KAUA'I BLACK BAND DISEASE

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Overview

- *Coral Reef Biology*
- *History of the Black Band Disease*
- *Current Research & Findings*
- *Way Forward*

IMPORTANCE OF CORAL REEFS

Biodiversity

Habitat

IMPORTANCE OF CORAL REEFS

Shoreline Protection

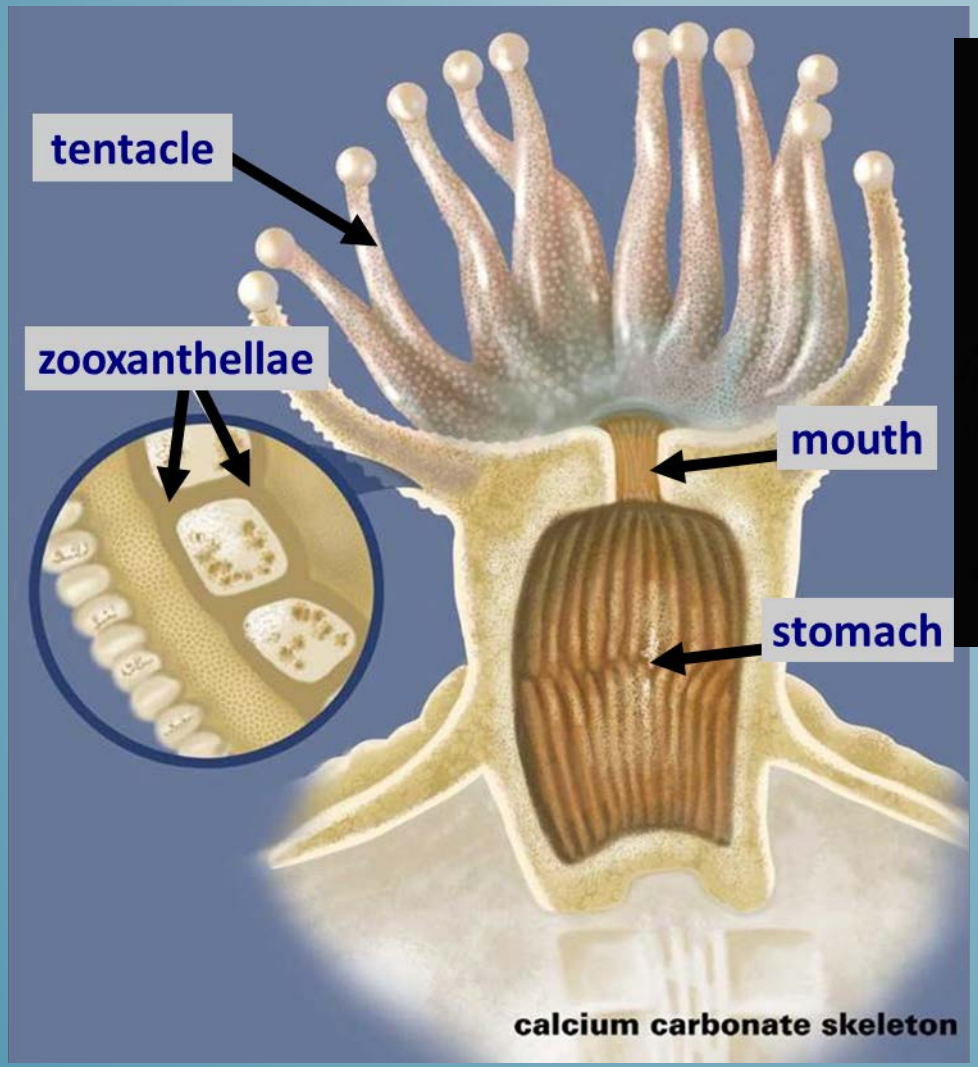
Tourism

IMPORTANCE OF CORAL REEFS

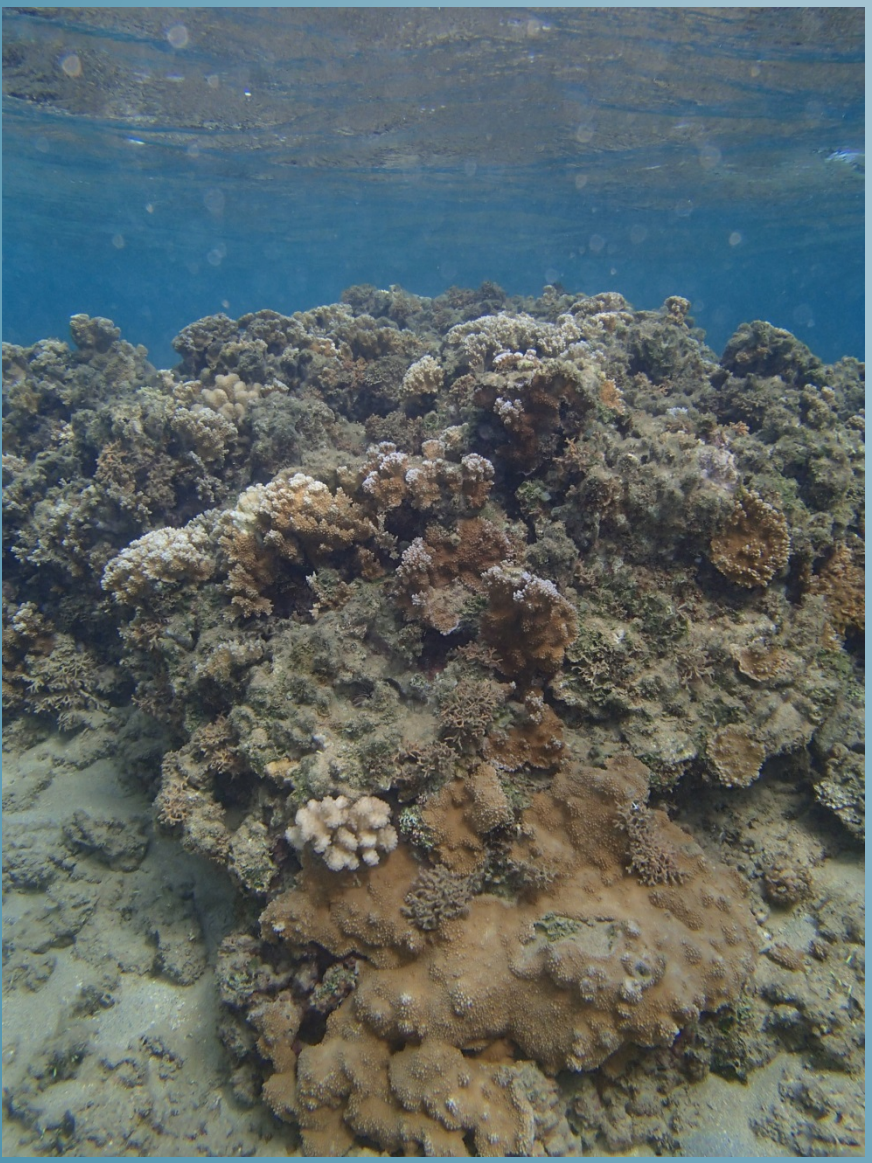
Cultural Uses

Resources

CORAL BASICS



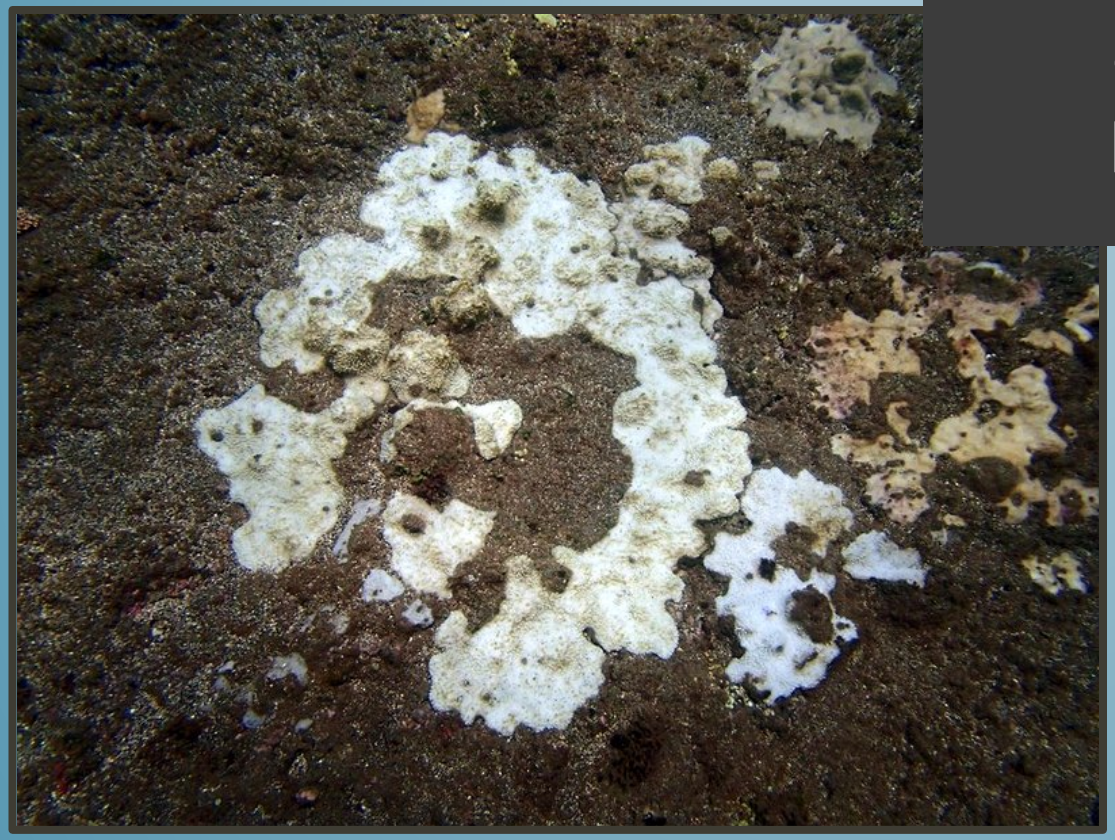
CORAL BASICS



Coral Habitat Requirements:

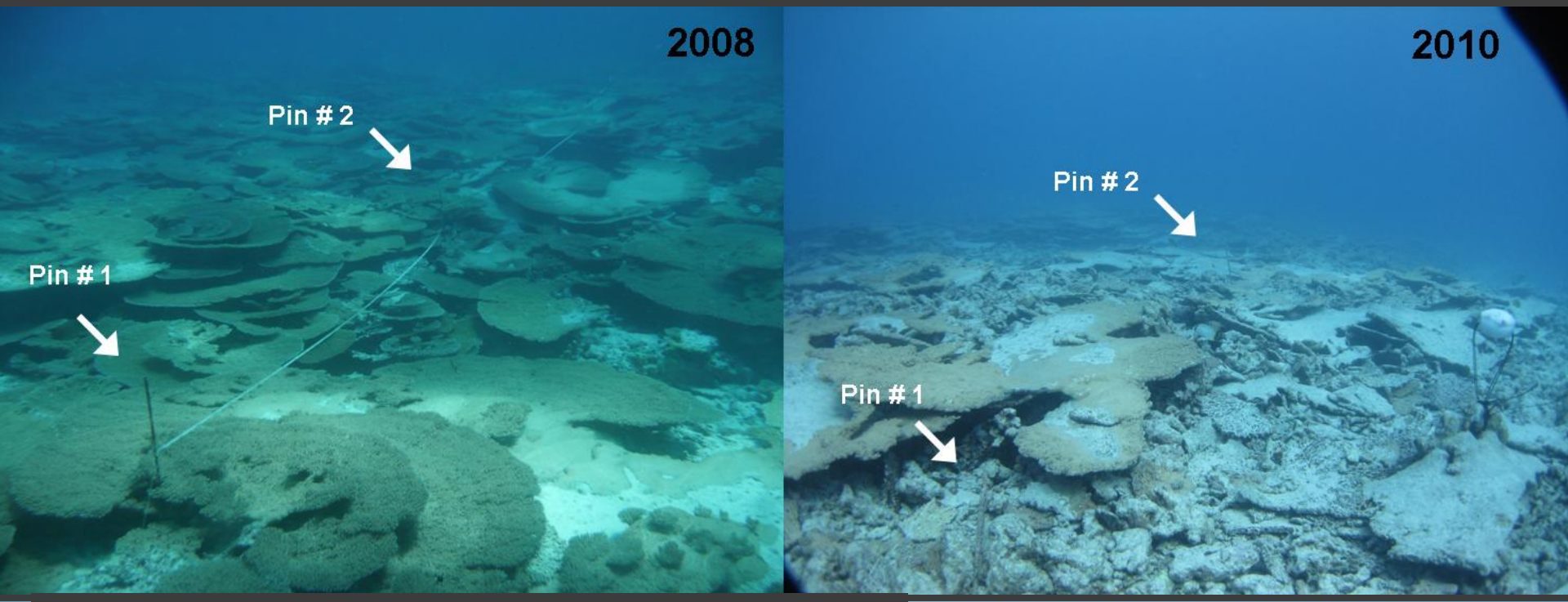
- *Nutrient poor, clear water*
- *Saline waters*
- *Warm temperatures*
- *Wave action*

