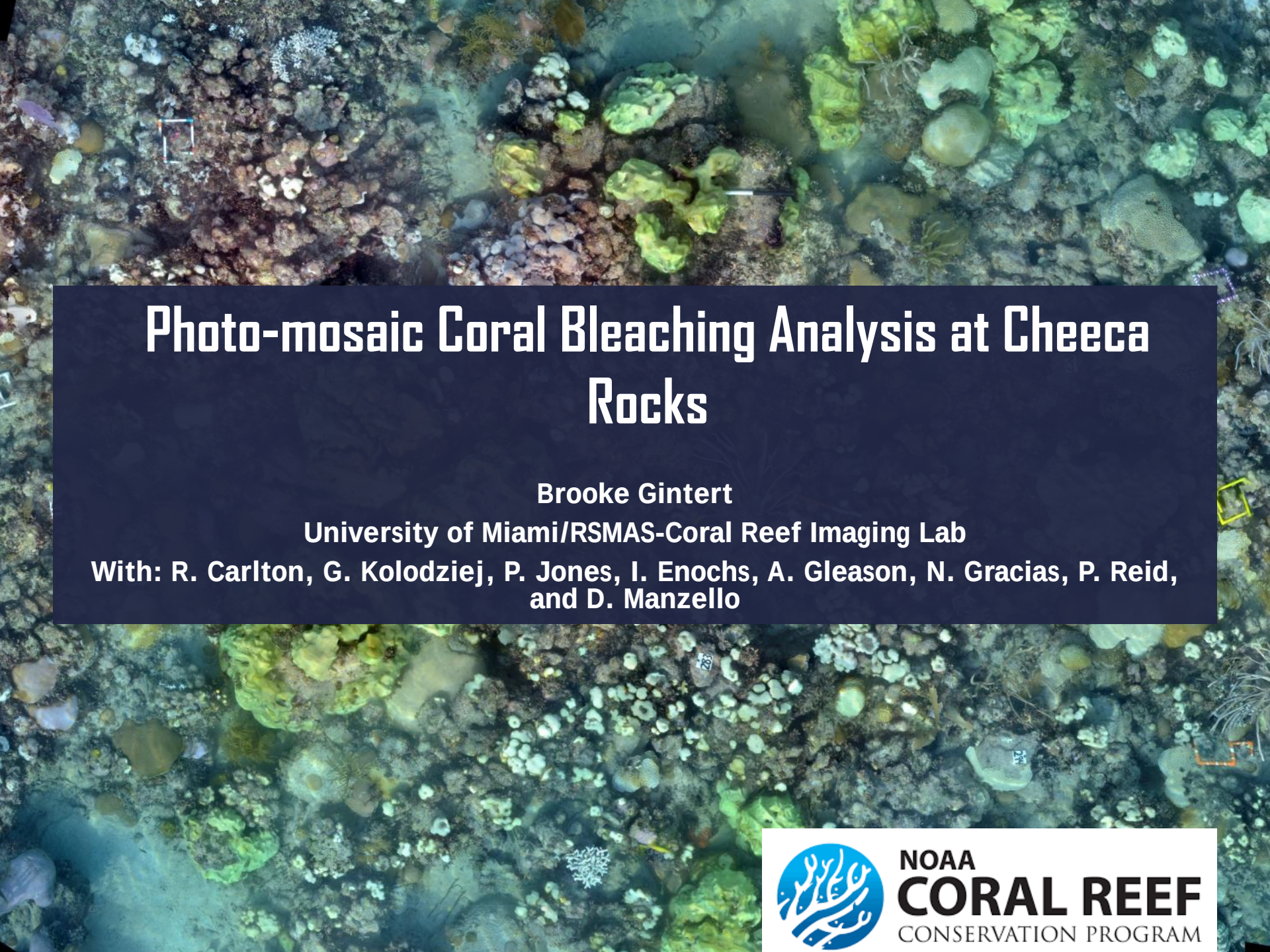


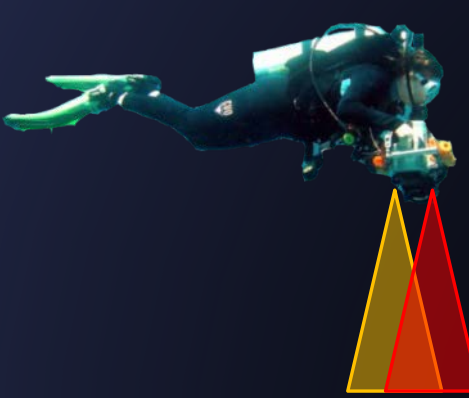
Photo-mosaic Coral Bleaching Analysis at Cheeca Rocks

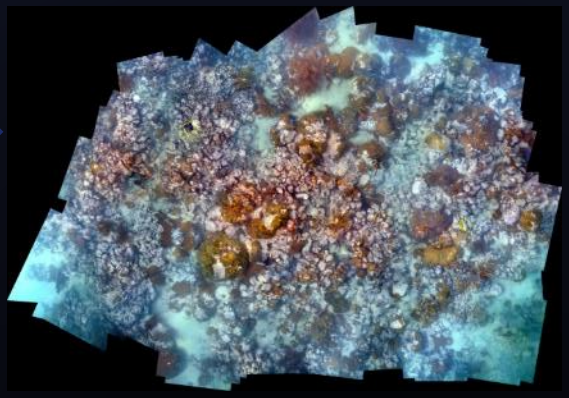
Brooke Gintert

University of Miami/RSMAS-Coral Reef Imaging Lab

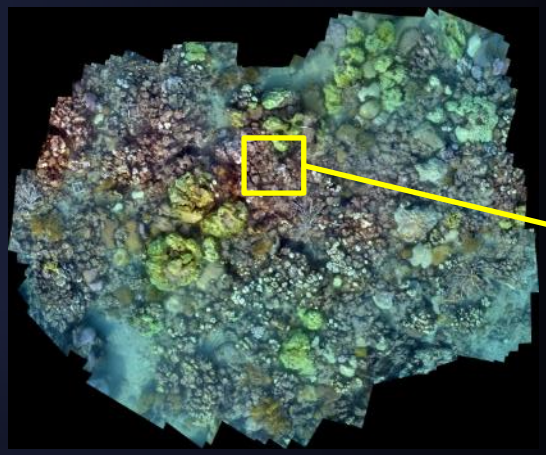
With: R. Carlton, G. Kolodziej, P. Jones, I. Enochs, A. Gleason, N. Gracias, P. Reid, and D. Manzello

NOAA CORAL REEF CONSERVATION PROGRAM

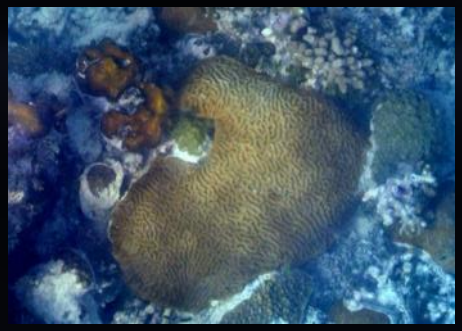




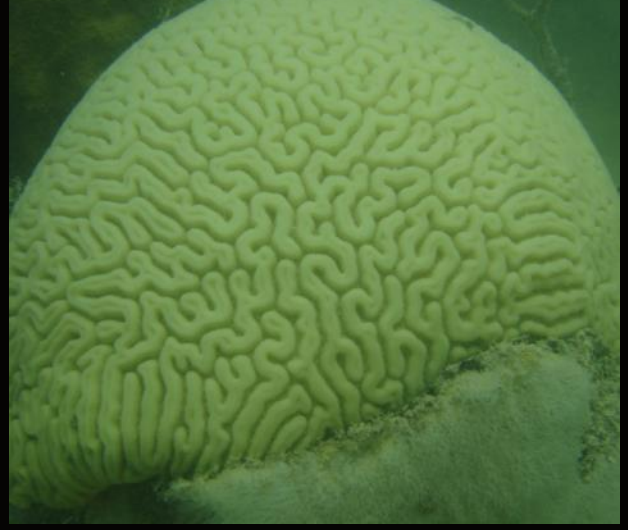
Imaging Technology



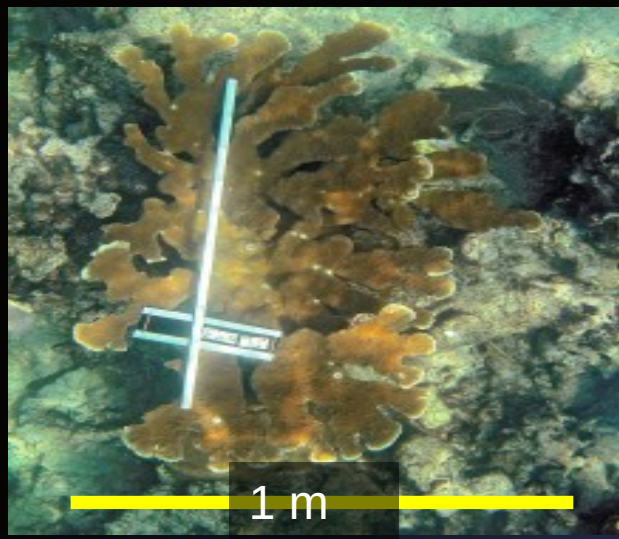
Document Bleaching



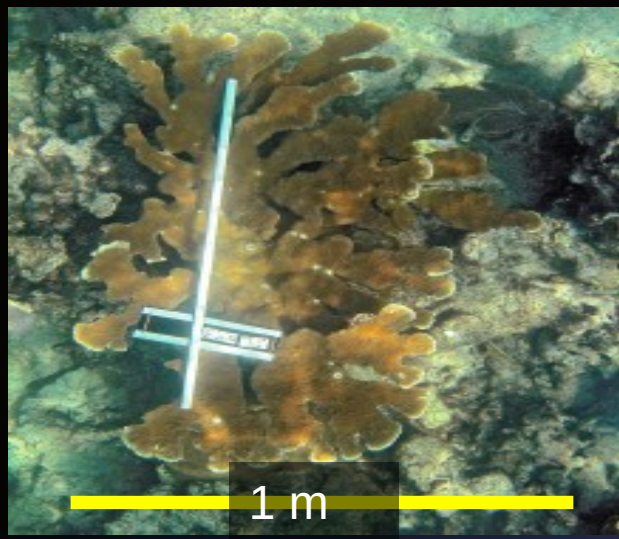
Resistance & Resilience



Numerous methods for coral reef monitoring



Same Monitoring Goals



Measure Change

Document

Link patterns/ processes

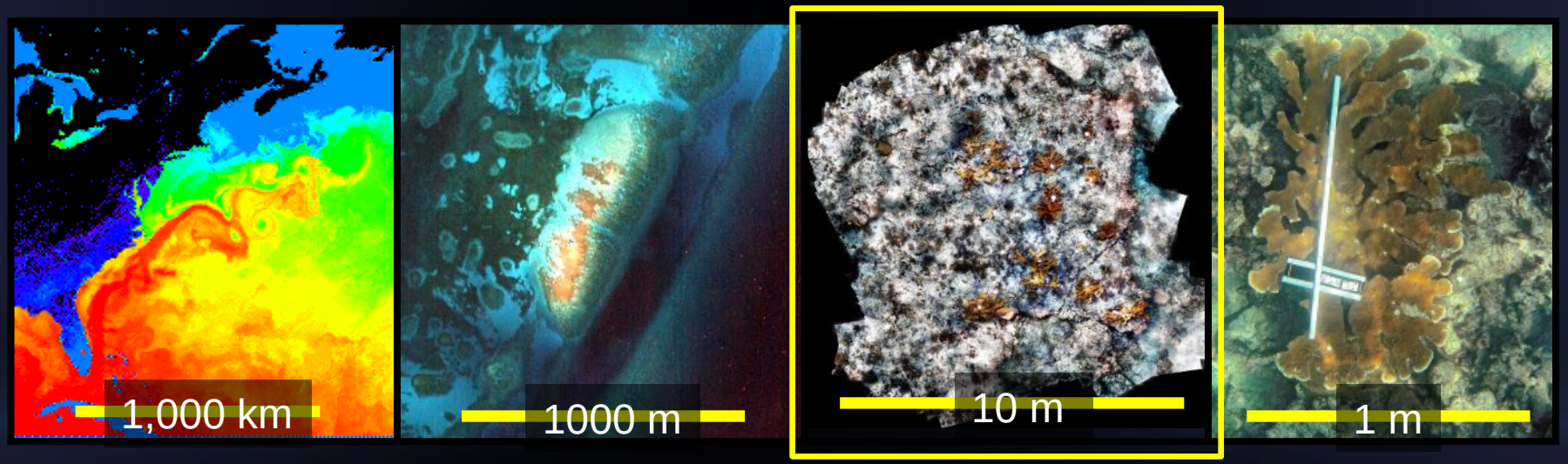
Good Management

- Only if the right metrics are collected
- Always sub-sampling
- A-priori decisions
- Cumulative, poor if documentation or measurements of change are insufficient or inaccurate

- Detect / Measure Changes
- Interpret Patterns with Processes
    - [illegible] changes

Filling the Gaps

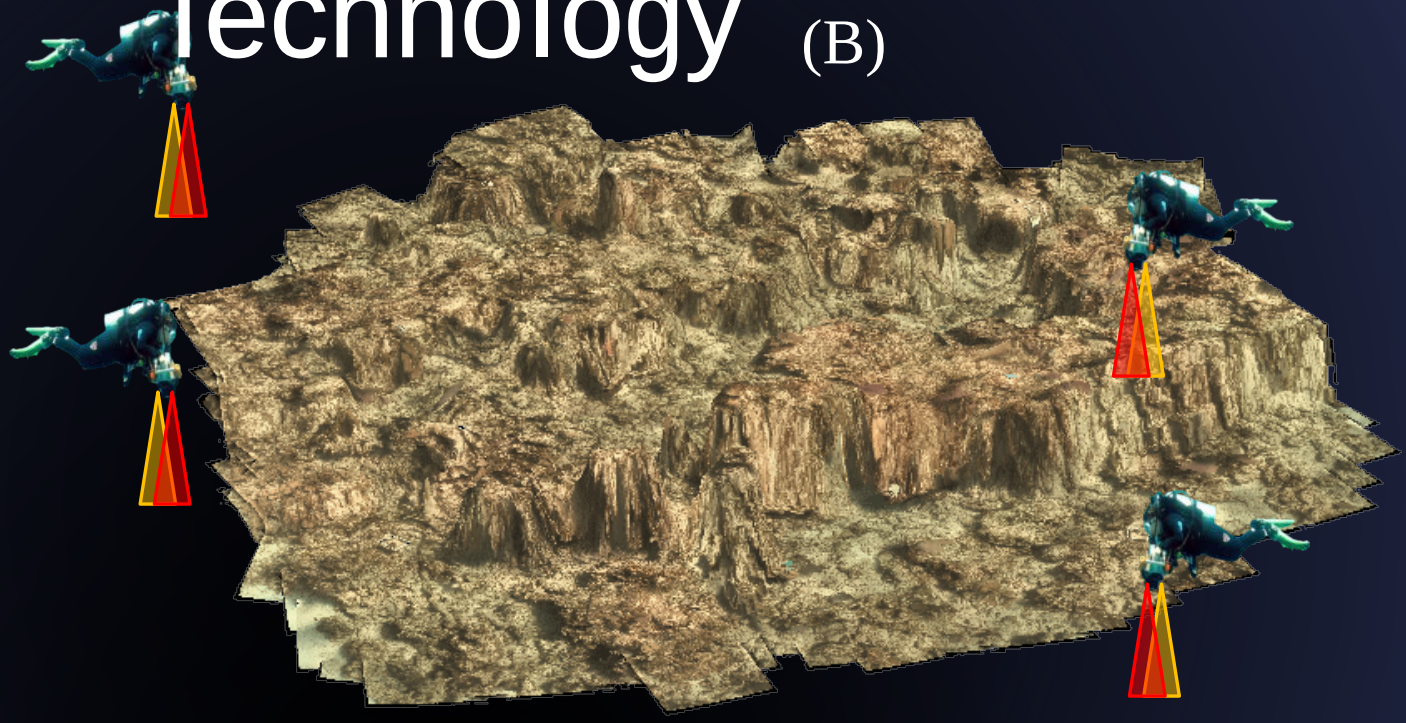
1. Image solutions for monitoring and mapping coral communities



