Coral Reef Targeted Research & Capacity Building for Management

Underwater Cards for Assessing Coral Health on Caribbean Reefs

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Underwater Cards for
Assessing Coral Health on Caribbean Reefs

Ernesto Weil[1], Anthony J. Hooten[2].

Coral Disease

Coral reefs are under increasing stress globally from a number of causes, including climate warming, poor water quality and over fishing. Disease outbreaks not only result in coral loss, but they also cause significant changes in community structure, species diversity and reef-associated organisms.

Coral diseases in the Caribbean have become a major player in the progressive decline of these important communities. They impact both well-managed and unmanaged reefs. However, strategies for dealing with disease outbreaks are currently non-existent. The increasing frequency with which diseases influence and alter reef communities means they must be considered and incorporated into management plans.

The CRTR Disease Working Group

The CRTR *Disease Working Group* has been funded by the Coral Reef Targeted Research & Capacity Building for Management Program (CRTR) to advance understanding of coral disease in a number of key areas.

In particular, the CRTR *Disease Working Group's* research is providing a greater understanding of the ways in which coral diseases can alter reef function and the conditions under which outbreaks may occur.

Documenting abundance and prevalence of disease and monitoring changes in disease through time are key steps in understanding how factors like ocean warming and deteriorating water quality may affect disease dynamics.

To assist with our objectives, the CRTR *Disease Working Group* has produced these Underwater Cards for Assessing Coral Health on Caribbean Reefs so that recreational, professional and scientific divers can all assist with gathering information on the occurrence of coral reef diseases.

By using these cards, you can:

- Learn to identify diseases in Caribbean coral and other reef organisms and survey techniques for measuring coral disease prevalence;
- Gather information on the distribution and abundance of coral diseases on local reefs;
- Monitor the health of local coral reefs and identify potential drivers of disease abundance;
- Contribute to a world-wide data base on coral disease;
- Help to conserve the world's coral reefs.

How to use these cards

These cards start with a decision tree for assessing the health status of Caribbean corals and other reef organisms. The decision tree is color coded to assist with navigation through the cards. After reviewing all disease descriptions and images to gain an overview of the range of signs of disease and compromised health, the following steps will enable you to assess the health status of a coral, sponge, octocoral, etc. Note that a variety of factors other than disease (e.g. predation, grazing, anchors) cause lesions.

1. Decide if a coral shows signs of tissue loss (red section), tissue discoloration (blue section), anomalous growth (green section) or some other sign of compromised health (yellow section).
2. At each level in the key for the colored section selected, decide which category best describes the signs observed.
3. Go to the appropriate colored section in this card set to check disease images and descriptions.
4. Record your observations on the data sheet provided at the end of this card set.

The CRTR Program is a partnership between the Global Environment Facility, the World Bank, The University of Queensland (Australia), the United States National Oceanic and Atmospheric Administration (NOAA) and approximately 50 research institutes and other third-parties around the world.

GEF

The University Of Queensland AUSTRALIA

CRTR Program Project Executing Agency, Centre for Marnie Studies, Gerhmann Building, The University of Queensland, St Lucia, QLD 4072, Australia
Telephone: +61 7 3346 9942 Facsimile: +61 7 3346 9987 Email: info@gefcoral.org Internet: www.gefcoral.org

[1] Department of Marine Sciences, University of Puerto Rico. [2] US Coordinator Global Coral Reef Targeted Research Program and AJH, Environmental Services.

How to use these cards

Caribbean Coral Health – Decision Tree

Tissue Loss – Predation
1. Fish Predation (FPR)
2. Invertebrate Predation (IPR)

Tissue Loss – Non-Predation – Colored Band Diseases
3. Black Band Disease (BBD)
4. Caribbean Ciliate Infection (CCI)
5. Aspergillosis (ASP)
6. Purple Spots (PS)
7. Red Band Disease (RBD)

Tissue Loss – Caribbean White Syndromes
8. White Band Disease (WBD)
9. White Plague (WP)
10. White Patch Disease (WPA)
11. Caribbean White Syndromes (CWS)

Tissue Discoloration – White
12. Bleaching (BL)

Tissue Discoloration – Non White
13. Dark Spots Disease (DSD)
14. Caribbean Yellow Band Disease (CYBD)

Growth Anomalies
15. Growth Anomalies (GAN)

Compromised Health
16. Compromised Health in Hard Corals (CHC)
17. Compromised Health in Octocorals (CHO)
18. Competition – Overgrowth (CO)

Diseases in Other Reef Organisms
19. Coralline White Band Syndrome (CWBS)
20. Other Reef Organisms – Sponges
21. Other Reef Organisms – Zoanthids & Hydrocorals

Coral Reef Targeted Research & Capacity Building for Management

Caribbean – Decision Tree

Fish Predation (FPR)

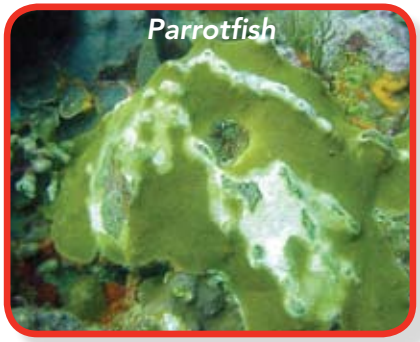
- Few organisms feed exclusively on coral tissues. Common large predators include parrotfish, surgeonfish and urchins. Small predators include butterfly -fish, damselfish, snails and fireworms.

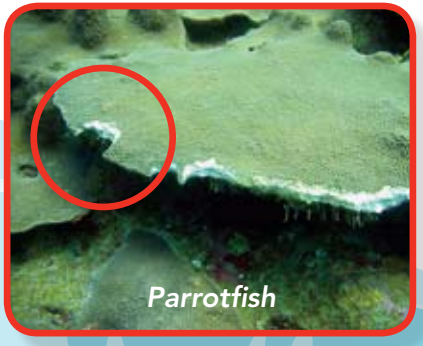
Commonly confused with:

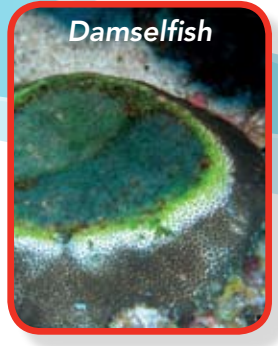
- White band disease, white plague disease, white syndromes, bleaching and other white scars.

