# Monitoring  Reefs for
# Stony Coral Tissue Loss Disease

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Atlantic and Gulf Rapid Reef Assessment (AGRRA)
www.agrra.org

January 26, 2021

*With thanks and gratitude to our Caribbean colleagues*

AGRRA

ORE
Ocean Research & Education Foundation

MPA connect

A network for learning among Caribbean marine resource managers

# How to  identify abnormal corals, evaluate disease signs and distinguish SCTLD*



*Stony coral tissue loss disease*

*25+ susceptible species*

*\* See A. Brukner, Sept. 15, 2020  MPA Connect Webinar*

# Coral SCTLD stages (invasion, outbreak, endemic)



| **Invasion** | **Outbreak** | **Endemic** |
|---|---|---|
| 1 - 7 months (often <3 months) | 3 months - 1 year | 1 - 4+ years |

**Disease Prevalence**

| | | |
|---|---|---|
| Low. Acute lesions in species most susceptible | High. Acute lesions in all suscptible species | Low. Least susceptible corals with acute and chronic lesions |

**Coral Community**

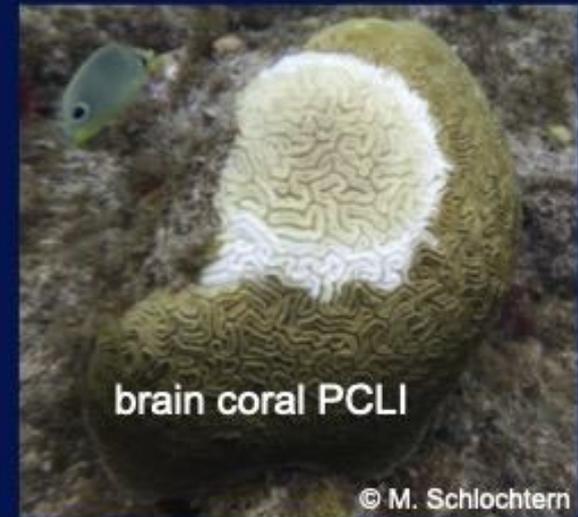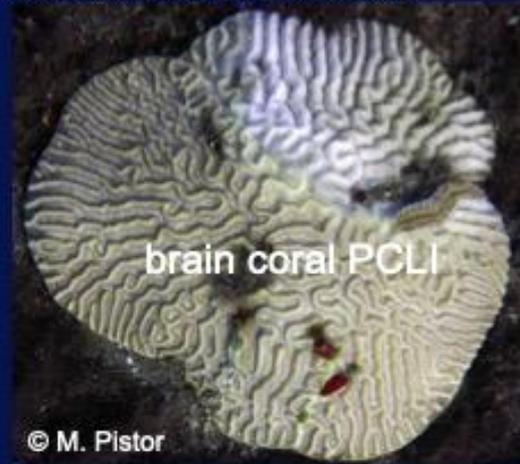| | | |
|---|---|---|
| All species still present; species most susceptible start dying | Rapid transition to many early susceptible, and then progressively less, susceptible species | Few or no susceptible species remain. Coral cover reduced; proportion of non-susceptible species has increased |

*From:  J. Lang, Sept. 15, 2020  MPA Connect*

Adapted from Neely, 2018

SCTLD: **Invasion Stage**
Any pillar, maze, or perhaps some brain, corals will start to die...

pillar coral DCYL

© A. Zimmermann

maze coral MMEA

© A. Zimmermann

brain coral PSTR

massive starlet coral SSID

© A. Acosta

...any massive starlet corals may also be dying–*or they may not !*

*From: J. Lang, Sept. 15, 2020 MPA Connect Webinar*

SCTLD: Invasion₋₂/Outbreak may Start

Most brain corals also start to die.

brain coral CNAT
© E. Hernandez

brain coral PCLI
© M. Pistor

brain coral PCLI
© M. Schlochtern

brain coral PSTR
© M. Soto

Lettuce corals and smooth flower corals may die– *or may not yet die.*

lettuce coral AAGA

flower coral EFAS
© M. Pistor

*From: J. Lang, Sept. 15, 2020 MPA Connect Webinar*

# SCTLD: Invasion$_{-3}$/Outbreak started

Any star and great star corals start
to die; if more susceptible corals
are present, many will be dying


lobed star coral OANN
© B. Charpentier


great star coral MCAV
© M. Soto


brain coral DLAB
mountainous star coral OFAV
© A. Zimmermann

*From: J. Lang, Sept. 15, 2020 MPA Connect Webinar*

# Endemic Stage Photos

Grim, but some corals recruit to the newly exposed surfaces of the dead corals

© K. Marks

# If SCTLD is suspected

## Take close-up and scenery-scale photos



maze coral MMEA
© A. Zimmermann

brain coral
maze coral
© J. Townsend

**Report:** to AGRRA at
www.agrra.org/coral-disease-outbreak
and to your local reporting networks.

brain coral

great star coral
© G. Halpern

## Inform
your local governmental personnel
your local networks, MPA Connect and AGRRA

MPAConnect  materials provide guidance when SCTLD is confirmed, e.g.:

Monitor its spread within and between corals and reefs

Educate others

Dive responsibly

Decontaminate dive gear

*See* www.gcfi.org/emerging-issues-florida-coral-disease-outbreak/



MPAConnect guide to detect
**Stony Coral Tissue Loss Disease on Caribbean coral reefs**

MPA connect
A partnership between:
GCFI — Gulf and Caribbean Fisheries Institute
NOAA CORAL REEF CONSERVATION PROGRAM

**Total loss of affected tissue**
Bare skeleton with no tissue
Sloughing away of tissue

**Be Alert!**
A new coral disease is causing high mortality of stony corals
Cause is unknown but it is water-borne and may spread via direct contact
Take care not to confuse with other coral diseases, bleaching or fish bites
Correct field diagnosis depends on multiple factors

**Highly susceptible species**
1
*Meandrina meandrites*
*Eusmilia fastigiata*
*Dendrogyra cylindrus*
*Dichocoenia stokesii*
2
*Pseudodiploria clivosa*
*Diploria labyrinthiformis*
*Colpophyllia natans*
*Pseudodiploria strigosa*
3
*Orbicella species*
*Montastrea cavernosa*
*Siderastrea siderea*

Typical order of infection

**Rapid spread**
Within one week to two months

**High prevalence and mortality**
Among susceptible species

~2–3% Normal background disease prevalence
66–100% Species-specific Stony Coral Tissue Loss Disease prevalence

**On coral colonies** Multiple lesions
Rapid mortality

**On dive sites** Rapid spread among corals

**What can managers do?**
1 Monitor highly susceptible species via roving diver surveys
2 Monitor sentinel sites weekly – old, large, healthy, spawning colonies
3 Monitor suspected cases every three days to weekly, take photos, note date and location
4 Inform your agency about new threat, seek contingency support, investigate supplies for treatment
5 Inform relevant stakeholders, encourage reporting
6 Prevent spread – wash dive gear in lots of fresh water and sun dry, disinfect survey tools, dive on clean sites before infected sites
7 Promote ballast water management, exchange ballast offshore and not on coral reefs
8 Seek training in protocols for treatment of priority corals

February 2019
Coral photography: K. Neely, Nova Southeastern University.
Graphic Design: ©2019 Deviate Design

Contact MPAConnect for advice and training mpaconnect@gcfi.org
For more information, see https://floridakeys.noaa.gov/coral-disease/
and https://www.gcfi.org/emerging-issues-florida-coral-disease-outbreak/