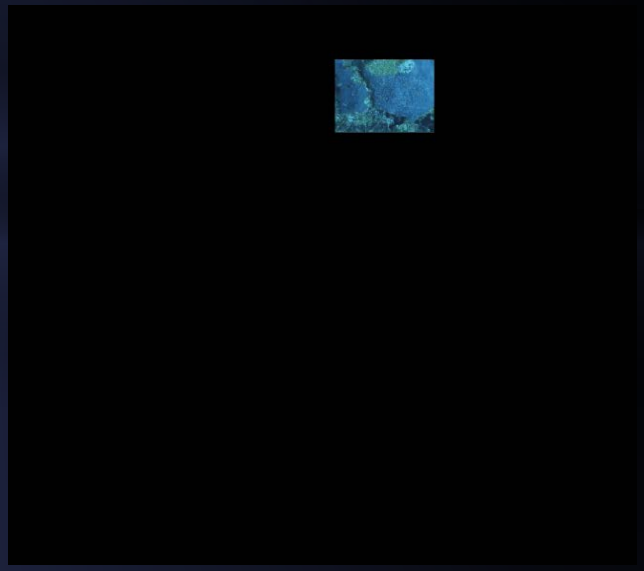
Technology

(A)

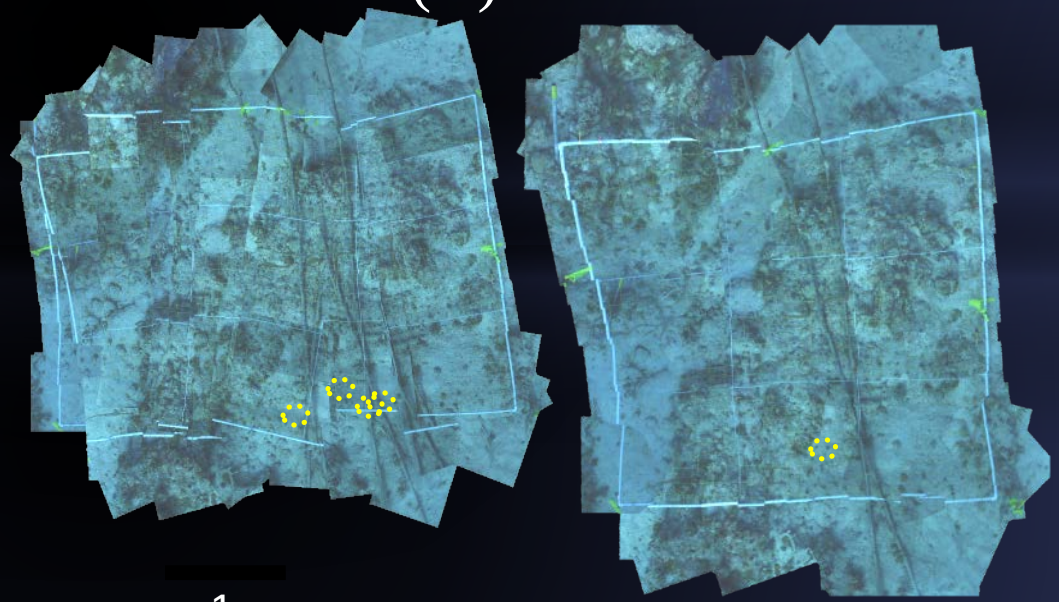
(B)



(C)

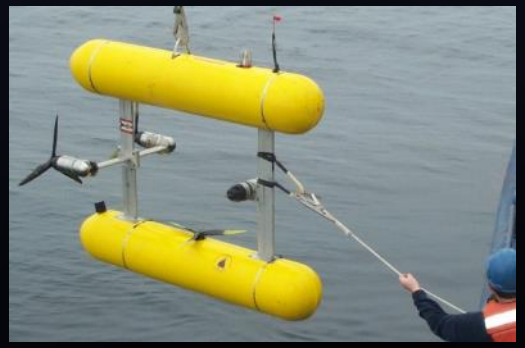


(D)



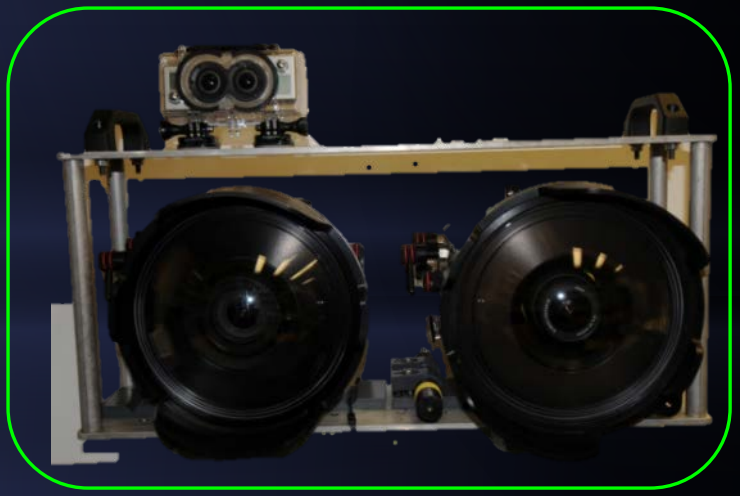
Input Data

DV camera



SeaBED AUV

Nikon D200 and Sony HDV

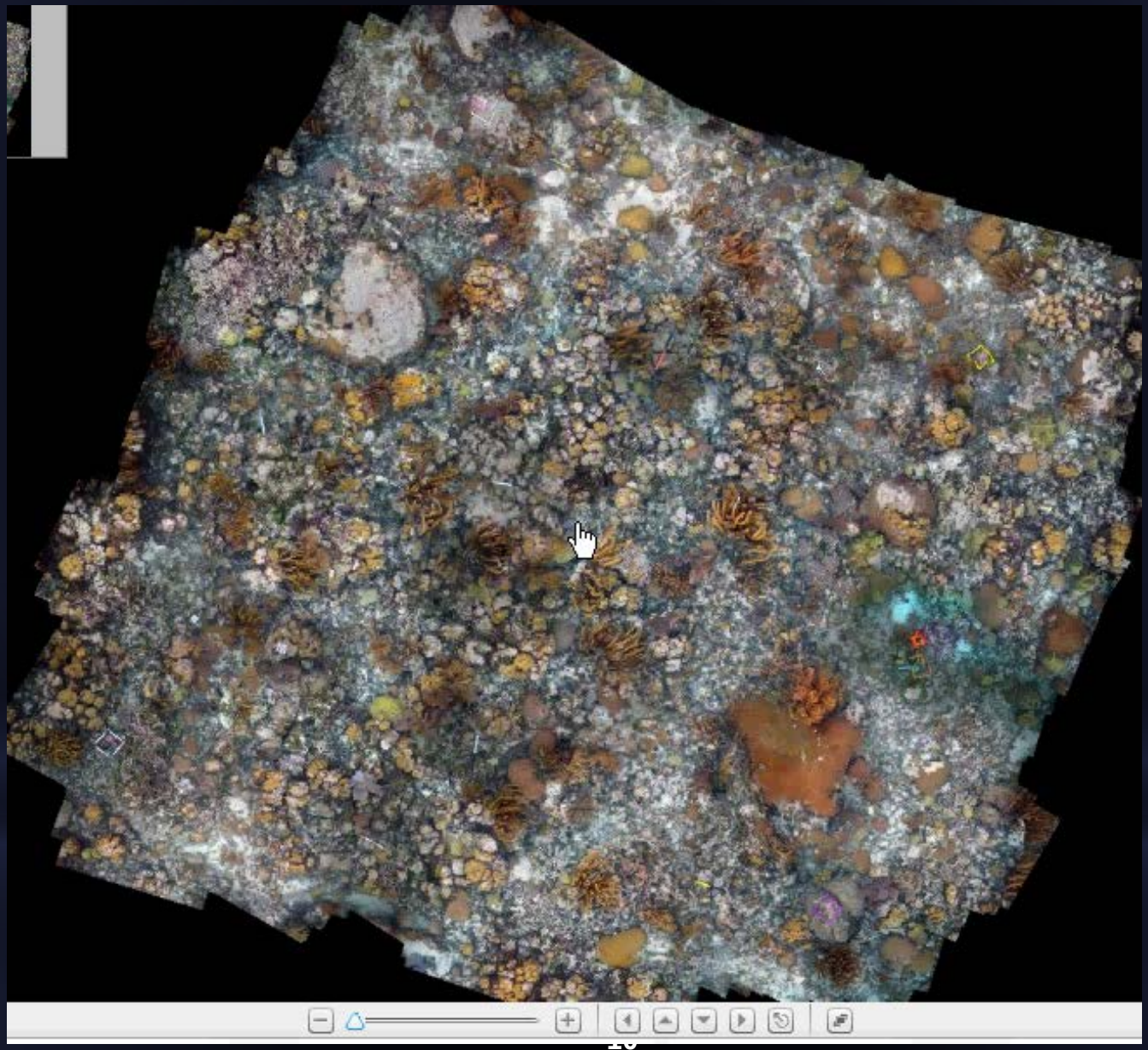


Dual Nikon D7000

Go Pro Hero2 Dive Housing

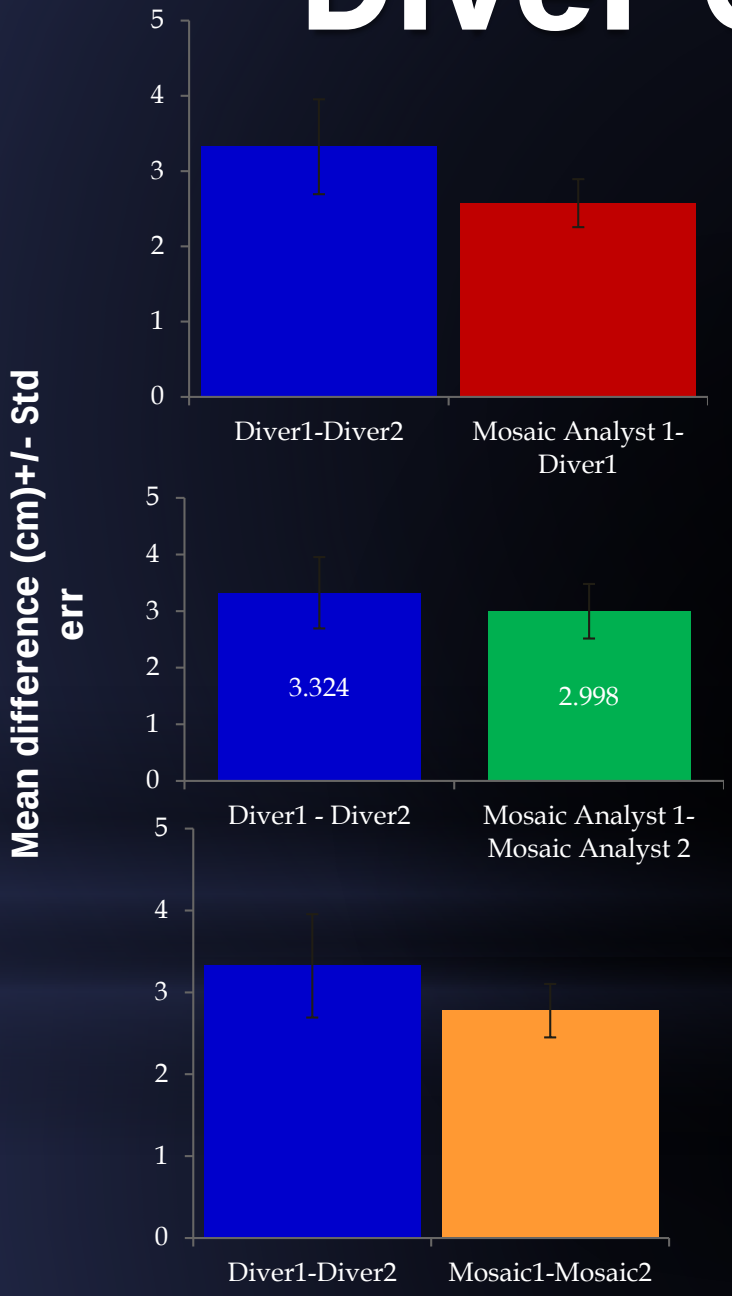
Canon Powershot D10

A Mosaic View of Coral Reefs



A Mosaic View of

Diver Comparisons

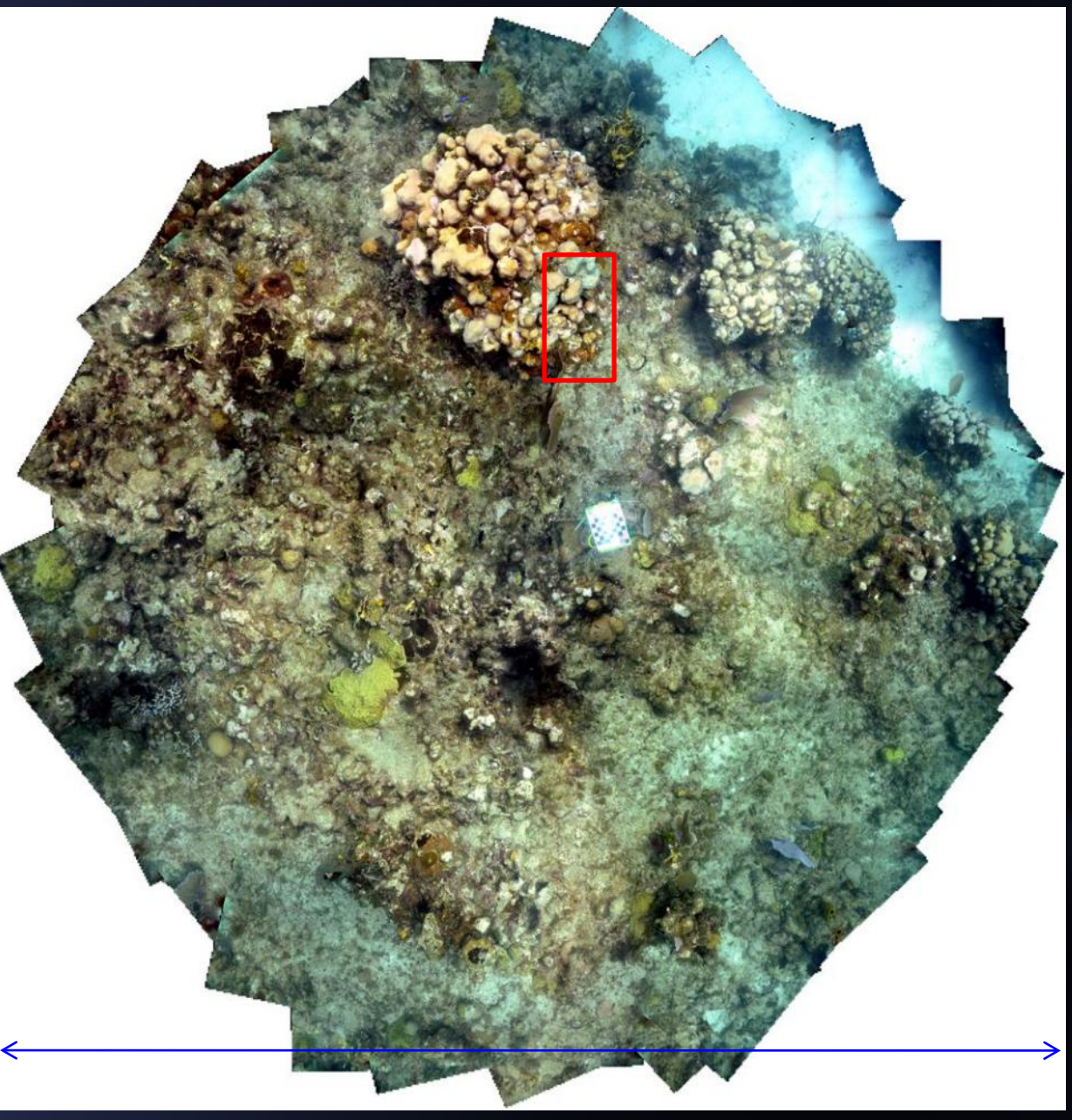


No significant differences between Diver and Mosaic measurements for:

- Percent Cover
- Coral Colony Sizes
- Distances

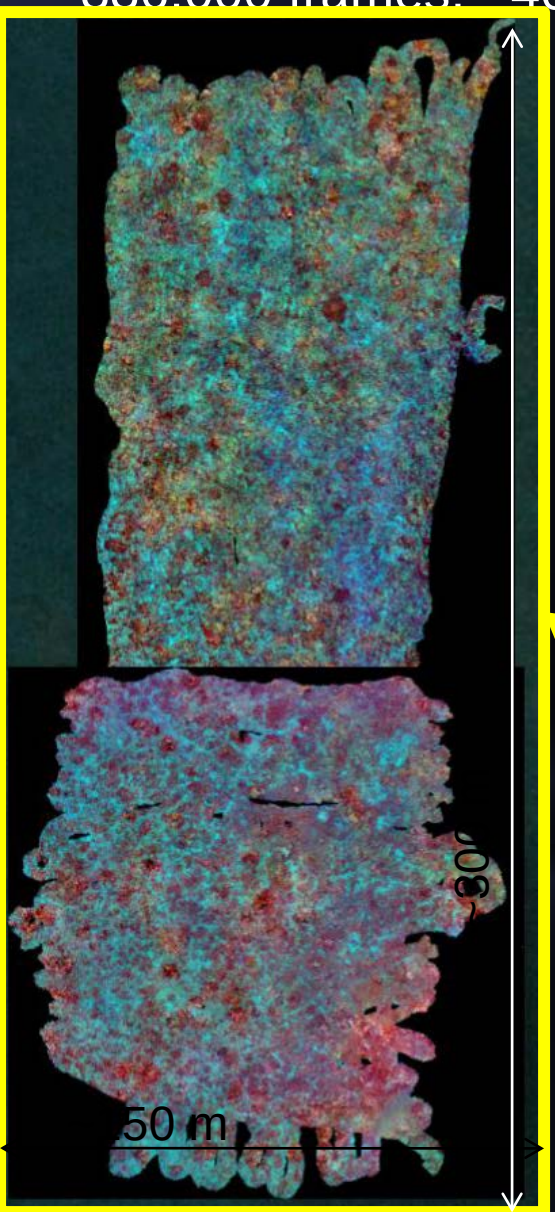
Minute Mosaics

- 19-44m^2, 10-90 corals
- 60 – 90 images @ 1/sec
- 138 mosaics in 3 days/5km



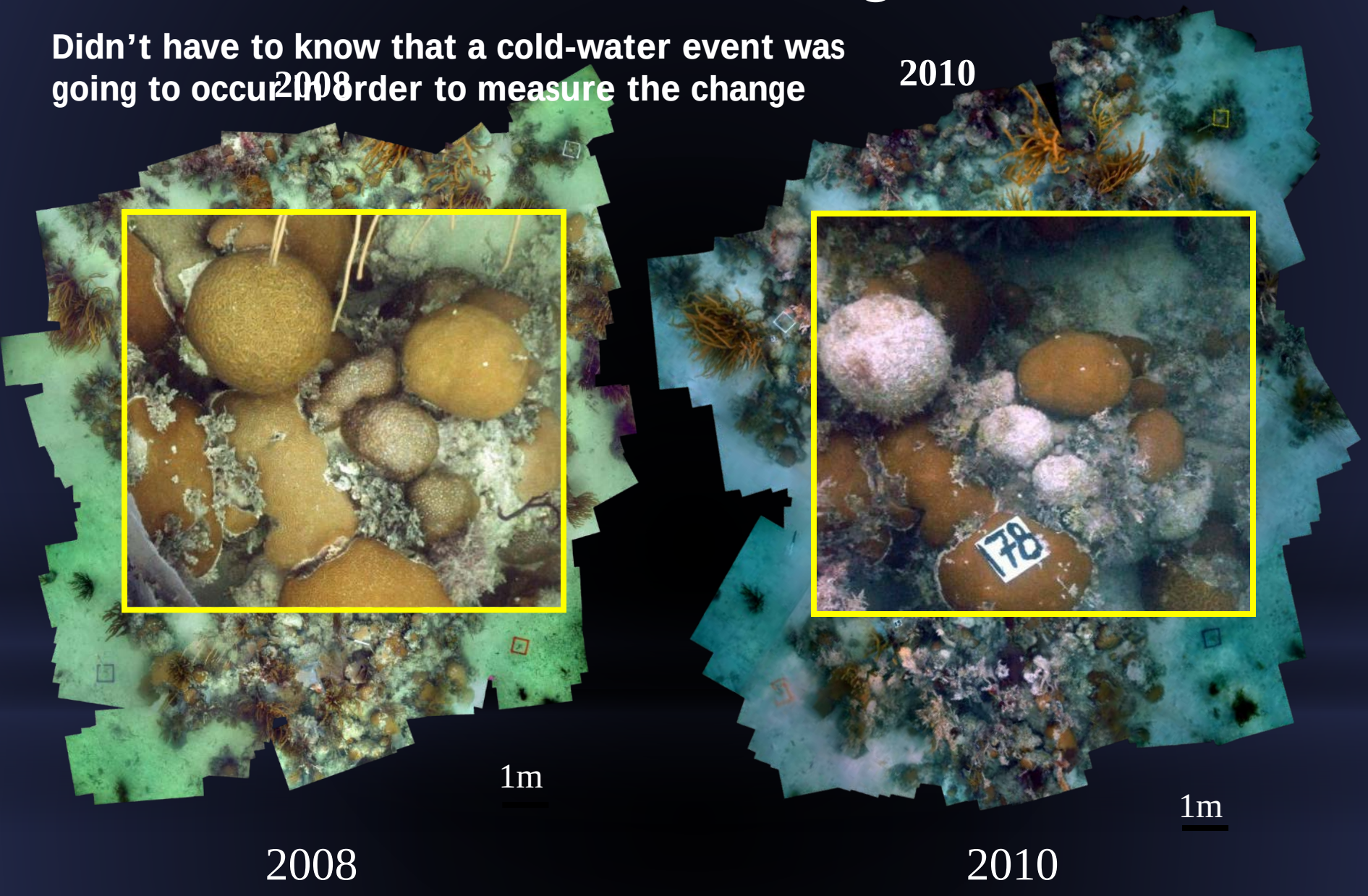
Large Areas

- 8 gopro cameras, two days
- 336,000 frames, ~40,000 m^2, 6mm/pixel

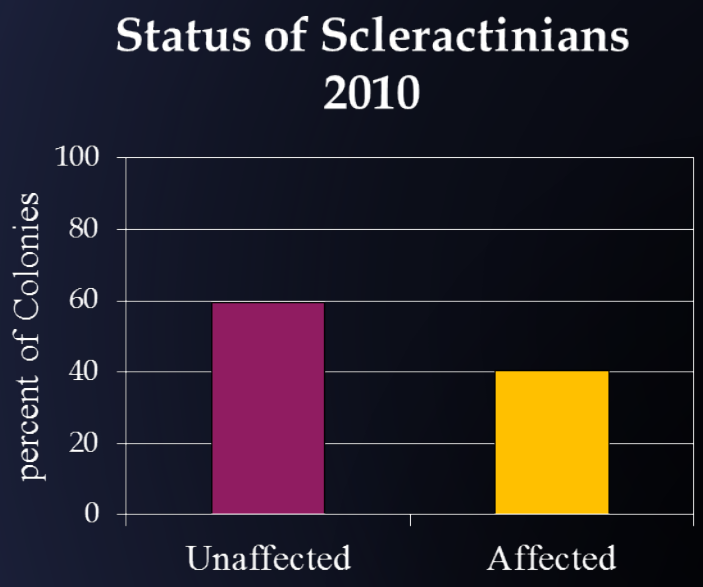


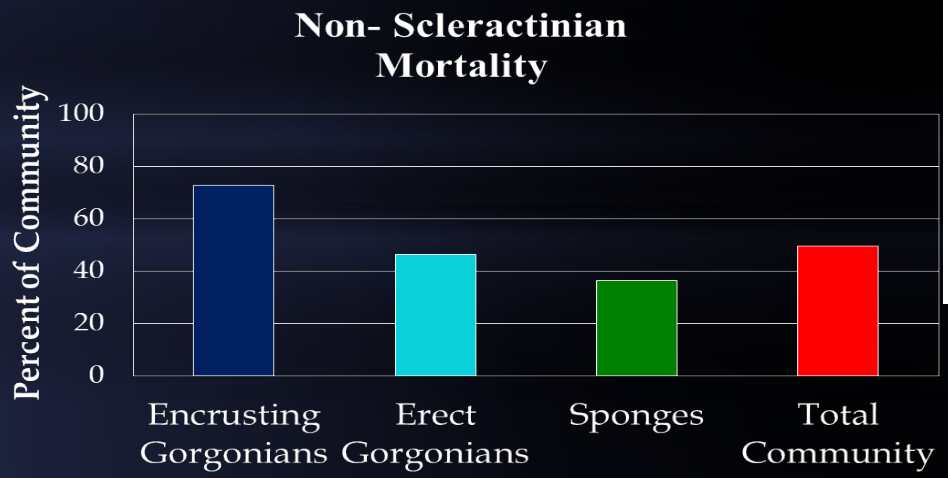
Mosaic Benefit: Change Detection

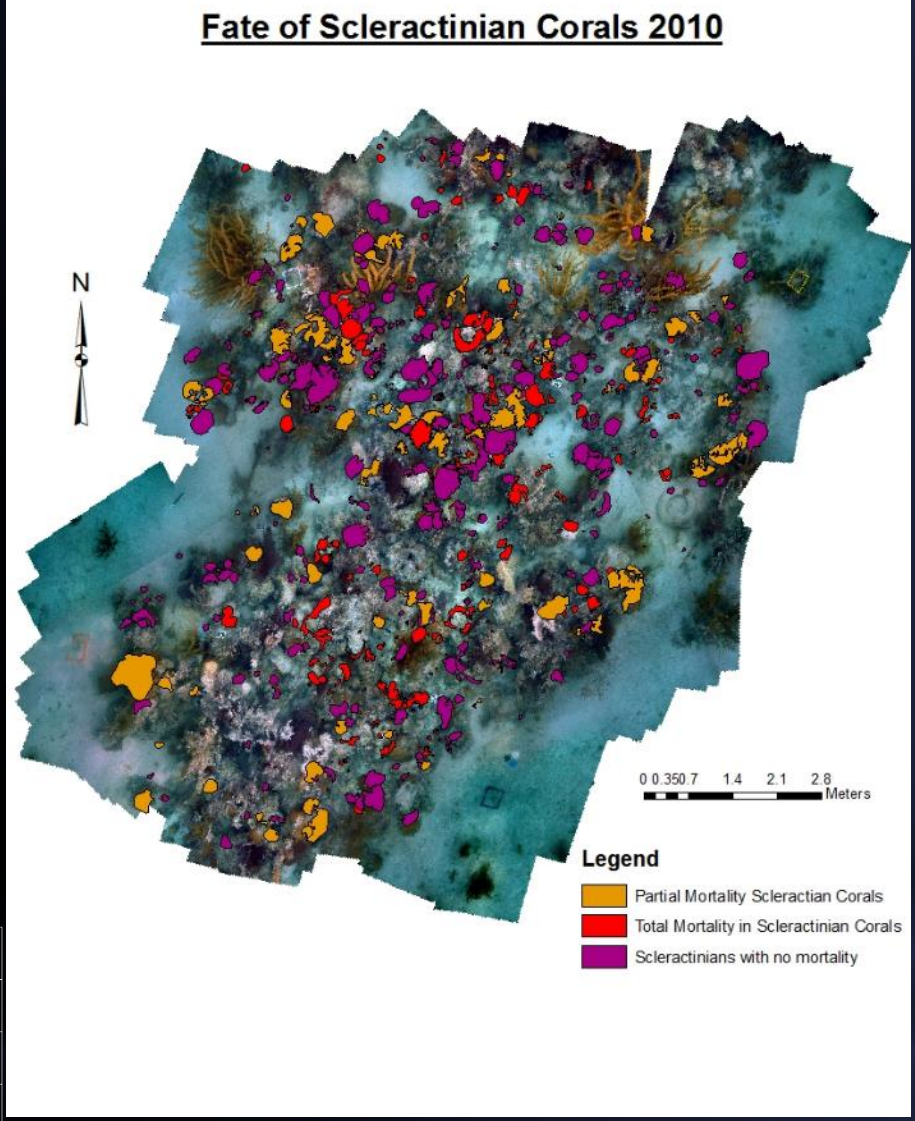
Didn't have to know that a cold-water event was going to occur in order to measure the change



Mosaic Benefit: Change Detection

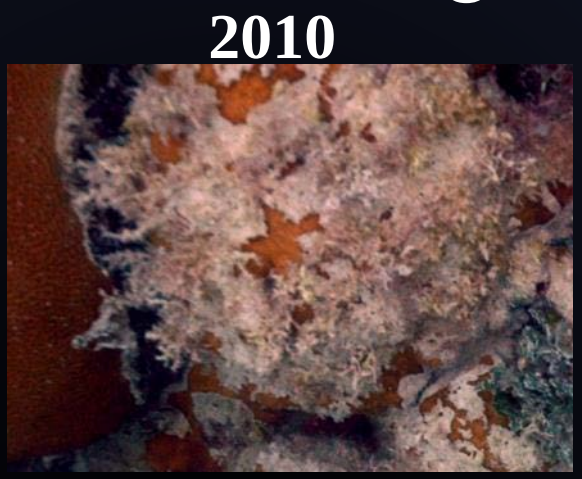


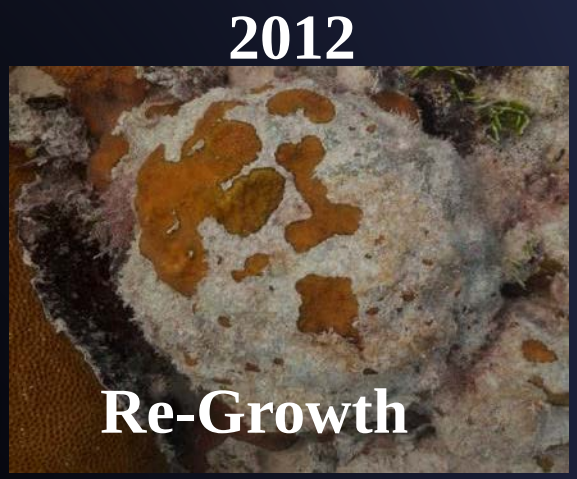


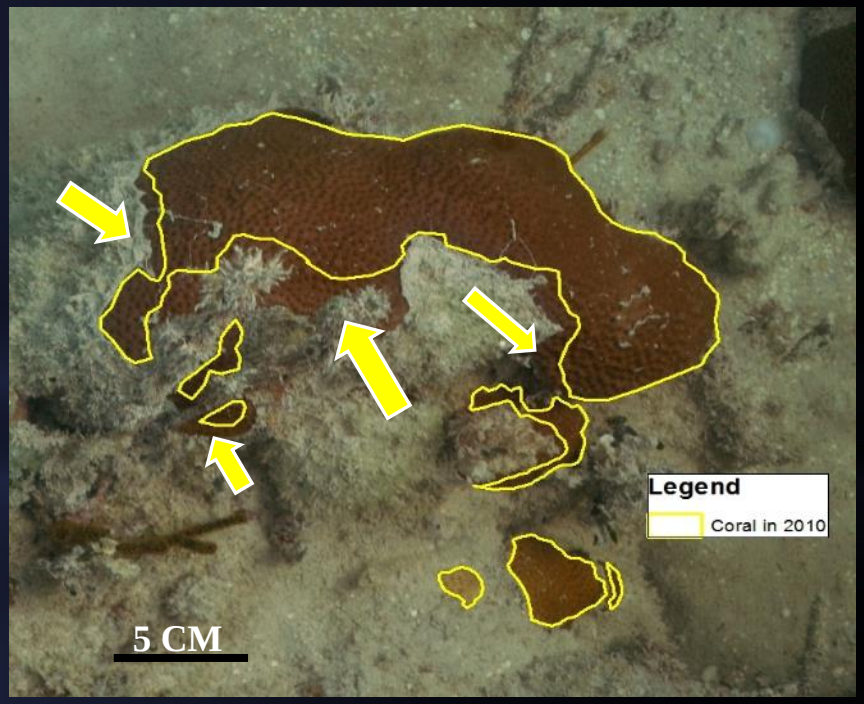


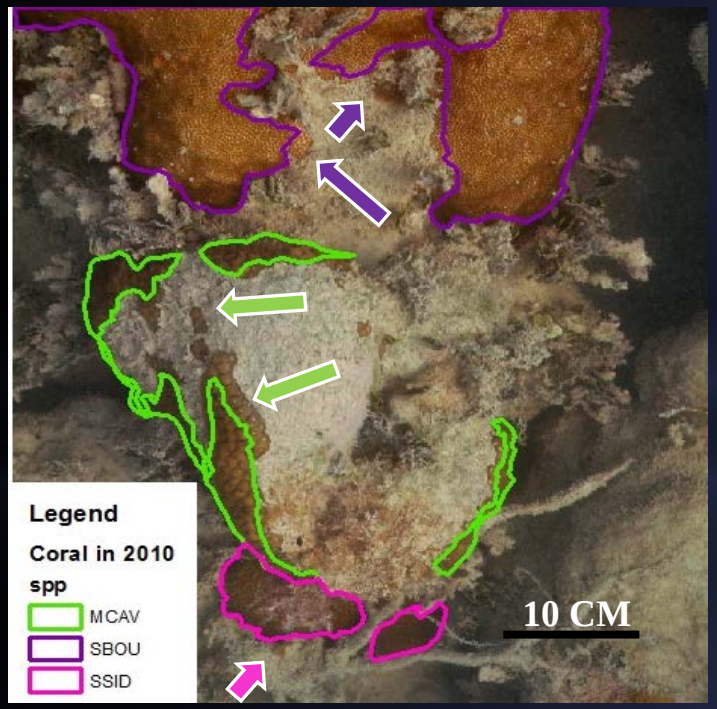
Mosaic Benefit: Change Detection

- Recovery
- Time-scales of recovery can be decades – centuries
- Colony-recovery can be a health indicator