CORAL STRESSORS



Sedimentation & Freshwater Input

CORAL STRESSORS



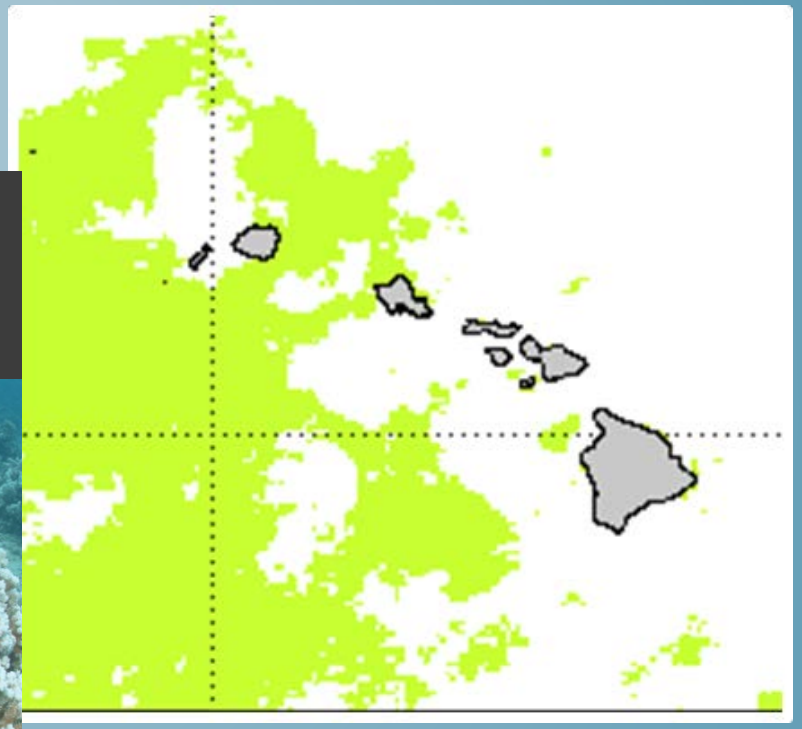
Physical Damage

CORAL STRESSORS

Resource Extraction

CORAL STRESSORS

Climate Change



CORAL STRESSORS

Land-based Pollution

CORAL DEVELOPMENT NORTH SHORE KAUA'I

- *Dynamic & relatively harsh environment*
  - *High wave energy*
  - *Heavy freshwater influx*
  - *High turbidity*
  - *Naturally high sediment load*
- *Low overall coral cover*

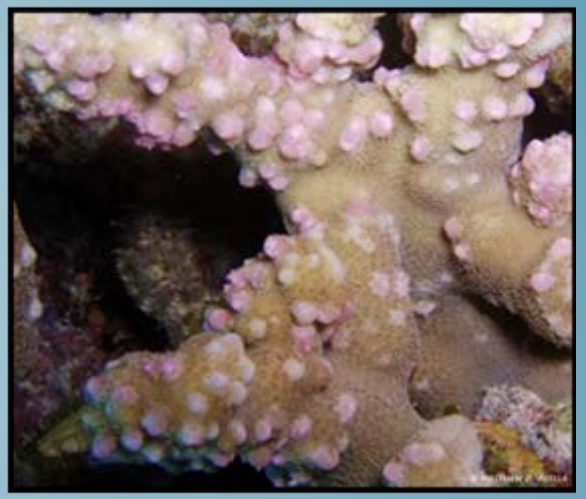
  Average 14%

  Source: Friedlander & Brown
- *Self-recruiting*

CORAL DISEASE

Tissue Loss

Growth Anomaly



Discoloration

- *Corals are living animals and as such are susceptible to disease.*
- *Disease is a natural aspect of populations and one mechanism by which population numbers are kept in check.*
- *Disease is defined as "any impairment to health resulting in physiological dysfunction."*

Source: Coral Disease Handbook

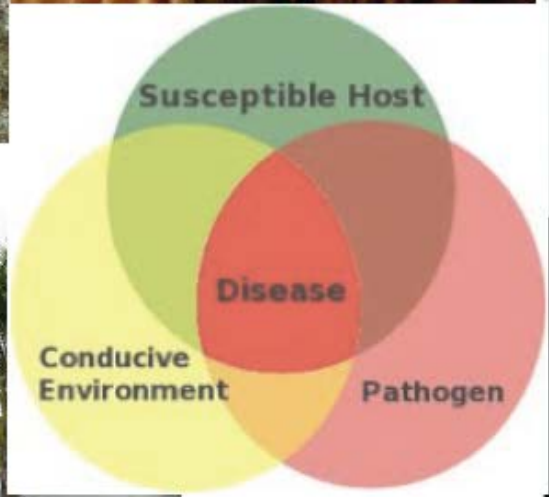
CORAL DISEASE

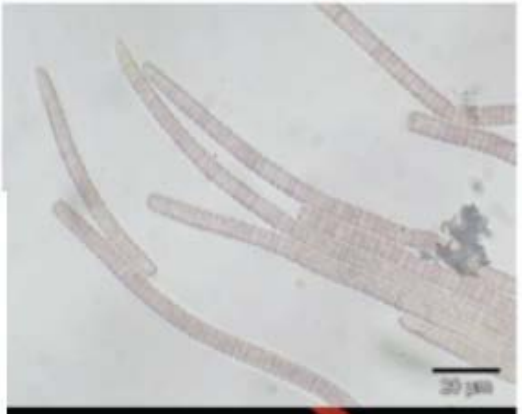
*What is the difference between **BACKGROUND** coral disease levels, a coral disease **OUTBREAK**, a coral disease **EPIDEMIC**, and a coral disease **PANDEMIC**?*

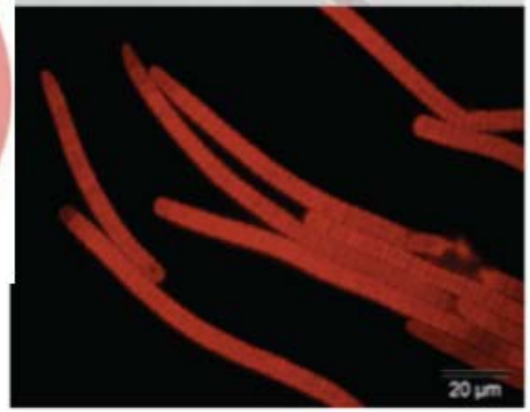
- ***Background levels:*** *the stable level of disease that can be seen under average conditions*
- ***Outbreak:*** *occurrence of cases of disease in excess of what would normally be expected*
- ***Epidemic:*** *disease substantially exceeds what is expected based on recent experience*
- ***Pandemic:*** *disease that has spread across a large region*

CORAL DISEASE

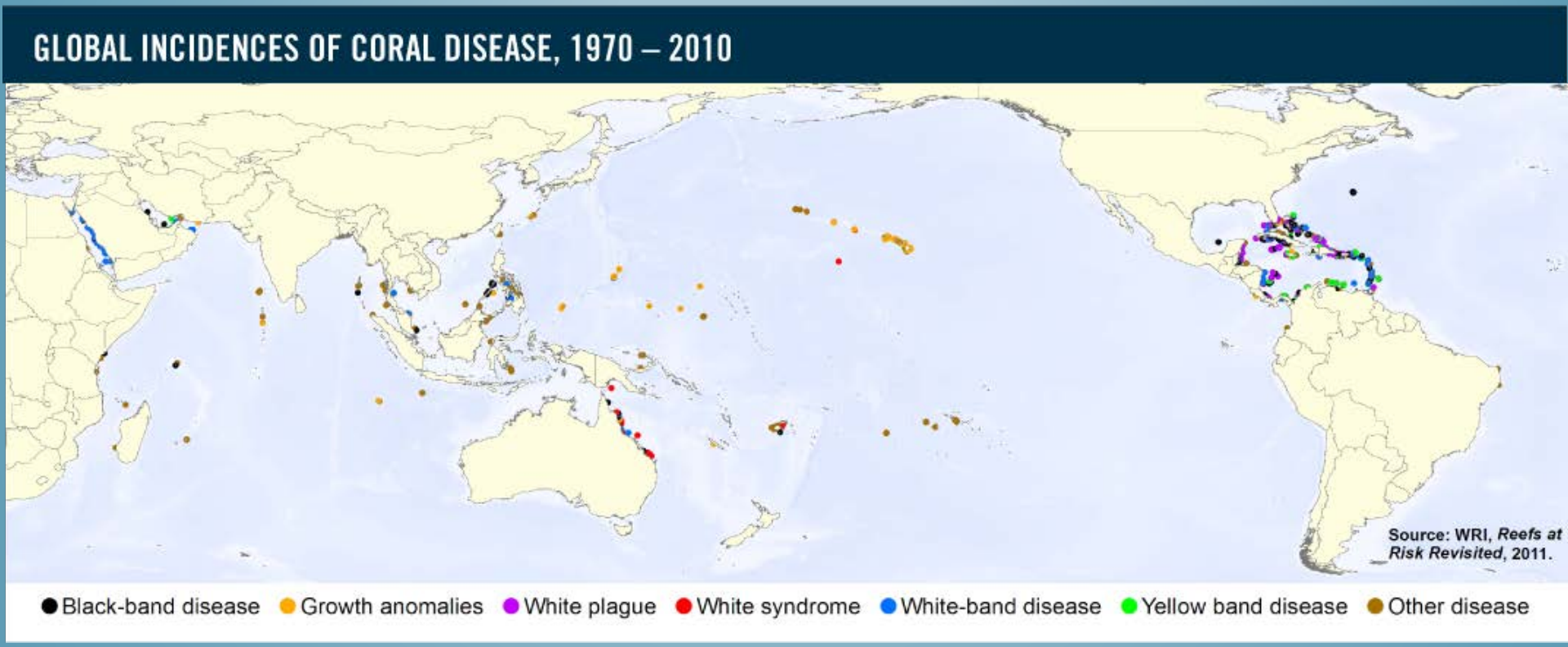
Disease Triangle





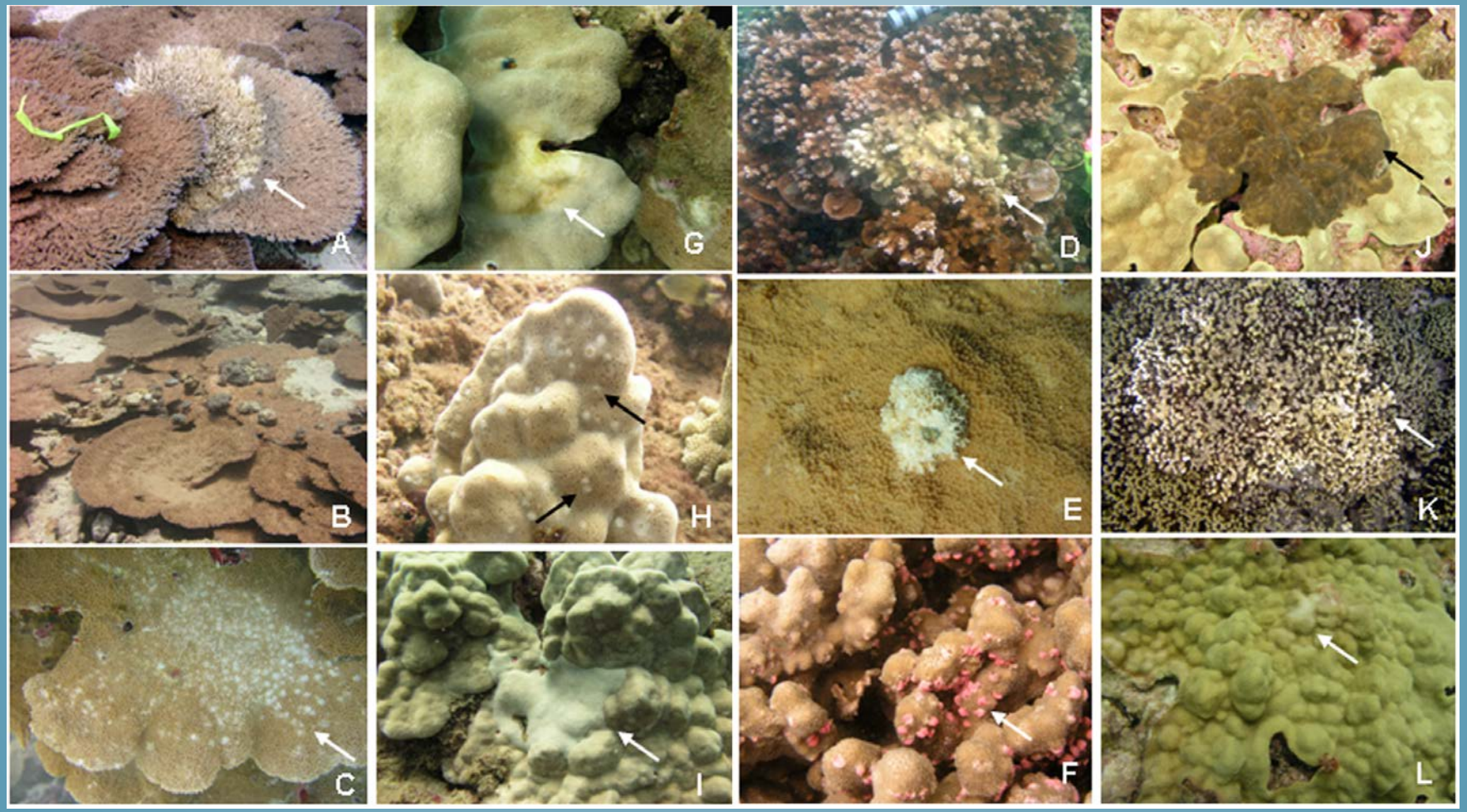


CORAL DISEASE



- *Globally, incidence of coral disease outbreaks are on the rise.*
- *Coral Disease is listed as one of the six priority threats to coral reefs by the U.S. Coral Reef Task Force.*

