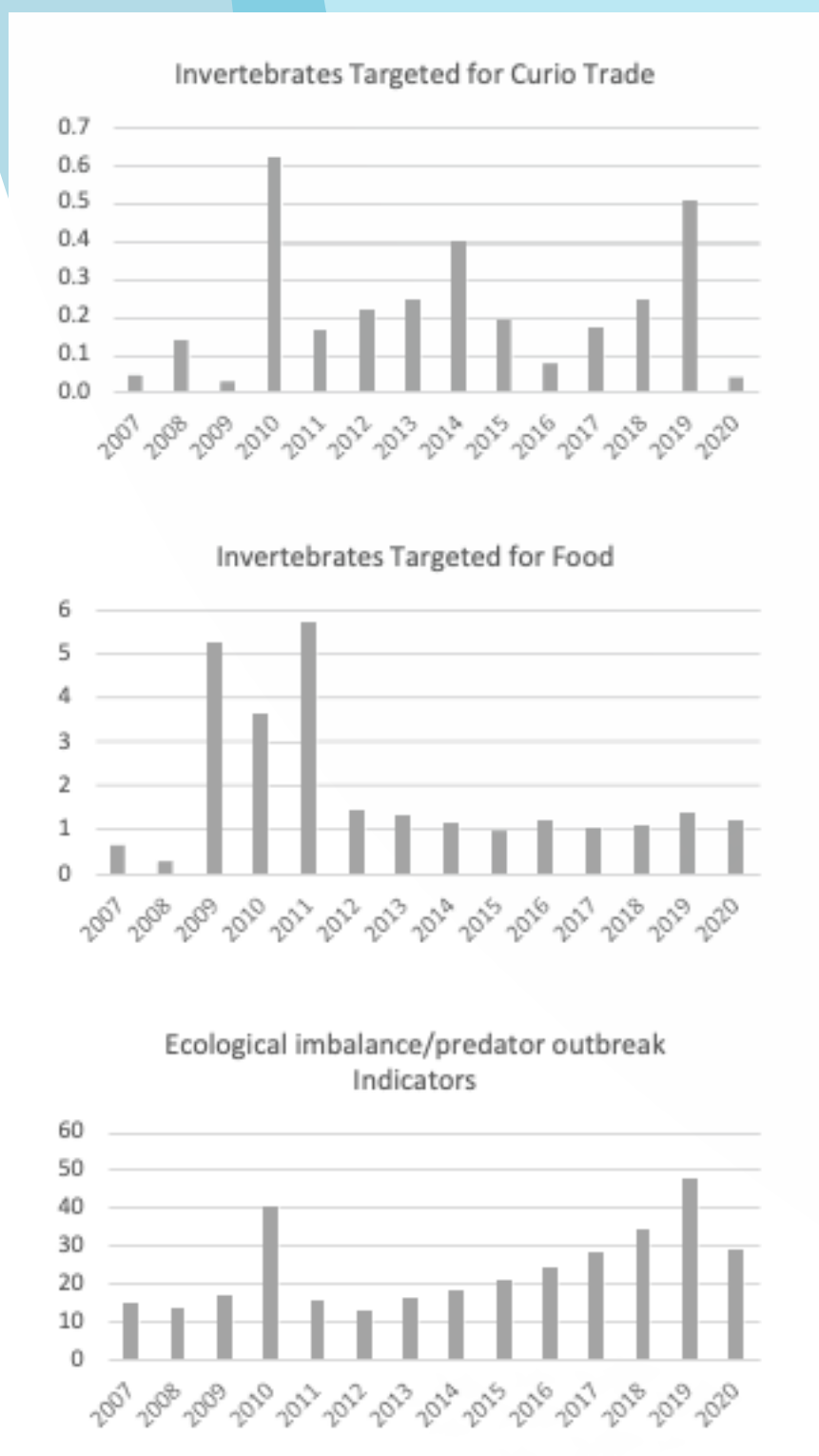
- The reefs in North Borneo have maintained more or less the same over the years.
- All substrate categories do not show much changes.

Fish



- The abundance of fish targeted for aquarium trade is declining in the last 5 years.
- The abundance of fish targeted for food and live-food fish trade is inconsistent over the years.

Invertebrate



- The abundance of invertebrates targeted for curio trade is inconsistent over the years.
- Very low abundance of invertebrates targeted for food.
- The abundance of indicators for ecological imbalance/predator outbreak is increasing.

Local Changes in Reef Health

This section provides details of the health of coral reefs around Malaysia over the last 6 years, from 2015 to 2020. Only islands/areas with permanent sites that were surveyed every year over the period are included in this section.

Sunda Shelf – Tioman

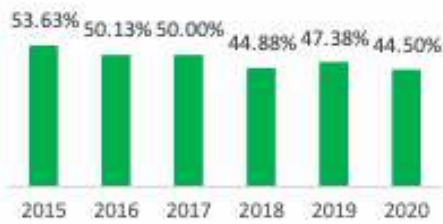


- Tioman reefs have maintained in 'good' condition.
- Live coral cover shows slight increase. The spike in 2017 is considered to reflect the elimination of one site that year, rather than an actual increase in live coral cover.
- Disturbance indicators have decreased but the level is still slightly high.
- Pollution indicators have decreased, the cause of the spike in 2019 is not known.
- In 2020, Crown-of-thorns population has increased significantly, above what a healthy reef can support (0.2-0.3 individual per 100m²). This is a cause for concern and existing efforts by reef managers to control the population of Crown-of-thorns need to be heightened.

Sunda Shelf – Bidong & Yu



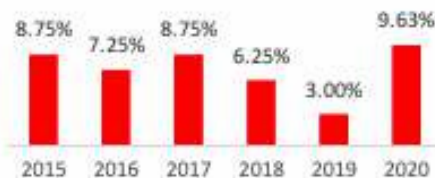
- Bidong and Yu reefs have deteriorated from 'good' to 'fair' condition, as reflected by the decrease in live coral cover.
- The decrease in live coral cover is highly likely due to high abundance of Crown-of-thorns, which is above what a healthy reef can sustain (0.2-0.3 individual per 100m²).
- The sharp decrease in live coral cover in 2019 is probably due to Tropical Storm Pabuk which struck Bidong and Yu in January that year, causing major physical damage to shallow reefs.
- In 2020, the reefs show some recovery.
- Pollution indicators has increased significantly.
- Available substrate for new coral recruits to attach to has decreased. However, the level is still high which shows possible chance of reef recovery if human impacts and Crown-of-thorns population are dealt with.