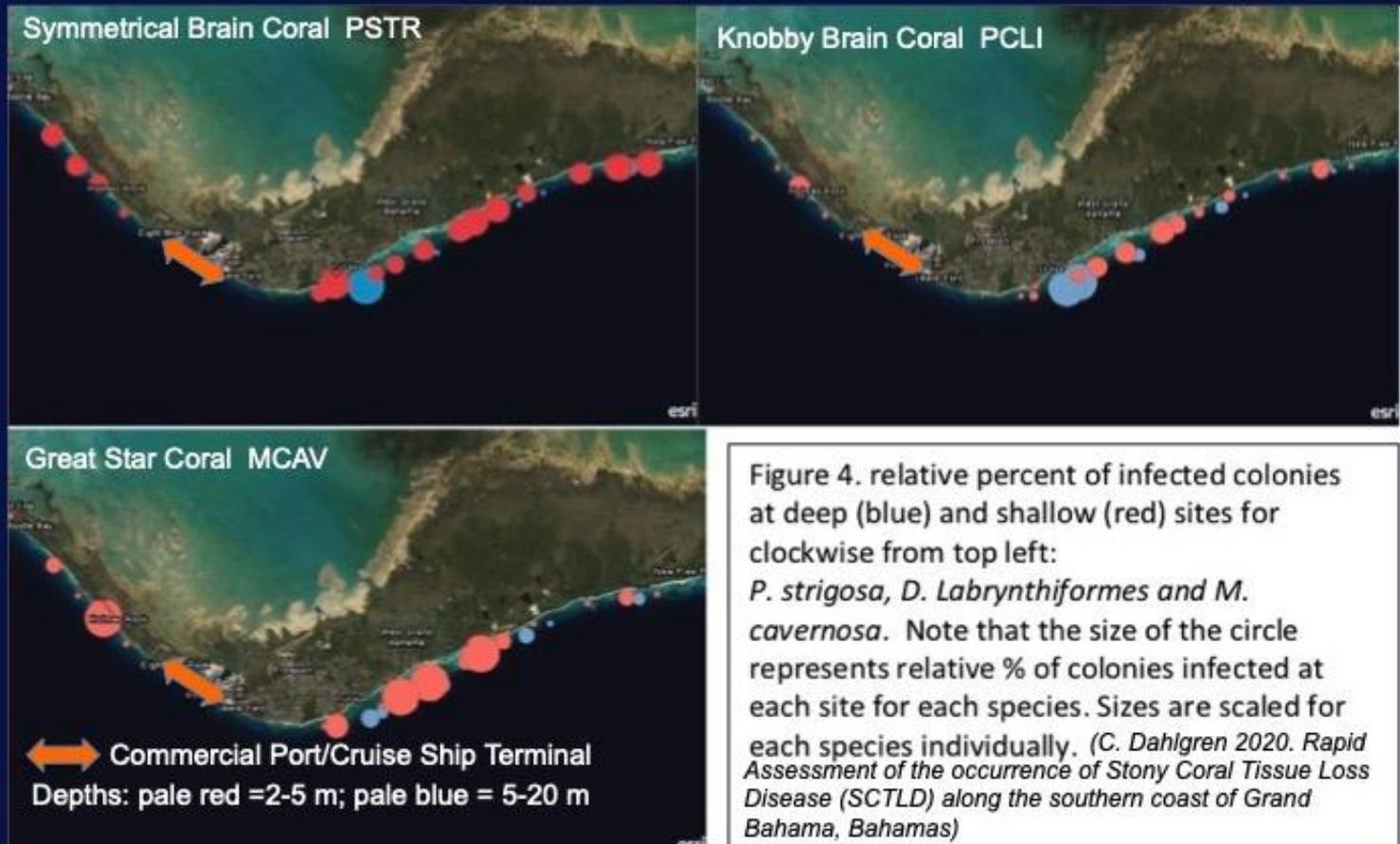# If SCTLD is present, quickly approximate the <u>spatial extent of the disease.</u>

On linear reefs, can conduct "spot checks," or manta tows if time allows, at intervals away from discovery site (red below), or away from areas of particular concern.



From C. McCoy et. al. 2020. Research Project Summary:
Addressing the Threat of SCTLD in the Cayman Islands
Figure 5: Grand Cayman SCTLD manta-tow survey results.

*From J. Lang, Sept. 15, 2020  MPA Connect Webinar*

# If SCTLD is present, quickly approximate the spatial extent of the disease.



On patchy reefs, can conduct spot checks, or rover diver surveys if time allows, away from discovery site or an area of concern (⟷).

Symmetrical Brain Coral  PSTR

Knobby Brain Coral  PCLI

Great Star Coral  MCAV

⟷  Commercial Port/Cruise Ship Terminal
Depths: pale red =2-5 m; pale blue = 5-20 m

Figure 4. relative percent of infected colonies at deep (blue) and shallow (red) sites for clockwise from top left:
*P. strigosa, D. Labrynthiformes and M. cavernosa.* Note that the size of the circle represents relative % of colonies infected at each site for each species. Sizes are scaled for each species individually. *(C. Dahlgren 2020. Rapid Assessment of the occurrence of Stony Coral Tissue Loss Disease (SCTLD) along the southern coast of Grand Bahama, Bahamas)*

*From Sept. 15, 2020  MPA Connect Webinar*

Prepare to conduct species-level surveys of the prevalence  of SCTLD  (= percent of corals with SCTLD at the time of the survey).

Use local knowledge (fishers, industry and recreational divers) of the locations of :

- particularly susceptible corals, especially if naturally rare and/or iconic;
- most important reef framework builders; and
- MPAs and other areas of value *(e.g.,* as natural breakwaters, for tourism or recreation).
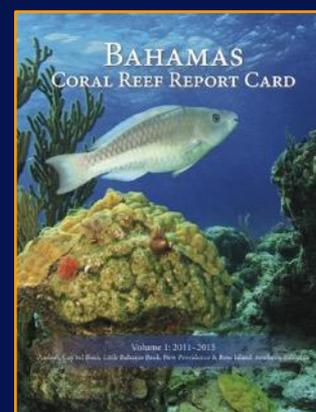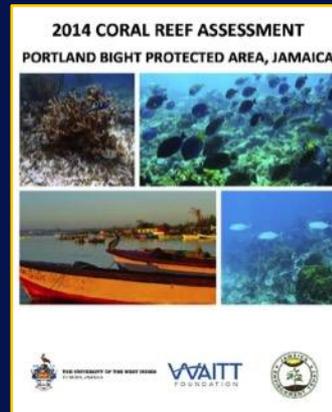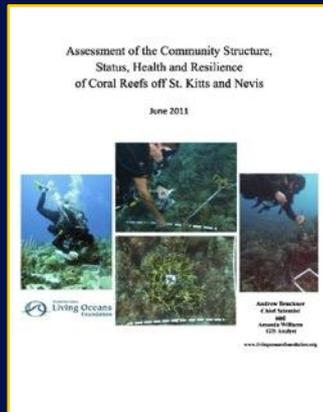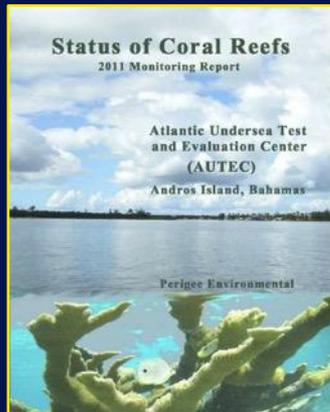


some AGRRA reports

Also use any surveys or reports with species-level coral data *(e.g.*, AGRRA, CARICOMP, GCRMN).