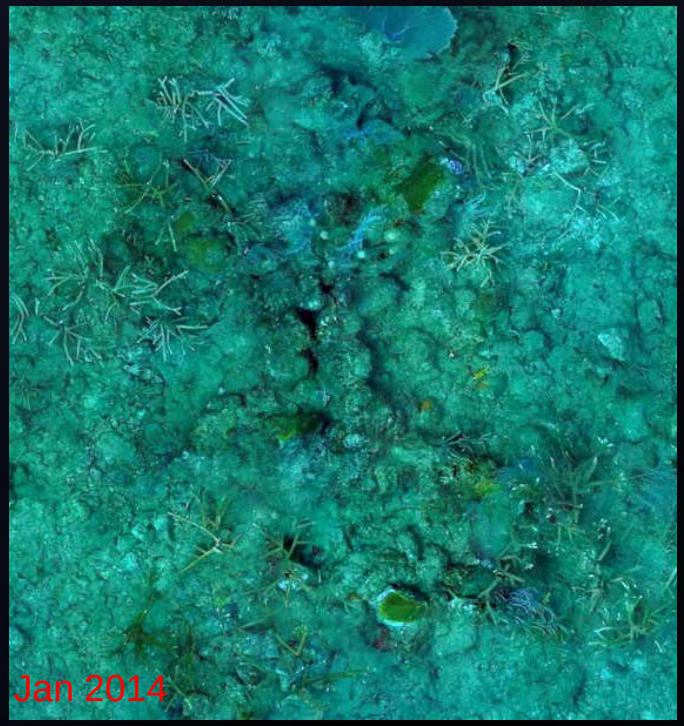


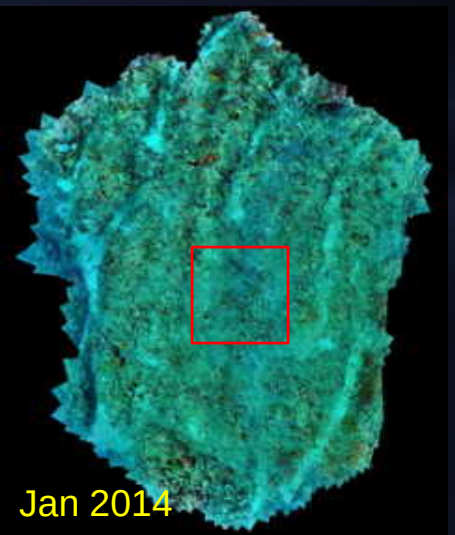


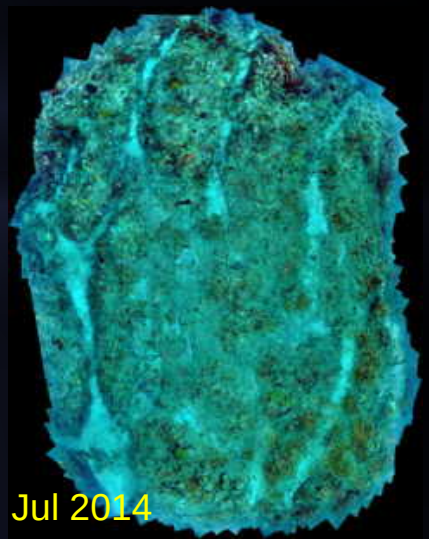


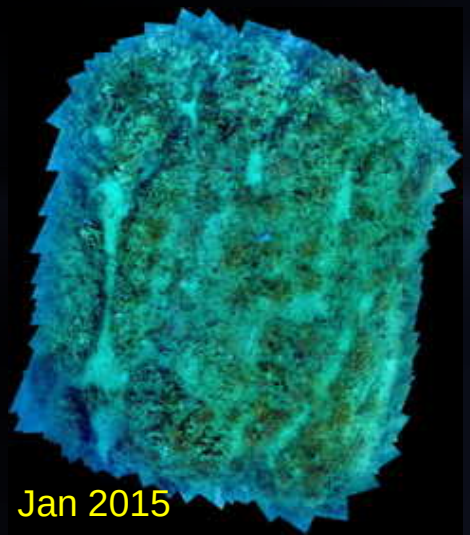


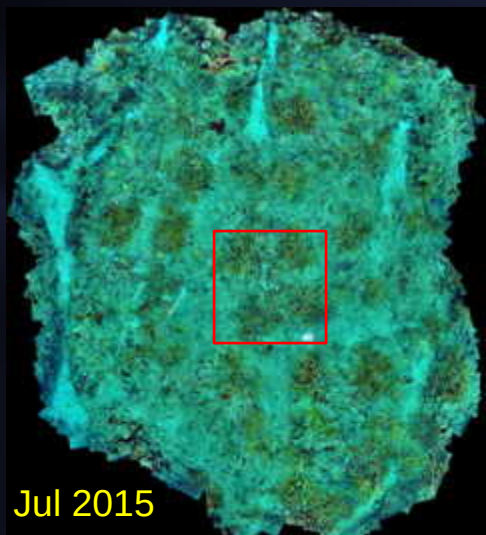
Coral Restoration at Matthews

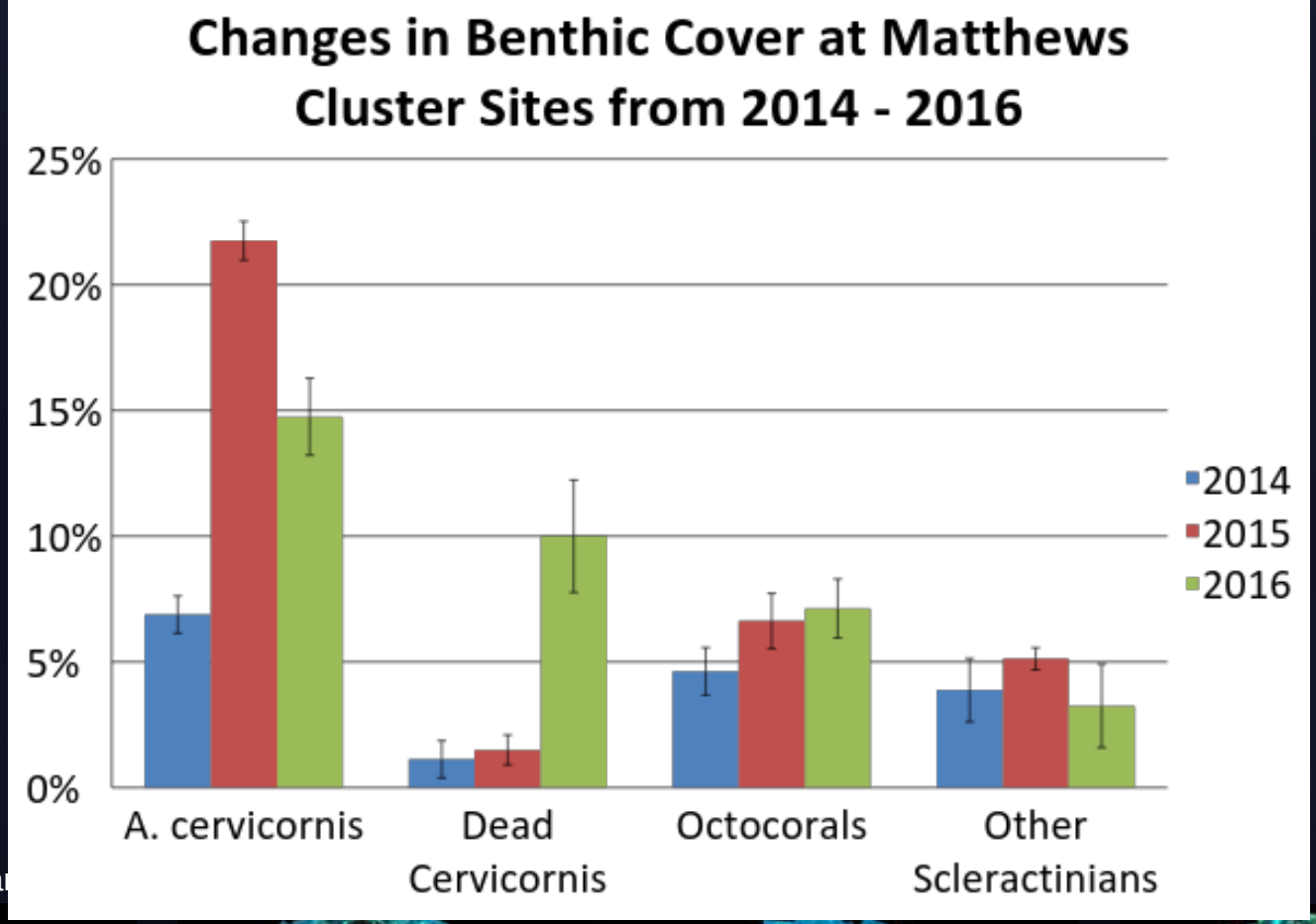




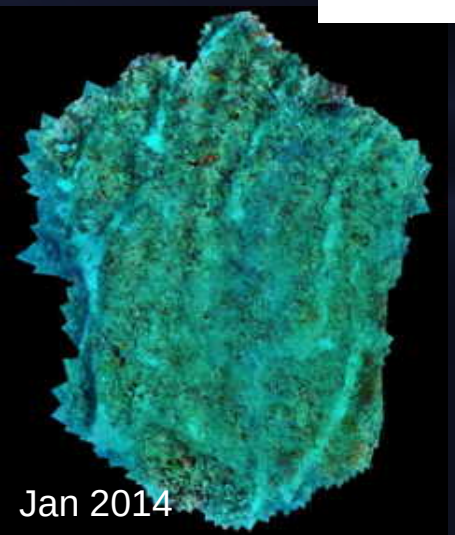


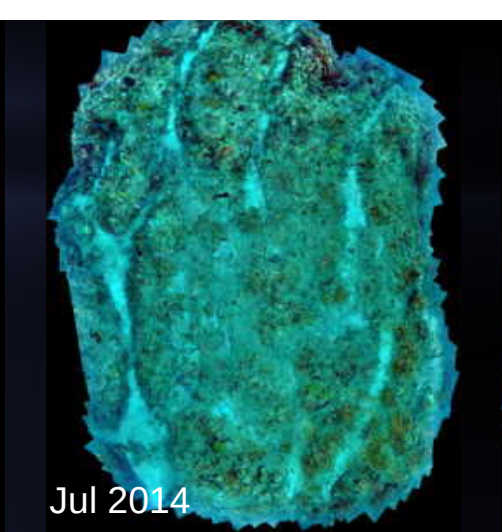


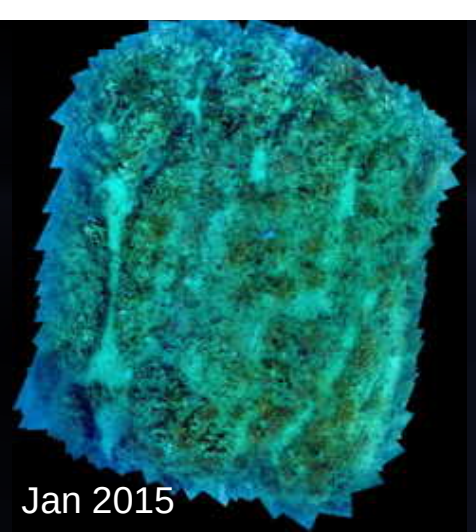


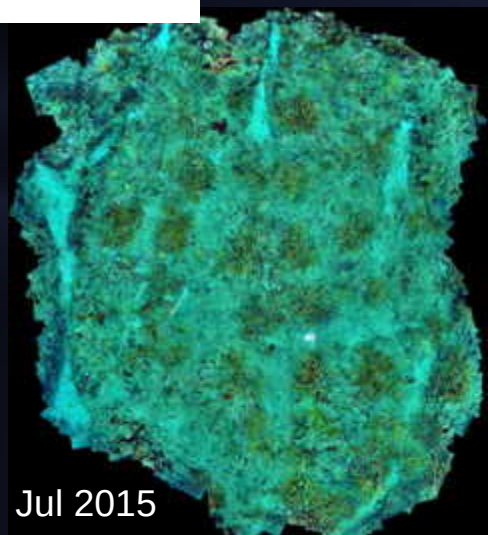


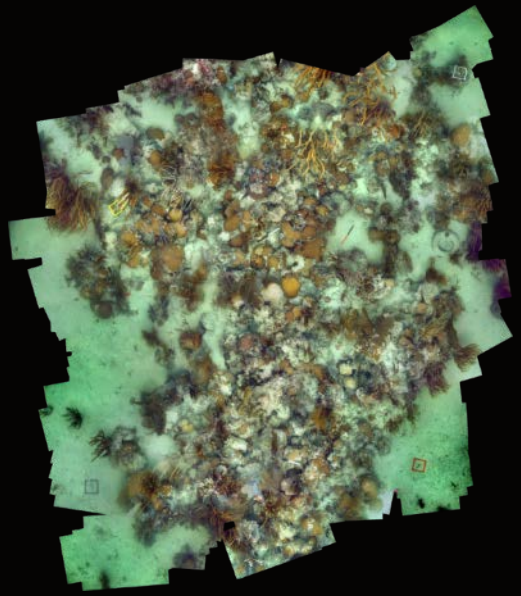
Error bars +/- standar





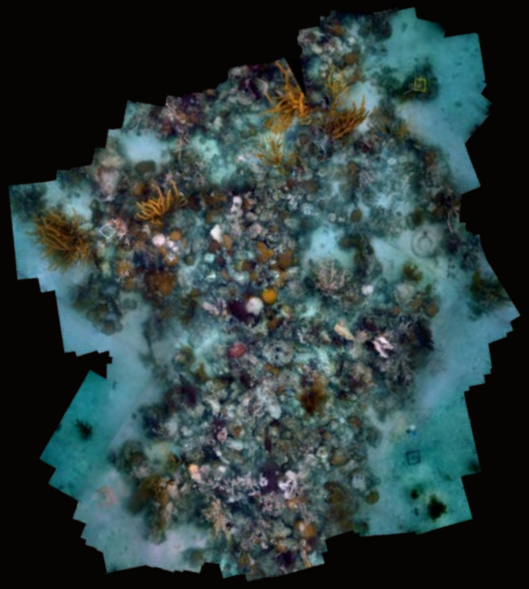






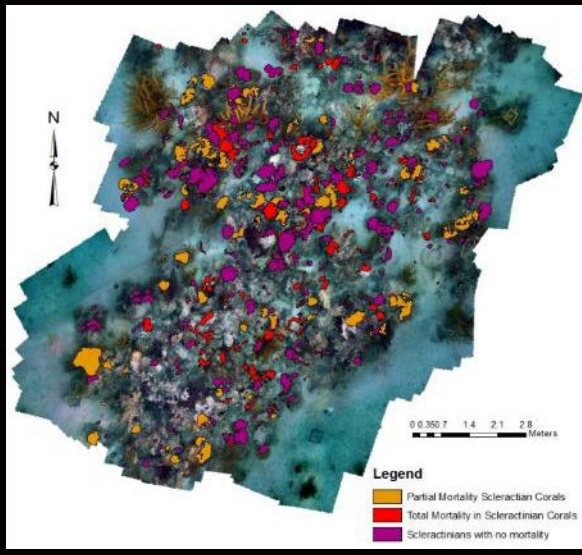
Document

- Entire benthic communities



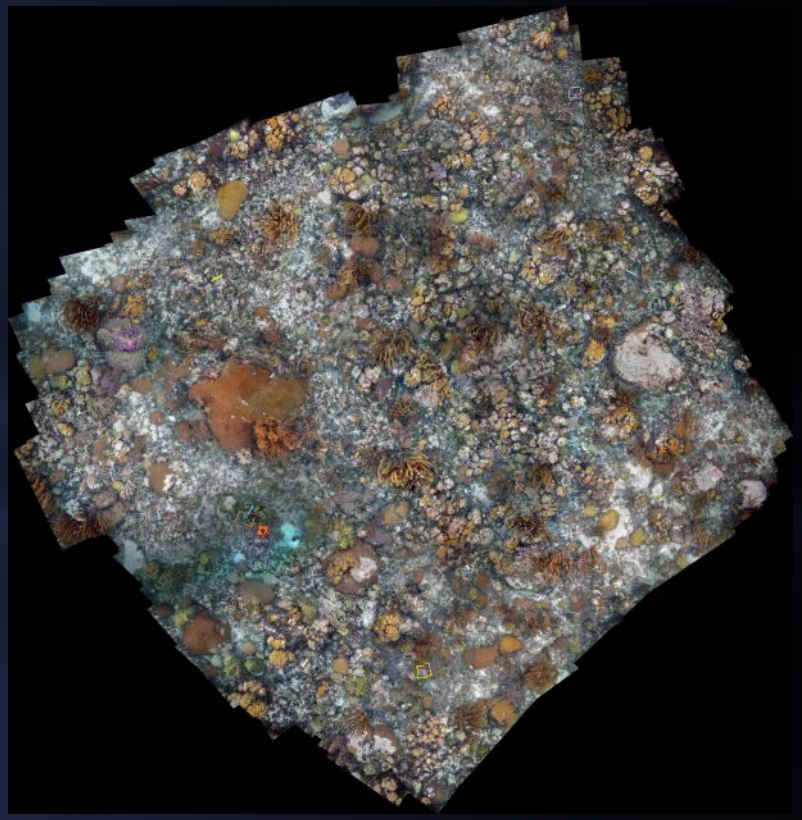
Measure Change

- Don’t have to predict what is going to happen

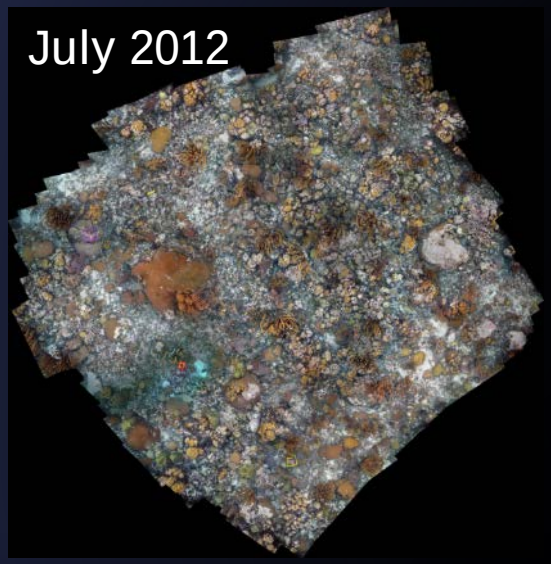


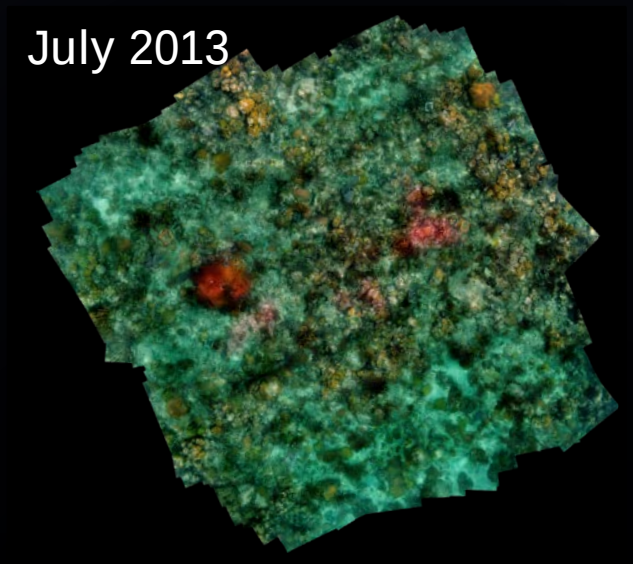
Link patterns/ processes

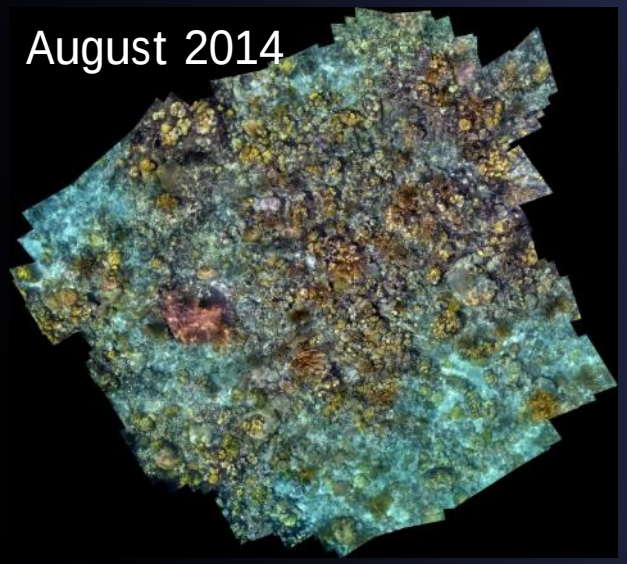
- Better information = better prediction



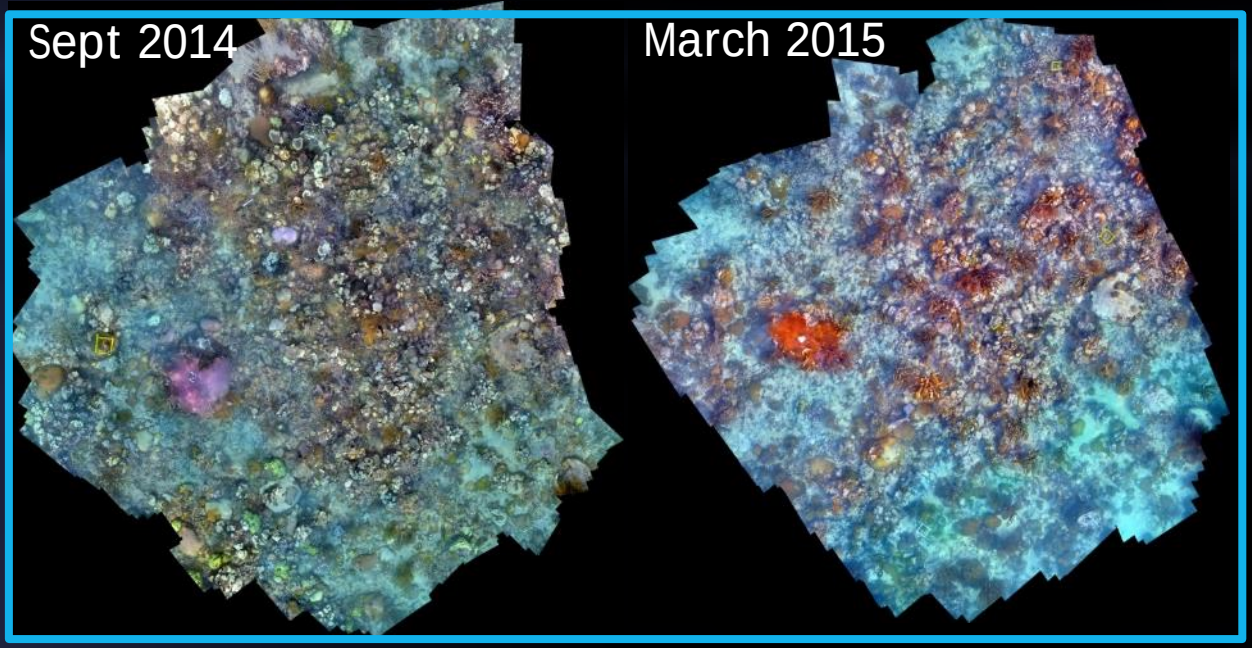
* Cheeca Rocks, Florida Keys