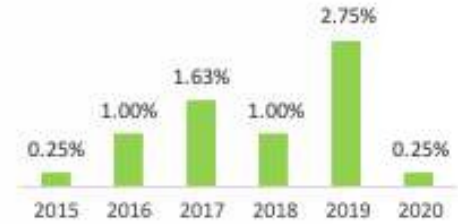
Available Substrate



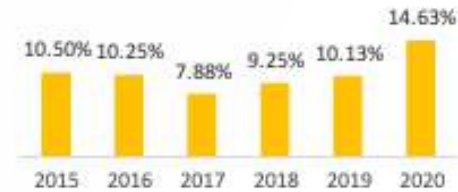
Disturbance Indicators



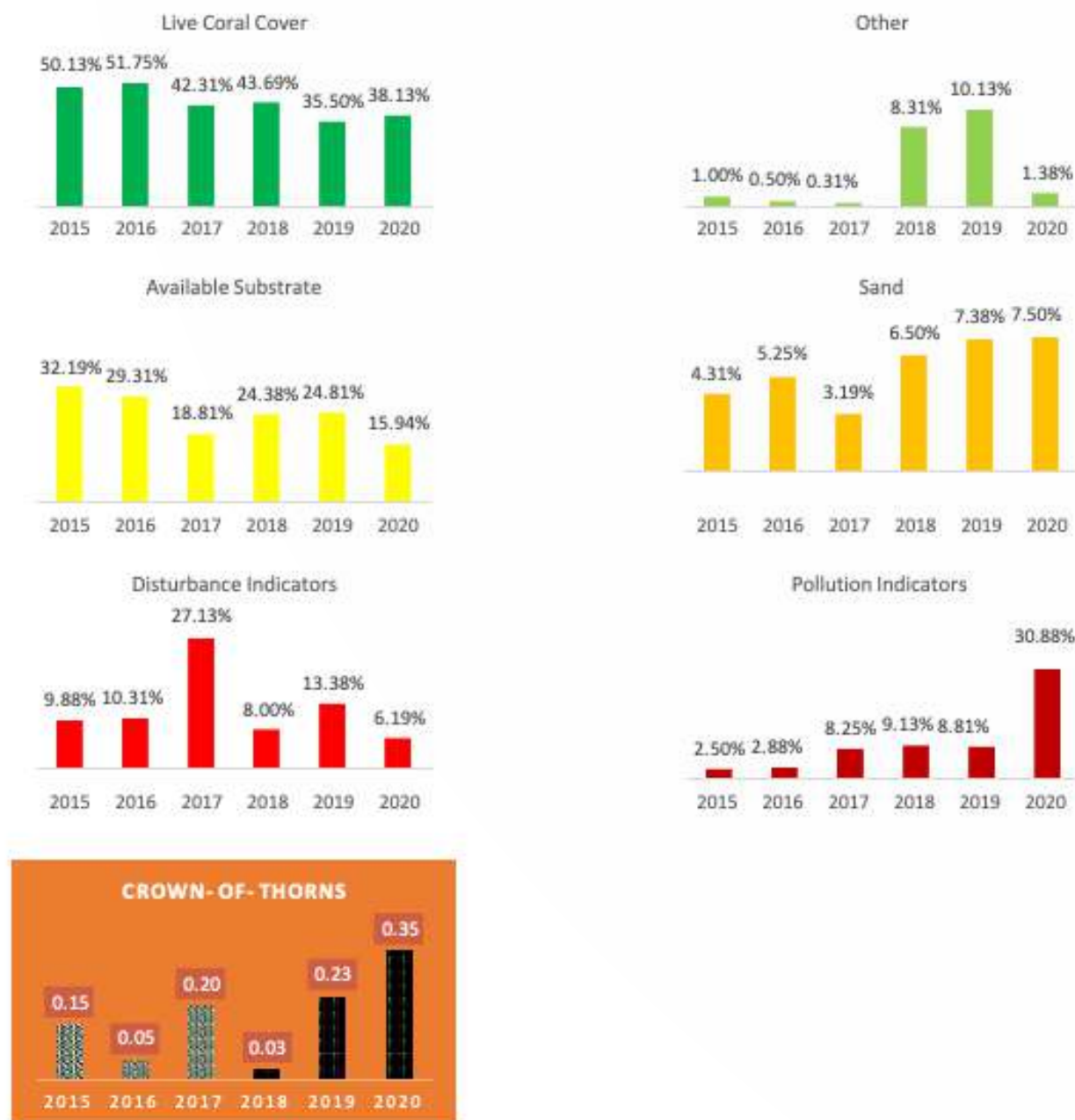
Pollution Indicators



Sand



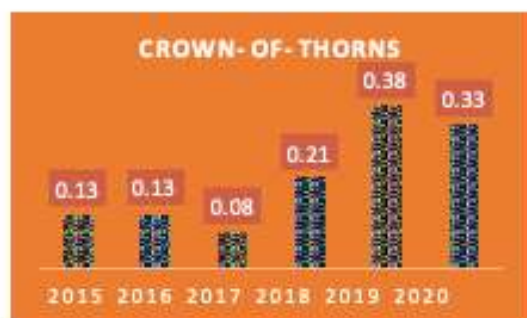
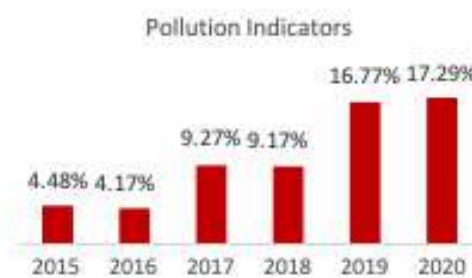
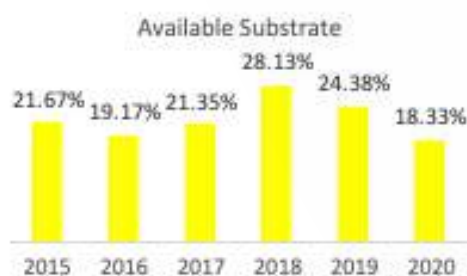
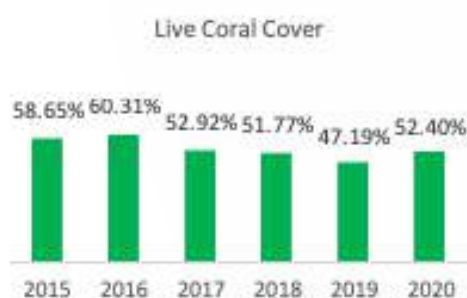
- Kapas reefs have deteriorated from 'good' to 'fair' condition, as reflected by the decrease in live coral cover.
- The decrease in live coral cover is highly likely due to high abundance of Crown-of-thorns, which is above what a healthy reef can sustain (0.2-0.3 individual per 100m²).
- From 2018 to 2020, Crown-of-thorns population has decreased. In 2020, the abundance has decreased to within what a healthy reef can sustain.
- Disturbance indicators have been slightly high over the years.
- Pollution indicators have been inconsistent.
- Available substrate for new coral recruits to attach to is very high, possible chance of reef recovery if human impacts and Crown-of-thorns abundance are in check.



- Perhentian reefs have deteriorated from 'good' to 'fair' condition, as reflected by the decrease in live coral cover.
- The sharp decrease in live coral cover in 2017 is most likely due to physical damage caused by human activities. The sharp decrease in live coral cover in 2019 is probably due to Tropical Storm Pabuk which struck Perhentian in January that year, causing major physical damage to shallow reefs. Both are reflected by the sharp increase in disturbance indicators. In 2020, the reefs show some signs of recovery.
- Pollution indicators have increased, significantly in 2020. This could be a cause of the increase in Crown-of-thorns abundance, which is now above what a healthy reef can support.
- Available substrate for new coral recruits to attach to has decreased. However, the level is still high which shows possible chance of reef recovery if human impacts and Crown-of-thorns population are dealt with.



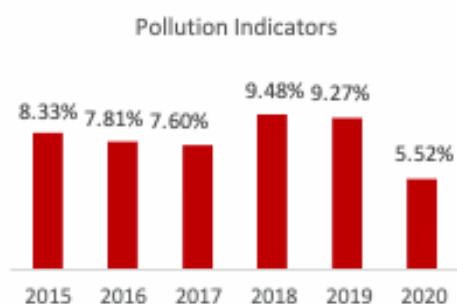
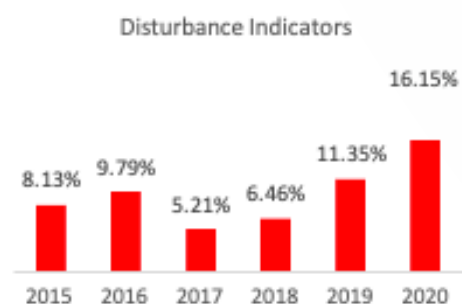
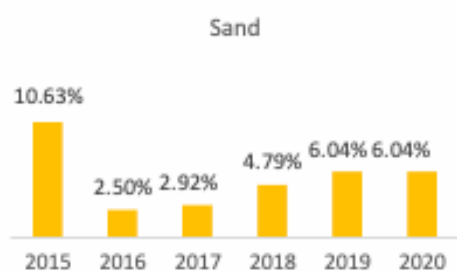
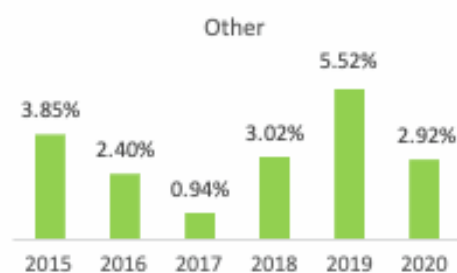
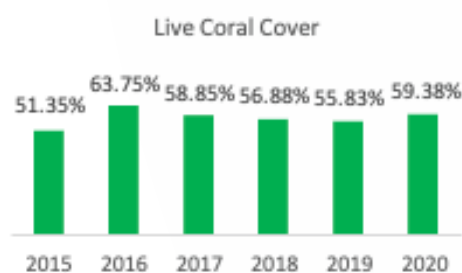
- Redang reefs have deteriorated from 'good' to 'fair' condition, as reflected by the decrease in live coral cover.
- The decrease in live coral cover from 2016 to 2018 is highly likely due to high abundance of Crown-of- thorns, which is above what a healthy reef can sustain (0.2-0.3 individual per 100m²), even though there was some reduction in 2019 and 2020.
- The sharp decrease in live coral cover in 2019 is probably due to Tropical Storm Pabuk which struck Redang in January that year, causing major physical damage to shallow reefs, as reflected by the sharp increase in disturbance indicators and level of sand that year. Reefs show some recovery in 2020, suggesting there is some resilience in the island's reefs.
- Available substrate for new coral recruits to attach to has decreased. However, the level is still high which shows possible chance of reef recovery if human impacts and Crown-of-thorns population are dealt with.