*Text after J. Lang, Sept. 15, 2020  MPA Connect Webinar*

# Value of prior species-level data
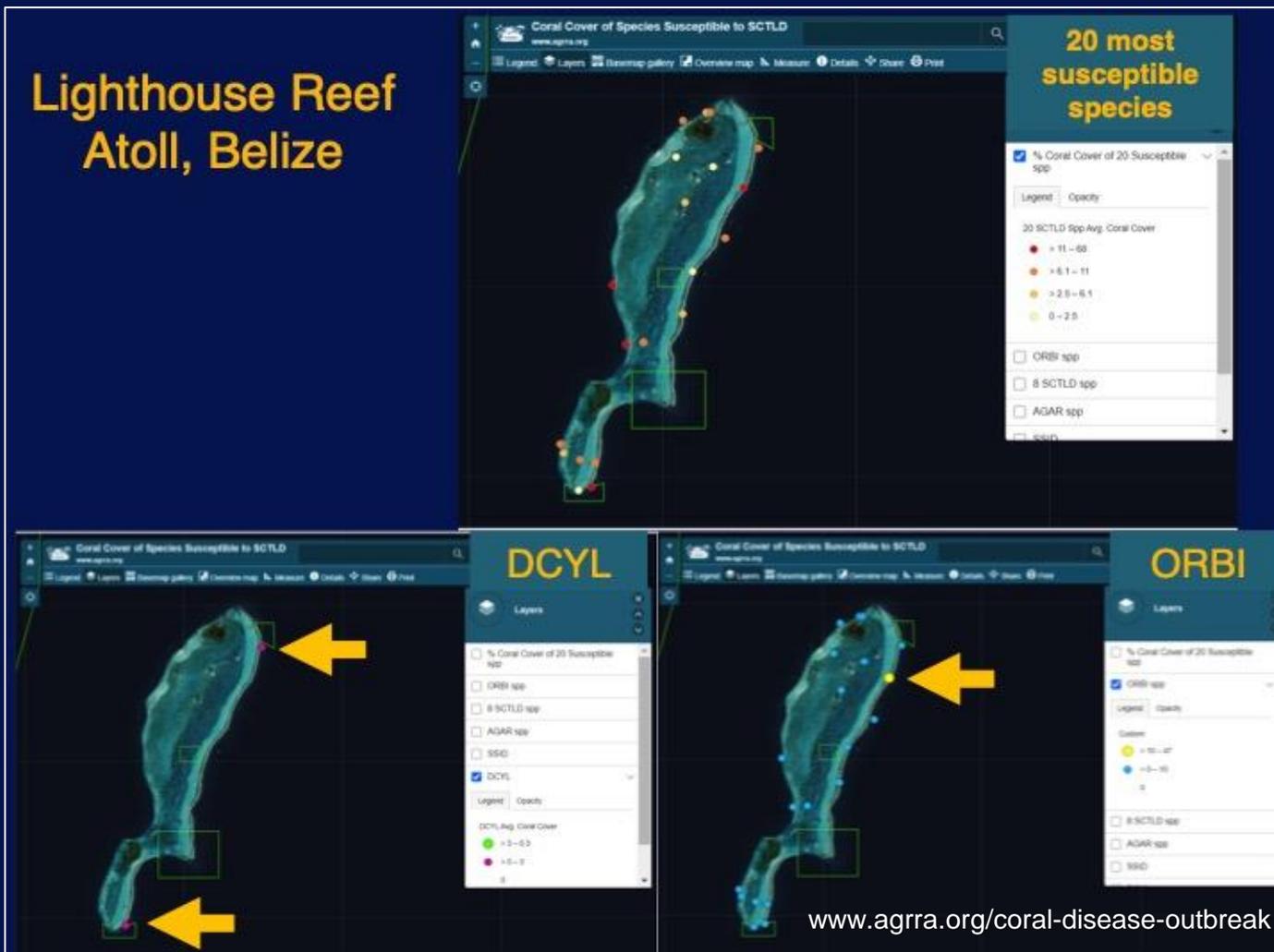


Maps show abundances of 20 most susceptible of the SCTLD species, and abundances of DCYL (pillar coral) and ORBI (star corals), for AGRRA sites at Lighthouse Atoll before SCTLD invaded in 2020.

*From Sept. 15, 2020  MPA Connect Webinar*

# Before starting to survey for SCTLD


© A. Zimmermann

Select sites:  e.g.
 "repeat random" &/or
  strategic (with SCTLD-susceptible or
  iconic corals, important reef builders,
  or reefs in MPAs and any other
  valuable areas) &/or
 "opportunistic" corals.

Chose a <u>survey method</u>: e.g., roving diver or bar-drop

Learn or review corals most likely to get SCTLD
by either their common or scientific names or scientific codes
(e.g., pillar coral = Dendrogyra cylindrus = DCYL).

Prepare slates,  data cards, any other needed equipment.

# Focus on susceptible corals*

| High Susceptibility | Intermediate Susceptibility | Presumed Susceptibility | Low/No Susceptibility |
|---|---|---|---|
| *Colpophyllia natans* (Boulder brain coral) | *Orbicella annularis* (Lobed star coral) | *Agaricia agaricites* (Lettuce coral) | *Porites astreoides* (Mustard hill coral) |
| *Dendrogrya cylindrus* (Pillar Coral) | *Orbicella* faveolata (Mountainous star coral) | *Agaricia* spp. (Plate / saucer corals) | *Porites porites* (Finger coral) |
| *Dichocoenia stokesii* (Elliptical star coral) | *Orbicella franksi* (Boulder star coral) | *Madracis arenterna* (Pencil coral) | *Porites divaricata* (Thin finger coral) |
| *Diploria labyrinthiformis* (Grooved brain coral) | *Montastraea cavernosa* (Large-cup star coral) | *Favia fragum* (Golfball coral) | *Porites furcata* (Branched finger coral) |
| *Eusmilia fastigiata* (Smooth flower coral) | *Solenastrea bournoni* (Smooth star coral) | *Mussa angulosa* (Spiny flower coral) | *Acropora palmata* (Elkhorn coral) |
| *Meandrina meandrites* (Maze coral) | *Stephanocoenia intersepta* (Blushing star coral) | *Scolymia* spp. (Disc coral) | *Acropora cervicornis* (Staghorn coral) |
| *Pseudodiploria strigosa* (Symmetrical brain coral) | *Siderastrea siderea* (Starlet coral) | *Isophyllia* spp. (Sinuous cactus coral; rough star coral) | *Oculina* spp. (Bush corals) |
| *Pseudodiploria clivosa* (Knobby brain coral) | | | *Cladocoraarbuscula* (Tube coral) |

*Susceptibility in Florida, in the Case Definition of SCTLD, in 2018.
 Relative susceptibiliby varies among the Caribbean's countries and territories.

# SCTLD Survey Materials

## AGRRA Data Card



## Disease Identification Cards

# AGRRA SCTLD/Bleaching Survey Card

Designed for beginning (basic) or advanced (detailed) surveyors.

Follows the layout of the AGRRA online, survey data entry tools.*

Accommodates roving diver, bar-drop or other species-level surveys.