CORAL DISEASE IN HAWAI'I

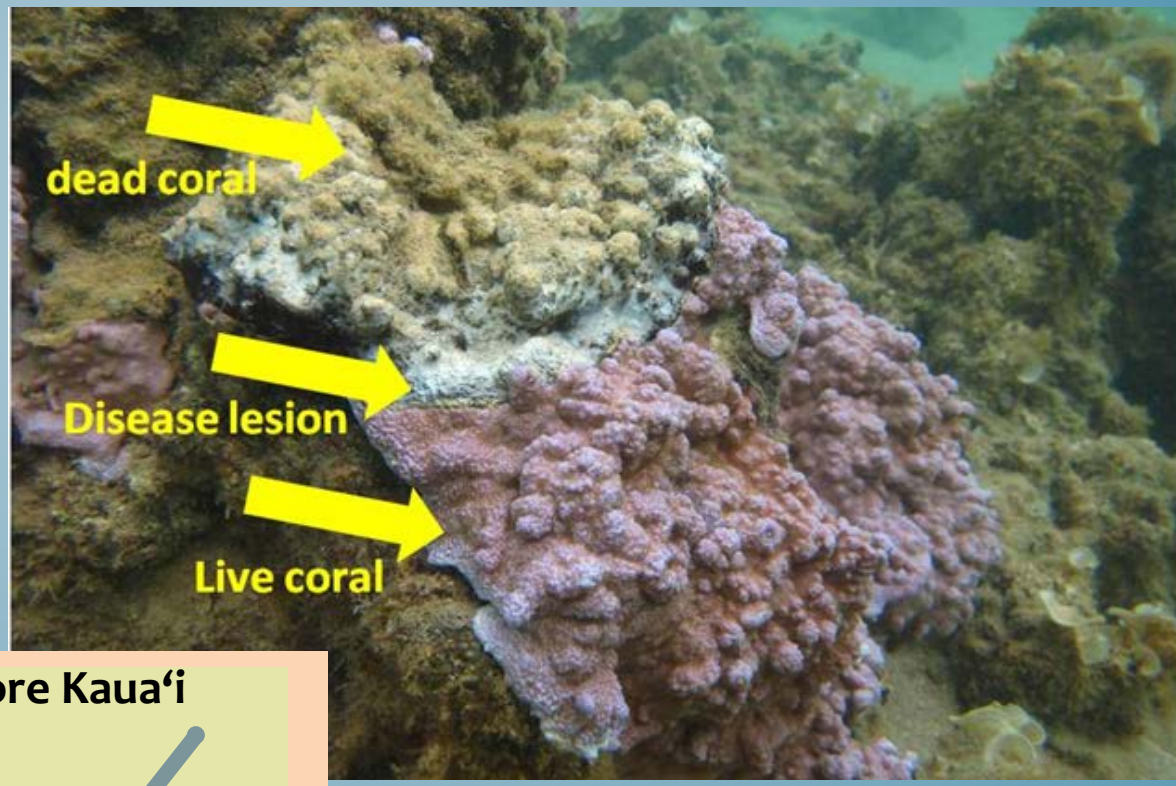


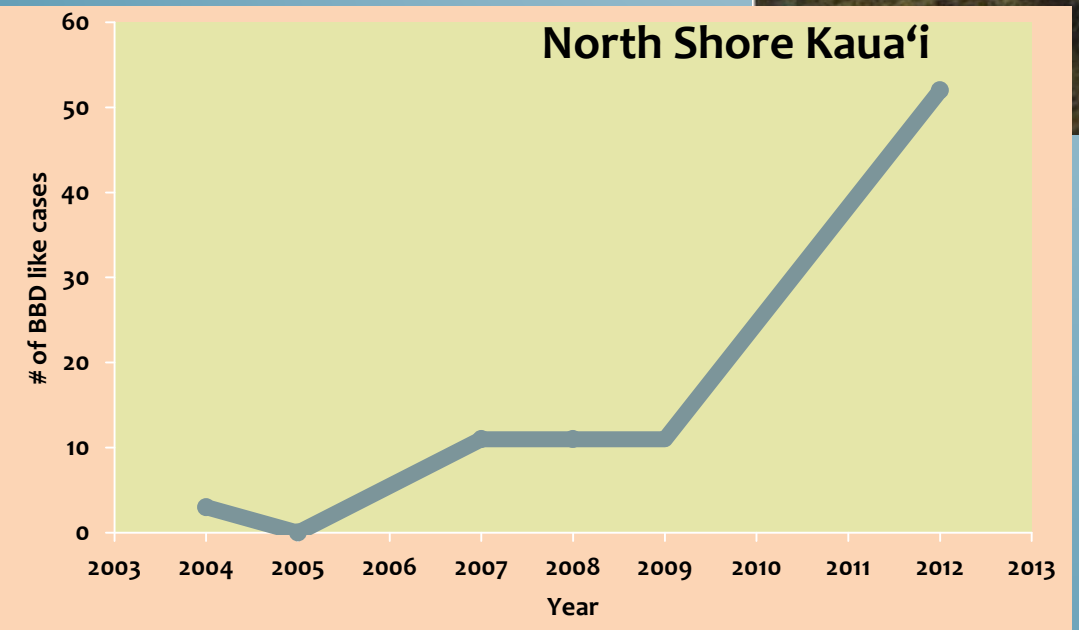
- *18 observed coral diseases across the Hawai'i*

Aeby et al 2011

BLACK BAND DISEASE ON KAUA'I

A Black Band Like Disease (BBLD) was first observed on Kaua'i in 2004 by Dr. Greta Aeby and Dr. Alan Friedlander.





Aeby unpublished data

Historical coral disease surveys on Kauai

(Aeby)

year	# sites surveyed	total reef area (m^2)	Avg. *Montipora* cover (%)	tot # cases cyanobacteria infection
2004	6	470	13.3	3
2005	12	3522	0.15	0
2007	4	1200	13	11
2008	4	1200	14.7	11
2009	4	1200	15.8	11

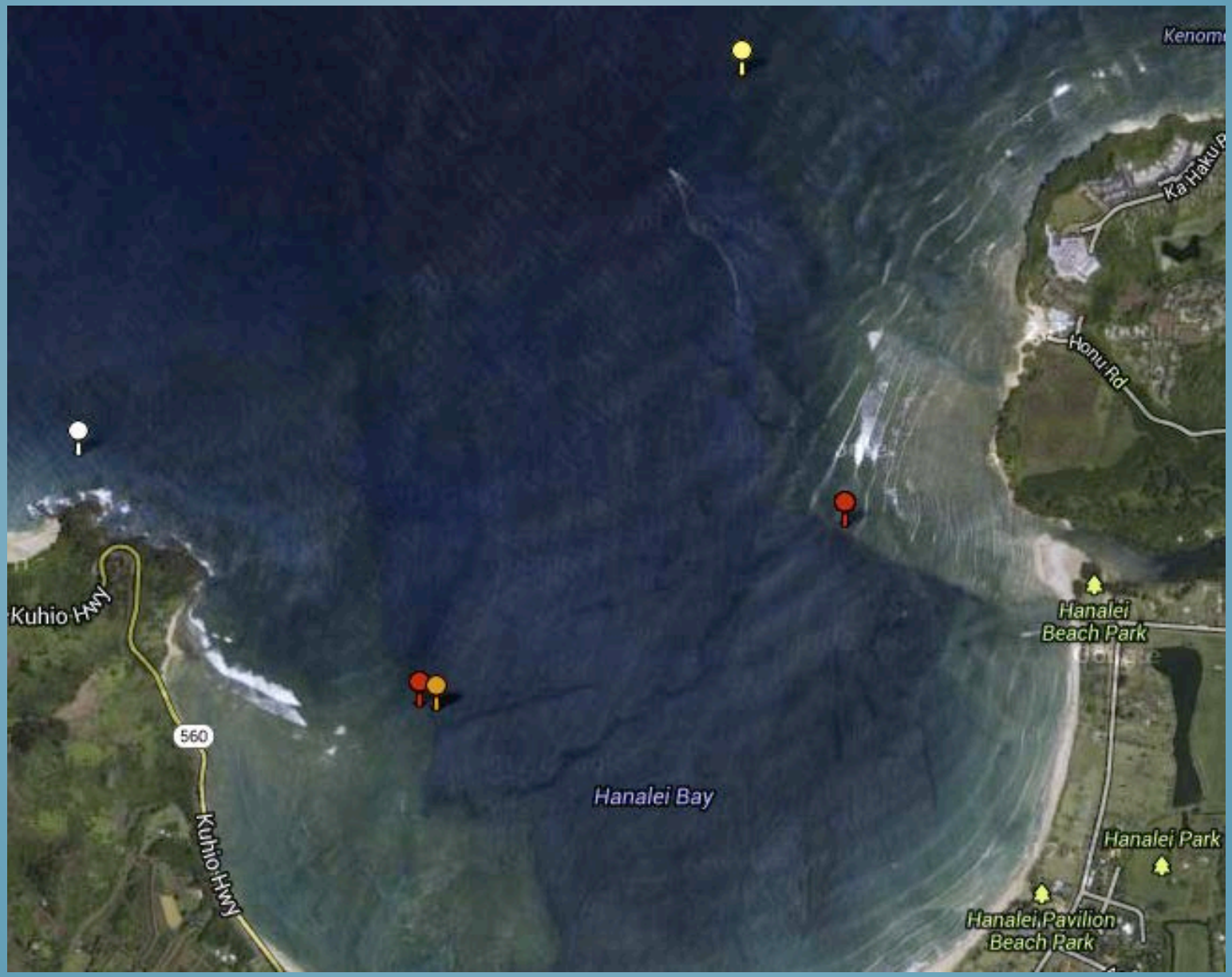
Historical Disease Surveys: N Shore Kauai 2004-2009

Sites
Red: RAMP
White: CRAMP

BBLD Sites
White: No MBTL
Orange:2004
Yellow: 2008
Red: 2004 & 2007

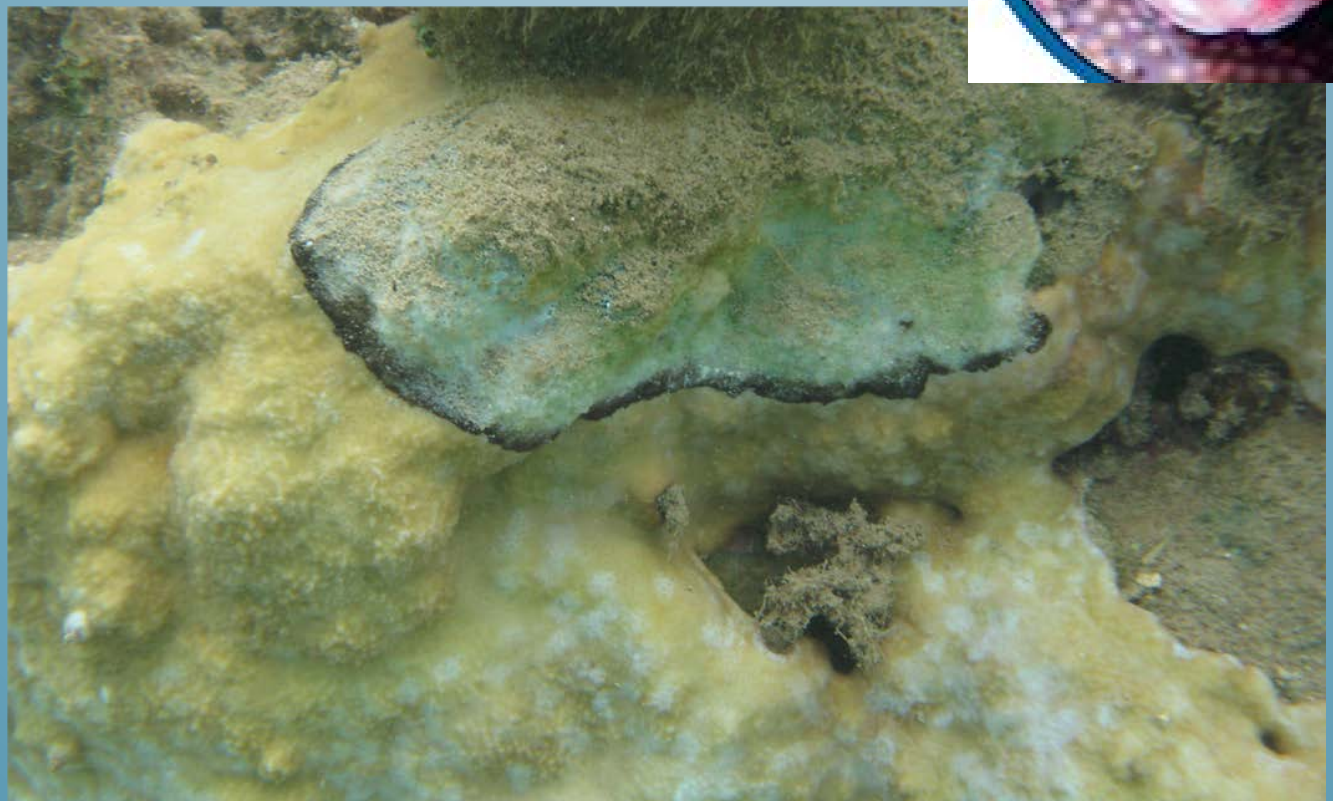
Historical BBLD Surveys: N Shore Kauai 2004-2009