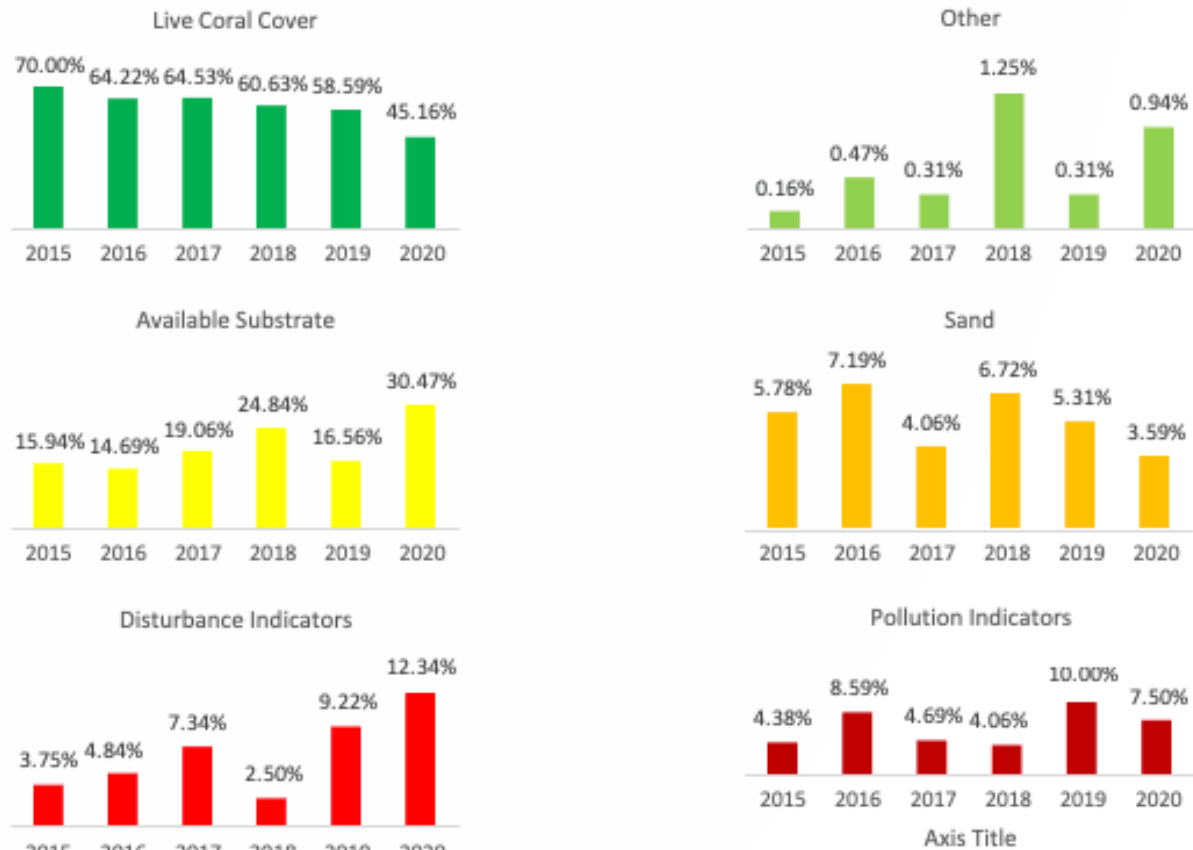
- Tenggol reefs have deteriorated although they maintained in 'good' condition.
- The sharp decrease in 2019 is probably due to Tropical Storm Pabuk which struck Tenggol in January that year, causing major physical damage to shallow reefs, as reflected by the increase in disturbance indicators.
- In 2020, the reefs show some recovery.
- Pollution indicators has increased.
- Crown-of-thorns population has increased to above what a healthy reef can sustain (0.2-0.3 individual per 100m²).
- Available substrate for new coral recruits to attach to has decreased. However, the level is still high which shows possible chance of reef recovery if human impacts and Crown-of-thorns population are deal with.



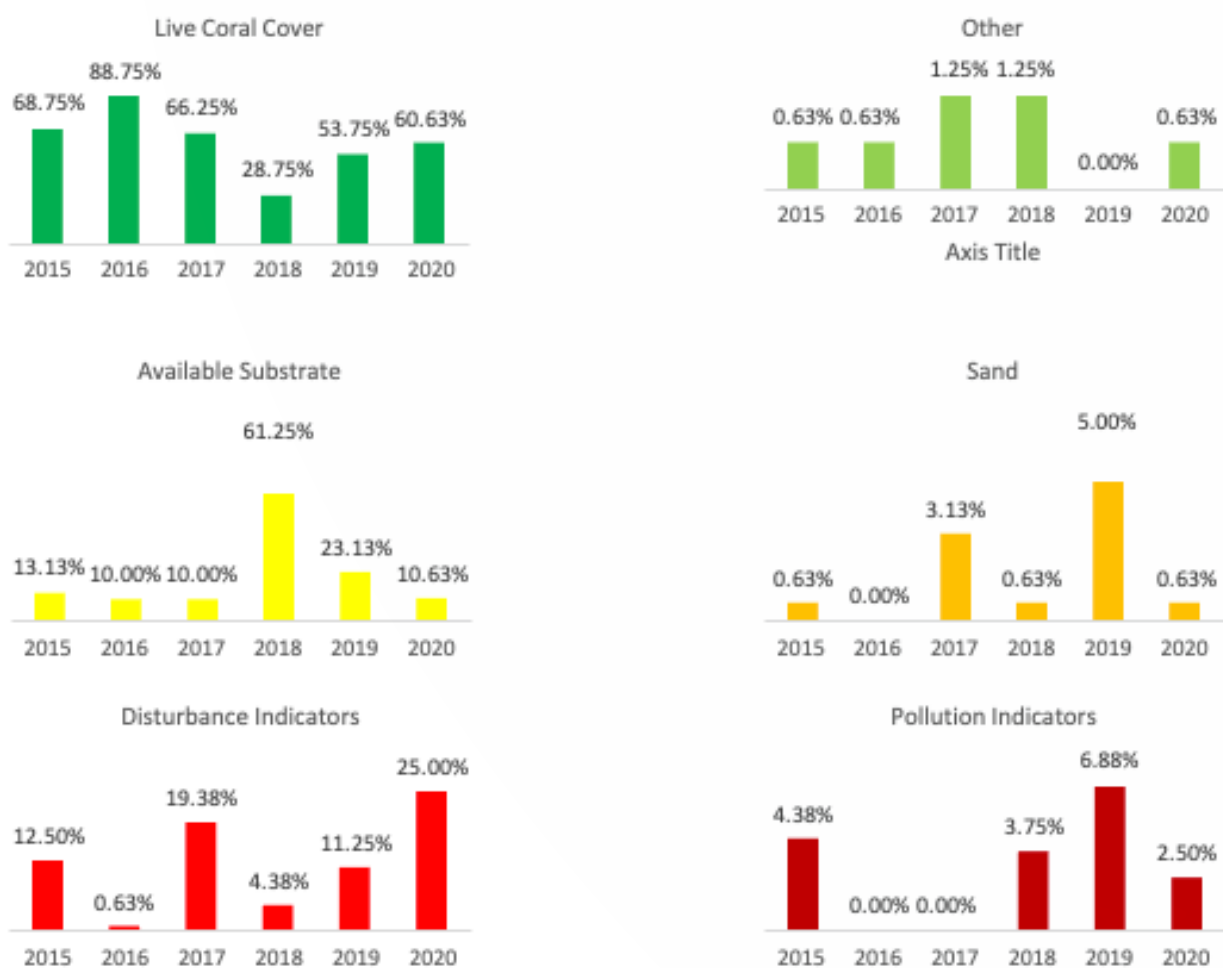
- The health of Pemanggil reefs has been inconsistent, as reflected by the inconsistency in live coral cover.
- The decrease in live coral cover in 2016 is highly likely due to high abundance of Crown-of-thorns, which is above what a healthy reef can sustain (0.2-0.3 individual per 100m²).
- Since 2017 Crown-of-thorns abundance has decreased to and maintained within the healthy range.
- The decrease in live coral cover from 2018 to 2020 is probably due to raised level of nutrient in the waters around the islands, as reflected by the increase in pollution indicators.
- Disturbance indicators has decreased.
- Available substrate for new coral recruits to attach to is high, possible chance of reef recovery if human impacts are deal with.



- Siburo reefs have maintained in 'good' condition.
- Disturbance indicators have increased. This is reflected by the increase in sand level. Increasing amount of sand can be an indication of disturbance as dead coral breaks off and are eroded into fine particles (sand) by wave action.
- Pollution indicators have been slightly high over the years with some improvement in 2020.
- Available substrate for new coral recruits to attach to has decreased.