Key ID characteristics:

- Fish and urchin feeding leave irregular scars with broken skeleton. Parrotfish bites are usually large and focused along ridges or edges, or at the center of colonies.
- Damselfish create their feeding gardens biting and killing coral tissue so algae can grow. Areas are usually round and not larger than 50cm in diameter. Fish defends territory aggressively.
- Common coral genera affected include ***Montastraea, Diploria, Colpophyllia, Acropora, Stephanocoenia***, etc.







Invertebrate Predation (IPR)

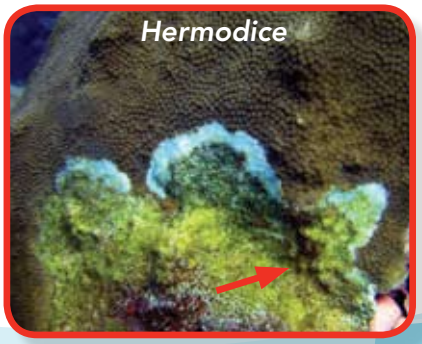
- Snails (*Coralliophilia*) and fireworms (*Hermodice*) are most common invertebrate predators in Caribbean.
- Sea urchins accidentally feed on coral while grazing nearby. Surveyors must carefully look around areas of recent coral tissue mortality and try to find potential predators.

Commonly confused with:

- White band disease, white plague disease, white syndromes, bleaching and other white scars.

Key ID characteristics:

- Snail and fireworm scars show irregular edges devoid of tissue and no apparent skeletal damage. Area affected usually small with turf algal growth preceding recently denuded area. Edge may show strings of tissue or mucus. Not too many colonies affected, unless high densities of predators present. Common coral affected include *Montastraea, Acropora, Diploria* and *Colpophyllia.*



Colored Band Diseases
Black Band Disease (BBD)

- Discrete dark band or fuzzy, filamentous bacterial mat dominated by cyanobacteria at interface of live tissue and bare skeleton, sometimes overlapping live tissue.
- Band color can vary from black to reddish-brown.

Pathogen(s): *P. coralliticum, Disulfovibrio sp.* and *Beggiatoa sp.* and other bacteria.

Distribution: Wider Caribbean (1-25m).

Host range: 19 coral and 6 octocoral species (*Montastraea, Diploria, Siderastrea, Colpophyllia, Pseudoplexaura, Gorgonia,* etc).

Commonly confused with:

- Caribbean ciliate infections, dark spots disease, dark bands, etc.

Key ID characteristics:

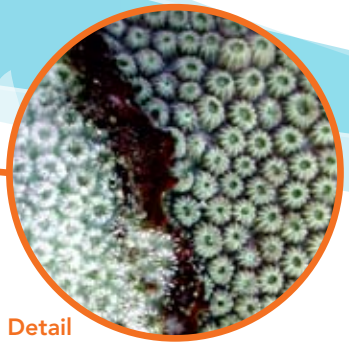
- Macroscopically, the fuzzy, black and white peppered, thread-like filamentous bacterial mat, the clean bare skeleton, and the distant, secondary algal growth.
- Microscopically, the thread like, filamentous cyanobacteria.

Rate of advance: Variable (1.5-40cm/mth).

Impact: Partial to total colony mortality.

Seasonality: Summer-Fall months.

Detail



Detail

Colored Band Diseases Caribbean Ciliate Infection (CCI)

- Dark, mostly spotted, scattered or dense band formed of ciliates that could lag behind disease (WPD or CYBD) edge or be intermingled with live tissue.

Pathogen(s): Foliculinid ciliates (*Halofoliculina sp.*).

Distribution: Wider Caribbean (1-20m).

Host range: 22 coral species (*Montastraea, Diploria, Agaricia, Acropora, Dichocoenia,* etc) and *Millepora*.

Commonly confused with:

- Black band disease, dark bands.

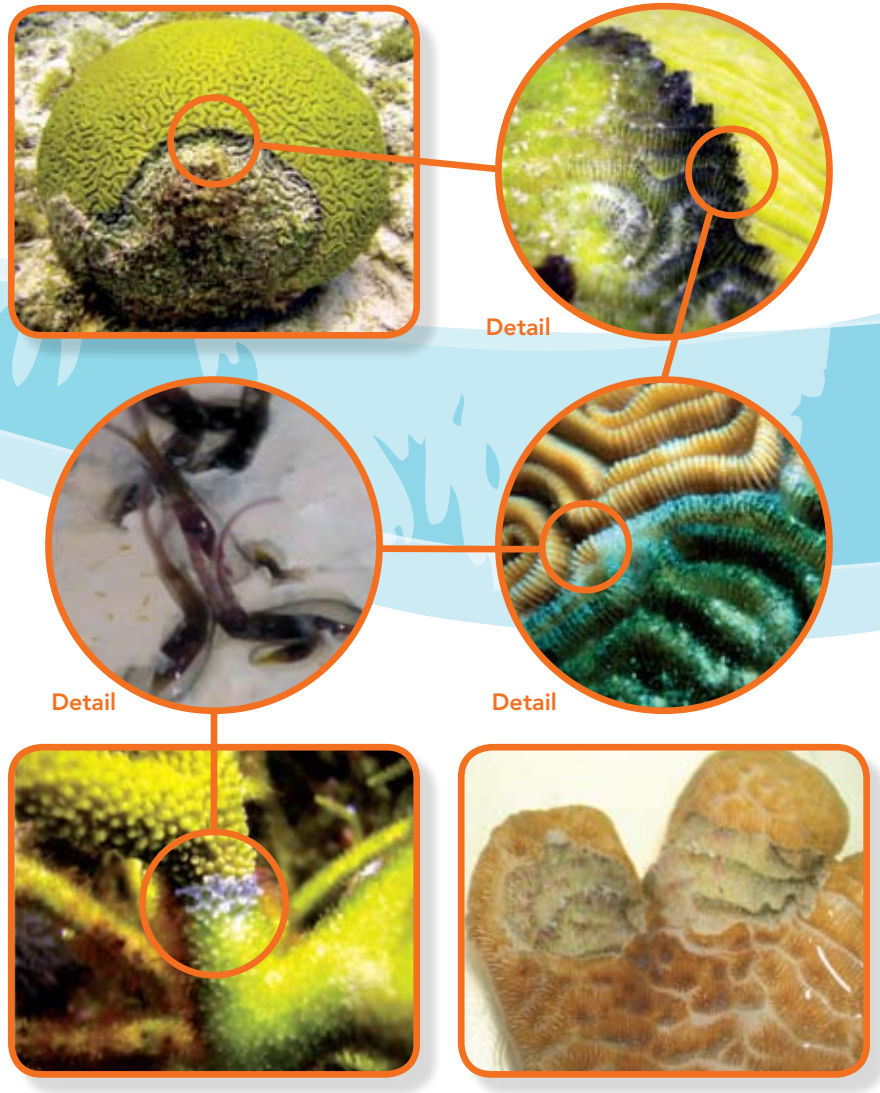
Key ID characteristics:

- Appearance might vary, from few, dark spots to a discrete, black band of varying width.
- When looked at closely, the tiny, individual dark ciliates can be seen.