MBTL Sites
White: No MBTL
Orange:2004
Yellow: 2008
Red: 2004 & 2007



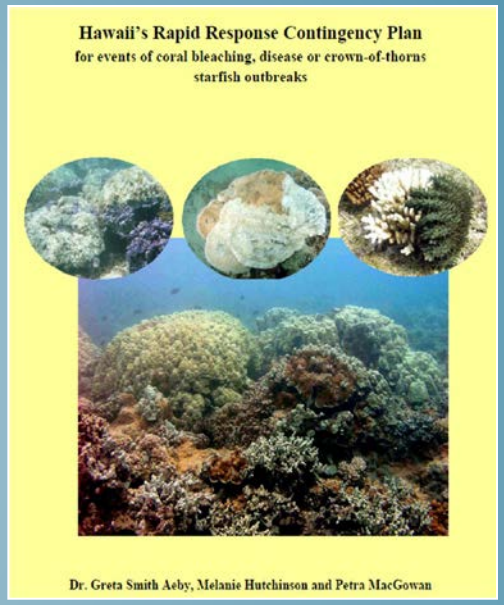
BLACK BAND DISEASE ON KAUA'I

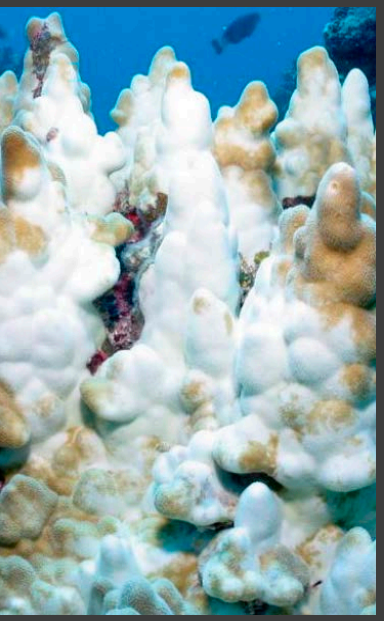
In 2012 the BBLD was reported by a trained Eyes of the Reef Network Member at higher then previously observed levels.

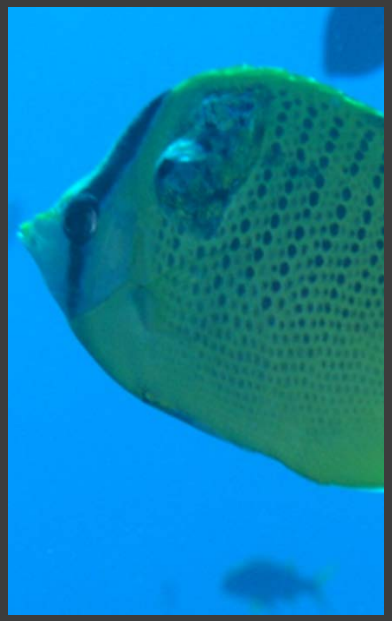


Rapid Response Contingency Plan

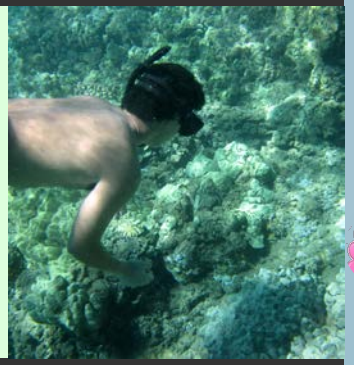
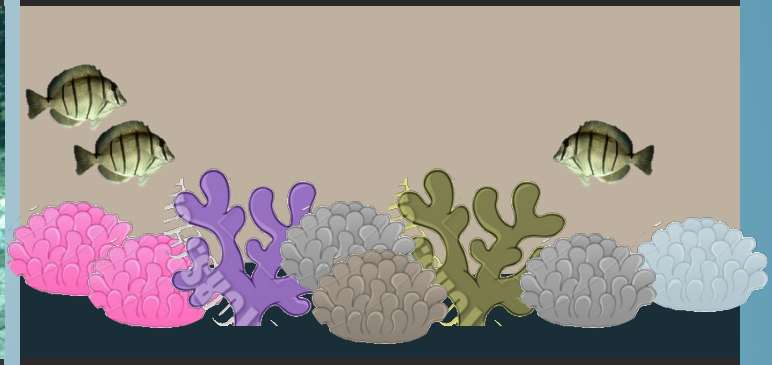
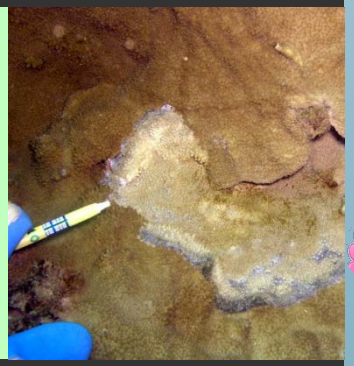
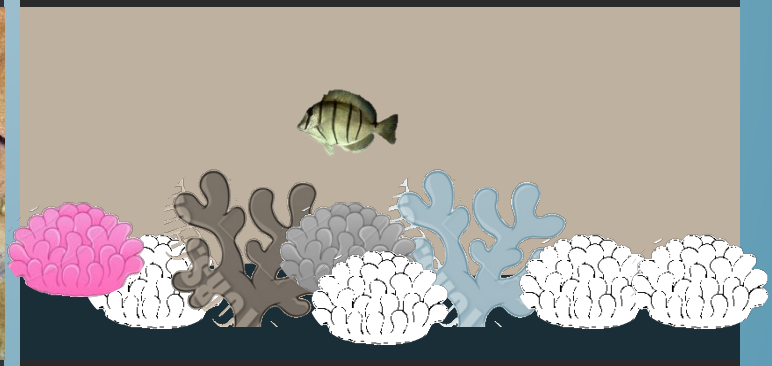
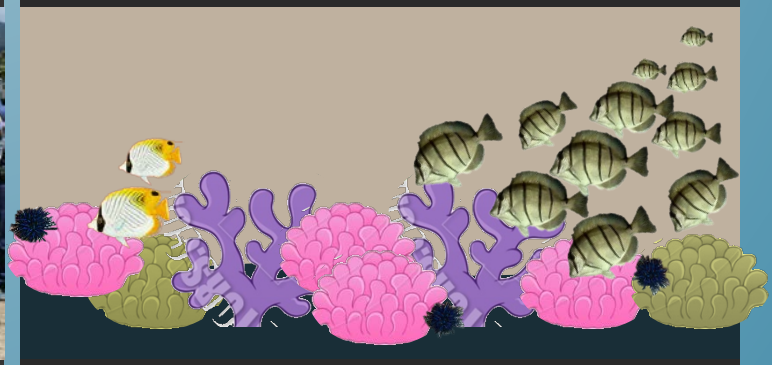
The Rapid Response Contingency Plan provides the Department of Natural Resources (DLNR), Division of Aquatic Resources (DAR) and its partners with a plan to respond to unusual events including coral bleaching, coral disease, Crown-Of-Thorn Starfish (COTS) outbreaks, fish and other marine life mortality, and Aquatic Invasive Species (AIS).







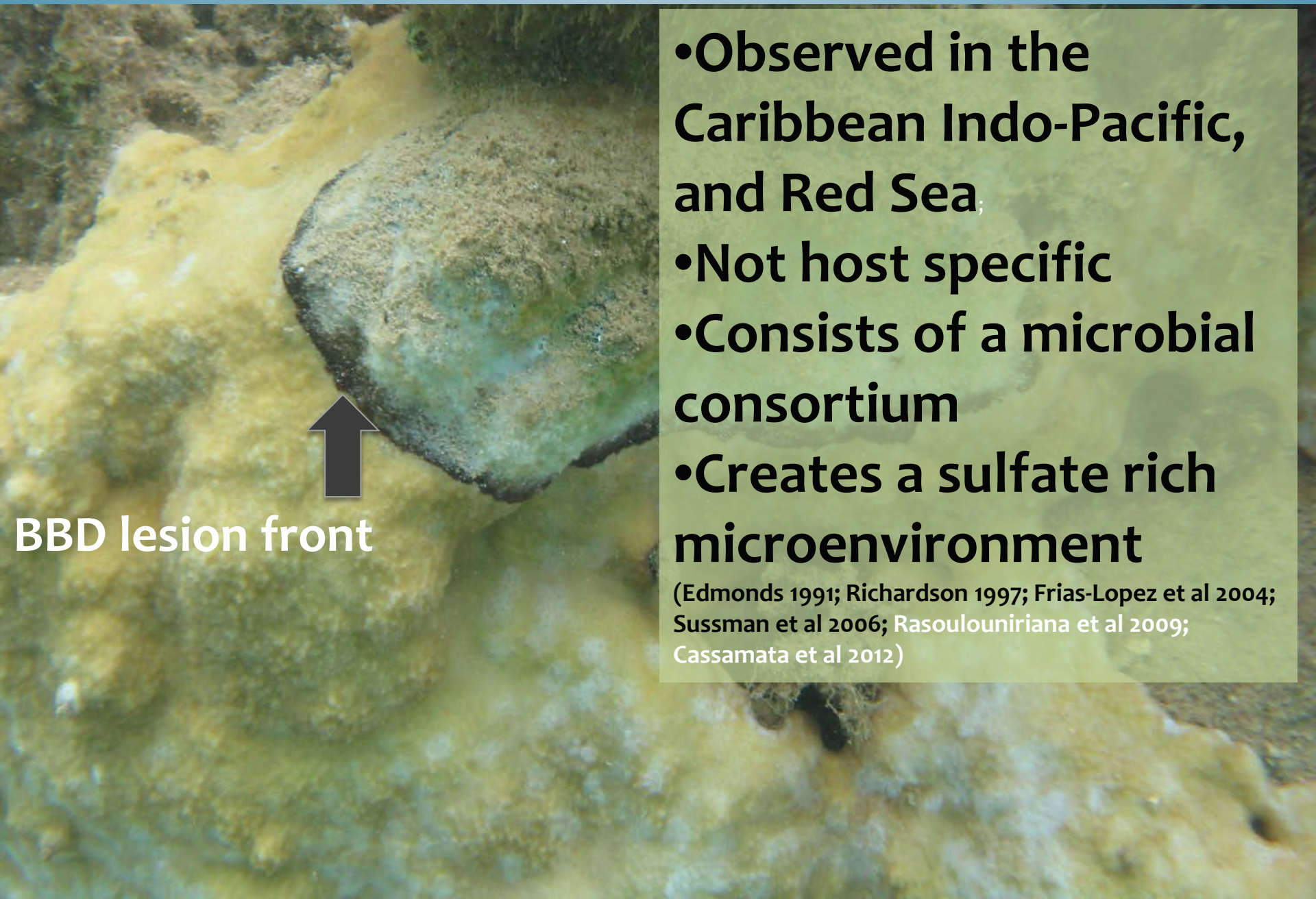
REEF RESPONSE PROGRAM

Who is responsible	Action	Stage of Event
Eyes of the Reef	• Community is trained • Online report of event • Verification photos	 
Rapid Response Team	• Initial assessment conducted • Samples collected • Monitor impact and recovery	 
Management Response Team	• Data is reviewed • Information is shared with public • Management actions are assessed	 

BLACK BAND DISEASE RESEARCH QUESTIONS

1. *Is this really BBD?*
2. *What is the spatial distribution and disease levels of BBD on Kaua'i*
3. *Which species are affected?*
4. *What is the rate of progression of the lesion?*
5. *How virulent is this BBD?*
6. *Who are the pathogens involved?*

IS THIS REALLY BBD?