- Tinggi reefs have deteriorated from 'good' to 'fair' condition, as reflected by the decrease in live coral cover.
- The decrease is most likely due to physical damage caused by human activities, as reflected by the increase in disturbance indicators.
- Pollution indicators have been inconsistent over the years and the level is slightly high in the last 2 years.
- Available substrate for new coral recruits to attach to has increased, possible chance of reef recovery if human impacts are dealt with.



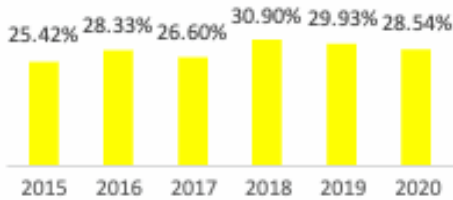
- Pangkor Laut reefs have maintained in 'good' condition.
- The cause of the drastic decrease in live coral cover in 2018 is not known.
- All substrate categories are showing inconsistency.



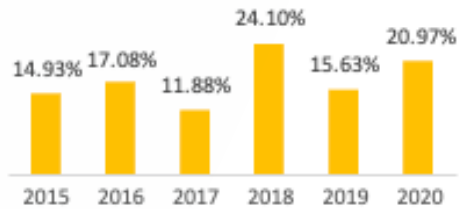
Available Substrate



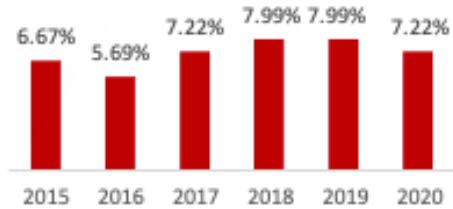
Sand



Disturbance Indicators



Pollution Indicators

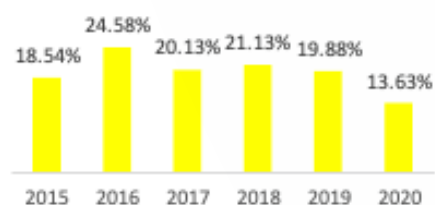


- Sembilan reefs have maintained in 'fair' condition.
- The decrease in live coral cover in 2017 is most likely due to physical damage caused by human activities, as reflected by the increase in disturbance indicators that year. In 2017, there was a massive construction on the beach at Pulau Lalang. Under the directive of Perak state government, structures built on the beach were removed later that year and the island is closed for boat landing until today.
- In 2018, the reefs show some recovery and have been showing recovery since.
- Disturbance indicators has decreased although the level is still high.
- Pollution indicators have maintained over the years.
- Available substrate for new coral recruits to attach to is very high, possible chance of complete reef recovery if human impacts are in check.





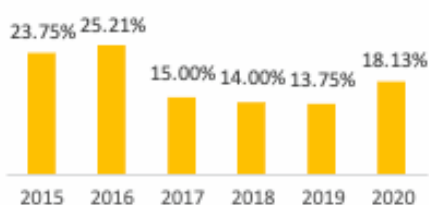
Available Substrate



Disturbance Indicators



Sand



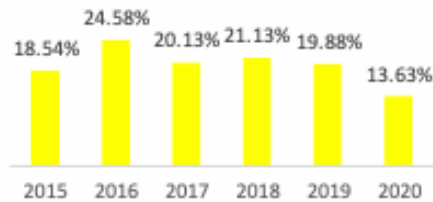
Pollution Indicators



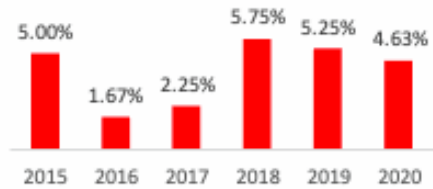
- Payar reefs have improved from 'fair' to 'good' condition, as reflected by the increase in live coral cover.
- The increase is most likely due to reduced level of nutrient in the waters around the islands, as reflected by the decrease in pollution indicators.