## Always record site information

| AGRRA  SCTLD/Bleaching Survey Data Card | | | | |
|---|---|---|---|---|
| Surveyor Name: | Date: | Tine: | Latitude:          Longitude: (or Location): | Reef  Name (if known): |
| Detailed Surveys: AGRRA Site Code if any: | Detailed Surveys: MPA Status: Yes?     No?     Unsure? | Detailed Surveys: If a Restoration Site: Outplant?   Nursery? | Reef Type: Backreef?   Reef Crest?   Patch Reef?   Fore Reef? Other (Describe)? | |
| Average Depth:        m? or ft? | Bottom Temp.:        ºC or ºF? | Site Comments (e.g., major organisms): | | |

Must have  GPS coordinates or ability to locate survey on a Google Earth map to use AGRRA's data entry tools.

* See www.agrra.org/coral-disease-outbreak

# Conducting a SCTLD roving diver survey

Materials needed:
- Slate or clipboard
- Data sheet printed on underwater paper
- Pencil
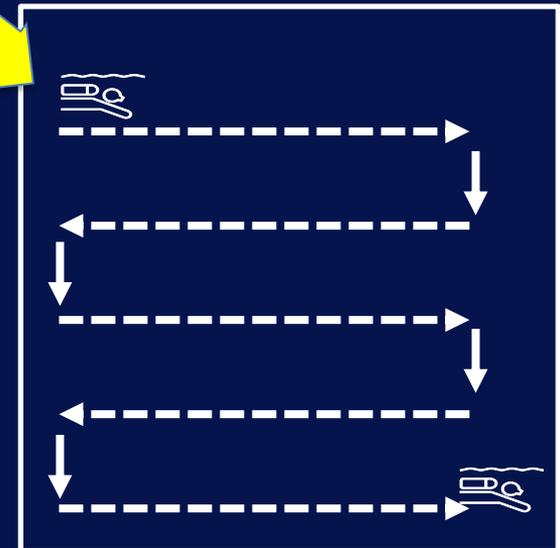- Underwater camera

© A. Zimmermann

# At the survey site

- Record site information

- Swim site to cover ~ 50 m area

- Survey 100-200 SCTLD-susceptible corals unless susceptible species are rare, to gain a representative sample of the habitat

- Avoid counting the same corals twice, keep ~2 m apart from other divers

- Start before SCTLD invades or, when in outbreak, also survey sites in advance of the outbreak.

- Repeat surveys at the same site allow disease <u>incidence</u> estimates (number of new cases, or probability of developing the disease).



© A. Zimmermann

Swim across wide reefs or along the tops of narrow lobes.

# Tally condition of SCTLD-susceptible corals

| | | | # Corals with SCTLD &/or Fully Bleached (BL), Partially Bleached (PB), or Pale (P) | | | # Corals Fully Bleached (BL), Partially Bleached (PB), or Pale (P) | | | # Corals with other Diseases(s) | # Recently Fully Dead Corals | Notes & any Photographs? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tally all corals (including clumps) of species known to be susceptible to SCTLD.** | | | | | | | | | | | |
| **Species** | **# Healthy Corals** | **#SCTLD Corals** | **BL** | **PB** | **P** | **BL** | **PB** | **P** | | | |
| **OFFEN SEEN** *Colpophyllia natans:* CNAT (Boulder Brain)\*\*\* | | | | | | | | | | | |
| *Dendrogyra cylindrus:* DCYL (Pillar)\*\*\* | | | | | | | | | | | |
| *Dichocoenia stokesii:* DSTO (Elliptical Star)\*\*\* | | | | | | | | | | | |
| *Diploria labyrinthiformis:* | | | | | | | | | | | |

## Count corals that are
- ✓ Healthy
- ✓ SCTLD
- ✓ SCTLD + Bleaching (As BL, PB, P)*
- ✓ Bleaching (As BL, PB, P)*
- ✓ Other Diseases
- ✓ Recently Fully Dead*

*See next slide

+ Take photos!
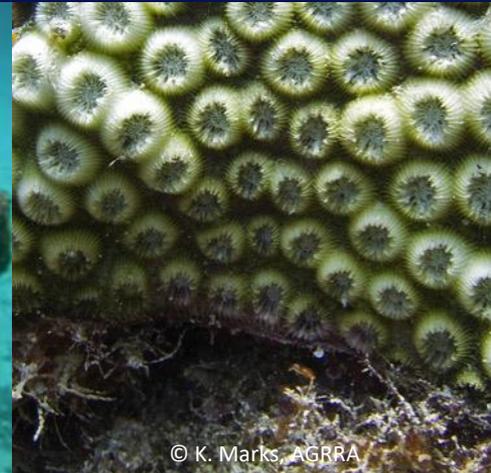
# What to look for:



**Healthy**      **SCTLD**      **Bleached***      **Recently dead****

© K. Marks, AGRRA    © M. Helion, Guadeloupe    © B.Quiroga, Mexico    © K. Marks, AGRRA

**Healthy + SCTLD:** review with A Bruckner's webinar and other materials at
www.agrra.org/coral-disease-outbreak  and www.gcfi.org/emerging-issues-florida-coral-disease-outbreak/

**\*Bleaching Conditions**

Pale (**P**): polyps are just starting to bleach or are in recovery.

Partly Bleached (**BP**): some polyps are fully bleached and others are either unbleached or pale

Bleached (**BL**): all (>90%) polyps are fully bleached

**\*\*Recently Fully Dead Corals\*\*** (within last several days to  weeks)

*Detailed only:* % of corals at the site with recent mortality

# Maps in
# Roving Diver Reports



DEPARTMENT OF ENVIRONMENT
CAYMAN ISLANDS GOVERNMENT

August 2020

GRAND CAYMAN
SCTLD SURVEY RESULTS

SCTLD Presence
- Possible SCTLD
- Confirmed SCTLD
- Surveyed
- Not Surveyed

Figure 5: Grand Cayman SCTLD manta-tow survey results.

*From C. McCoy et. al. 2020. Research Project Summary: Addressing the Threat of SCTLD in the Cayman Islands*

Shows spatial extent of SCTLD at start of the outbreak

Shows relative prevalence of SCTLD in MCAV (great star coral)  on patches away from a port/terminal at 2 depths.

*C. Dahlgren 2020. Rapid Assessment of the occurrence of Stony Coral Tissue Loss Disease (SCTLD) along the southern coast of Grand Bahama, Bahamas)*

Great Star Coral  MCAV

⬌ Commercial Port/Cruise Ship Terminal
Depths: pale red =2-5 m; pale blue = 5-20 m

# Tabular data in Roving Diver Reports

## List of susceptible species arranged in approximate order of susceptibility, either with or without signs of SCTLD.

In total approximately 3,630 corals were assessed with over 930 or 25% infected with SCTLD across all sites. The 18 taxa observed to be affected by SCTLD included (Fig. 3):

**+ SCTLD**

- *Pseudodiploria strigosa* (symmetrical brain coral)[1]
- *Pseudodiploria clivosa* (knobby brain coral)[1]
- *Diploria labyrinthiformis* (grooved brain coral)[1]
- *Montastraea cavernosa* (large-cup star coral)[1]
- *Colpophyllia natans* (boulder brain coral)[1]
- *Dendrogyra cylindrus* (pillar coral)[1]*
- *Dichocoenia stokesii* (elliptical star coral)[1]
- *Eusmilia fastigiata* (smooth flower coral)[1]
- *Meandrina meandrites* (maze coral)[1]
- *Siderastrea siderea* (starlet coral)*
- *Orbicella annularis* (lobed star coral)*
- *Orbicella faveolata* (mountainous star coral)*
- *Orbicella franksi* (boulder star coral)*
- *Solenastrea bournoni* (smooth star coral)
- *Stephanocoenia intersepta* (blushing star coral)
- *Agaricia agaricites* (lettuce coral)
- *Mycetophyllia spp.* (cactus coral)
- *Favia fragum* (golfball coral)