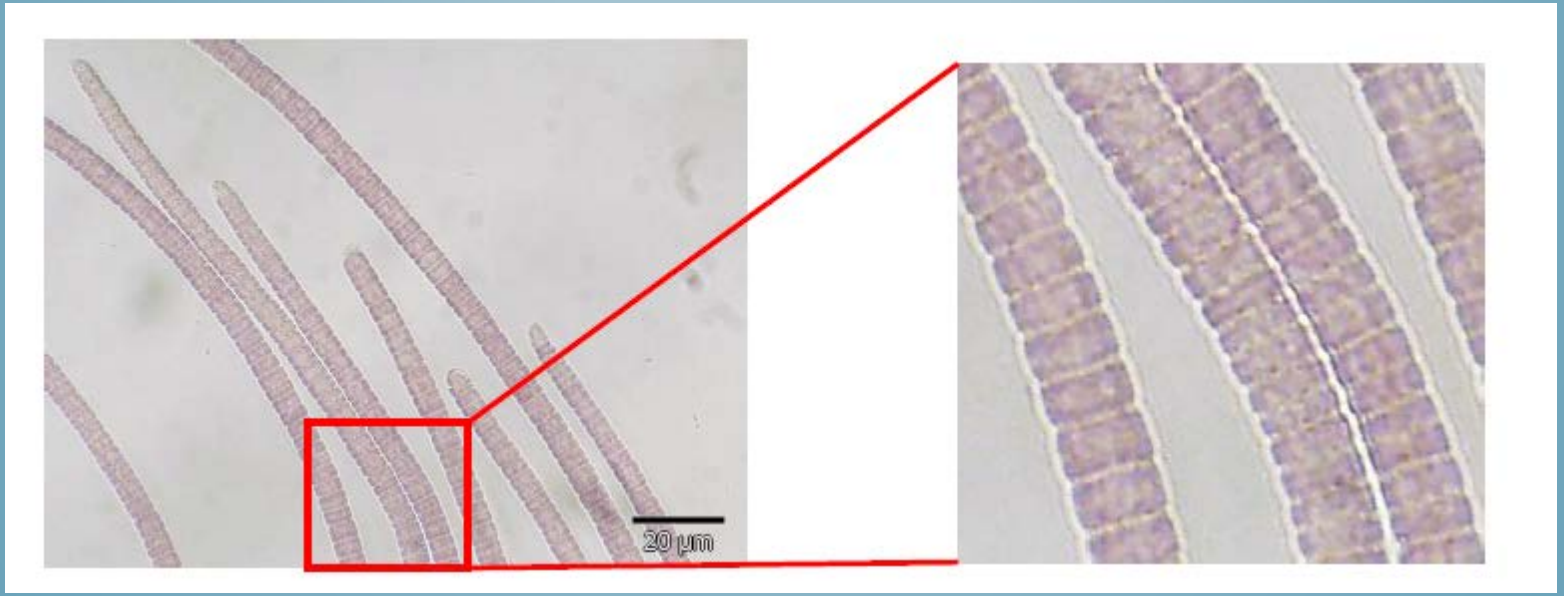


- Observed in the Caribbean Indo-Pacific, and Red Sea;
- Not host specific
- Consists of a microbial consortium
- Creates a sulfate rich microenvironment

(Edmonds 1991; Richardson 1997; Frias-Lopez et al 2004; Sussman et al 2006; Rasoulouniriana et al 2009; Cassamata et al 2012)

IS THIS REALLY BBD?

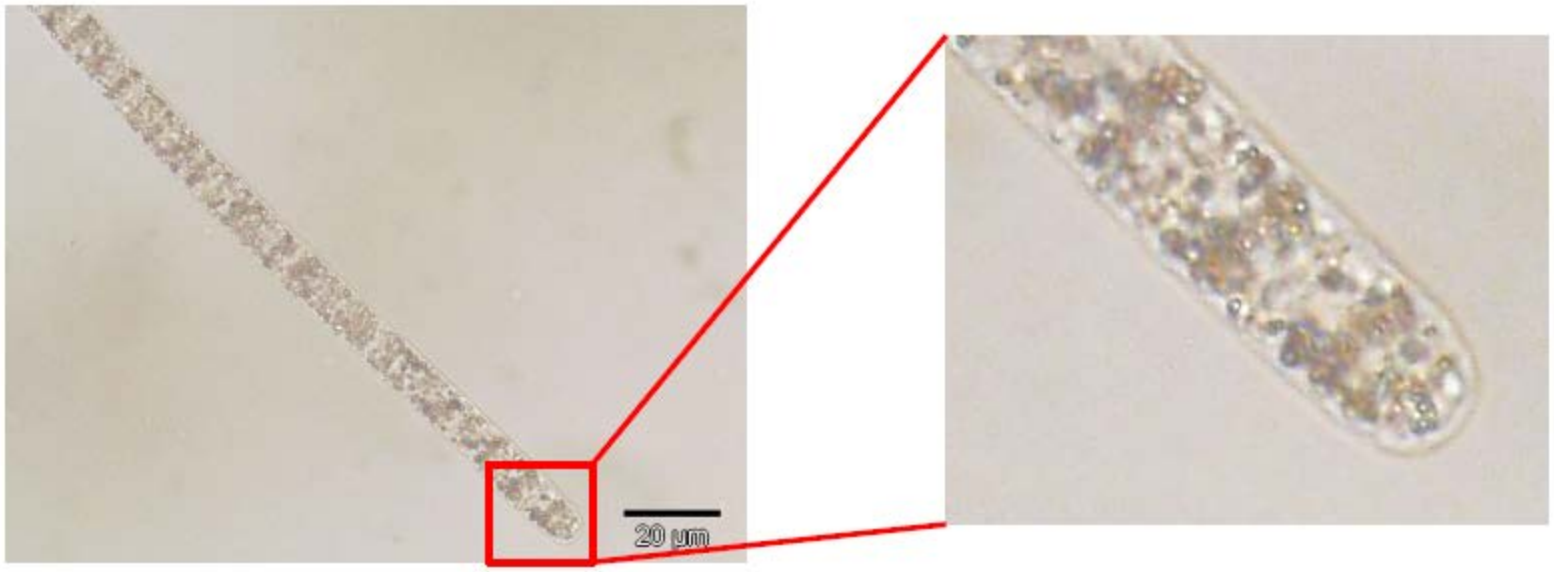
Histology results (T. Work) confirmed association of Cyanobacteria with lesions.



- *Identified as Pseudoscillatoria*
- *99% similar to cyanobacteria responsible for BBD in the Red Sea and Palau*

IS THIS REALLY BBD?

- *Sulfur-oxidizing bacteria (Beggiatoa)*
- *Sulfate reducing bacteria*



• Granules are inclusion bodies of sulfur

Dr. Callahan (UH Micro)

Bacterial consortium identified. Confirmed as Black Band Disease (BBD).

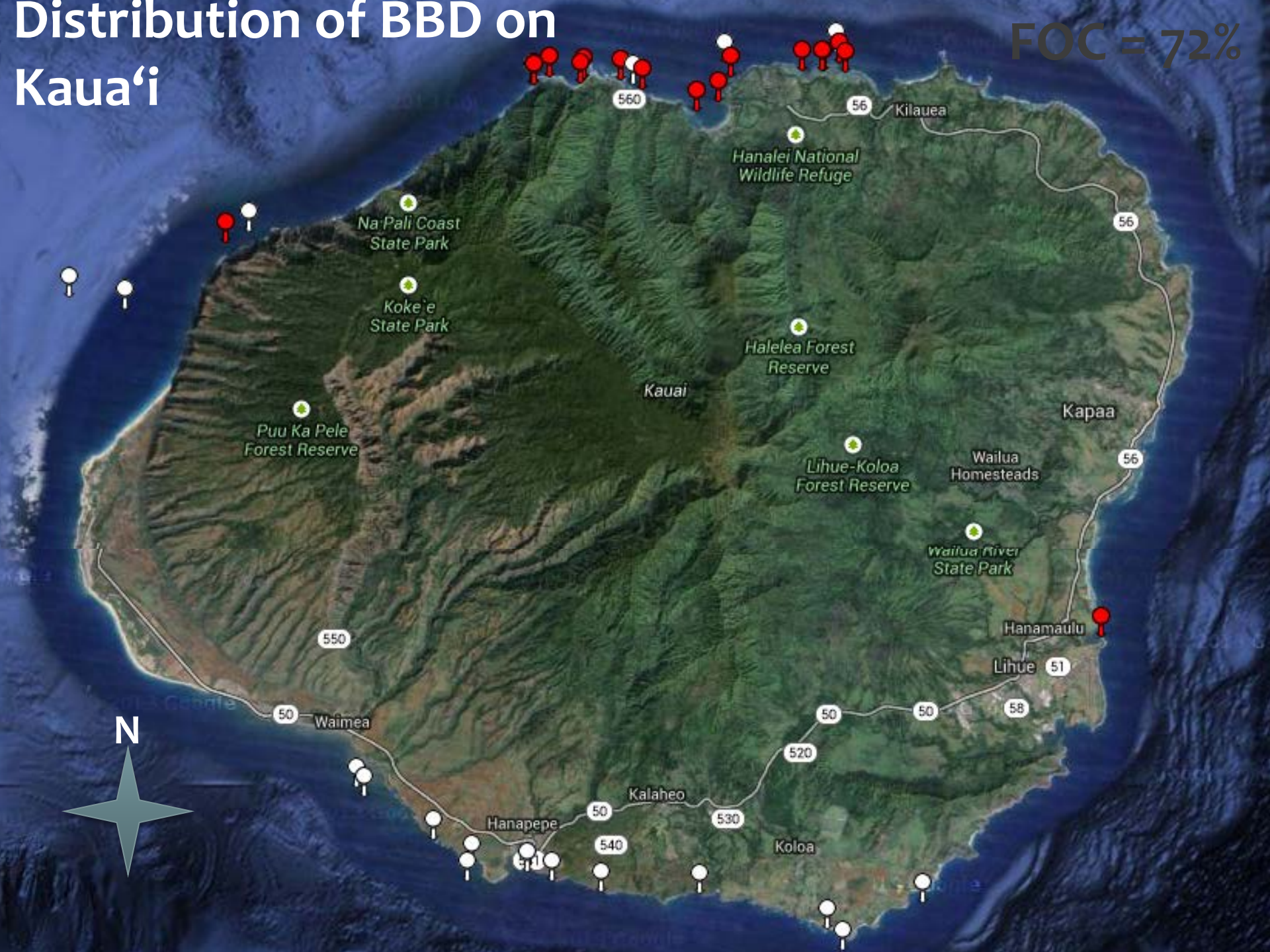
Also gives us the pathogens involved.

WHAT IS THE SPATIAL DISTRIBUTION AND DISEASE LEVELS OF BBD ON KAUA'I?

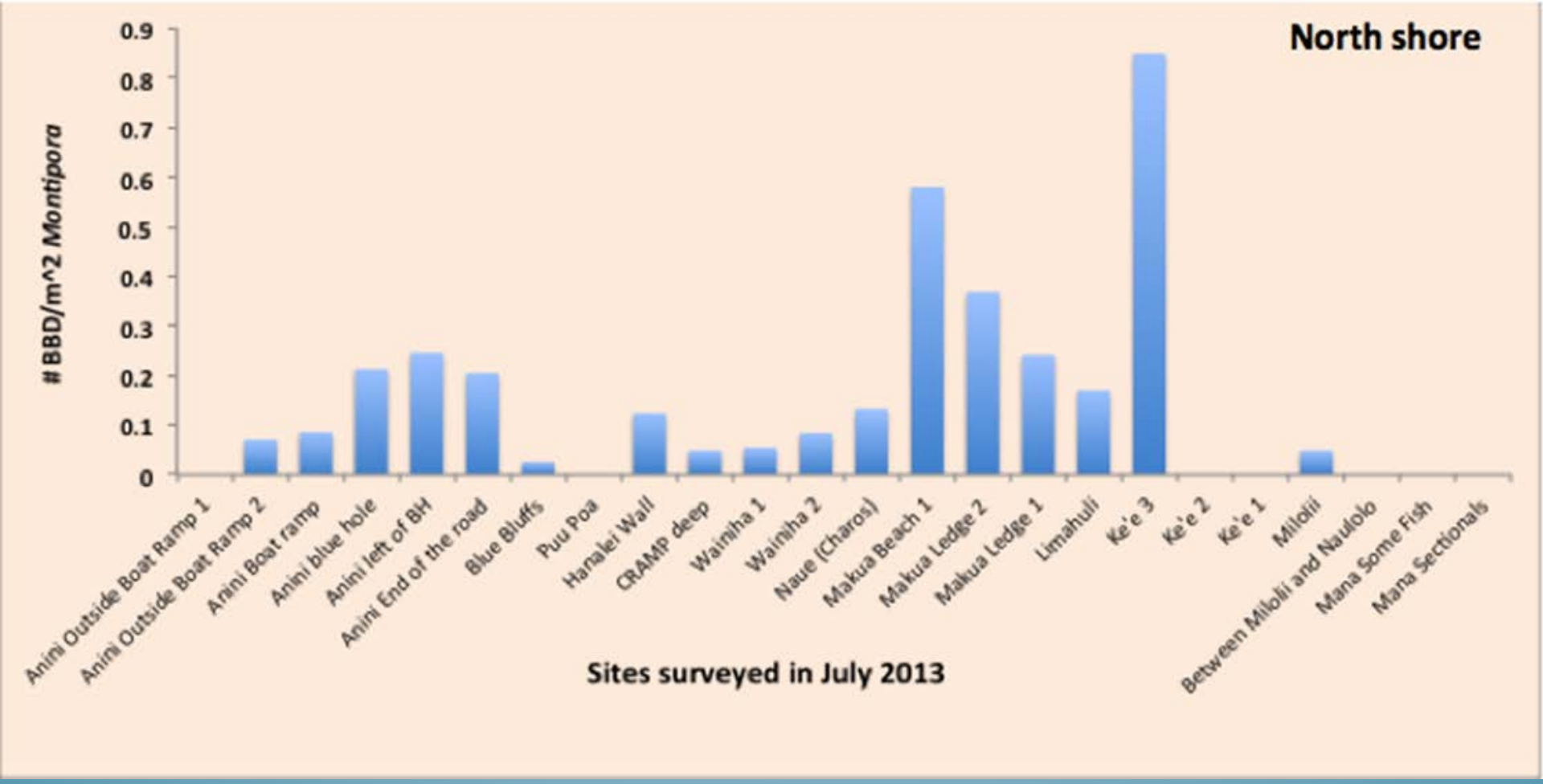
Distribution of Black Band Like Disease on Kaua‘i