Rate of advance: Unknown but generally slow.

Impact: Slowly kills tissues and colonies over time.

Seasonality: None.



Colored Band Diseases Aspergillosis (ASP)

- An octocoral disease, most commonly found on sea fans (***Gorgonia ventalina***). Purple or colored areas (host reaction) around dead tissue and exposed endoskeleton.

Pathogen: the fungus ***Aspergillus sydowii***. Other species of this genus might be involved.

Distribution: Wider Caribbean (0-30m).

Host range: 10 octocoral species (***Gorgonia, Pseudoterogorgia, Plexaura, Plexaurella***).

Commonly confused with:

- Other purple pigmentation responses produced by predation, competition, mechanical injuries, other pathogens.

Key ID characteristics:

- The purple bands/areas on the sea fan blade around the infected areas. Coloration is a host response.
- With magnifying lens, fungal hyphae (filaments) might be seen in infected tissues.

Rate of advance: Usually slow, 0.5cm/mth.

Prevalence: Variable (0.1%-30%).

Seasonality: All year.

Impact: From partial tissue loss to total colony mortality over time.

Colored Band Diseases
Purple Spots (PS)

- Infections appear as small purple dots of similar size all over the colony. Purple areas produced by the host response to the pathogens.

Pathogen(s): Protozoan (unknown Labyrinthulomycote). Small hydrozoan produce similar spots.

Distribution: Caribbean, few reports from Florida, Mexico and Puerto Rico (3-20m).

Host range: The sea fan *Gorgonia ventalina* and other octocorals.

Commonly confused with:

- Aspergillosis or other pigmentation responses.

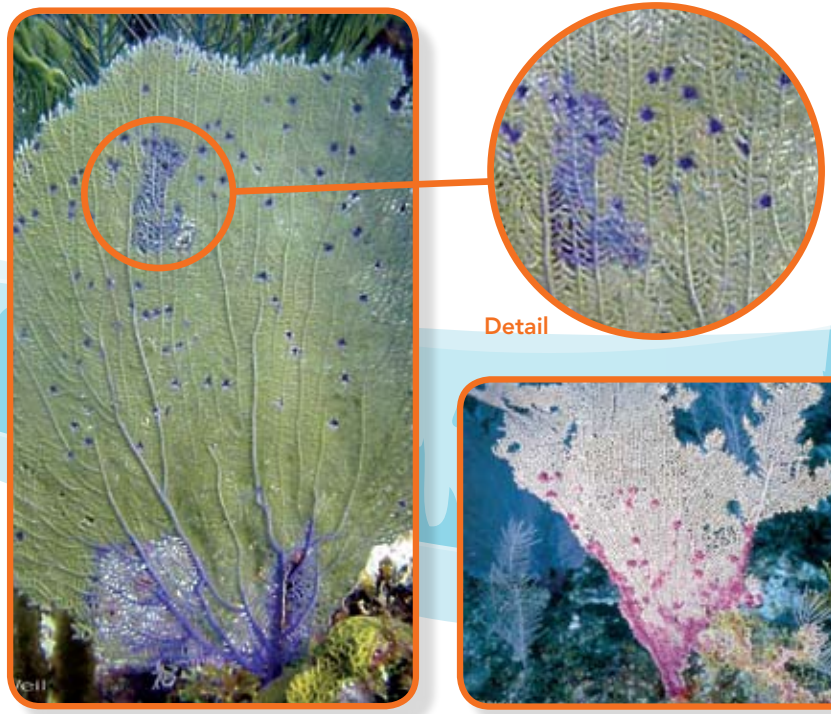
Key ID characteristics:

- Typically small uniform purple dots spread over the blade of the sea fan.

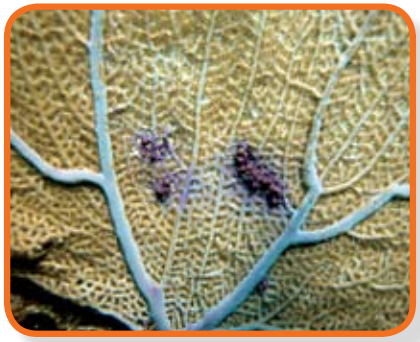
Prevalence: Low, no data available.

Seasonality: Unknown.

Impact: No apparent mortality of significant areas.



Detail



Colored Band Diseases
Red Band Disease (RBD)

- Red/maroon band of mostly cyanobacteria that kills tissue leaving bare skeletal areas in both octocorals and hard corals.

Pathogen(s): Cyanobacteria (*Oscillatoria* spp.), sometimes *Schizothrix* spp.

Distribution: Wider Caribbean (4-20m).

Host range: 13 octocoral spp. (*Gorgonia, Plexaura,* etc.), and few corals.

Commonly confused with:

- Black band disease.

Key ID characteristics:

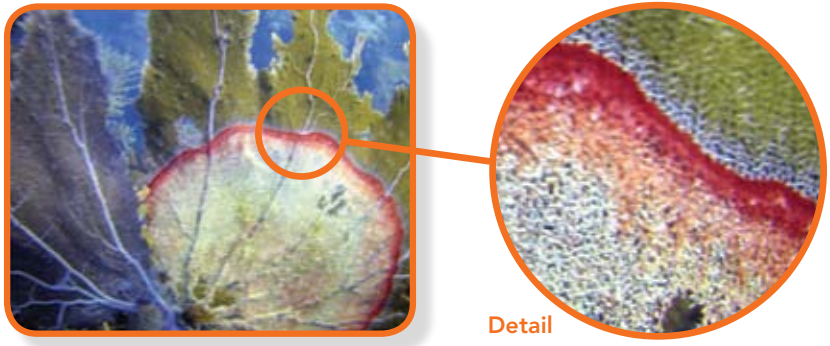
- Red band looks fuzzy and filamentous and is usually clear in seafans but not in other octocorals or hard corals, where it might be darker and more compact.