Taxa at low risk of infection, or are presumed susceptible that were observed at sites but were not observed to have SCTLD included:

**- SCTLD**

- *Agaricia* spp. (plate/saucer corals)
- *Porites astreoides* (mustard hill coral)
- *Porites porites*(finger coral)
- *Porites divaricata* (thin finger coral)
- *Porites furcata* (branched finger coral
- *Acropora palmata* (elkhorn coral)*
- *Acropora cervicornis* (staghorn coral)*
- *Acropora prolifera* (fused staghorn coral –hybrid between the other 2 Acropora species)
- *Scolymia* spp. (disc coral)

*C. Dahlgren 2020. Rapid Assessment of the occurrence of Stony Coral Tissue Loss Disease (SCTLD) along the southern coast of Grand Bahama, Bahamas)*

# Graphs in Roving Diver Reports

# corals/SCTLD-susceptible species/site, arranged in approximate order of susceptibility
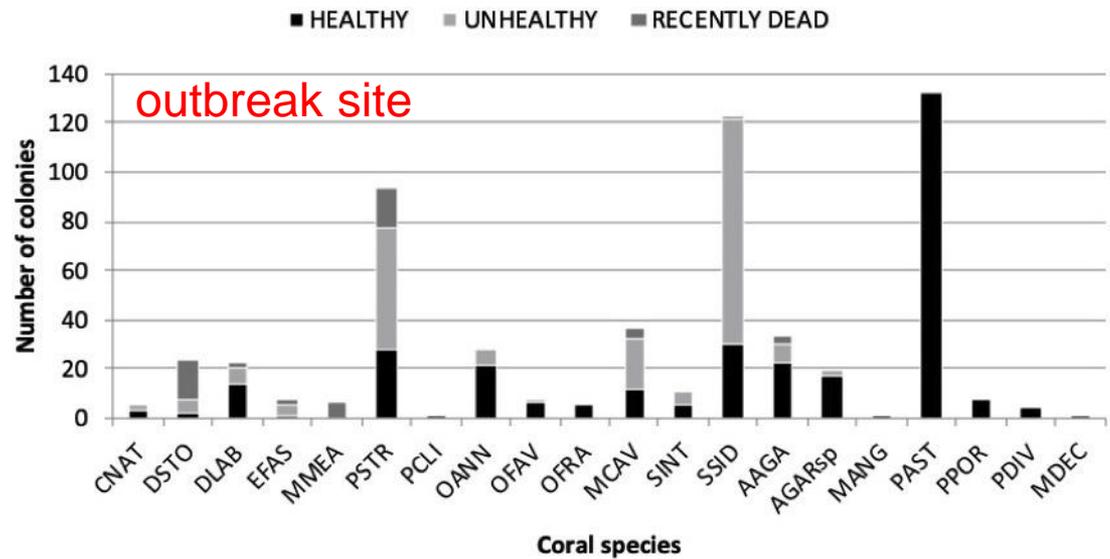


Figure 2: Results from a 60-minute roving diver, coral disease survey at Penny's Arch dive site, north of Grand Cayman, 29/JUNE/2020.
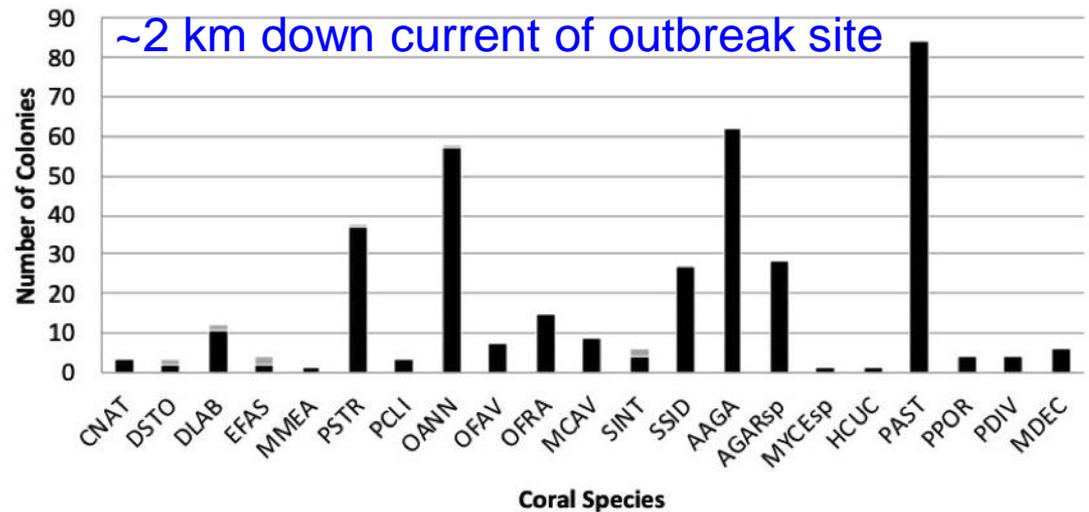


Figure 3: Results from a 60-minute roving diver, coral disease survey at Max's Garden dive site, north of Grand Cayman, 30/JUNE/2020.

*From C. McCoy et. al. 2020. Research Project Summary: Addressing the Threat of SCTLD in the Cayman Islands*

# Other SCTLD Graphs

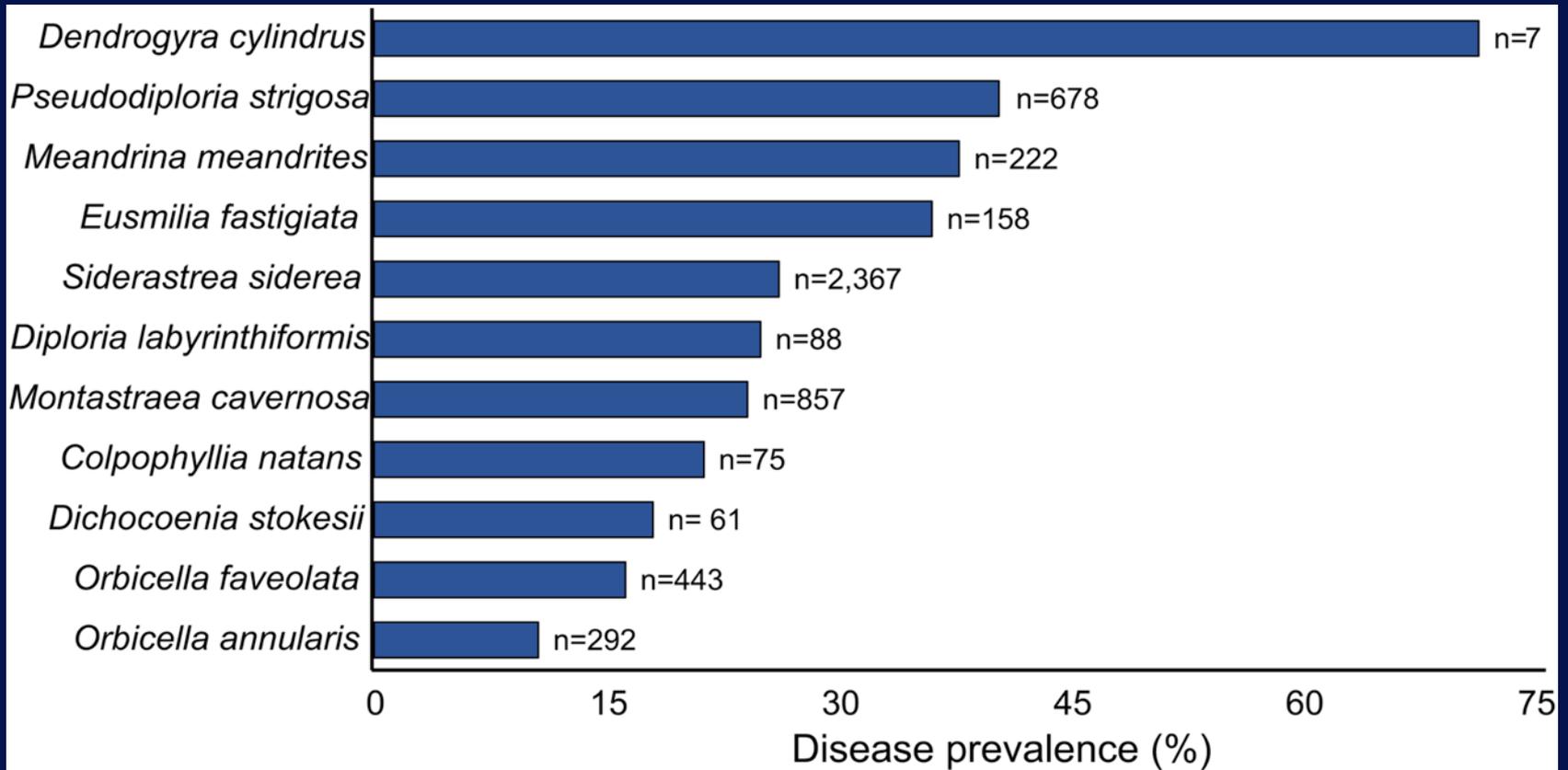## % of corals with SCTLD arranged in order of susceptibility