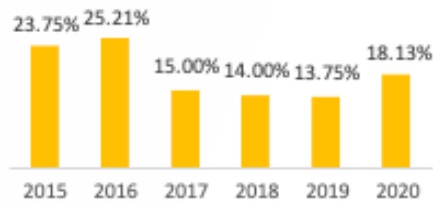
Available Substrate



Disturbance Indicators



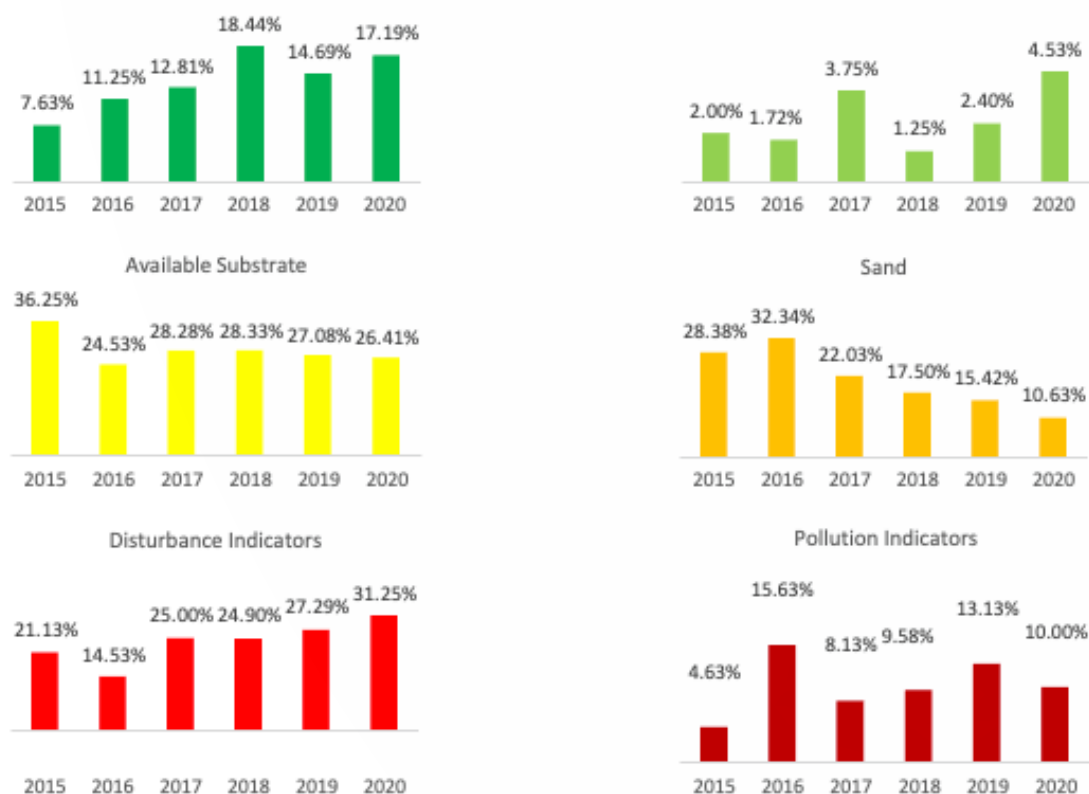
Sand



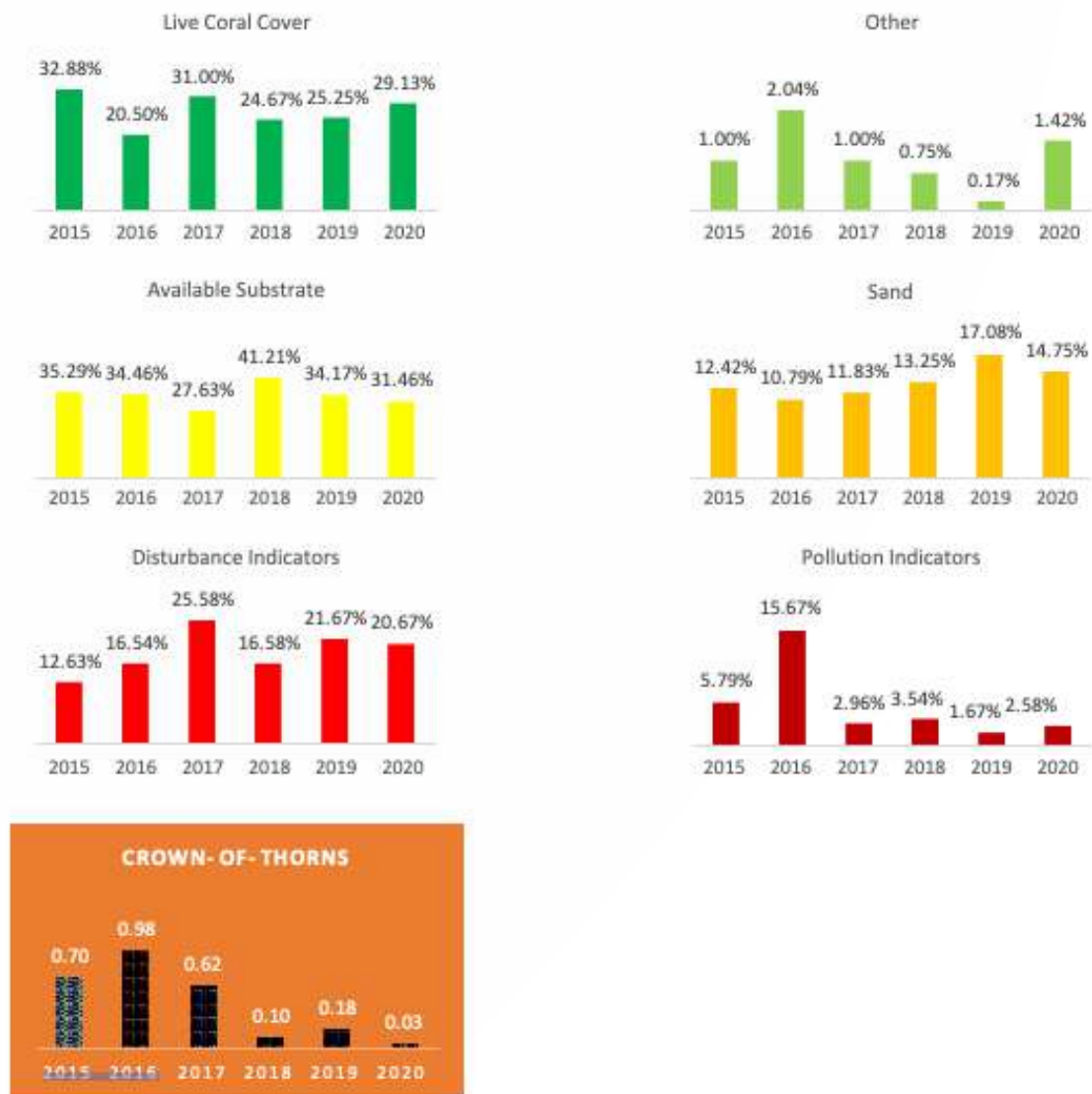
Pollution Indicators



- Payar reefs have improved from 'fair' to 'good' condition, as reflected by the increase in live coral cover.
- The increase is most likely due to reduced level of nutrient in the waters around the islands, as reflected by the decrease in pollution indicators.



- Kapalai reefs have improved although they maintained in 'poor' condition, as reflected by the increase in live coral cover.
- While disturbance indicators have increased, the level of sand has decreased. Decreasing amount of sand can be an indication of decreasing disturbance.
- Pollution indicators have increased. The cause of the spike in 2016 is not known.
- Available substrate for new coral recruits to attach is very high.



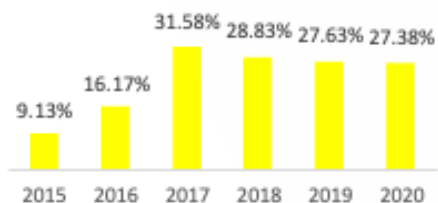
- Lahad Datu reefs have maintained in 'fair' condition.
- The decrease in live coral cover in 2016 is highly likely due to raised level of nutrient in the waters around the islands, as reflected by the increase in pollution indicators that year.
- High abundance of Crown-of-thorns, which is above what a healthy reef can sustain (0.2-0.3 individual per 100m²), also contributes to the decrease. Since 2018, Crown-of-thorns abundance has decreased to and maintained within the healthy range.
- Disturbance indicators are high.
- Pollution indicators have decreased.
- With the decrease in Crown-of-thorns abundance and pollution indicators, Lahad Datu reefs are showing recovery. Available substrate for new coral recruits to attach to is extremely high, possible chance of complete reef recovery if human impacts are in check.



Available Substrate



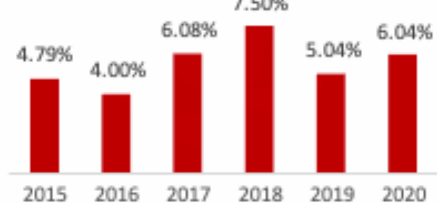
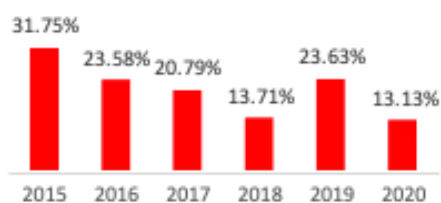
Sand



Disturbance Indicators



Pollution Indicators



- Lankayan reefs have maintained in 'fair' condition.
- Disturbance indicators have decreased.
- Pollution indicators have increased slightly over the years.
- Available substrate for new coral recruits to attach to is very high.



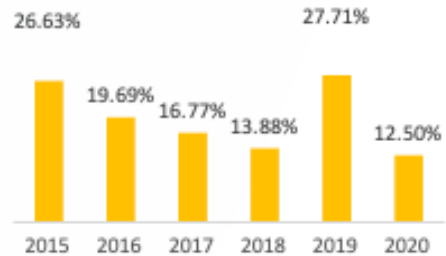
Available Substrate



Sand



Disturbance Indicators



Pollution Indicators



- Mabul reefs have deteriorated from 'fair' to 'poor' condition, as reflected by the decrease in live coral cover.
- The decrease is most likely due to physical damage caused by human activities, as reflected by the increase in disturbance indicators.
- The decrease in 2020 is also due to elimination of three sites that year as a result of Covid-19 pandemic which hampered survey efforts.
- Pollution indicators have decreased.
- Available substrate for new coral recruits to attach to is high, possible chance of reef recovery if human impacts are dealt with.





Available Substrate



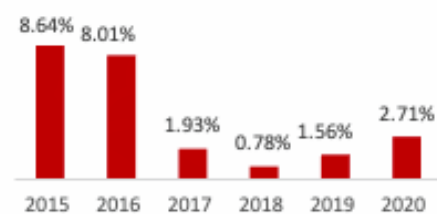
Sand



Disturbance Indicators



Pollution Indicators



- Mantanani reefs have deteriorated although they maintained in 'fair' condition, as reflected by the decrease in live coral cover.
- The decrease is most likely due to physical damage caused by human activities, as reflected by the increase in and high level of disturbance indicators.
- The spike in coral cover in 2017 is considered to reflect the addition of one site that year, rather than an actual increase in live coral cover.
- Pollution indicators have decreased however they are showing an increasing trend in the last 3 years.
- Available substrate for new coral recruits to attach to has decreased. However, the level is still very high which shows possible chance of reef recovery if human impacts are deal with.