Rate of advance: Intermediate, 2-5cm/mth over *G. ventalina*.

Prevalence: Low.

Seasonality: Mostly during Summer and Fall.

Impact: From partial tissue loss to total colony mortality over time.



White Band Disease (WBD)

- Band of white, exposed skeleton or bleached tissue separates healthy coral tissue from algal colonized skeleton. It can range from a few mm to several cm wide.

Pathogen: Bacterium – *Vibrio charchariae* and possibly other vibrios.

Distribution: Caribbean, Gulf of Mexico, Florida and Bahamas (0-20m).

Host range: Acroporids (*Acropora palmata, A. cervicornis* and the hybrid *A. prolifera*).

Commonly confused with:

- Bleaching, white plague, white pox, other white syndromes and predation by snails and fireworms.

Key ID characteristics:

- Wide band of clean skeleton separates edge of tissue from algae colonized skeleton. Sometimes tissue strings and pieces sloughing off at the interface, usually not observed in predation.

Rate of advance: Usually fast, 0.5-10cm/day.

Prevalence: Highly variable (<1%-30%).

Seasonality: Summer-Fall.

Impact: Partial and whole colony mortality.

White Plague (WP)

- Wide band of white, exposed skeleton borders sharp edge of healthy coral tissue. Gradient of algal colonized skeleton in denuded skeleton.

Pathogen: Bacterium – *Aurantimonas coralicida*.

Distribution: Wider Caribbean (1-30m).

Host range: 42 coral species and *Millepora complanata* (*Montastraea, Colpophyllia, Diploria, Mycetophyllia, Dendrogyra, Stephanochoenia, Siderastrea* etc).

Commonly confused with:

- Bleaching, other white syndromes and predation by snails, and fireworms.

Key ID characteristics:

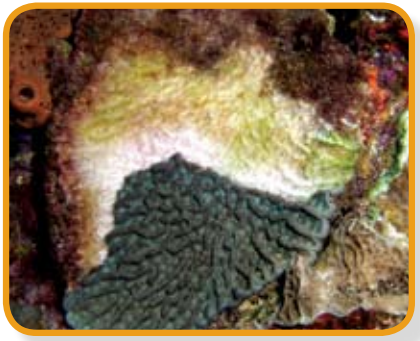
- Fast advancing, wide white band starts at interface with sediment at base of colony, from depressions and crevices over the colony, and from underneath *Halimeda* algal mats in contact with live tissue. Tissue "dissolves" fast, no strings or pieces sloughing off infected area. Sharp edge.

Rate of advance: Variable but fast (1-10cm/day).

Prevalence: Variable (<1%-25%).

Impact: Second most damaging disease, significant fast partial and colony mortality.

Seasonality: Outbreaks usually during Summer-Fall.



White Patch Disease (WPA)

- Also termed "white pox", "acroporid serriatosis" and "patchy necrosis". Irregular patches of tissue-free skeleton on ***A. palmata*** colonies. Varying sizes. Fast tissue resheeting may seal the lesion shortly after the injury was produced.

Pathogen: Bacterium – ***Serratia marcenses*** for white pox cases in Florida colonies. Others Unknown.

Distribution: Gulf of Mexico, Florida, Bahamas and Caribbean.

Host range: *Acropora palmata*.

Commonly confused with:

- Bleaching, white band disease, white plague, other white syndromes, tissue loss by apoptosis, and predation by snails and damselfish.

Key ID characteristics:

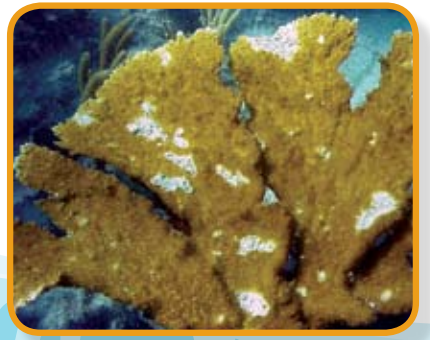
- Irregularly shaped, white tissue-free areas of different sizes over the colony with or without tissue bits sloughing over the injured area or at interface with live tissue area.

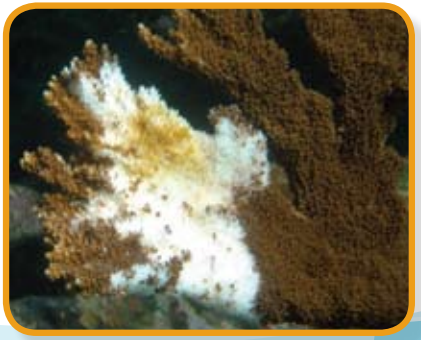
Rate of advance: Fast (2.5-3cm/day).

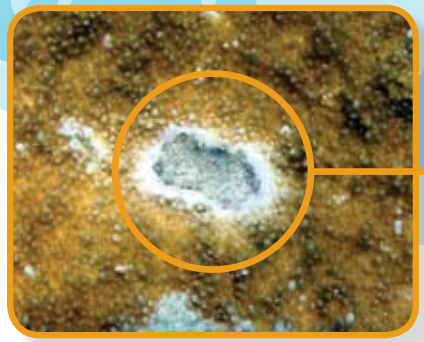
Prevalence: Variable (<1%-15%) during outbreaks.

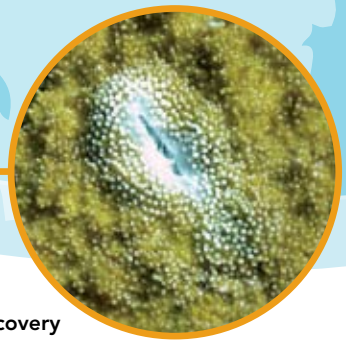
Impact: High proportion of tissue loss during outbreaks. Rarely kill the entire colony.

Seasonality: Summer-Fall with short-time outbreaks.