Distribution of BBD on Kaua‘i

FOC = 72%



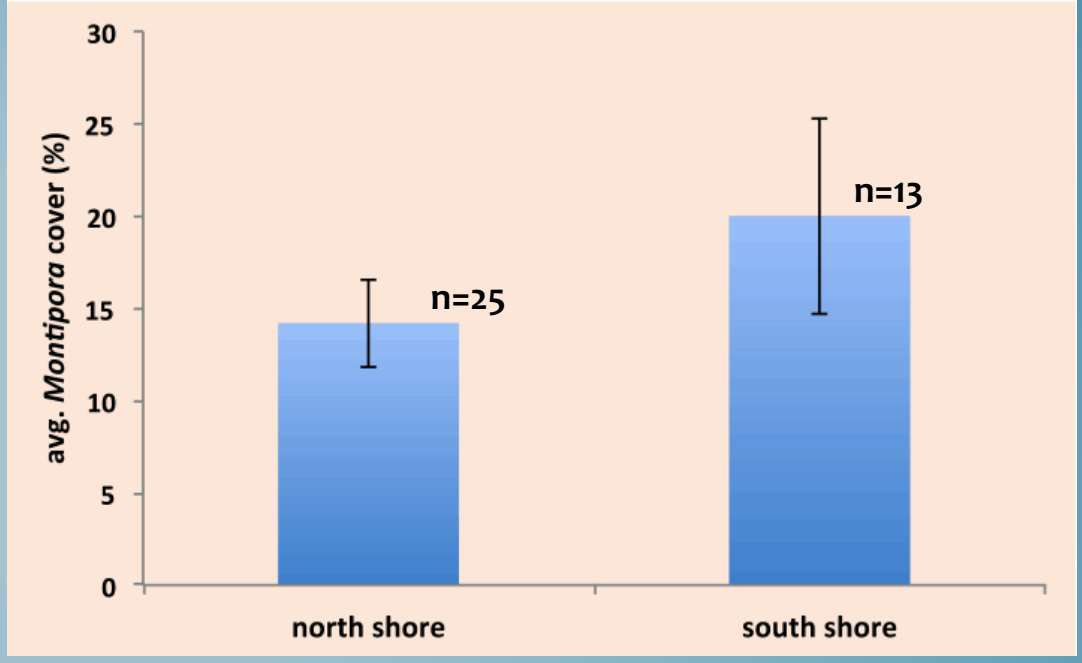
DISEASE LEVELS ON NORTH SHORE

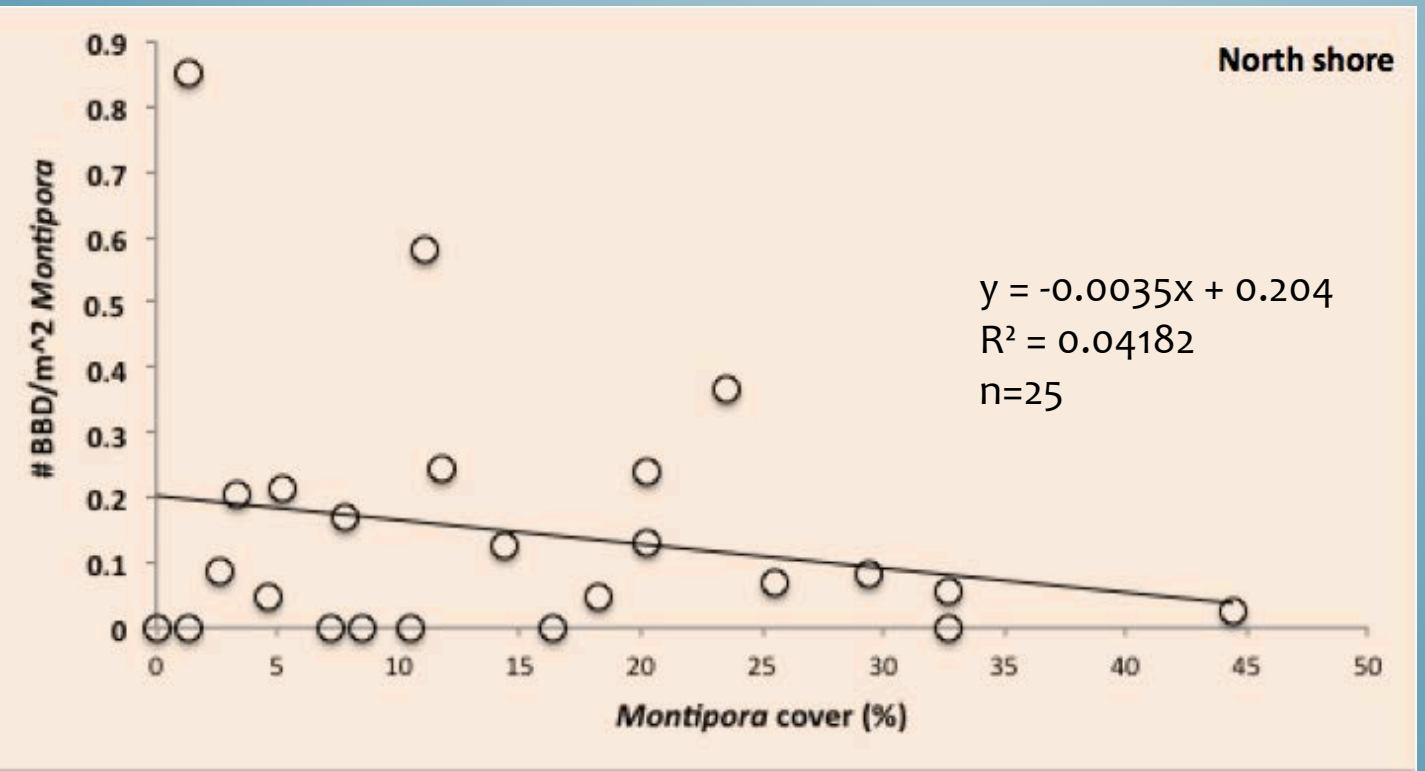


Hot spots of occurrence

Runyon unpublished data

No relation of host abundance to disease abundance





Runyon unpublished data

Disease Distribution and Prevalence

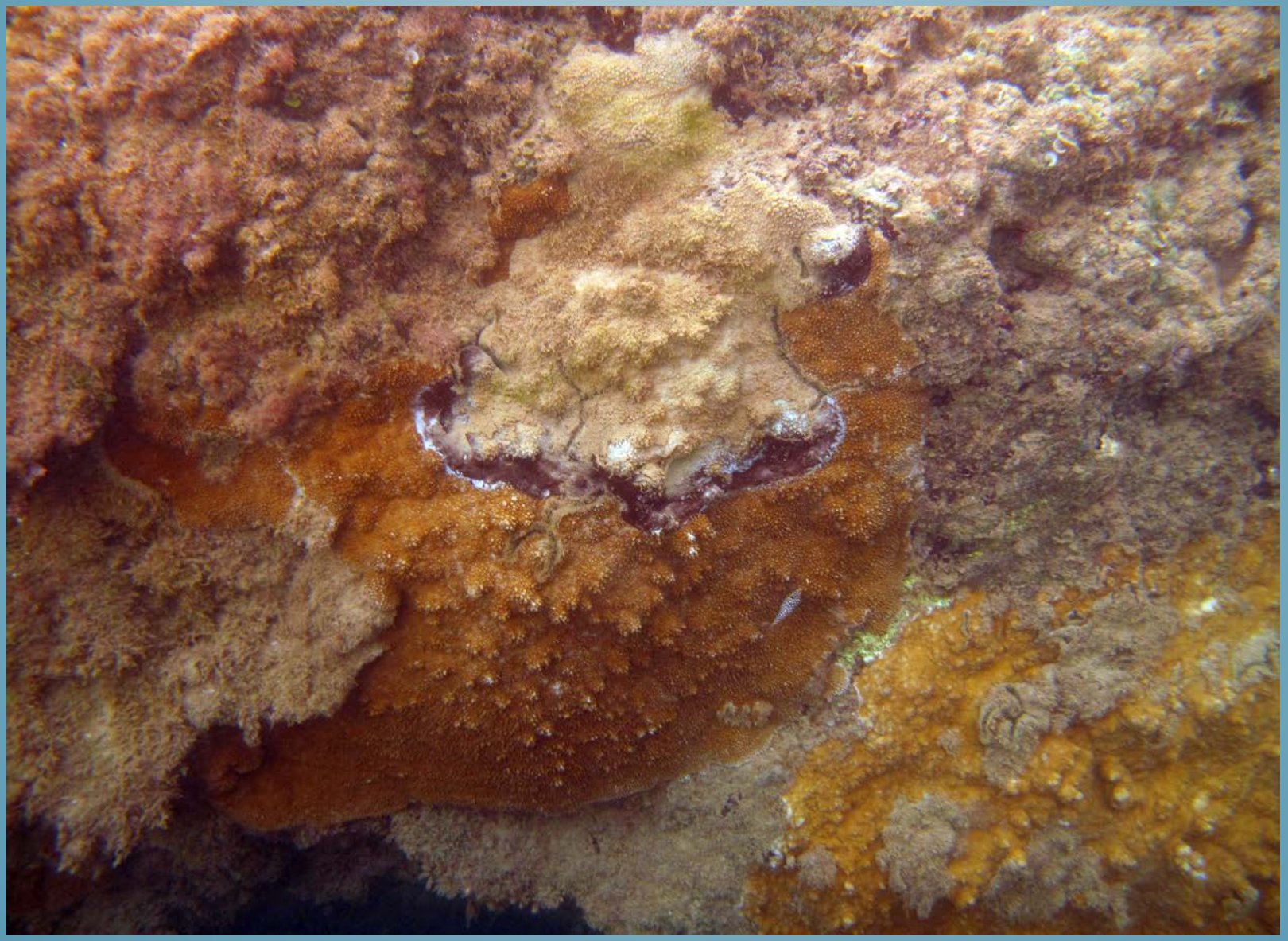
Anini Beach:

Oct. 2012	8/133 = 6%
Nov. 2012	2/98 = 2%
June 2013	1/122 = 0.82%

Anini Boat Ramp:

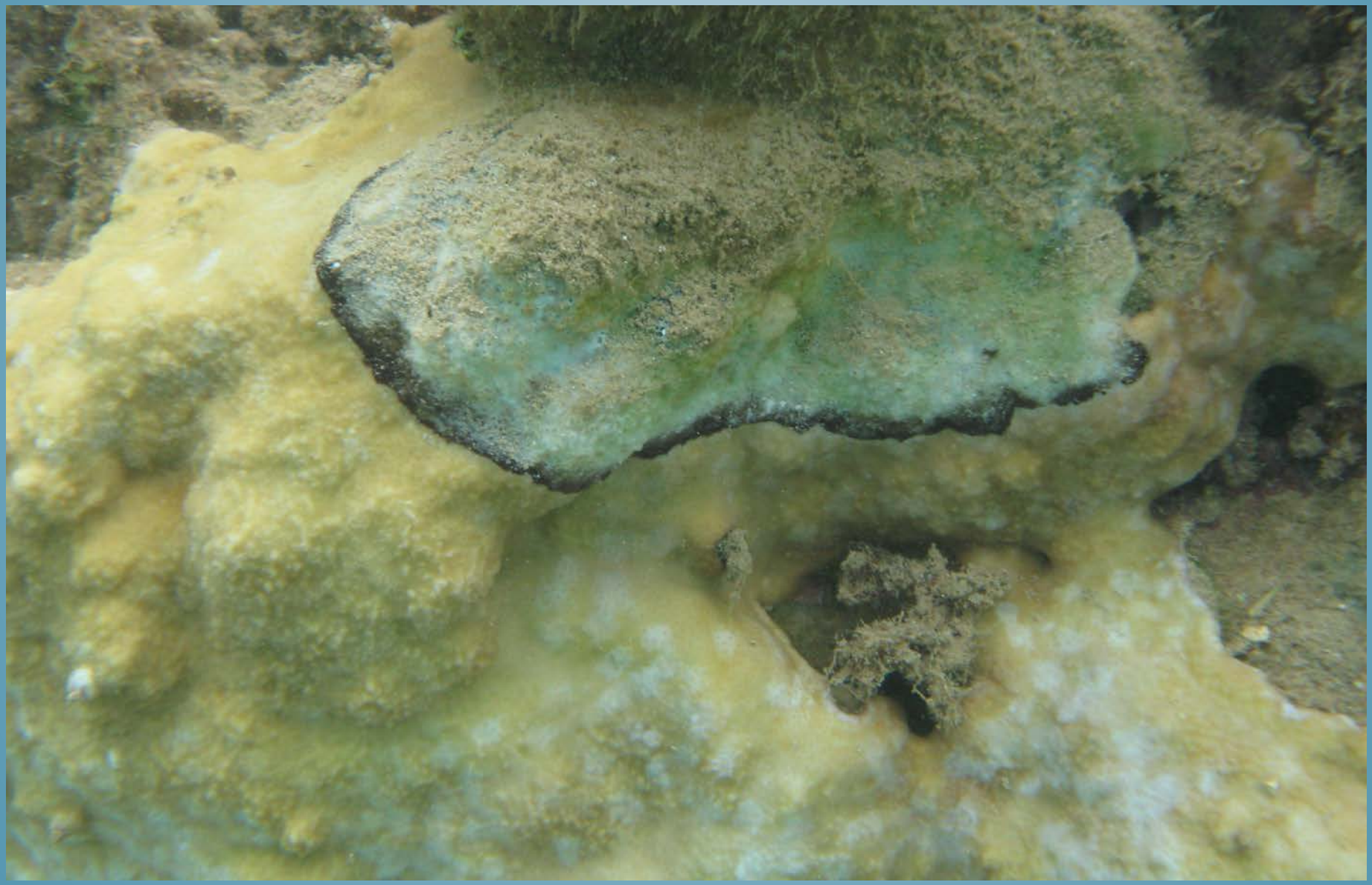
Nov. 2012	13/170 = 7.6%
June 2013	1/85 = 1.2%

WHICH SPECIES ARE AFFECTED?