  * 6 sites established
  * Inshore patch reef
  * Coral cover
* NOAA's National Coral Reef Monitoring Program (NCRMP)
* Mosaic sampling 2012-present
* Additional sampling September 2014 and March 2015 to document the effect of mass bleaching on coral community

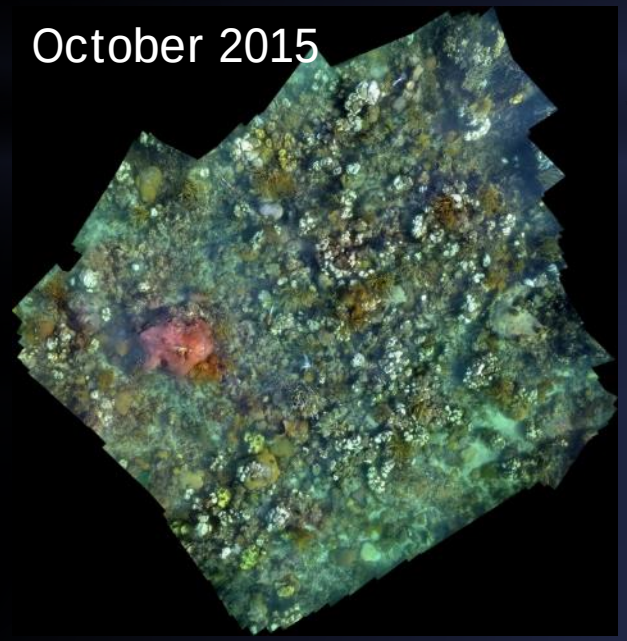




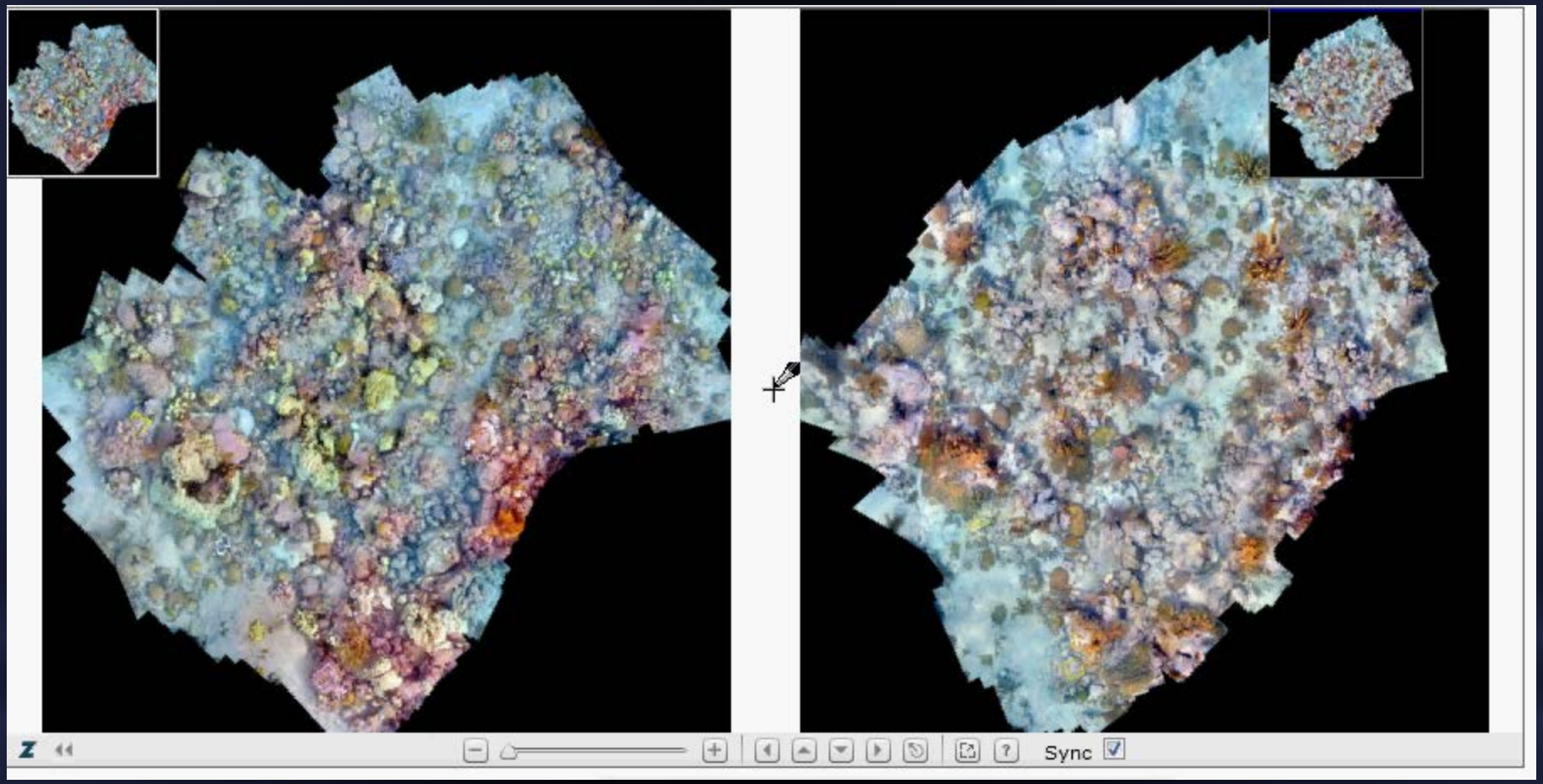


New Approach to Monitoring

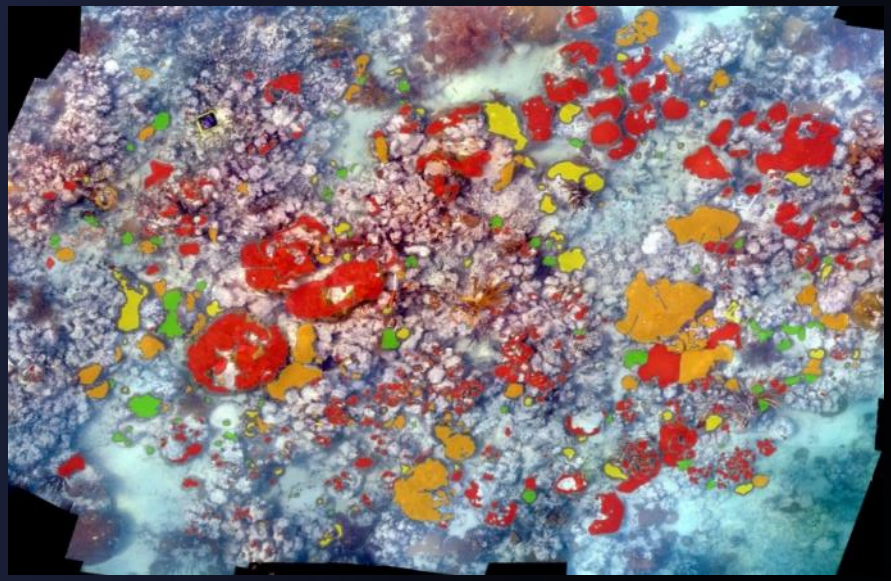




A Mosaic View of Coral Reefs

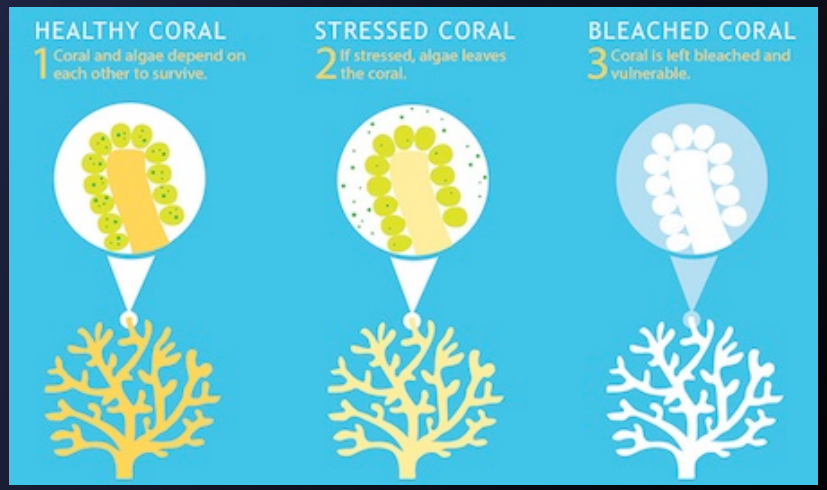


Fate Tracking

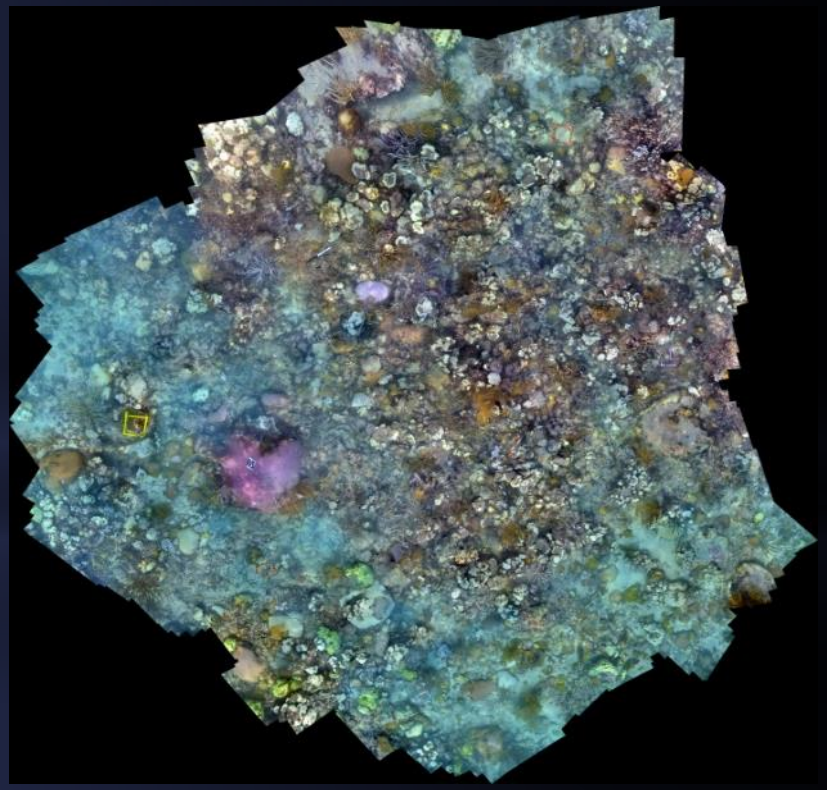


None
Pale
Partially Bleached
Bleached
Complete Mortality

- Digitized and track changes in all corals within the field of view
- >5,000 colonies
- Why use this level of detail?
  - OA study site – Provides a detailed record of health for carbonate budget analysis
  - 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



www.noaa.gov



* Using detailed community information from a bleaching event we can ask interesting questions:

* Are some species more resistant to bleaching?