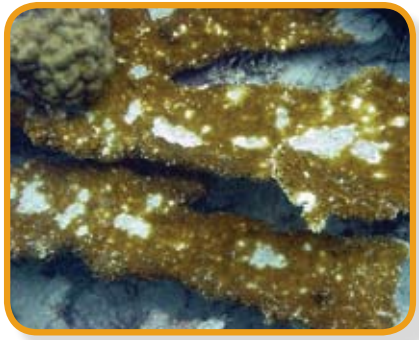


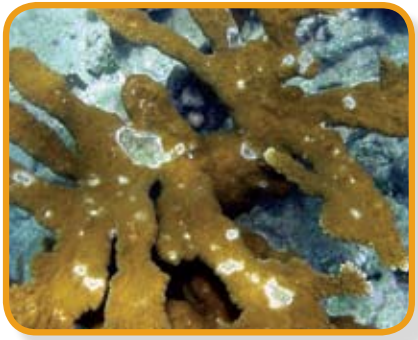






Recovery





Caribbean White Syndromes (CWS)

- Diffuse patterns of tissue loss exposing bands, patches or irregular shapes of bare skeletal areas in contact with live tissue. May appear anywhere on the colony.
- Coloration gradient indicating different stages of algal colonization.

Pathogen(s): Unknown.

Distribution: Wider Caribbean (3-20m).

Commonly confused with:

- White plague, white band or tissue loss by apoptosis, predation from snails or fireworms.

Key ID characteristics:

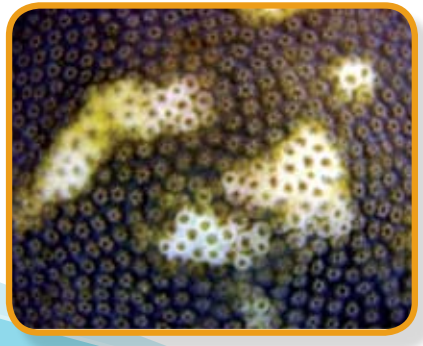
- Irregular patterns of tissue loss or whitening, focal origins in some cases. Could affect any areas of the colony, spreading from the focal origin.

Rate of advance: Variable.

Prevalence: Variable but generally low.

Impact: Low, with partial to total colony mortality.

Seasonality: Summer-Fall with short-time outbreaks.



Bleaching (BL)

- Focal, multifocal-to-coalescing, or irregular areas of tissue discoloration due to the loss or reduction in the number of endosymbiotic algae (zooxanthellae) from coral tissue.
- The degree of bleaching can vary from pale to white.
- Tissue is present, but with reduced (pale) or absent pigmentation.

Cause: Associated with higher than normal water temperatures, high UV, high sedimentation and turbidity, cold water snaps, etc.

Distribution: Wider Caribbean (1-45m).

Commonly confused with:

- White plague, white band or tissue loss by apoptosis, white patch disease, other white syndromes, and predation from snails or fireworms.

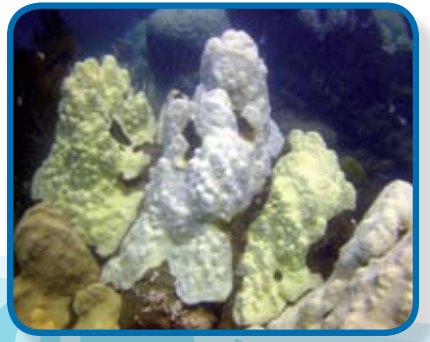
Key ID characteristics:

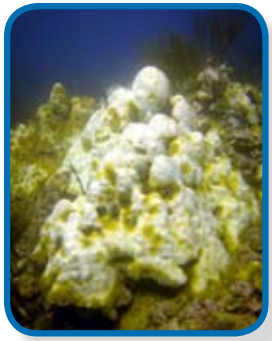
- Tissue always present in discolored (bleached) areas (compared with diseases).
- After some time, bleached tissue may be associated with irregular patterns of partial or whole colony tissue loss.

Prevalence: Variable and low (background bleaching= <1%) to high (80%) in warm water years.

Seasonality: Summer-Fall and could extend through Winter-Spring.

Impact: Partial to total coral mortality depending on intensity and duration.





Dark Spots Disease (DSD)

- Dark colored irregular or round spots, patches or bands of variable sizes where skeletal and tissue area could be depressed.

Pathogen: Unknown.

Host range: 16 coral species, most common in *Siderastrea, Montastraea, Colpophyllia* and *Stephanocoenia.*

Distribution: Wider Caribbean (0-40m).

Seasonality: Variable but most common in Summer-Fall.

Commonly confused with:

- Compromised health problems, other dark responses.

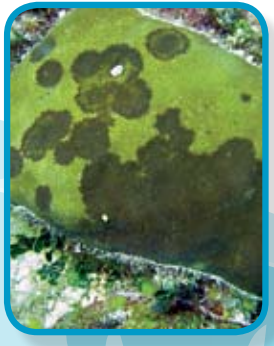
Key ID characteristics:

- Tissue always present in darker areas. These areas are usually depressed.
- Distribution over the colony is not regular and number of spots/areas may vary over time.
- Most common species affected include *S. siderea, M. faveolata* and *S. intersepta.*
- *S. intersepta* is only affected in the southern Caribbean.

Prevalence: Variable and low (<1%) except on outbreaks (36%).

Seasonality: Summer-Fall but could extend through Winter-Spring.

Impact: Usually limited partial mortality over long periods of time.



Caribbean Yellow Band Disease (CYBD)

- Pale, yellow or white area that develops into rings of 1-5cm wide bands that grow outward killing coral tissue. Multiple focal areas in same colony may coalesce.

Pathogen: *Vibrio* complex. May be a disease of the zooxanthellae.

Host range: 11 coral species (*Montastraea, Colpophyllia, Diploria*).

Distribution: Wider Caribbean (5-20m).

Commonly confused with:

- Bleaching, white plague, other white syndromes and predation.

Key ID characteristics:

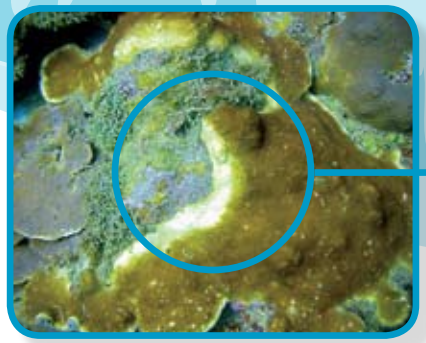
- Multifocal yellow/white tissue colored spots, concentric rings, or bands at the colony edges. May show color gradient within band. Width of yellow band spatially and seasonally variable (1-10cm).
- *Montastraea* is the most common genus affected. Other species are rarely affected.

Rate of advance: Variable (0.5-4cm/mth).

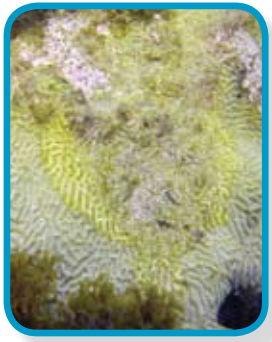
Prevalence: highly variable (<1%-60%).