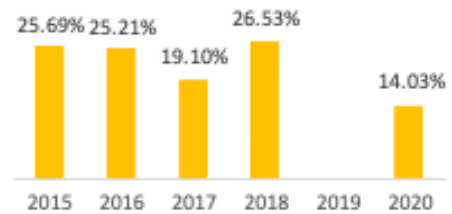
Available Substrate



Disturbance Indicators



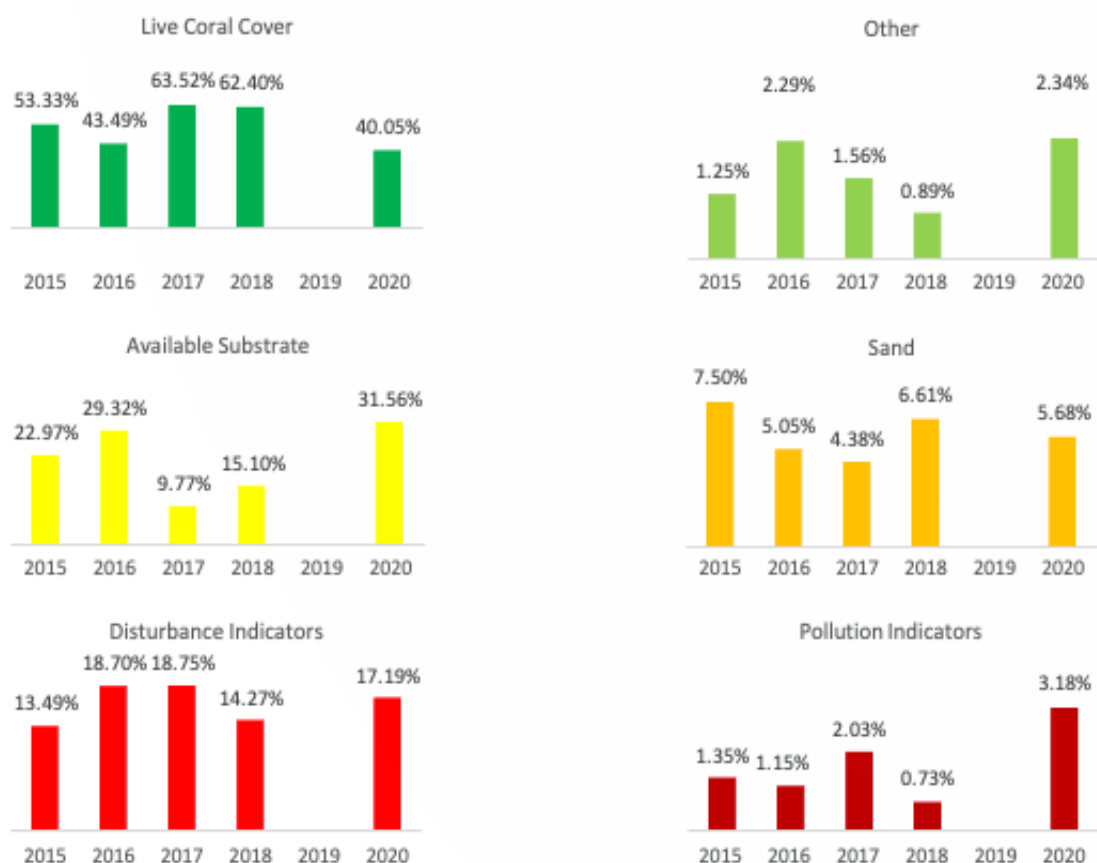
Sand



Pollution Indicators



- Pulau Penyu reefs have maintained in 'fair' condition.
- Disturbance indicators have decreased.
- Pollution indicators increased significantly in 2020.
- Available substrate for new coral recruits to attach has increased.



- Sipadan reefs have deteriorated from 'good' to 'fair' condition, as reflected by the decrease in live coral cover.
- The decrease is most likely due to combination of physical damage caused by human activities and pollution, as reflected by the increase in disturbance and pollution indicators.
- Available substrate for new coral recruits to attach to has increased, possible chance of reef recovery if human impacts are dealt with



- Tun Sakaran Marine Park reefs have deteriorated from 'good' to 'fair' condition, as reflected by the decrease in live coral cover.
- The decrease is most likely due to physical damage caused by human activities, as reflected by the increase in disturbance indicators and sand. Increasing amount of sand can be an indication of disturbance as dead coral breaks off and is eroded into fine particles (sand) by wave action.
- Available substrate for new coral recruits to attach to has increased, possible chance of reef recovery if human impacts are dealt with.

North Borneo – Usukan Cove



- Usukan Cove reefs have maintained in 'fair' condition.
- However, all substrate categories are showing inconsistency. The inconsistency is considered to reflect the irregularity in the number of sites surveyed every year.

5. Summary & Recommendations

Summary

The results of surveys conducted during 2020 suggest similar problems to those highlighted in our 2019 report: coral reef health is declining, fish and invertebrate populations are low, human impacts continue to increase, and climate change impacts are increasing. More specifically:

Substrate:

- Sites within MPAs show higher coral cover than sites outside MPAs, suggesting some benefits from protection.
- Most sites are still dominated by live coral cover and show healthy levels of hard coral cover, the main reef builder.
- Most sites have a reasonably high proportion of available substrate, indicating that there is potential for recovery if recruitment is high and both disturbance and pollution indicators can be controlled.
- The overall average coral cover is only 41.3%; most sites are in only “fair” condition and below their respective ecoregion’s average.
- The data show alarming signs that all sites recorded high indicators of disturbance and pollution indicators, including sites within MPAs.

Fish:

- Live-food fish trade indicators are absent at most sites and if present are only low in abundance.
- Fish targeted for food are low in abundance, suggesting that stocks have not recovered since past overharvesting and overfishing is still a problem.
- Several islands within MPAs (and Lahad Datu outside any MPA) have high abundance of Parrotfish, which is important to control proliferation of algae.

Invertebrates:

- Diadema abundance is high at most sites. Diadema can be both a positive indicator (controlling algae) and a negative indicator (suggesting nutrient pollution and being a bio-eroder) so the abundance needs to be viewed in connection with other indicators.
- Invertebrates targeted for food are low at most sites and are absent at some.
- Indicators for invertebrates collected for the curio trade are absent from all survey sites in Peninsular Malaysia. This may indicate that populations have not recovered from previous over-fishing; however, it could also be an indicator that populations are naturally low; a combination of the two is likely to mean very slow recovery of populations.
- Crown of Thorns populations is an issue at several islands in Peninsular Malaysia, particularly Perhentian, Redang, Bidong, Tenggol, Tioman and Aur. This could be an indicator that pollution levels are high.

An analysis of the data over the last six years reveals the following trends:

- Pahang: LCC increased slightly, disturbance and pollution indicators have decreased, COT is a problem in 2020.
- Terengganu: LCC is declining, COT is a problem, pollution indicators are increasing, available substrate for new corals to attach is declining (except for Kapas), but is still high for reef recovery if human impacts and COT are managed effectively.

- Johor reefs: LCC is inconsistent in Pemanggil but pollution indicators have increased; LCC in Sibu shows little change; LCC in Tinggi is declining while at the same time disturbance indicators have increased.
- Strait of Malacca: LCC at both Pangkor and Sembilan has remained consistent; LCC in Payar is increasing and pollution indicators have decreased.
- Sabah Parks: LCC in Pulau Penyu is consistent and disturbance indicators have decreased; in Sipadan and TSMP LCC is declining and disturbance indicators have increased.
- Sabah reefs (not marine parks): In Kapalai and Lahad Datu LCC is increasing; in Lankayan LCC is consistent; and in Mabul and Mantanani LCC is declining and disturbance indicators increasing; Usukan Cove LCC is inconsistent, probably due to irregularities of number of sites surveyed over the years.

Pollution, Crown of Thorns, fish bombing and tourism impacts appear to be the greatest threats facing coral reefs in Malaysia.

Recommendations

The year-on-year change in coral reef health is small and reef health in 2020 – in most survey sites – is not significantly different from the previous year.

However, the trend that is revealed from an analysis of data from surveys conducted over several years is clearly one of declining reef health – lower live coral cover, higher pollution and disturbance indicators and fish and invertebrate populations in general decline or not recovering:

- In the Sunda Shelf sites, Live Coral Cover has declined by 10 percentage points, from nearly 60% to under 50%.
- The Malacca Strait is little changed over the same period, with a small increase from just under 30% LCC to just over 40%.
- Meanwhile in North Borneo sites, there has been a decline in LCC from a high of 44% in 2014 to just over 30% in 2019, although there was a recovery in 2020 to 36%.

The threats facing coral reefs have been highlighted: pollution, disturbance (tourism, destructive fishing) and coral predators. Many of these threats can be addressed on a very local scale – at island level; the local NGOs, Tioman Marine Conservation Group (TMCG) and Reef Care programme initiated by DOFM demonstrate this. We recommend that:

- More management functions be devolved to island-level management bodies; that is where many of the immediate problems lie, and that is where solutions should be developed – on an island-by-island basis, by people who are familiar with the island's community and culture, its business patterns and the local ecology. Patrolling and enforcement should rightly remain the role of government agencies. But other management functions – monitoring, stakeholder consultations, education and awareness, etc., can be conducted by other stakeholders including communities and NGOs.
- Local stakeholders (both local communities and business such as tourism operators) should be involved in management through participatory or co-management schemes; giving local stakeholders a voice can significantly improve compliance and therefore conservation outcomes.
- Local conservation programmes should be implemented to address nutrient pollution (improve sewage treatment systems), tourism impacts (regulations for visitors and such as the Green Fins programme) and coral predator management.

Alongside this strengthening and empowering of local management, there is a need to address the larger challenges emerging from climate change, which is showing increasing clear impacts. We recommend:

- A stronger response from the government and related agencies to address climate change through the relevant inter- governmental programmes (e.g. IPCC). Malaysia is a coastal state; its marine estate is larger than its terrestrial area, yet there is little regulation of the latter.
- Building ecological resilience by controlling further tourism infrastructure development in coral reef areas and improving biological connectivity by establishing networks of MPAs to provide opportunities for more holistic management. This should include connectivity between islands but also connectivity between coastal and offshore ecosystems – mangroves to seagrass meadows to coral reefs; all are important marine ecosystems and are biologically connected.
- A new approach to tourism, with a strong focus on Sustainable Tourism, that takes into account both changes in the market and the need to conserve valuable ecosystems. Trends in tourism indicate a stronger preference for authentic experiences in pristine environments with few other visitors. Mass tourism is not the future and there is a need to build capacity in the tourism industry to exploit this change. A smaller number of higher value tourists can both maintain incomes while reducing damage to ecosystems.

Success in this endeavour will require much greater coordination between management agencies (such as Marine Parks), tourism authorities (MOTAC) and those Ministries responsible for biodiversity conservation (KeTSA) and environmental conservation (KASA). Such collaborations would also provide a platform to strengthen policies and regulations relating to marine resource conservation.

6. Conclusion

This review of the health of coral reefs around Malaysia in 2020 highlights similar concerns to previous years: while reefs are generally quite healthy, there is a long, slow decline that must be addressed.