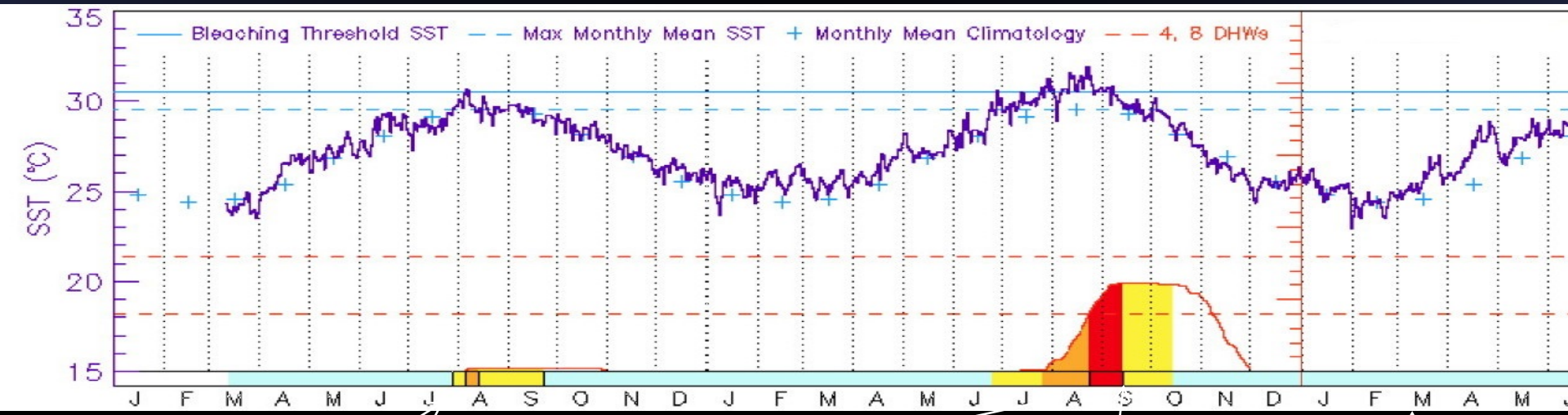
* Is bleaching susceptibility a precursor to mortality?

* Are there any factors that predispose a coral to mortality during a bleaching event?

2014 Bleaching Event

Average annual maximum
Annual max + 1 C
Florida Keys Record

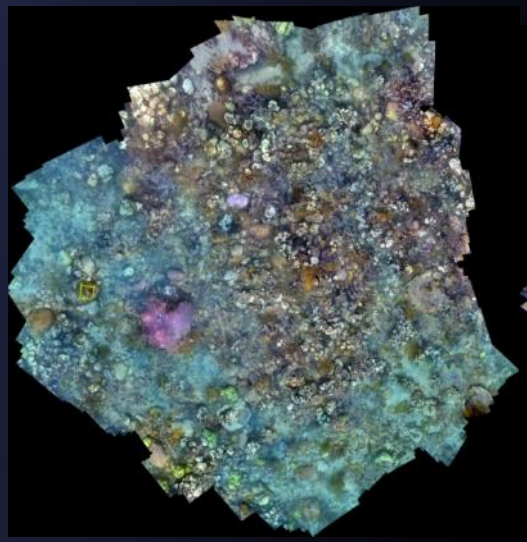
No Stress
Watch
Warning
Alert



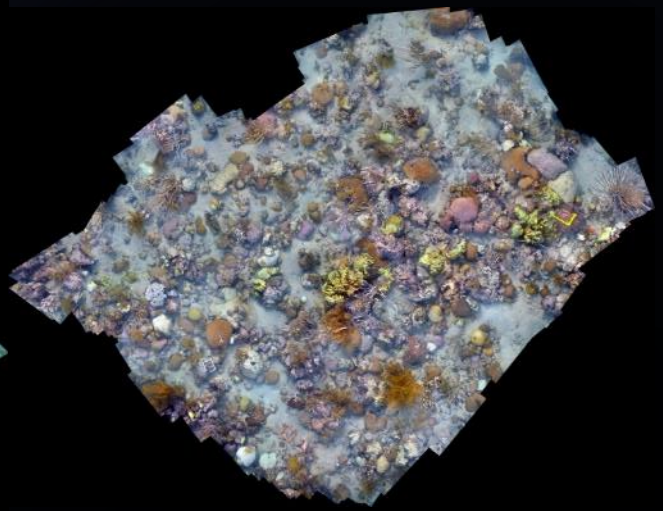
2013

2014

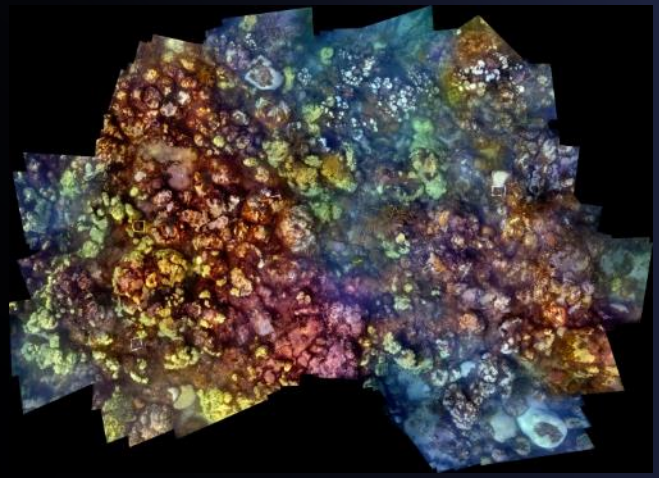
2015



Transect 1- 82.5%



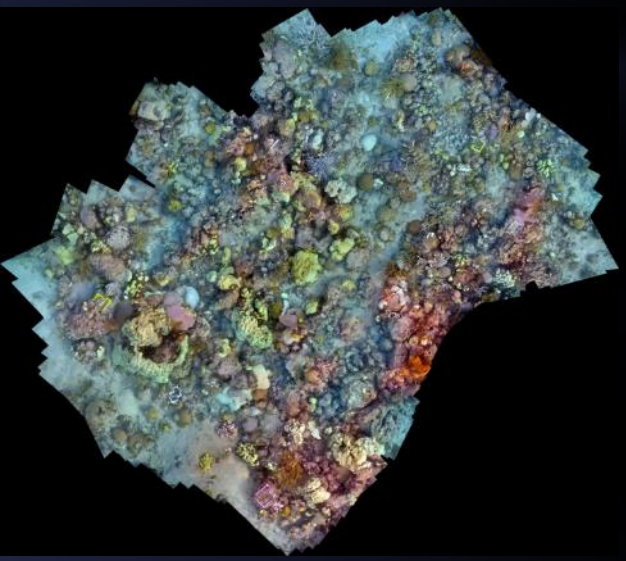
Transect 2= 50.3%



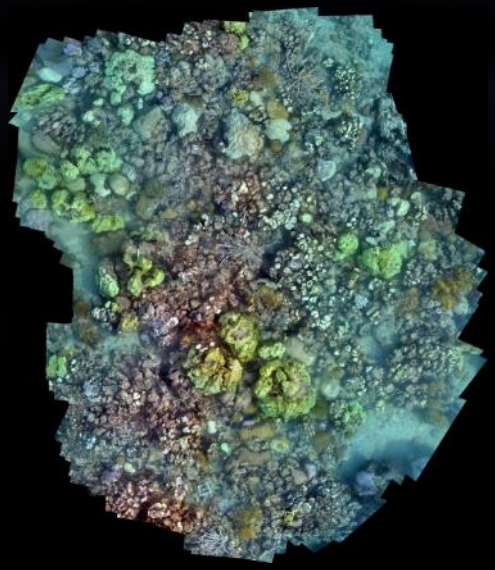
Transect 3= 84.2%

Total %Bleached = 72.8%

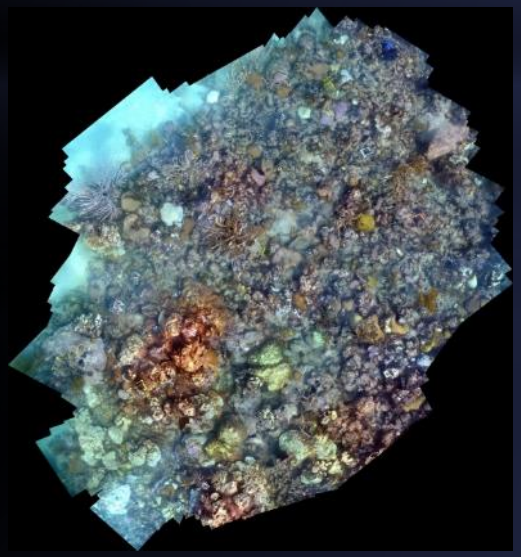
Transect 4= 69.8%



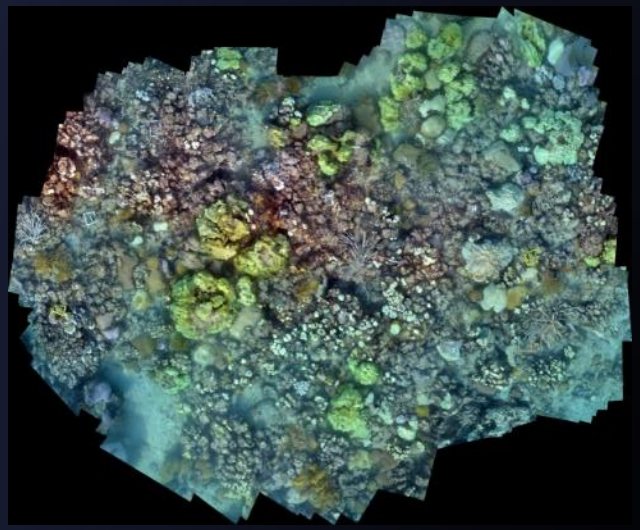
Transect 5= 84.7%



Transect 6= 68.4%

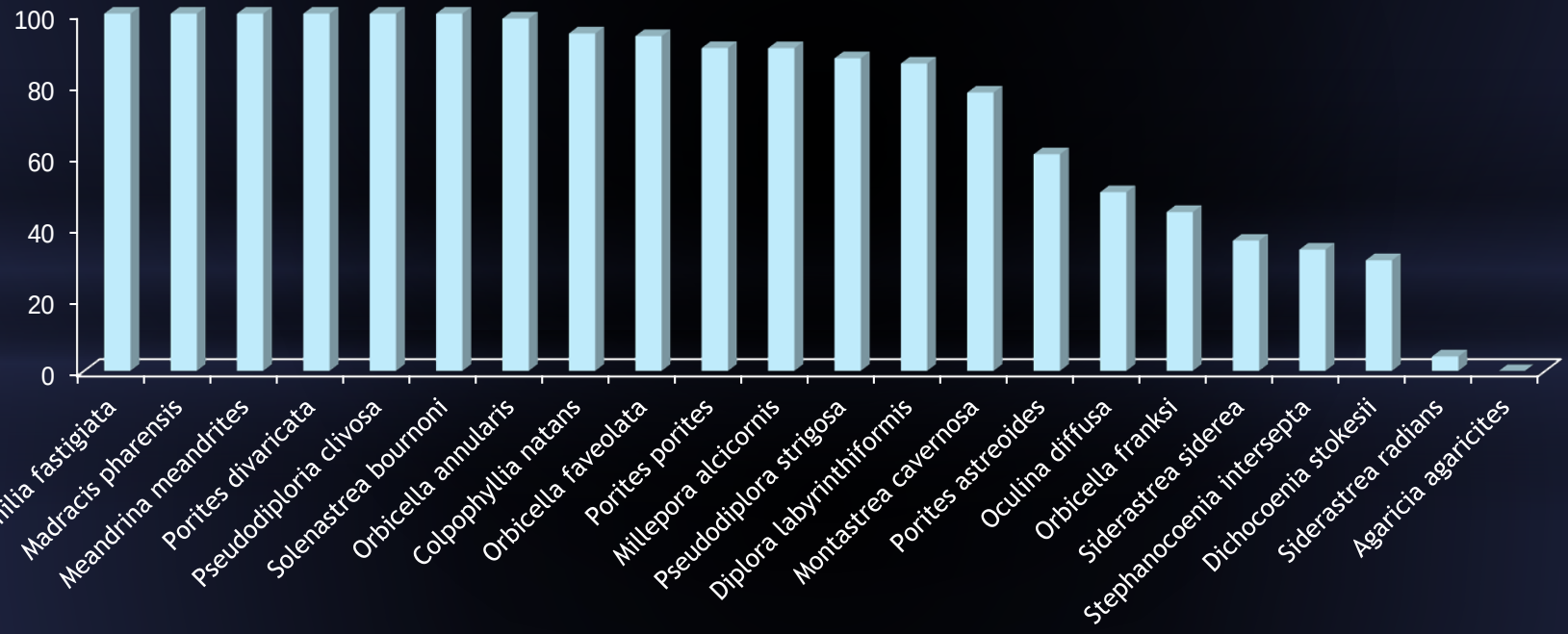


Bleaching Susceptibility

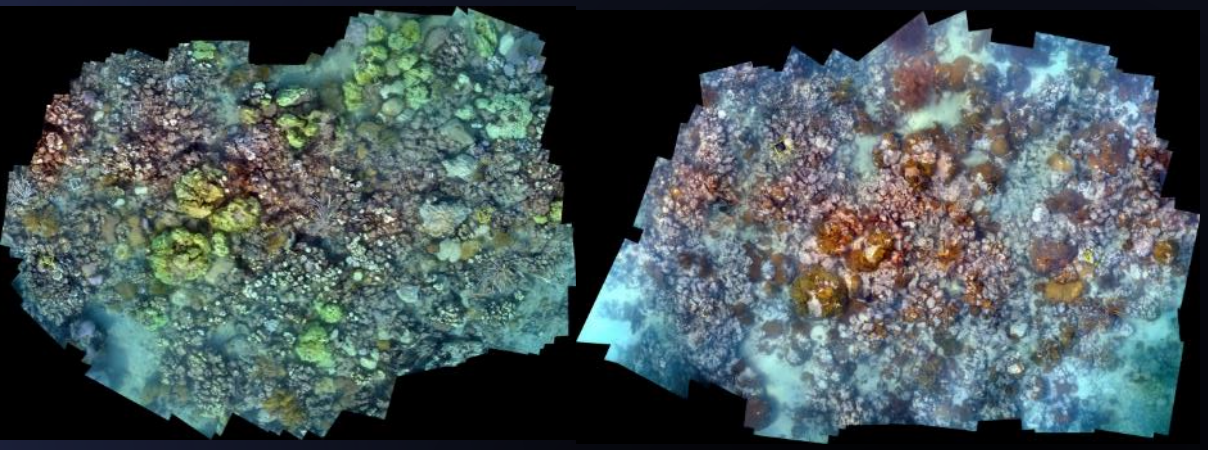


% Bleached Range: 49%-83%
All Sites: 71%
11 out of 22 species >90% bleached

Pseudodiploria clivosa – 100%
Orbicella annularis – 99%
Siderastrea siderea- 37%
Stephanocoenia intersepta- 35%