Seasonality: Summer-Fall but could extend through Winter-Spring.

Impact: Partial to total colony mortality. Most widespread and damaging coral disease.



Detail



Growth Anomalies (GAN)

- Tumor-like structures growing on surface of coral/octocoral colonies that usually show minor coloration changes or bleaching. Calical structure may or may not change.
- Invertebrate galls are produced by encroaching skeletal matrix around individual endolithic or invertebrate epibionts living in/on the coral skeleton (polychaetes, sypunculids, fungi, crabs, shrimp, algae, etc).
- Unexplained growth anomalies might be caused by endolithic algae, fungi, protozoans, virus or genetic mutations.

Host range: Several coral species (*Montastraea, Colpophyllia, Diploria, Acropora*) and octocoral spp. (*Gorgonia, Pseudoplexaura, Plexaura, Plexaurella*).

Distribution: Wider Caribbean (2-25m).

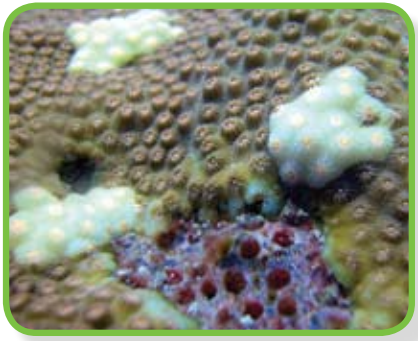
Commonly confused with: N/A

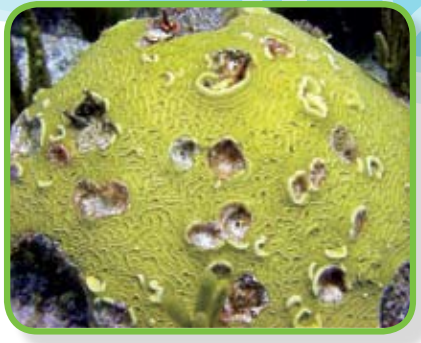
Key ID characteristics:

- Fast growing areas on colony surface with enlarged but otherwise not changed skeletal structures (hyperplasias) or uncharacteristic growth areas with significant lost of calical and skeletal structures (neoplasias).
- Coloration could vary or area might be bleached.

Prevalence: Highly variable (<1%-12% in some octocoral species).

Impact: Usually no mortality associated.





Compromised Health in Hard Corals (CHC)

- Unhealthy looking tissues with clear signs of recent mortality. Forms spots, bands, rings and irregular areas of different sizes and shapes.

Pathogen(s): Unknown.

Host range: 16 species of corals (*Montastraea, Siderastrea, Agaricia, Diploria, Dendrogyra, Mycetophyllia*).

Distribution: Wider Caribbean (2-25m).

Commonly confused with:

- Other disease problems such as white syndromes, dark bands, dark spots, Caribbean yellow band, etc.

Key ID characteristics:

- Unhealthy looking tissue usually at edge or around rings of dead, algae-recolonized areas over the colony. Some species show pigmentation responses.
- Tissues usually sloughing off the skeletal structure and sometimes a dark band of bacteria might be found (similar to atramentous necrosis in the IP).

Rate of advance: Unknown but low and variable.

Prevalence: Low.

Seasonality: No apparent seasonality.

Impact: Partial to total colony mortality.

Compromised Health in Octocorals (CHO)

- Unhealthy looking tissues with clear signs of recent mortality or "necrosis". Forms bands, focused or sparse spots or irregular areas of different sizes.

Pathogen(s): Unknown, might be caused by pathogens or environmental stress.

Host range: At least 6 species of octocorals.

Distribution: Wider Caribbean (2-20m).

Commonly confused with:

- Other disease problems in octocorals, aspergillosis.

Key ID characteristics:

- Unhealthy looking tissue usually showing signs of mortality and clean bare endoskeleton is exposed. Polyps retracted in affected areas and interphase and healthy-looking area may show pigmentation response. Tissues might be sloughing off the branches.

Rate of advance: Unknown but low and variable.

Prevalence: Low.

Seasonality: No apparent seasonality.

Impact: Partial to total colony mortality.

Competition Overgrowth (CO)

- Direct (contact) competitive interactions for substrate are common in sessile reef invertebrates. Indirect (shadowing, allelopathy, etc) and direct (aggression) competition might produce physiological stress and unhealthy tissue signs. Could produce tissue mortality, pigmentation responses and/or unhealthy looking tissues in one or both competing species.

Distribution: Wider Caribbean (2-25m).

Commonly confused with:

- Could produce signs that might be confused with other disease problems.

Key ID characteristics:

- Contact area between different species or colonies of the same species show stress signs manifested as discoloration or pigmentation, tissue sloughing, tissue mortality, etc. Many different interaction in coral community, most common between corals, between corals and sponges, corals and zoanthids, corals and algae, corals and cyanobacteria, etc. Very localized and not spread out over the community. Sponges and zoanthids might overgrowth and kill coral tissue underneath.

Rate of advance: Unknown but low and variable.

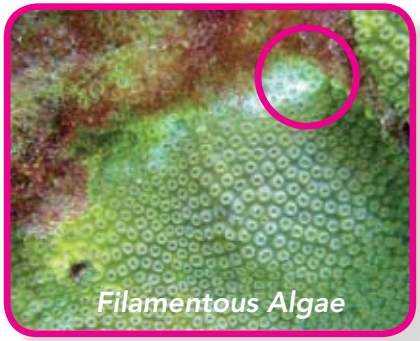
Prevalence: Variable.

Impact: Partial to total colony mortality.

Endolitic Sponge

Endolitic Sponge

Cyanobacteria


Filamentous Algae

Cyanobacteria

Coralline White Band Syndrome (CWBS)

- A thin (0.2-0.5cm) white band slowly advancing and leaving dead tissue areas that are quickly recolonized by algae. Rings may develop and coalesce producing irregular patterns.

Pathogen(s): Unknown, sometimes protozoans are associated with band, but maybe as opportunistic, secondary parasites.

Host range: At least three different crustose coralline algae affected (*Neogoniolithon, Lithophyllum, Titanoderma*).

Distribution: Wider Caribbean (2-25m).

Commonly confused with:

- Only white band observed on CCA.