**Figure2** PrevalenceoftheStonyCoralTissueLossDiseaseforthe11mostsusceptiblespeciesacross 82 reef sites in the Mexican Caribbean (n = number of colonies). For this figure, we include coral colonies with total mortality but for which death could be attributable to the SCTLD (exposed bright white skeletons…
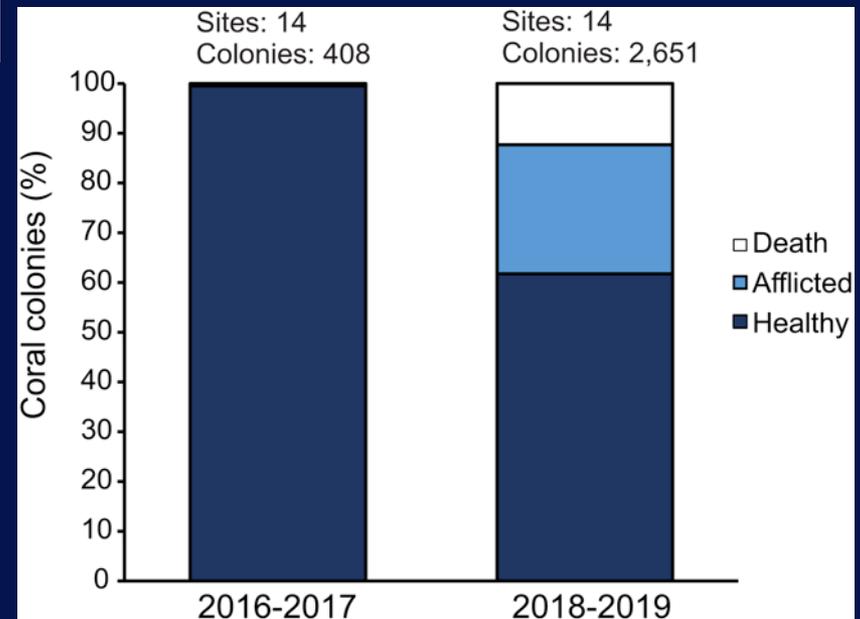
Alvarez et al. (2019)

# Other SCTLD Graphs
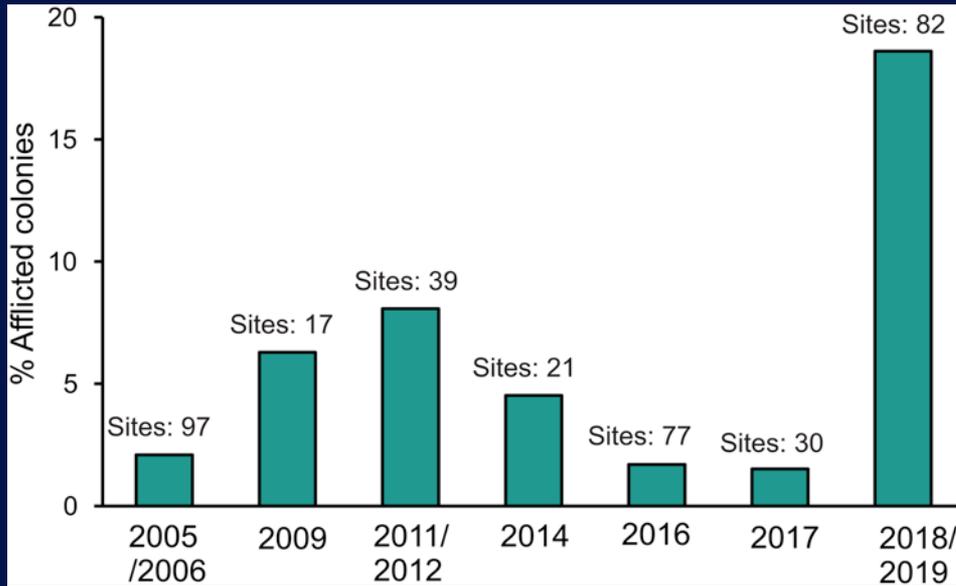


Alvarez et al. (2019)

Prevalence of 11 most susceptible species of corals with SCTLD at different numbers of sites between 2005/2006 and 2018/2019 in the Mexican Caribbean

Proportion of healthy, afflicted and dead colonies of the highly susceptible species at 14 sites before (22016-2017) and after (2018/2019) the start of the outbreak in the Mexican Caribbean.



Alvarez et al. (2019)

# Photos in Roving Diver Reports



Figure 1. Time series of *Pseudodiploria strigosa* brain coral infected with SCTLD from November 8, 2019 (left) to November 27, 2019 (middle) to January 16, 2020 (right). The scale bar in the right photo is marked in one inch increments (Photos courtesy of Coral Vita).

*C. Dahlgren 2020. Rapid Assessment of the occurrence of Stony Coral Tissue Loss Disease (SCTLD) along the southern coast of Grand Bahama, Bahamas)*

## Also illustrate temporal changes!



Figure 4: Repeted measures survey of a SCTLD infected Dichocoenia stokesii at Penny's Arch, 8th – 21st July 2020.