Bleaching Recovery

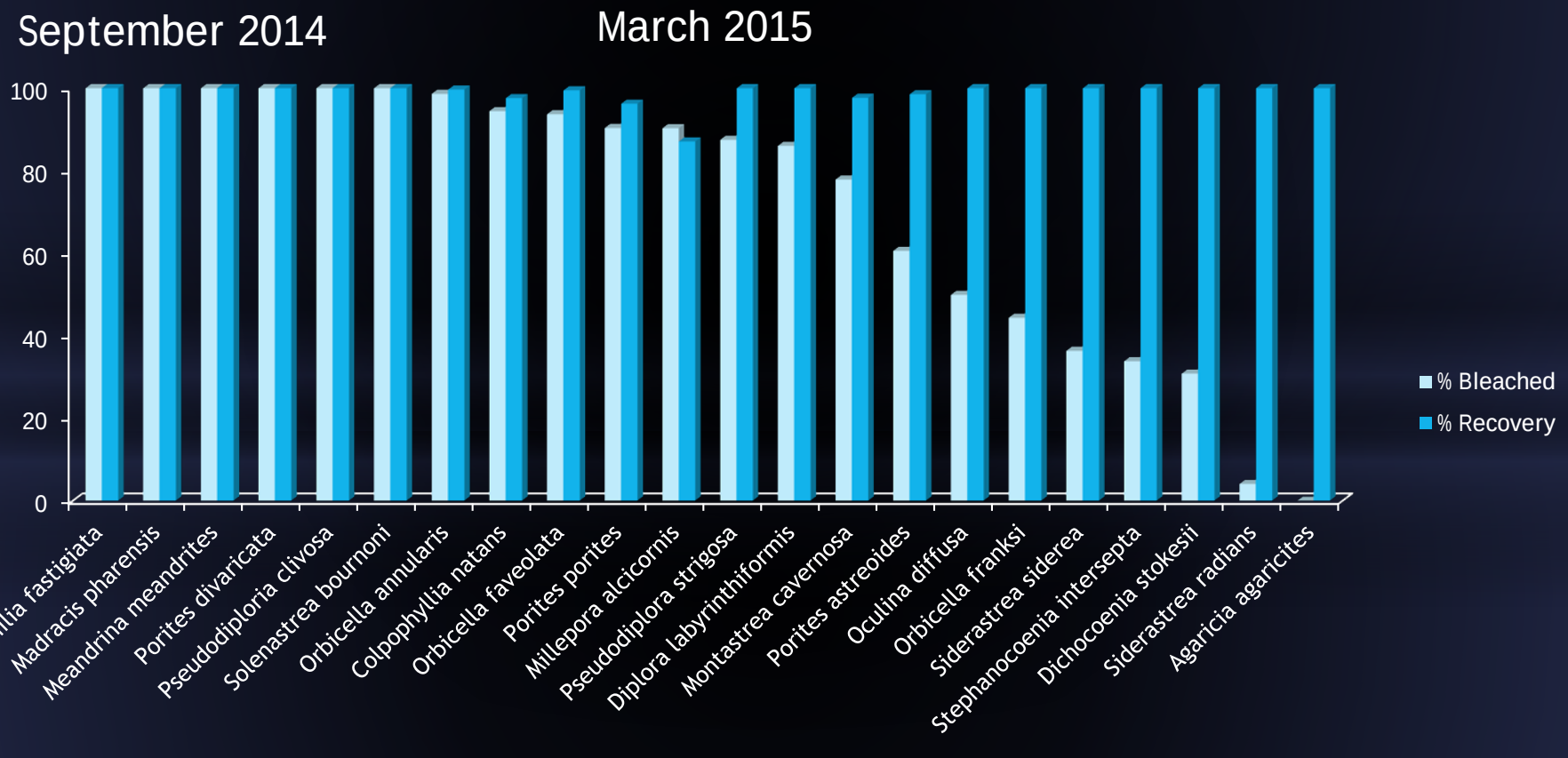


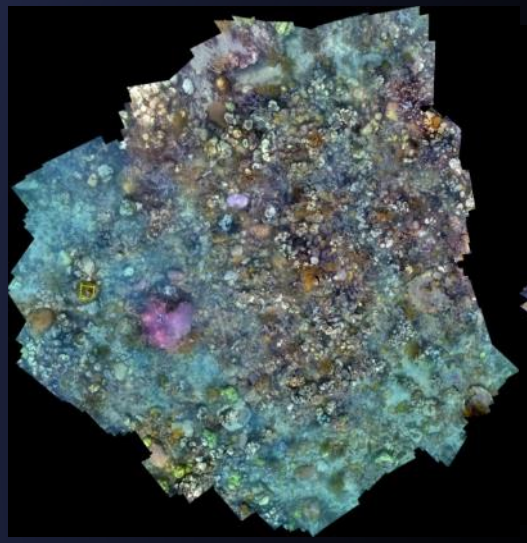
Coral bleached 2014 was it still there in 2015?

15 species 100% survivorship

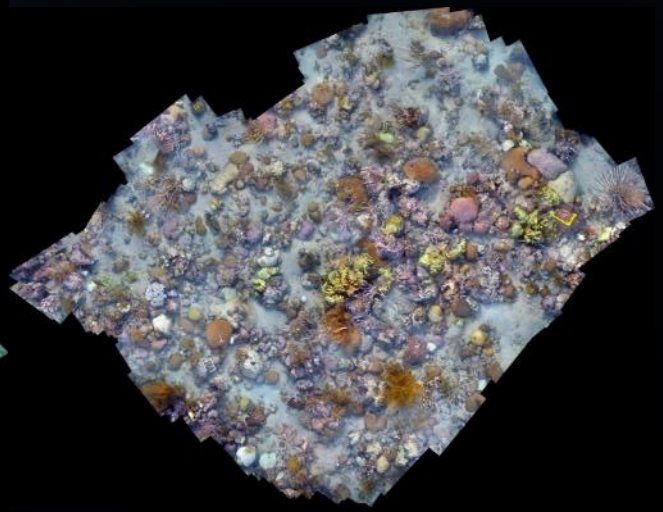
21 >96% survivorship

99% Survival

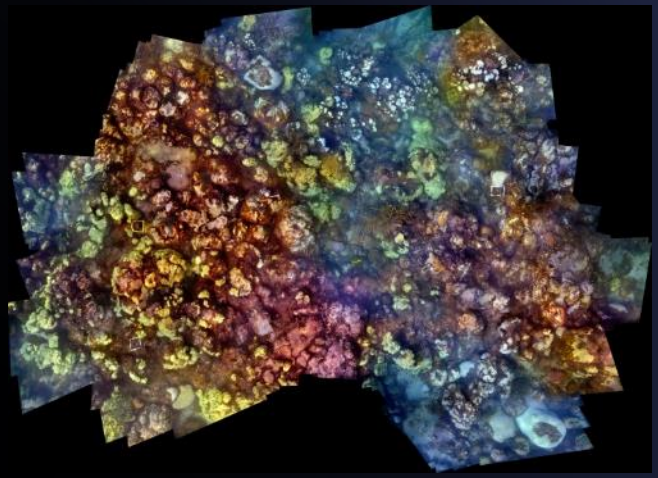




Transect 1=-3.4%



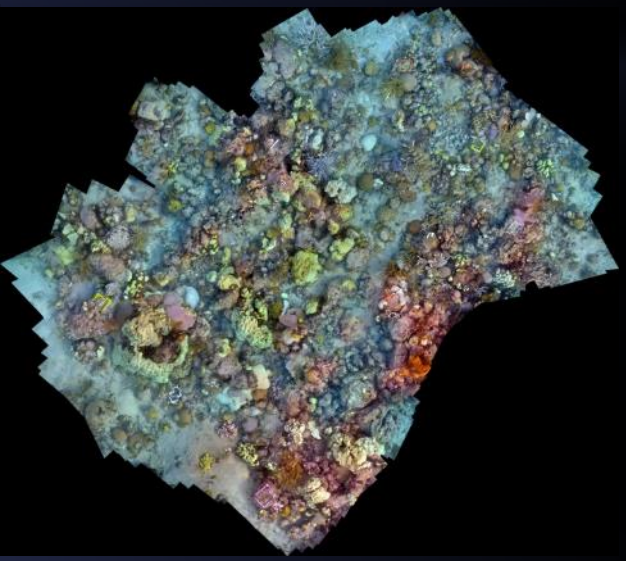
Transect 2=-7.8%



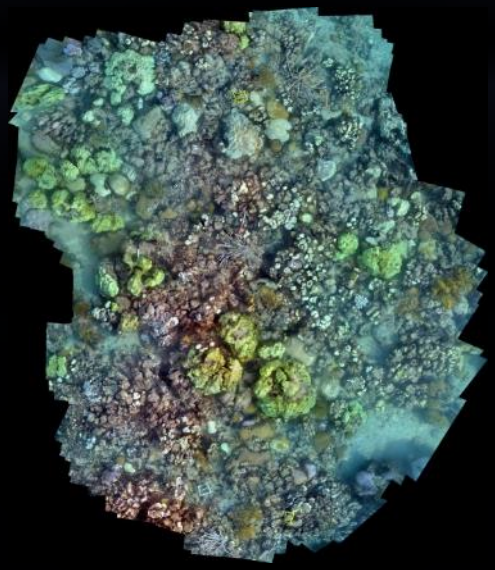
Transect 3= -3.0%

Total Tissue loss = -3.7%

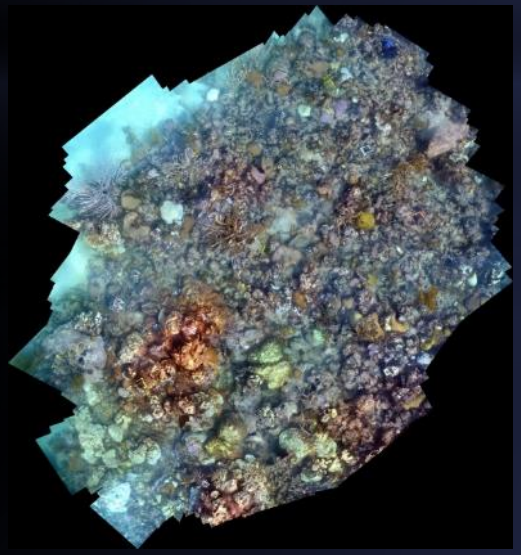
Transect 4= -3.5%



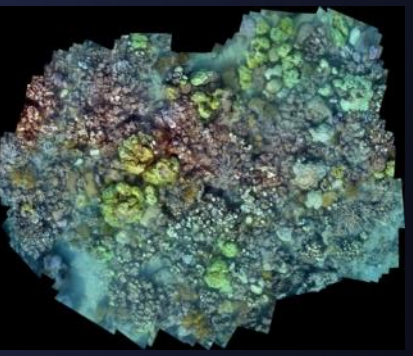
Transect 5= -1.3%



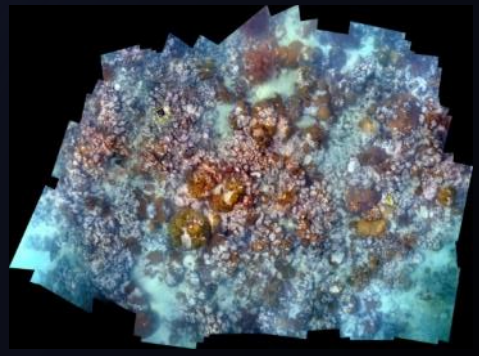
Transect 6= -1.6%



Partial Mortality following bleaching



September 2014

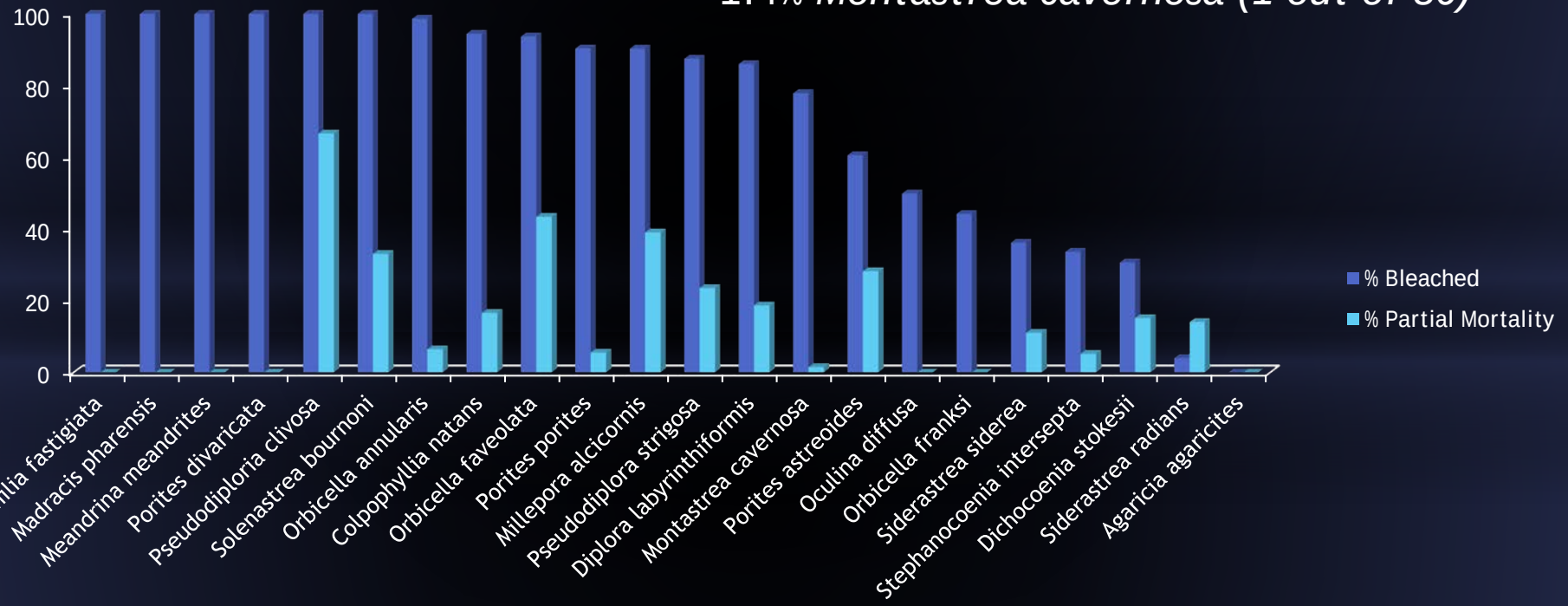


March 2015

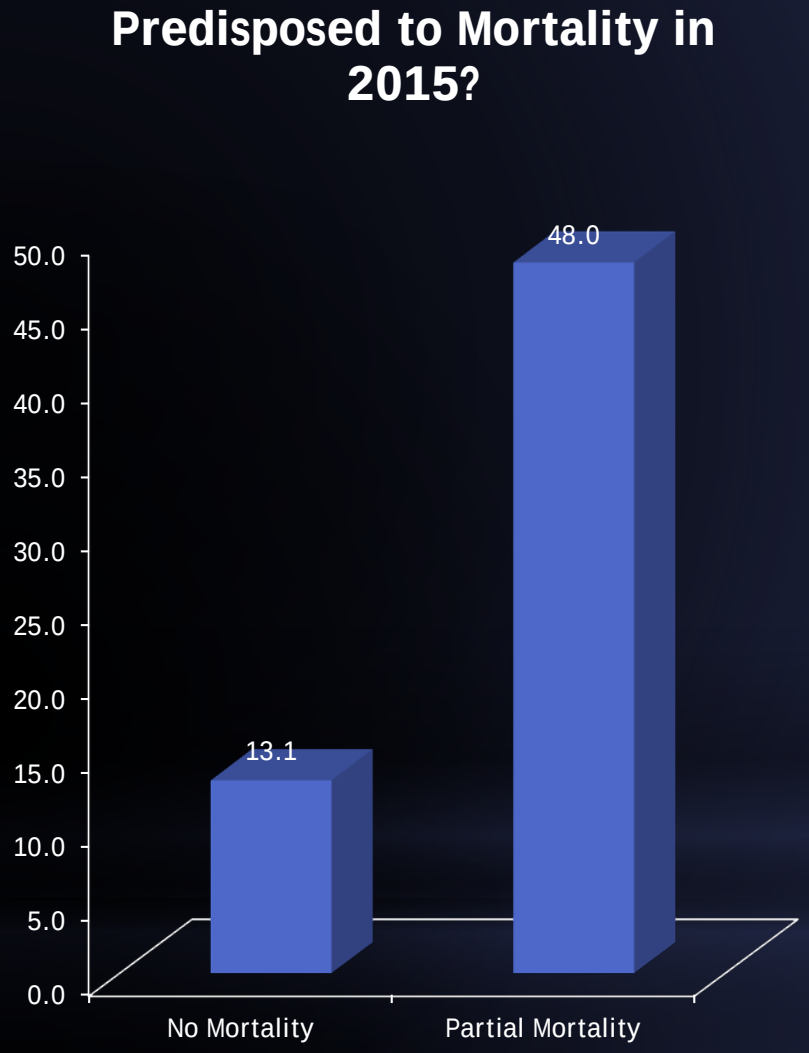
If a coral bleached in 2014 did it loose tissue?