Key ID characteristics:

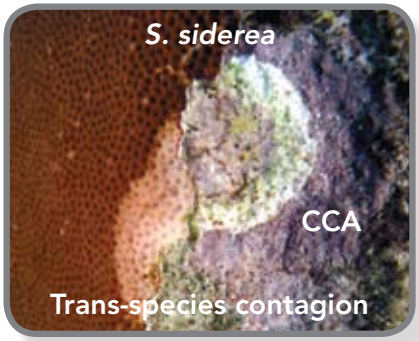
- White band is characteristically conspicuous against the light purple background of CCA.

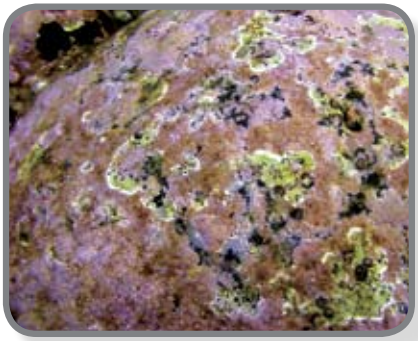
Rate of advance: 0.2-0.7cm/mth.

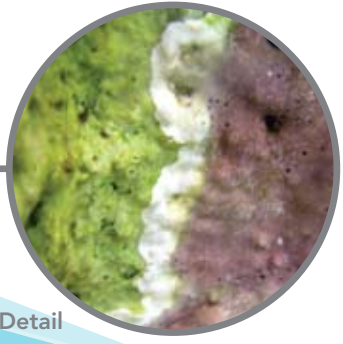
Prevalence: Highly variable, low (<1%) to high (>20%) during outbreaks.

Seasonality: No apparent seasonality.

Impact: Partial to total colony mortality. Kills large numbers of coralline algae colonies every year.







Other Reef Organisms – Sponges

- Several species of sponges are showing signs of disease throughout the Caribbean.
- Colonies show bands or areas of necrotic, sloughing tissue and exposed protein/ spicule matrix.

Pathogen(s): Unknown.

Host range: Several species in different genera (***Xetospongia, Amphimedon, Cliona***, etc).

Distribution: Wider Caribbean (2-25m).

Commonly confused with: N/A

Key ID characteristics:

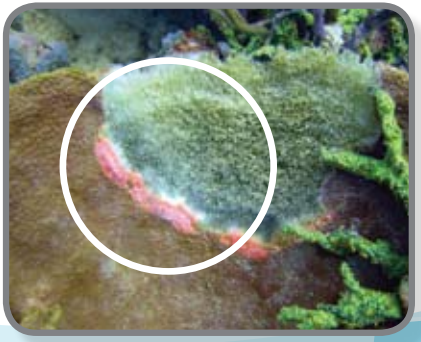
- Particular characteristics vary across species. *Cliona* shows unhealthy looking ("necrosis") tissue that sloughs off, leaving white, clean, exposed calcium carbonate. *Xetospongia* shows unhealthy tissue that disintegrates leaving internal matrix exposed, and then it collapses.
- Other crustose sponges show yellow bands or rings that spread out killing tissues.

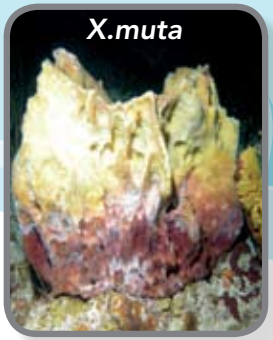
Rate of advance: Not known but variable. Some large ***X. muta*** colonies could get killed in less than a month.

Prevalence: Highly variable, low (<1%) to high (>20%) during outbreaks.

Seasonality: Mostly Summer-Fall.

Impact: Partial to total colony mortality.





Other Reef Organisms – Zoanthids & Hydrocorals

- Unhealthy looking tissues showing signs of physiological stress (disease) with clear signs of recent mortality. Form spots, bands, rings and irregular areas of different sizes.

Pathogen(s): Unknown – might be caused by pathogens or environmental stress.

Host range: At least two species of zoanthids *Palythoa* and two milleporids (*Millepora complanata*).

Distribution: Wider Caribbean (2-20m).

Commonly confused with:

N/A

Key ID characteristics:

- Unhealthy looking tissue usually at edge or center of colonies in both zoanthids and hydrocorals.
- In *Palythoa caribaeorum*, white areas with polyps retracted deeply and/or dissolution of individual calices leaving plain, flat area.
- White, bleached or dead area on blades of *Millepora complananta* are colonized by algae CCA, which might indicate a competition problem.

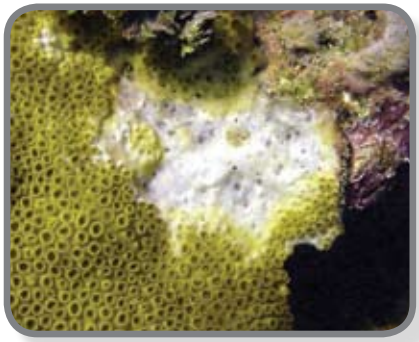
Rate of advance: Unknown but low and variable.

Prevalence: Low.

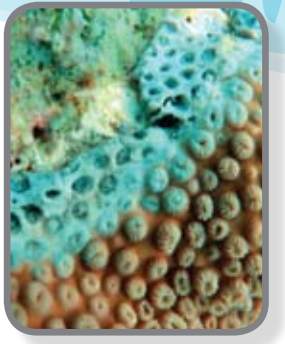
Seasonality: No apparent seasonality.

Impact: Partial to total colony mortality.

Zoanthid



Hydrocoral



Underwater Cards –
Options for Recording & Reporting Observations of Coral Disease

Qualitative observations of coral disease

At the simplest level, it is useful to photograph and/or record details of corals that are diseased or show signs of compromised health. The following data could be recorded:

Date & Recorder: _____

Site/Habitat/Depth: _____

Disease/compromised health sign: _____

Growth form/Genus/species of coral: _____

Photo name(s) & number(s): _____

Additional observations (e.g. #corals/species affected): _____

_____

Quantitative assessment of coral disease

Disease prevalence: The number of disease colonies and the total number of healthy corals per unit area gives a measure of disease prevalence. This is a better, but more time consuming way of quantifying disease than estimating disease abundance.

1. Select an appropriate sampling unit (e.g. 10m x 2m belt transect);
2. Select appropriate replication (e.g. 3-5 transects per depth interval or habitat and three habitats per reef site and 3 reefs per zone);
3. Record all corals showing signs of disease or compromised health and all healthy corals. Use formatted data sheets;
4. Calculate mean (± SE) percent of corals that are diseased per habitat, reef and/or zone.