*From C. McCoy et. al. 2020. Research Project Summary: Addressing the Threat of SCTLD in the Cayman Islands*

# Photo monitoring at the coral- and landscape-levels

## Photomosaics and 3-D Modelling



**Close-up views:** *Siderastrea siderea* with SCTLD

**Landscape view:** John Millar's Blue Hole

Perry Institute FOR MARINE SCIENCE

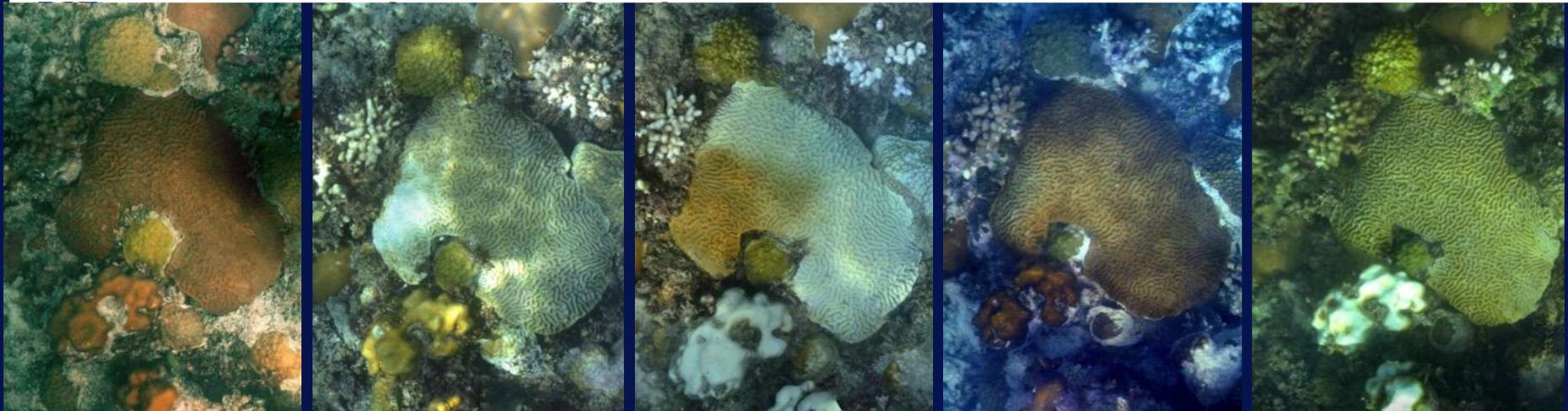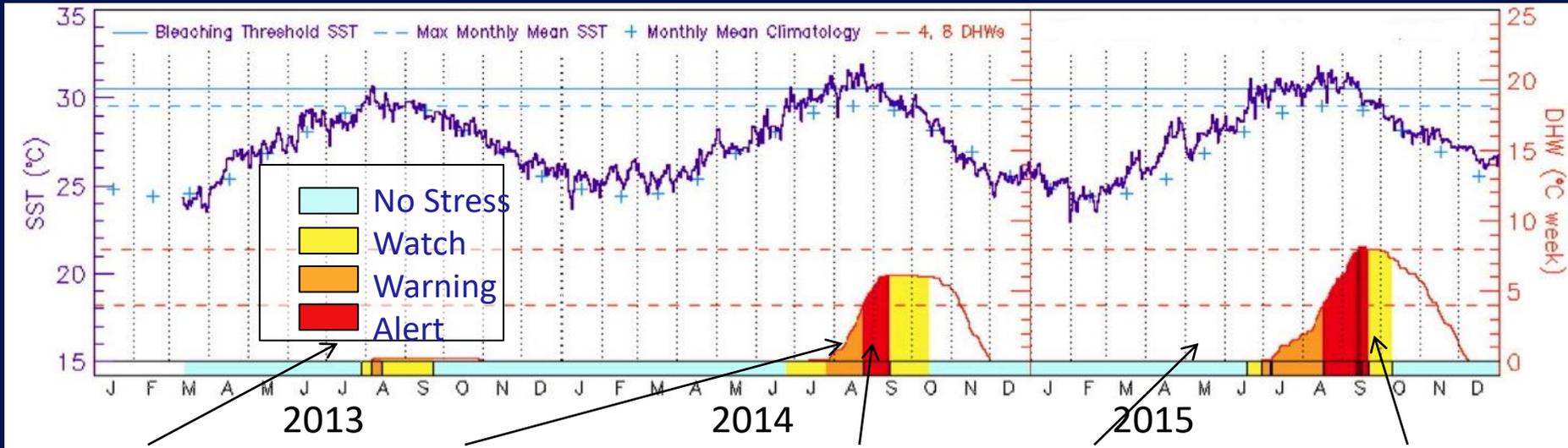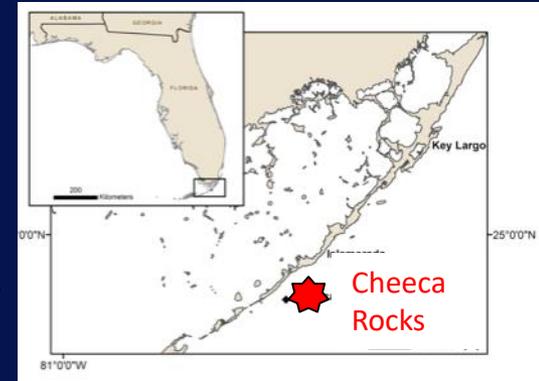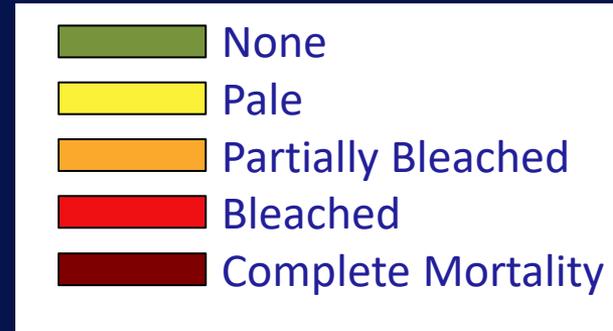*All photos:* © Will Greene, PIMS

# Coral-scale Tracking of Bleaching

"Virtual tagging" with mosaics permits fate tracking.

Less field time + no lost tags facilitates tracking *many* colonies

After Gleason from: Gintert et al. (2018)



Cheeca Rocks

# Landscape-scale Tracking of Bleached Corals



| | |
|---|---|
| ![green] | None |
| ![yellow] | Pale |
| ![orange] | Partially Bleached |
| ![red] | Bleached |
| ![darkred] | Complete Mortality |

Cheeca Rocks study (Gintert et al. 2018):

- Digitized and tracked changes for 4,234 colonies over 6 years *NO lost tags* !
- Why use this level of detail?
  - Higher power to detect change than random transects
  - Also allows you to take past history into account of coral dynamics
- Rapid field technique for entire community assessment
  - Not just specific corals of interest
- Corals at Cheeca Rocks seem to have become more resistant following multiple successive bleaching events.

After Gleason from: Gintert et al. (2018)