12.5% overall v.s ~5% 2003-2011 (Lirman et al, 2014)

66.6% Pseudodiploria clivosa(4 of 6)
43.6% *Orbicella faveolata* (240 of 550)
28.5% *Porites astreoides* (155 out of 544)
6.6% of *Orbicella annularis* (80 out of 1218)
1.4% *Montastrea cavernosa (1 out of 86)*

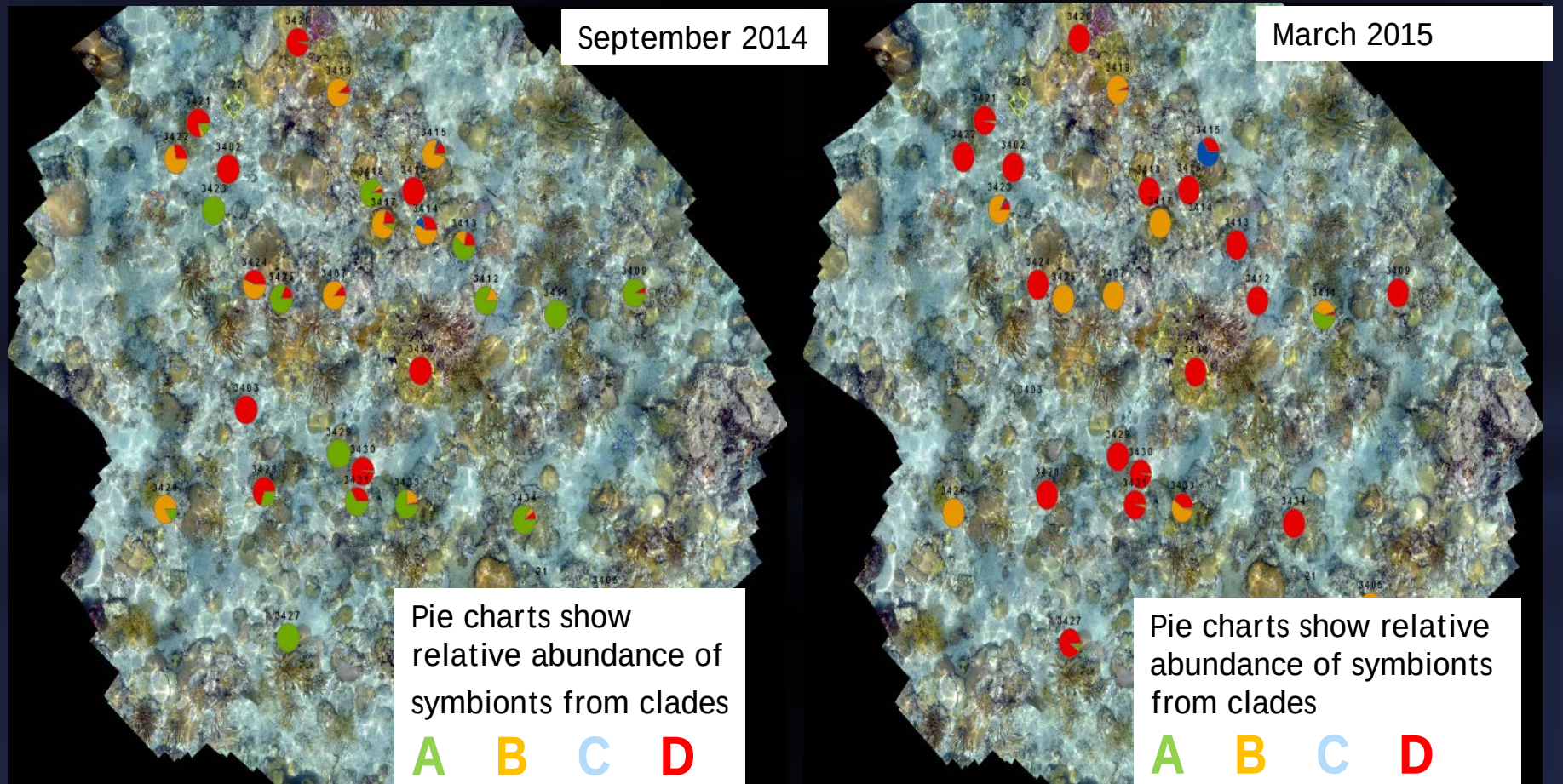


Fate-Tracking:Bleaching Resilience



- Not isolated events
- Help explain some of the variability in mortality
- Important as we move closer to periods when yearly bleaching is estimated to occur

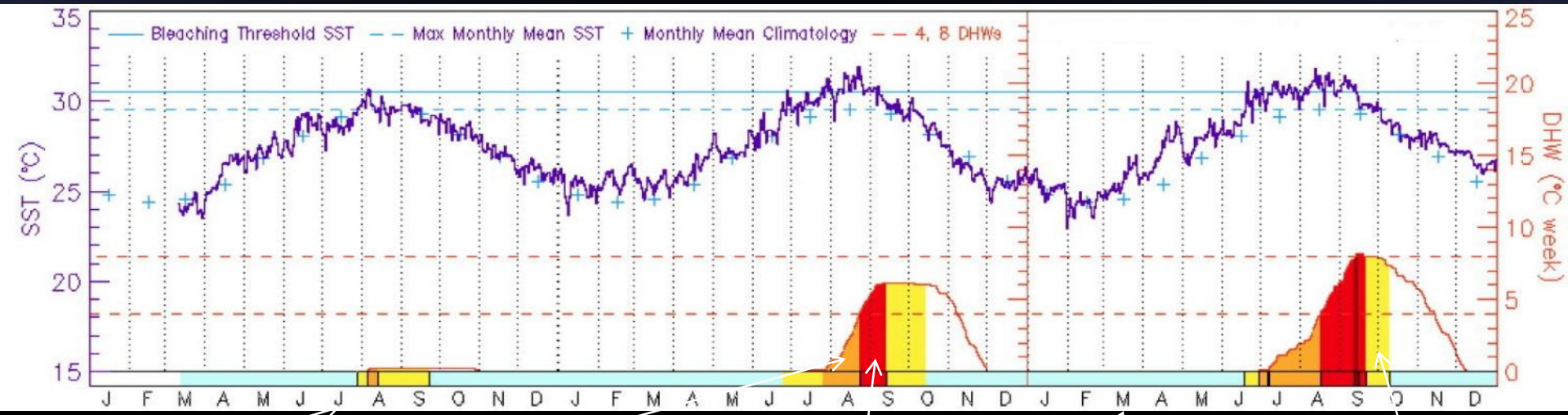
* Mosaics provide a demographic context for other work
* Paul Jones- Symbiont communities of *O. faveolata* during and following the 2014 mass bleaching
* Shift to Clade D coincided with reduced bleaching of *O. faveolata* in Summer 2015



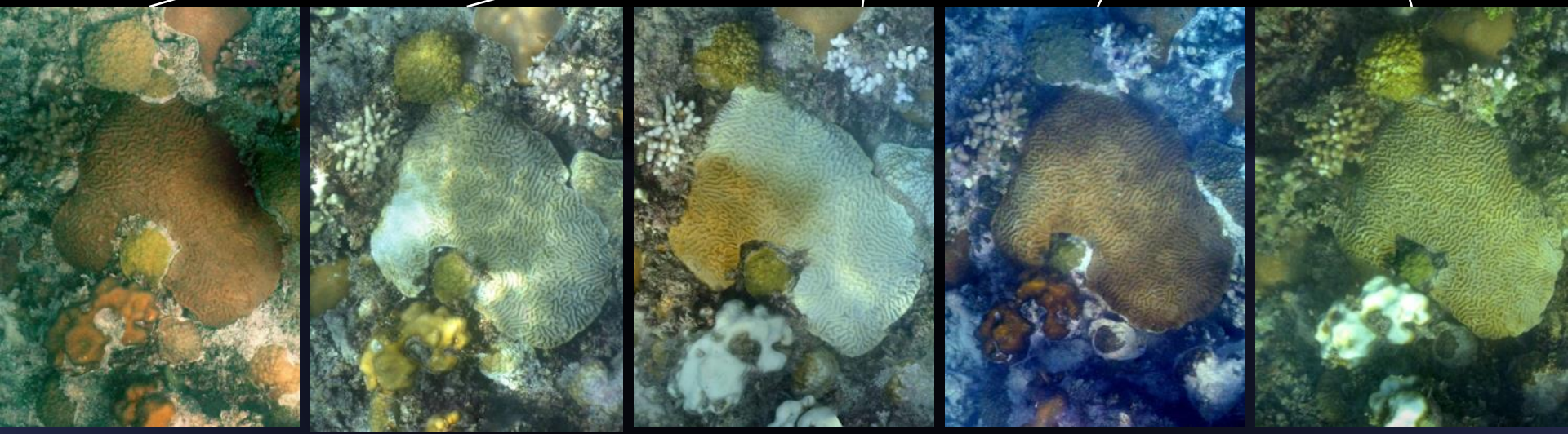
2014 and 2015 Bleaching Event

Average annual maximum
Annual max + 1 C

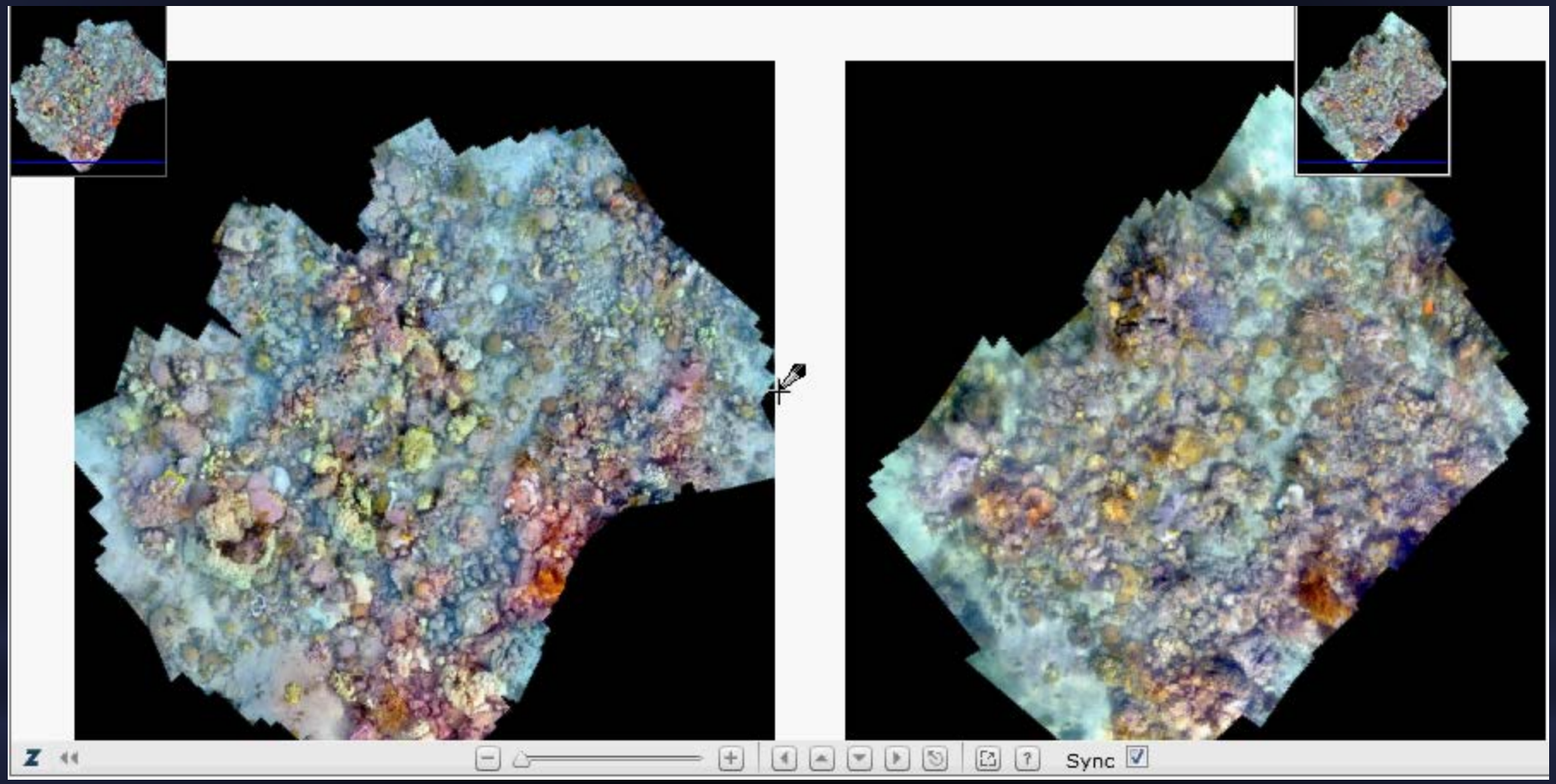
No Stress
Watch
Warning
Alert

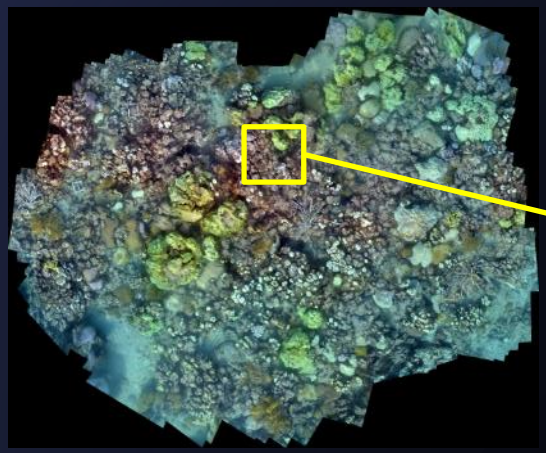


2013 2014 2015



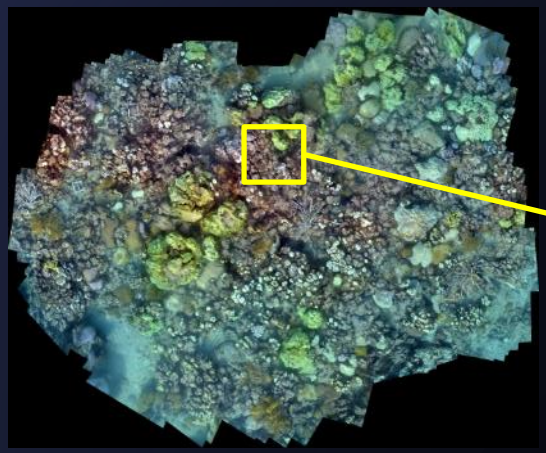
Bleaching 2014 vs. 2015





Identify resilient/resistant or susceptible corals with MINIMAL field time

* We can use new technologies to rapidly capture health information on 1,000's of corals in a single dive and analyze them in the lab
  * Eliminate Shifting Baselines
* We can also now SHOW and TELL the affects of various disturbances in a side-by-side view.
* September 2014 bleaching event- Coral communities can be resilient to moderate/severe bleaching
* Total coral mortality was rare (<1%)



Identify resilient/resistant or susceptible corals with MINIMAL field time

* Not isolated events. Previous mortality increases likelihood of mortality during thermal events

* Shift in algal symbiont communities maybe a very important resilience mechanism

* Natural Experiment-Two years of bleaching and recovery information

* Answer questions on resistance and resilience under multi-year bleaching conditions

THANK YOU