The pandemic provides us with an opportunity to pause and reflect on this. Many of the local impacts to coral reefs are tourism-related. Communities that rely on tourism are suffering; but at the same time impacts are greatly reduced. How do we protect both the former – and the latter?

We need to consider different approaches - to management, to tourism, to our economic activities. Empowering local stakeholders has been shown to have conservation benefits. Reducing tourism numbers – while increasing value – can allow communities to benefit from the same incomes while also benefiting from smaller numbers of visitors.

All stakeholders need to get together and discuss these challenges and derive solutions that benefit us all. We all rely on coral reefs, and the ecosystem services they provide; we all have a role in protecting them.

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NGOs



TENGGAH ISLAND
CONSERVATION

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Appendix 1: Survey Sites

Sunda Shelf		
Site Name	Island	Coordinate
Pirates Reef	Tioman	2 49.428 N 104 09.445 E
Renggis	Tioman	2 48.594 N 104 08.161 E
Fan Canyon	Tioman	2 54.650 N 104 06.753 E
Soyak South	Tioman	2 52.480 N 104 08.810 E
Soyak North	Tioman	2 52.558 N 104 08.828 E
Batu Malang	Tioman	2 54.139 N 104 06.148 E
Tekek House Reef	Tioman	2 48.960 N 104 09.062 E
Chebeh	Tioman	2 55.946 N 104 05.814 E
Sepoi	Tioman	2 53.883 N 104 03.100 E
Teluk Kador	Tioman	2 54.891 N 104 06.507 E
Tumuk	Tioman	2 47.581 N 104 07.335 E
Labas	Tioman	2 53.318 N 104 03.920 E
Teluk Dalam	Tioman	2 52.456 N 104 11.254 E
Jahat East	Tioman	2 40.127 N 104 10.518 E
Munjor South	Tioman	2 44.492 N 104 13.068 E
Nayak	Tioman	2 46.758 N 104 12.760 E
Saing	Tioman	2 45.502 N 104 11.950 E
Batu Nipah	Tioman	2 43.928 N 104 08.125 E
Heritage Row	Bidong/Yu	5 36.922 N 103 03.412 E
Pasir Tenggara	Bidong/Yu	5 36.607 N 103 03.780 E
P. Karah	Bidong/Yu	5 35.935 N 103 03.851 E
P. Tengkorak	Bidong/Yu	5 39.967 N 103 04.277 E
P. Yu Besar	Bidong/Yu	5 38.615 N 103 09.063 E
P. Yu Kecil	Bidong/Yu	5 37.533 N 103 09.570 E
Coral Garden 1	Kapas	5 14.113 N 103 15.678 E
Coral Garden 3	Kapas	5 14.149 N 103 15.782 E
Silent Reef	Kapas	5 13.785 N 103 16.079 E
Teluk Jawa	Kapas	5 12.526 N 103 16.165 E
Jellyfish City	Kapas	5 13.468 N 103 15.658 E
Batu Layar	Perhentian	5 54.722 N 102 44.693 E
Batu Nisan	Perhentian	5 55.259 N 102 43.536 E
Batu Tabir	Perhentian	5 56.345 N 102 43.321 E
Tukas Laut	Perhentian	5 53.162 N 102 46.216 E
Tiga Ruang	Perhentian	5 54.867 N 102 45.244 E
D' Lagoon	Perhentian	5 55.927 N 102 43.395 E
P. Rawa	Perhentian	5 57.777 N 102 40.833 E
Sea Bell	Perhentian	5 54.636 N 102 42.589 E
Shark Point	Perhentian	5 53.044 N 102 44.821 E
Tanjung Basi	Perhentian	5 55.387 N 102 45.518 E
Teluk Mat Delah	Redang	5 47.970 N 103 01.017 E
Chagar Hutang East	Redang	5 49.038 N 103 00.597 E
P. Kerengga Besar	Redang	5 45.261 N 103 01.737 E

P. Kerengga Kecil	Redang	5 45.519 N 103 01.751 E
P. Lima Southern Tip	Redang	5 46.397 N 103 03.553 E
P. Paku Besar	Redang	5 46.777 N 103 02.557 E
P. Paku Kecil	Redang	5 46.305 N 103 02.338 E
P. Pinang Marine Park Centre	Redang	5 44.814 N 102 59.987 E
Pasir Akar	Redang	5 44.398 N 102 59.955 E
Redang Kalong HR	Redang	5 45.660 N 103 01.584 E
Terumbu Kili	Redang	5 43.928 N 102 59.825 E
Mak Simpan	Redang	5 47.302 N 102 59.556 E
Freshwater Bay	Tenggol	4 48.546 N 103 40.669 E
Gua Rajawali	Tenggol	4 48.768 N 103 40.556 E
Pasir Tenggara	Tenggol	4 48.021 N 103 40.456 E
Rajawali Reef	Tenggol	4 49.037 N 103 40.755 E
Turtle Point	Tenggol	4 48.364 N 103 40.468 E
Teluk Rajawali	Tenggol	4 48.931 N 103 40.824 E
Atlantis Bay	Aur/Dayang	2 28.271 N 104 30.633 E
Pulau Lang	Aur/Dayang	2 27.594 N 104 29.358 E
Teluk Meriam	Aur/Dayang	2 26.509 N 104 30.571 E
Teluk Teluran	Aur/Dayang	2 27.617 N 104 31.587 E
Teluk Batu Kapal	Aur/Dayang	2 28.368 N 104 30.481 E
Teluk Jawa	Aur/Dayang	2 28.651 N 104 30.271 E
Bumphead Bay	Pemanggil	2 35.066 N 104 20.180 E
Lobster Bay	Pemanggil	2 34.237 N 104 19.306 E
Pemanggil Village South	Pemanggil	2 34.761 N 104 18.945 E
Tridacna Bay	Pemanggil	2 35.790 N 104 19.588 E
Palenting	Pulau Besar	2 27.408 N 103 58.298 E
Rapang	Pulau Besar	2 27.503 N 103 58.758 E
Teluk Buluh	Pulau Besar	2 26.543 N 103 58.385 E
Teluk Kalih	Pulau Besar	2 25.398 N 103 59.410 E
Teluk Meriam	Pulau Besar	2 26.672 N 103 59.309 E
Teluk Meriam South	Pulau Besar	2 26.127 N 103 59.610 E
Mirage	Pulau Besar	2 25.823 N 103 58.718 E
Buntut Meriam	Sibu	2 13.860 N 104 03.130 E
Malang Acha	Sibu	2 11.040 N 104 06.409 E
Beach 3	Sibu	2 11.268 N 104 05.888 E
Sibu Hujung	Sibu	2 10.374 N 104 06.721 E
Sibu Kukus	Sibu	2 10.696 N 104 06.553 E
The Coconut	Sibu	2 13.567 N 104 03.184 E
P. Mentinggi	Tinggi	2 16.405 N 104 06.940 E
P. Nanga	Tinggi	2 16.274 N 104 07.640 E
P. Ibol	Tinggi	2 18.183 N 104 08.935 E
P. Tanjung Gua Subang	Tinggi	2 18.792 N 104 07.552 E

Malacca Strait		
Site Name	Island	Coordinate
Pangkor Laut	Pangkor	4 11.393 N 100 32.899 E
Pasir Tengkorak, P. Lalang	Sembilan	4 00.162 N 100 32.802 E
Site 1, P. Saga	Sembilan	4 00.732 N 100 32.694 E
Site 2, P. Lalang	Sembilan	4 00.099 N 100 32.945 E
Site 2, P. Rumbia	Sembilan	4 01.344 N 100 32.874 E
Zoanthid Garden, P. Rumbia	Sembilan	4 01.926 N 100 33.000 E
P. Buluh	Sembilan	3 59.650 N 100 32.048 E
Anemone Garden, P. Saji	Sembilan	4 00.390 N 100 32.088 E
Frogfish, P. Nipis	Sembilan	4 03.450 N 100 32.382 E
Rock Garden, P. Saji	Sembilan	4 00.684 N 100 32.106 E
Coral Garden	Payar	6 03.371 N 100 02.157 E
Singapore Bay	Payar	6 03.639 N 100 02.472 E
Langkawi Coral	Payar	6 03.951 N 100 02.606 E
Kaca	Payar	6 04.389 N 100 03.444 E
Lembu	Payar	6 04.293 N 100 03.067 E