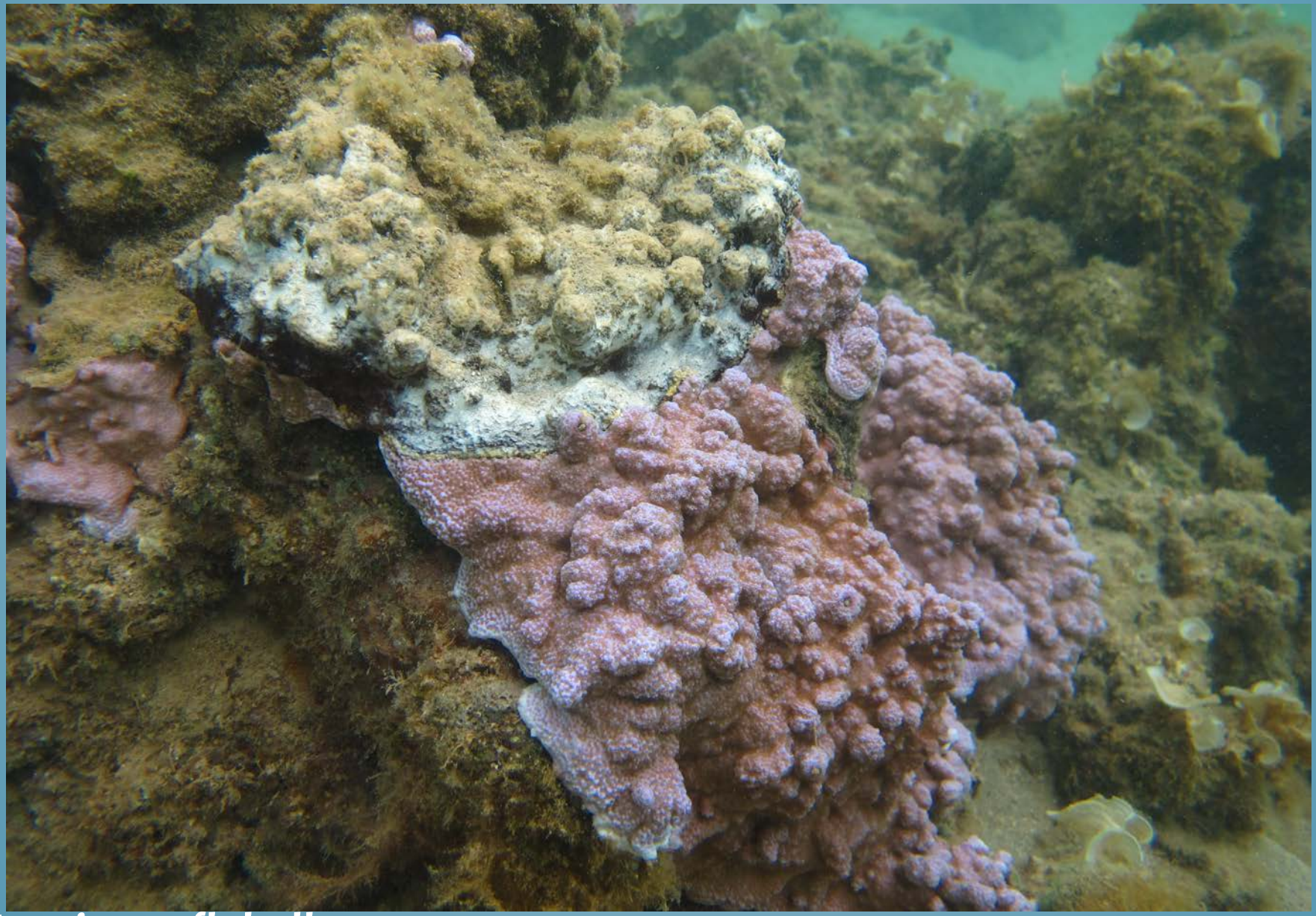
Montipora capitata

WHICH SPECIES ARE AFFECTED?



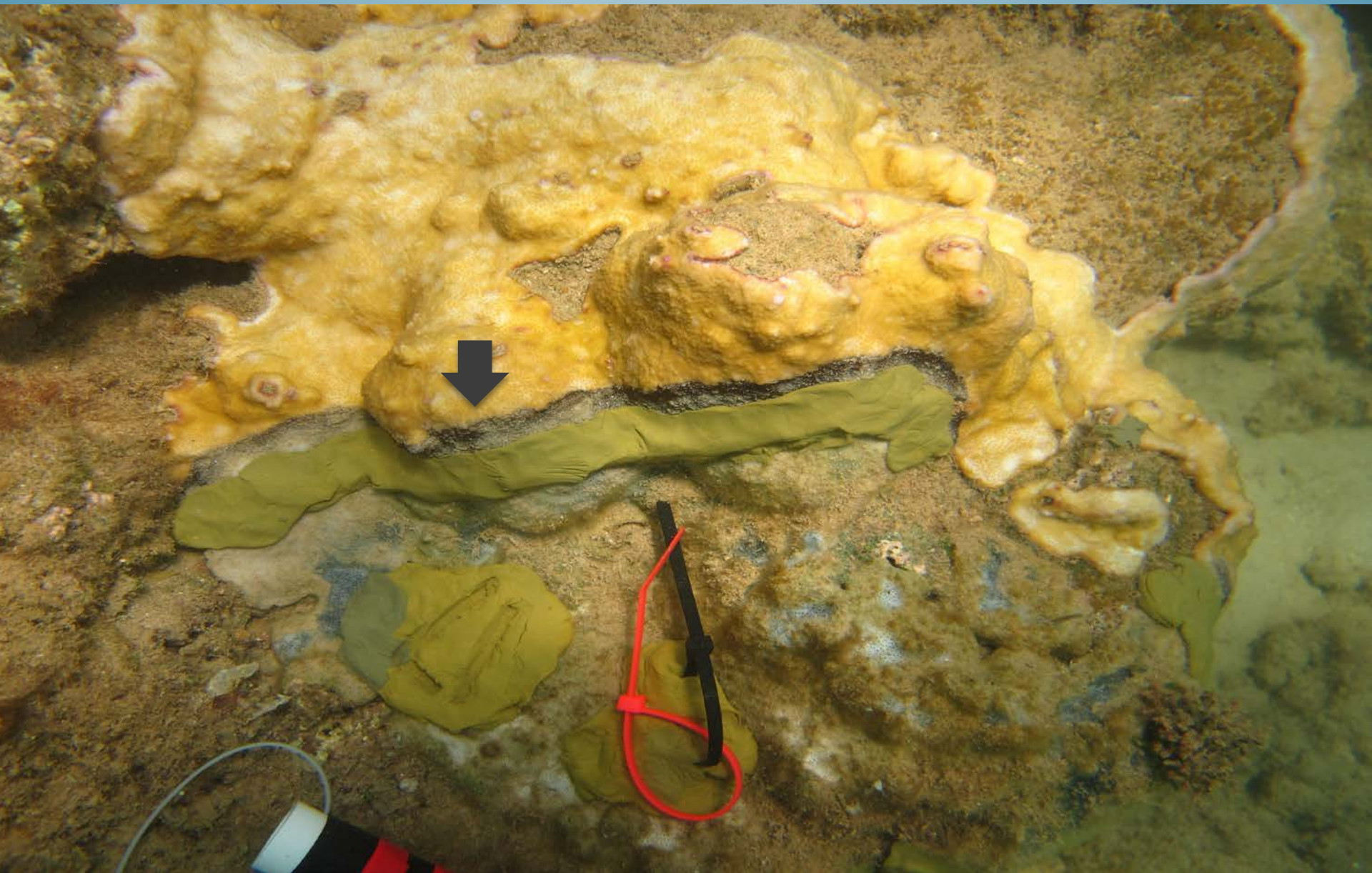
Montipora patula

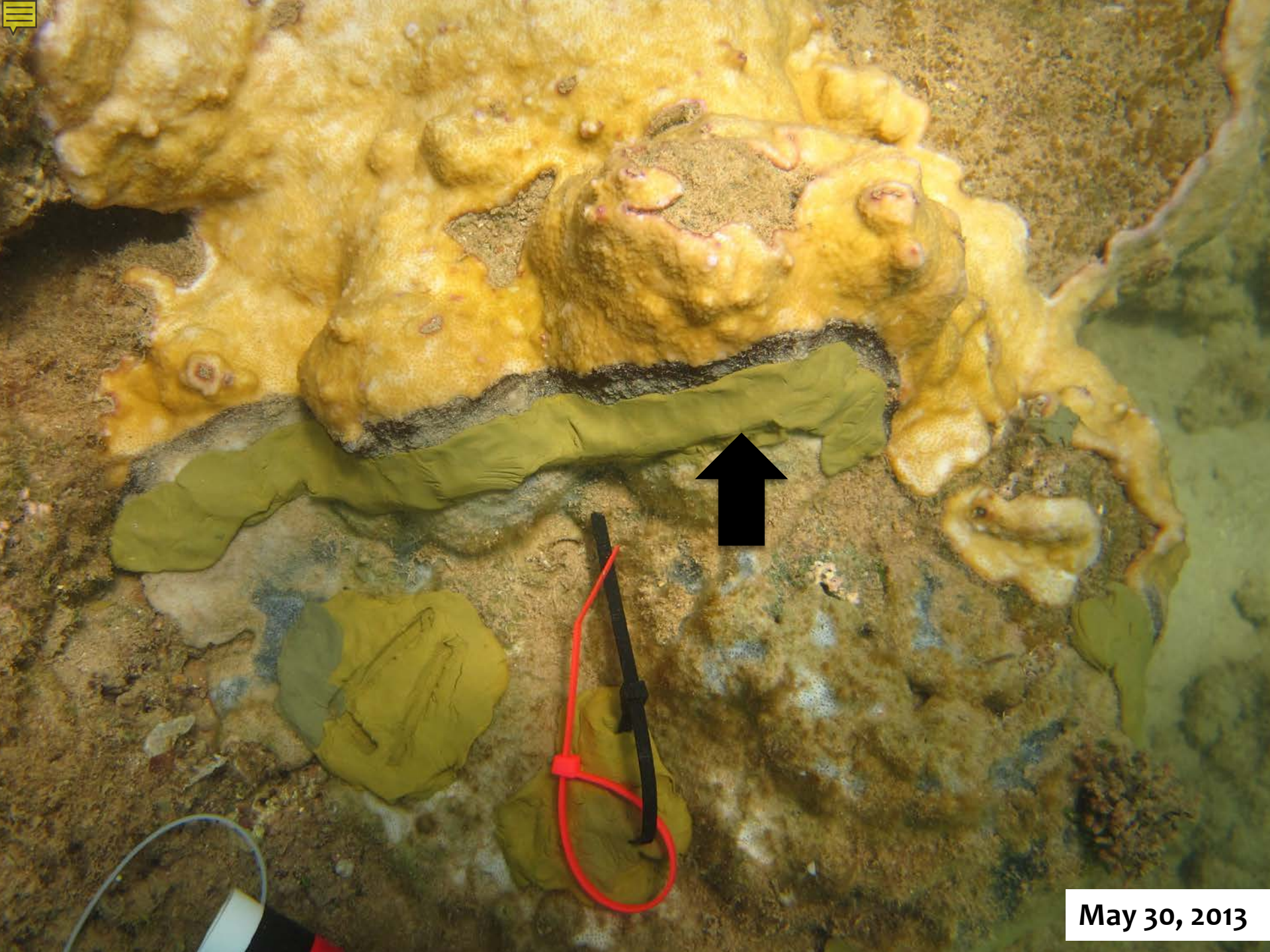
WHICH SPECIES ARE AFFECTED?