# Molasses Reef before & after Hurricane Rita (Sept. 19-20 2005)
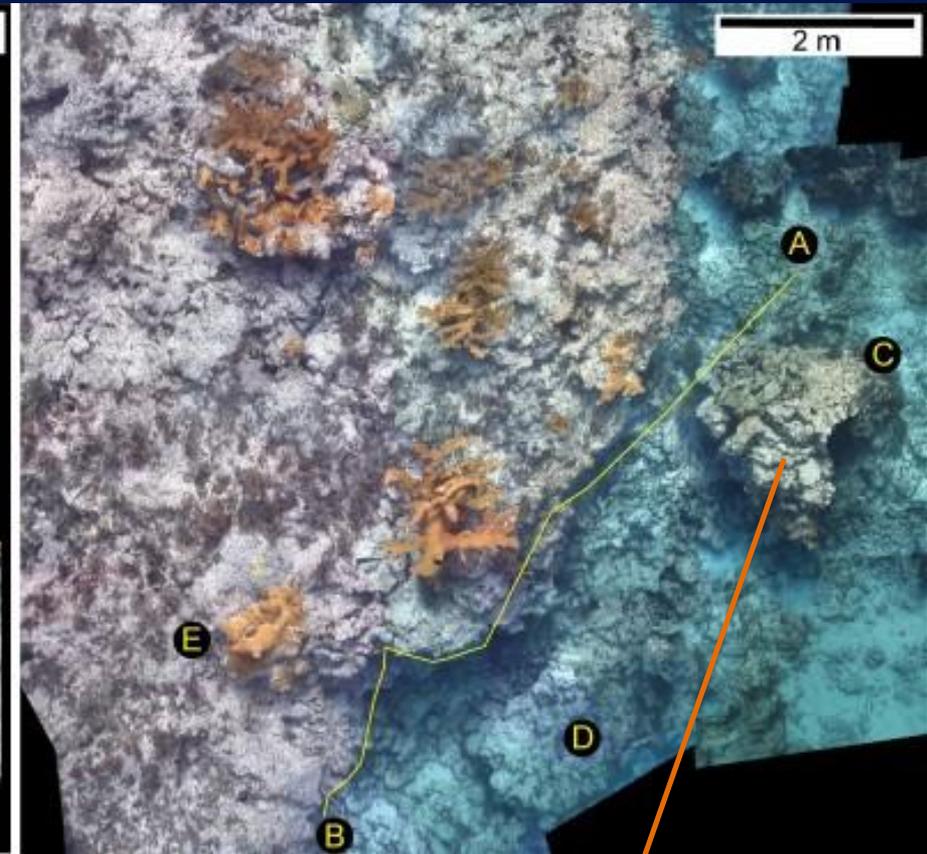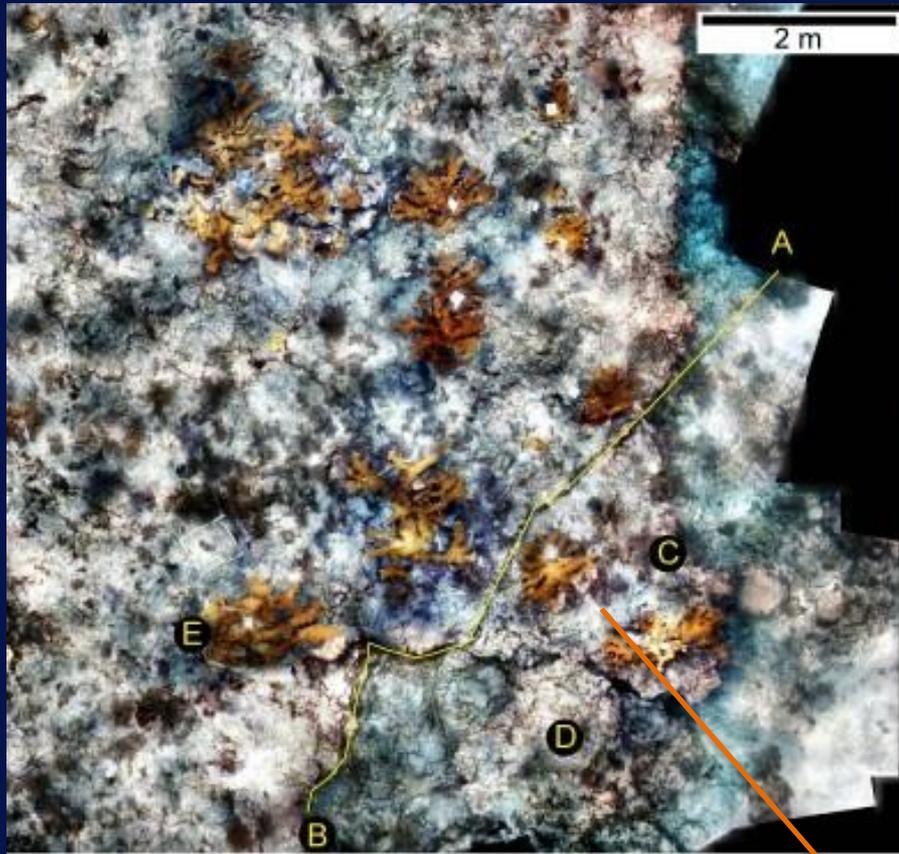


Little damage (10% overall) to 17/19 elkhorn corals; but 2 died after falling when part of the reef was dislodged along a pre-existing fracture. 13.7 m$^2$ of the reef's surface and 27 m$^3$ of its frame-work was lost.    Gleason al. (2007)

D. Williams photo

D. Williams photo

# Calculating Surface Areas:

- Live
- Diseased
- Old & Recent Mortality
- Total



Model

Meiling et al. (2020)

Live Coral + Old & Recent Mortality
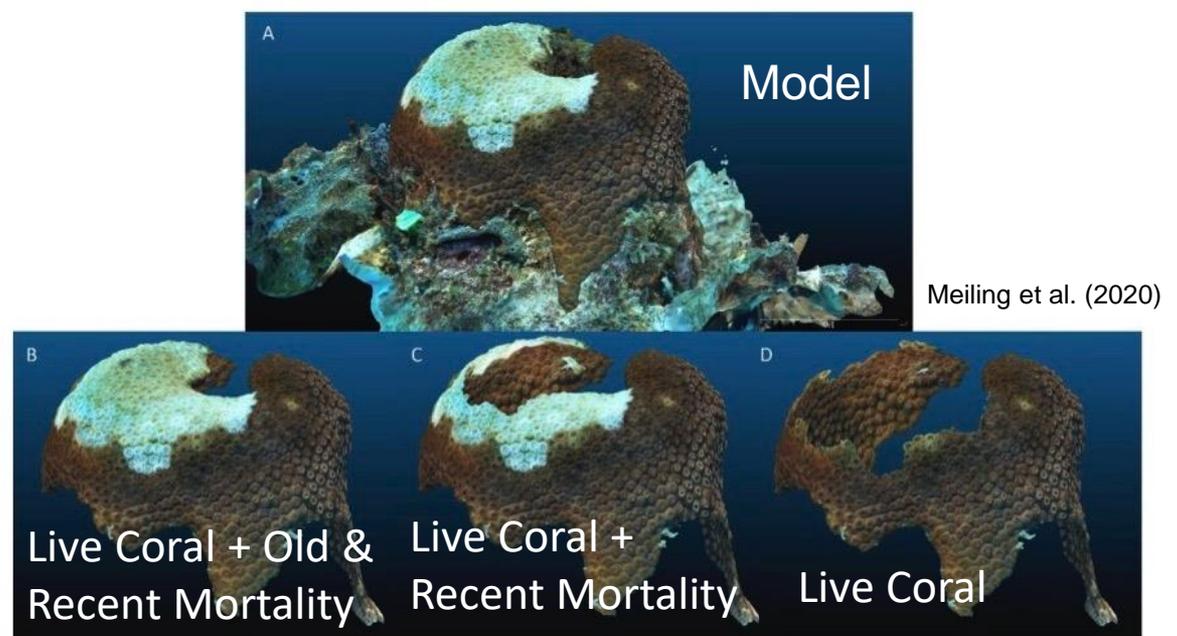
Live Coral + Recent Mortality

Live Coral

Figure S3. Distinguishing areas of a coral model. A: The full scaled model that is produced in Agisoft Metashape. B: Subtraction of the surrounding habitat. C: Subtraction of the area of old mortality. D: Subtraction of the area of recent mortality, leaving only the healthy tissue area to be measured.

***Papers:***
Gintert, B et al. (2018). Marked annual coral bleaching resilience of an inshore patch reef in the Florida Keys: A nugget of hope, aberrance, or last man standing? *Coral Reefs 37*:533-547.

Gleason, A et al. (2007). Documenting hurricane impacts on coral reefs using two-dimensional video-mosaic technology. Marine Ecology 28:254-258.

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