North Borneo		
Site Name	Island	Coordinate
Great Wall	Kapalai	4 13.767 N 118 40.800 E
Cleaning Station	Kapalai	4 13.517 N 118 41.283 E
Siu Siu Point	Kapalai	4 13.087 N 118 40.313 E
Lost World	Kapalai	4 12.093 N 118 41.392 E
House Reef	Lahad Datu	4 58.027 N 118 15.841 E
Cabbage Reef	Lahad Datu	4 56.927 N 118 15.470 E
Paradise	Lahad Datu	4 56.548 N 118 17.637 E
Lam's Point	Lahad Datu	4 56.275 N 118 16.464 E
Nemo Garden	Lahad Datu	4 56.494 N 118 16.945 E
Fish Eyes	Lahad Datu	4 57.782 N 118 15.165 E
Mid Reef	Lahad Datu	4 54.740 N 118 15.256 E
Small Reef	Lahad Datu	4 54.444 N 118 14.595 E
Adam's Point	Lahad Datu	4 57.052 N 118 15.473 E
Ira's Reef	Lahad Datu	4 55.412 N 118 15.363 E
Light House	Lahad Datu	4 56.922 N 118 15.076 E
P. Burung	Lahad Datu	4 55.439 N 118 16.003 E
P. Laila	Lahad Datu	4 55.811 N 118 13.711 E
P. Tabun	Lahad Datu	4 55.246 N 118 12.076 E
Tumunong Hallo	Lahad Datu	4 54.510 N 118 10.644 E
Bimbo Rock	Lankayan	6 31.240 N 117 55.763 E
Edwin Rock	Lankayan	6 30.806 N 117 55.499 E
Froggie Fort	Lankayan	6 30.806 N 117 54.337 E
Goby Rock	Lankayan	6 28.745 N 117 53.448 E
Jawfish Lair	Lankayan	6 29.182 N 117 54.670 E
Ken's Rock	Lankayan	6 30.393 N 117 55.651 E
Lycia Garden	Lankayan	6 29.895 N 117 55.634 E
Mel's Rock	Lankayan	6 29.140 N 117 53.584 E
Moray Reef	Lankayan	6 33.125 N 117 56.141 E

<u>Pegaso</u>	<u>Lankayan</u>	6 33.726 N 117 55.210 E
<u>Reef 38</u>	<u>Lankayan</u>	6 32.619 N 117 55.201 E
<u>Reef 77</u>	<u>Lankayan</u>	6 33.124 N 117 55.482 E
<u>Sandbar S</u>	<u>Lankayan</u>	6 29.900 N 117 54.681 E
<u>Veron</u>	<u>Lankayan</u>	6 31.259 N 117 54.944 E
<u>Zorro</u>	<u>Lankayan</u>	6 30.470 N 117 55.218 E
<u>Eel Garden</u>	<u>Mabul</u>	4 13.883 N 118 38.017 E
<u>Ribbon Valley</u>	<u>Mabul</u>	4 14.046 N 118 38.255 E
<u>Paradise</u>	<u>Mabul</u>	4 14.989 N 118 37.830 E
<u>Sahara</u>	<u>Mantanani</u>	6 43.295 N 116 20.905 E
<u>Abalone</u>	<u>Mantanani</u>	6 43.207 N 116 22.105 E
<u>Police Gate</u>	<u>Mantanani</u>	6 42.730 N 116 20.313 E
<u>Italian Place</u>	<u>Mantanani</u>	6 42.308 N 116 19.232 E
<u>Riza Garden</u>	<u>Mantanani</u>	6 42.136 N 116 21.812 E
<u>Linggisan</u>	<u>Mantanani</u>	6 42.832 N 116 20.084 E
<u>Stingray Point</u>	<u>Mantanani</u>	6 42.764 N 116 19.771 E
<u>Indian Brothers</u>	<u>Mantanani</u>	6 43.191 N 116 20.454 E
<u>Mari Mari House Reef</u>	<u>Mantanani</u>	6 42.396 N 116 19.275 E
<u>Coral Reef</u>	<u>Mantanani</u>	6 42.389 N 116 20.840 E
<u>Kolam</u>	<u>Mantanani</u>	6 43.930 N 116 21.567 E
<u>South East Point</u>	<u>Mantanani</u>	6 42.454 N 116 22.329 E
<u>Mid Reef</u>	<u>Pulau Penyu</u>	6 10.402 N 118 04.287 E
<u>Pulau Bakungan 1</u>	<u>Pulau Penyu</u>	6 10.192 N 118 06.538 E
<u>Pulau Bakungan 2</u>	<u>Pulau Penyu</u>	6 09.805 N 118 06.483 E
<u>Pulau Gulisan</u>	<u>Pulau Penyu</u>	6 09.268 N 118 03.512 E
<u>Selingan</u>	<u>Pulau Penyu</u>	6 10.813 N 118 03.803 E
<u>Lutjanus</u>	<u>Pulau Tiga</u>	5 43.213 N 115 38.688 E
<u>Larai-Larai</u>	<u>Pulau Tiga</u>	5 43.017 N 115 38.097 E
<u>Tanjung Putri</u>	<u>Pulau Tiga</u>	5 42.517 N 115 39.195 E
<u>Tagi Beach</u>	<u>Pulau Tiga</u>	5 42.768 N 115 40.347 E
<u>Senanggol</u>	<u>Pulau Tiga</u>	5 42.482 N 115 41.958 E
<u>Mid Reef</u>	<u>Pulau Tiga</u>	5 42.302 N 115 37.705 E
<u>Larai-Larai Midreef</u>	<u>Pulau Tiga</u>	5 43.779 N 115 36.477 E
<u>Barracuda Point</u>	<u>Sipadan</u>	4 07.130 N 118 37.745 E
<u>Coral Garden</u>	<u>Sipadan</u>	4 06.342 N 118 37.722 E
<u>Drop Off</u>	<u>Sipadan</u>	4 07.092 N 118 37.675 E
<u>Hanging Garden</u>	<u>Sipadan</u>	4 06.703 N 118 37.495 E
<u>Lobster Lair</u>	<u>Sipadan</u>	4 06.557 N 118 37.540 E
<u>Mid Reef</u>	<u>Sipadan</u>	4 06.812 N 118 38.158 E
<u>South Point</u>	<u>Sipadan</u>	4 06.258 N 118 38.110 E
<u>Staghorn Crest</u>	<u>Sipadan</u>	4 06.257 N 118 37.895 E
<u>Turtle Patch</u>	<u>Sipadan</u>	4 06.450 N 118 38.177 E
<u>White Tip</u>	<u>Sipadan</u>	4 07.137 N 118 38.055 E
<u>West Ridge North</u>	<u>Sipadan</u>	4 06.910 N 118 37.487 E
<u>Base Camp</u>	<u>Tunku Abdul Rahman Park</u>	6 00.491 N 116 01.322 E
<u>Mamutik</u>	<u>Tunku Abdul Rahman Park</u>	5 58.067 N 116 00.756 E
<u>Manukan West</u>	<u>Tunku Abdul Rahman Park</u>	5 58.246 N 115 59.659 E
<u>Mid Reef</u>	<u>Tunku Abdul Rahman Park</u>	5 58.433 N 116 00.750 E
<u>Police Beach</u>	<u>Tunku Abdul Rahman Park</u>	6 02.483 N 116 01.183 E

<u>Sapi</u>	<u>Tunku Abdul Rahman Park</u>	6 00.479 N 116 00.190 E
<u>Sulug</u>	<u>Tunku Abdul Rahman Park</u>	5 57.547 N 115 59.464 E
<u>Tanjung Wokong</u>	<u>Tunku Abdul Rahman Park</u>	5 59.433 N 116 02.417 E
<u>Kapikan Reef</u>	<u>Tun Sakaran Marine Park</u>	4 37.698 N 118 50.112 E
<u>Mantabuan</u>	<u>Tun Sakaran Marine Park</u>	4 37.933 N 118 47.798 E
<u>Ribbon Reef</u>	<u>Tun Sakaran Marine Park</u>	4 36.135 N 118 46.090 E
<u>South Rim</u>	<u>Tun Sakaran Marine Park</u>	4 34.078 N 118 45.498 E
<u>Sibuan</u>	<u>Tun Sakaran Marine Park</u>	4 39.154 N 118 39.884 E
<u>Tanjung Kenangan</u>	<u>Tun Sakaran Marine Park</u>	4 35.127 N 118 47.155 E
<u>Uban-Uban</u>	<u>Usukan Cove</u>	6 23.442 N 116 19.342 E
<u>Pandan-Pandan</u>	<u>Usukan Cove</u>	6 21.265 N 116 18.666 E
<u>Poduko</u>	<u>Usukan Cove</u>	6 22.322 N 116 19.438 E
<u>Lok Liak</u>	<u>Usukan Cove</u>	6 22.126 N 116 19.101 E
<u>Keramat</u>	<u>Usukan Cove</u>	6 23.635 N 116 19.637 E

Catatan



DEPARTMENT OF FISHERIES MALAYSIA
MINISTRY OF AGRICULTURE AND FOOD INDUSTRY