Disease abundance: A simpler way of recording the number of cases of disease per unit area without recording all healthy corals gives a measure of disease abundance. Same method as prevalence but without recording all healthy colonies.

Disease incidence/recovery: Tagging and monitoring the number of diseased corals in a given area through time identifies the number of new cases of disease and the recovery colonies per unit time. It provides a measure of **disease incidence** or spread throughout the population and **population recovery**.

1. Select an appropriate area (e.g. 10m x 10m quadrat);
2. Select appropriate replication (e.g. 3 quadrats per habitat or reef site);
3. Tag and map all diseased colonies within each quadrat;
4. Monitor quadrats regularly (e.g. weekly during outbreaks or monthly), counting and tagging all new cases of disease and checking old cases;
5. Calculate mean (± SE) # of new diseased and recovered colonies per unit time.

Disease progression: Tagging and photographing corals through time enables rates of disease progression across corals to be calculated.

1. Tag several (>10) diseased colonies/species at study site;
2. Photograph each diseased coral with a scale bar and at a standard angle - a tag or a nail could be used as a reference point;
3. Re-photograph tagged corals at regular intervals (e.g. weekly or monthly);
4. Measure linear spread of disease front or progressive area of tissue loss from images;
5. Calculate mean (± SE) rate of disease progression.

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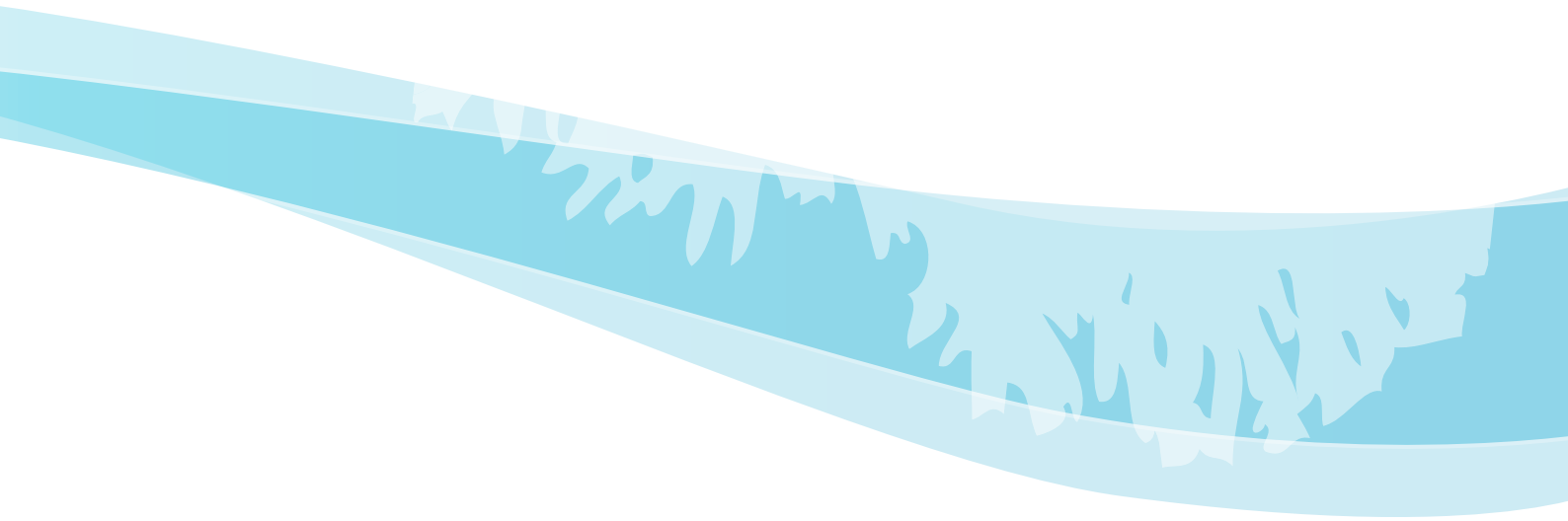

Name:

Date:

Reef:

				Tissue Loss												
				Predation				Non-Predation (i.e. Disease)								
								Colored Band Diseases					Non-Distinct Bands			
Genus	Species	Healthy	Unknown	COR	FISH	HER	Other	BBD	CCI	ASP	PS	RBD	WBD	WPD	WPA	WS
Acropora	*A.cervicornis*															
	A.palmata															
Montastraea	*M.faveolata*															
	M.annularis															
	M.franksi															
	M.cavernosa															
Siderastrea	*S.siderea*															
Stephanocoenia	*S.intersepta*															
Colpophyllia	*C.natans*															
Diploria	*D.strigosa*															
	D.labyrinthiformis															
Porites	*P. porites*															
	P.astreoides															
Undaria	*U.agaricites* (all)															
Agaricia	*A.lamarcki*															
Meandrina	*M.meandrites*															
Dendrogyra	*D.cylindrus*															
Mycetophyllia	*M.ferox*															
	M.aliciae															
Gorgonia	*G.ventalina*															
Erythropodium	*E.caribaeorum*															
Palythoa	*P.caribaeorum*															
Octocorals																
CCA																
Sponges																
Other																

GPS coordinates:

Depth (m) Ave: m

Depth (m) Max: m

Temp °C

Name:
Date:
Reef:

		Tissue Discoloration Bleaching			Non-White		Growth Anomalies		Compromised Health Competition		Other Reef Organisms			
Genus	Species	%	Focal	Other	DSD	CYBD	GAN	Unex	CHE	CO	CWBS	Other	Unk	Other
Acropora	*A.cervicornis*													
	A.palmata													
Montastraea	*M.faveolata*													
	M.annularis													
	M.franksi													
	M.cavernosa													
Siderastrea	*S.siderea*													
Stephanocoenia	*S.intersepta*													
Colpophyllia	*C.natans*													
Diploria	*D.strigosa*													
	D.labyrinthiformis													
Porites	*P. porites*													
	P.astreoides													
Undaria	*U.agaricites* (all)													
Agaricia	*A.lamarcki*													
Meandrina	*M.meandrites*													
Dendrogyra	*D.cylindrus*													
Mycetophyllia	*M.ferox*													
	M.aliciae													
Gorgonia	*G.ventalina*													
Erythropodium	*E.caribaeorum*													
Palythoa	*P.caribaeorum*													
Octocorals														
CCA														
Sponges														
Other														

GPS coordinates:

Depth (m) Ave: m

Depth (m) Max: m

Temp °C