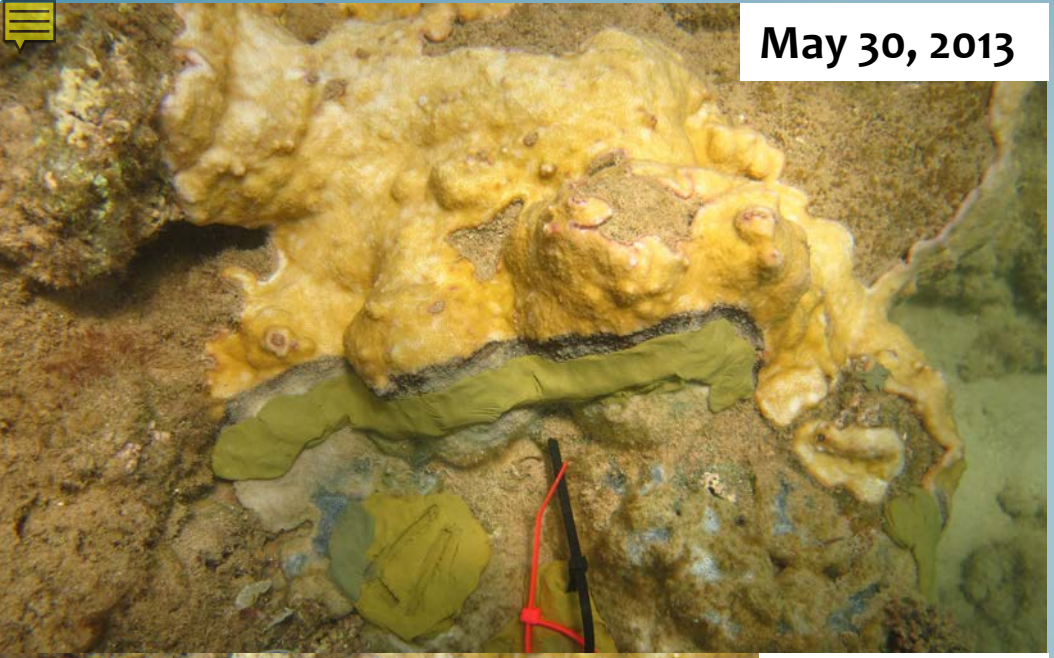


Montipora flabellata

WHAT IS THE RATE OF PROGRESSION OF THE LESION?




May 30, 2013

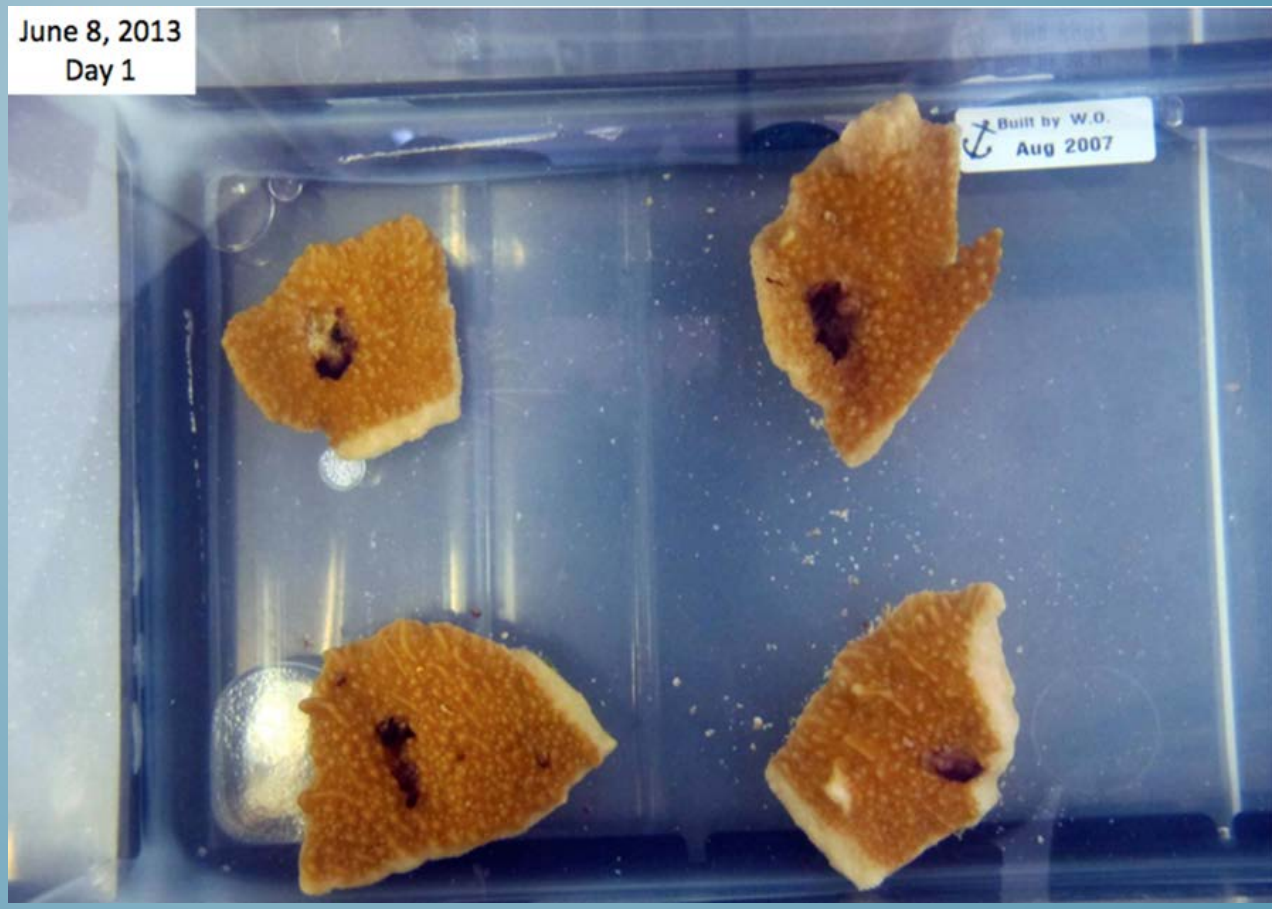


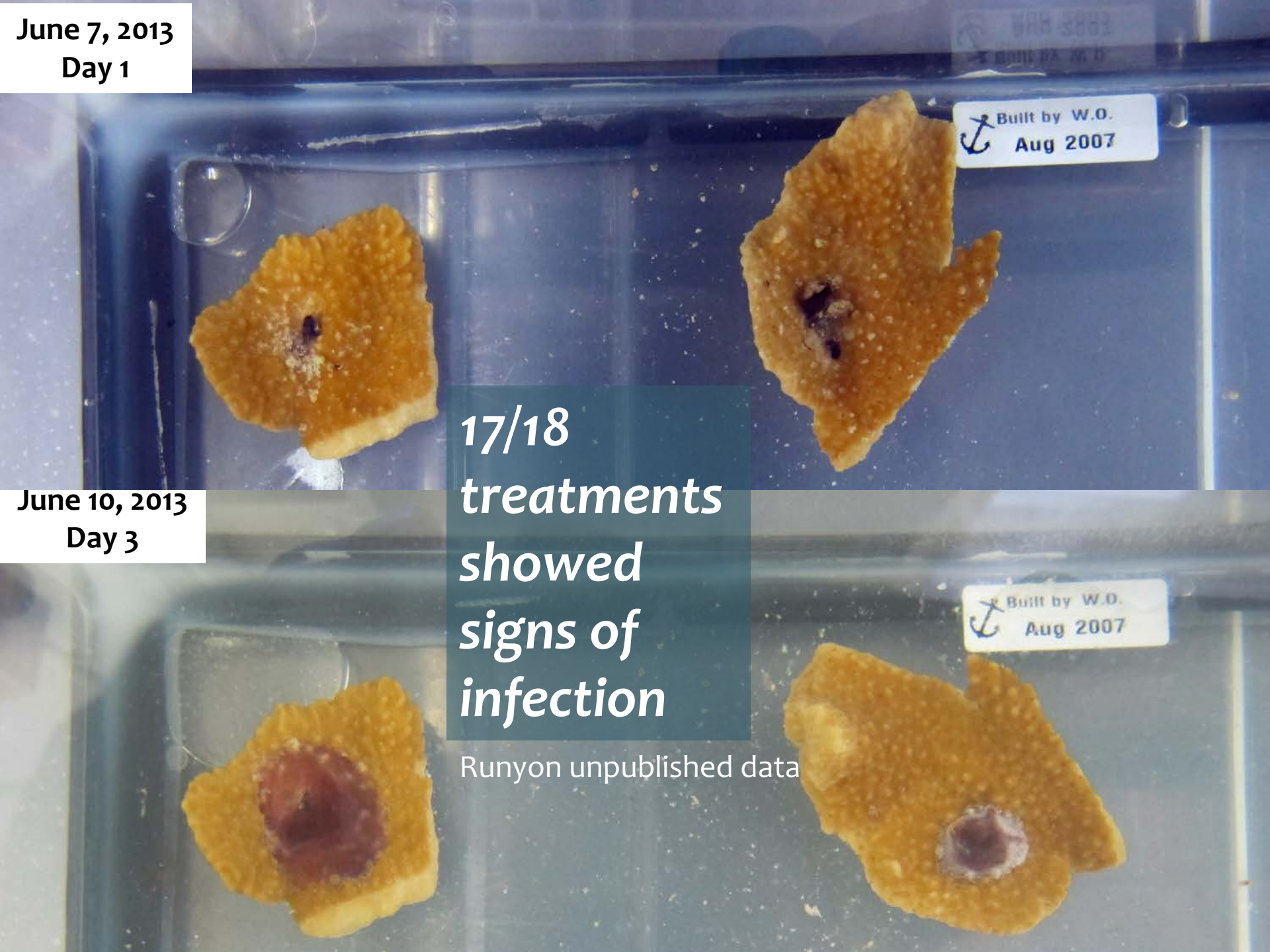
WHAT IS THE RATE OF PROGRESSION?

Average movement of the lesion across colony 6.5 ± SE 0.33mm/day n=48

HOW VIRULENT IS THE BBD?

- *Infection trials n=18*
- *Inoculated with material from the field*
- *Photographed over time*

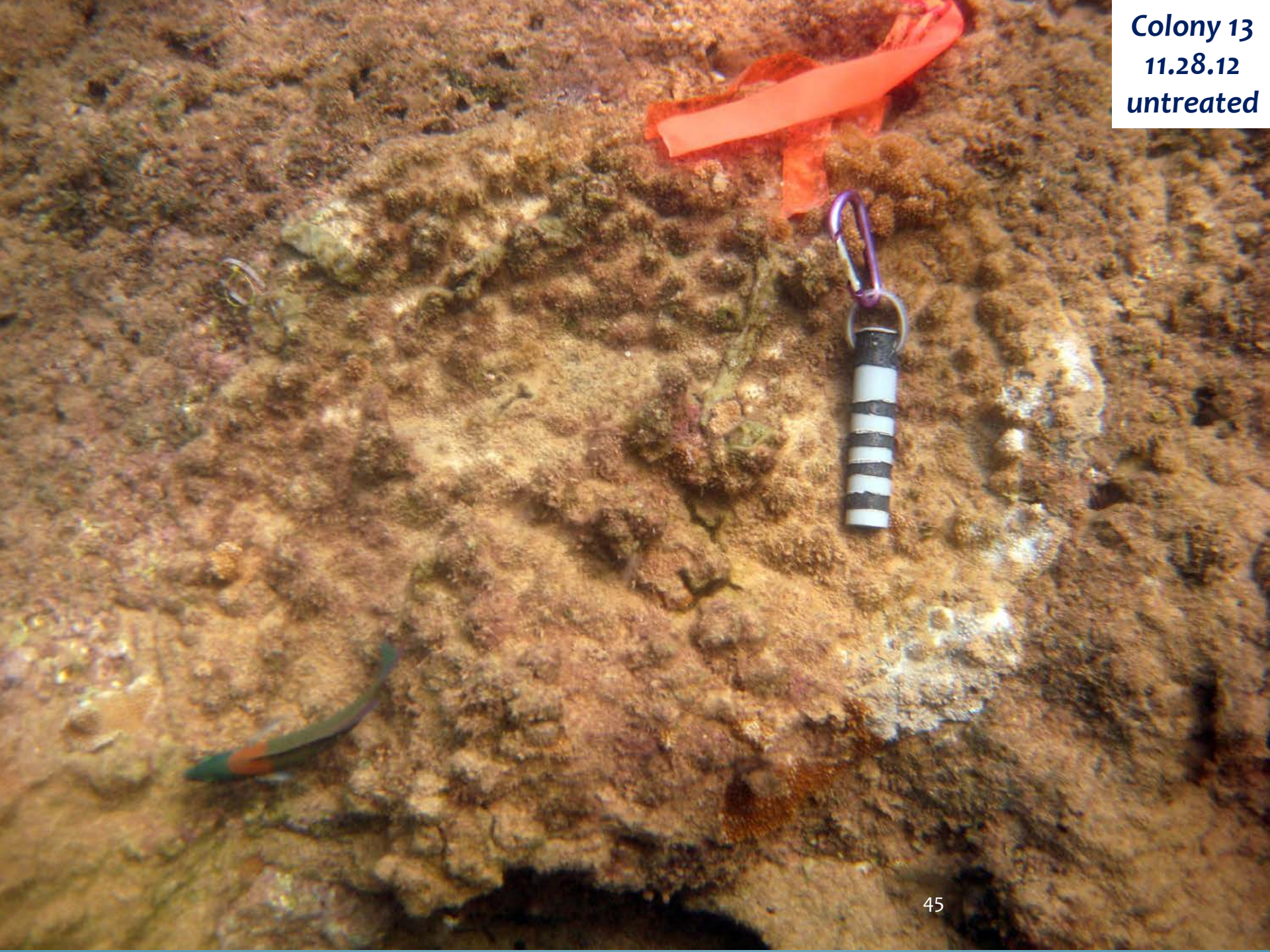




17/18 treatments showed signs of infection

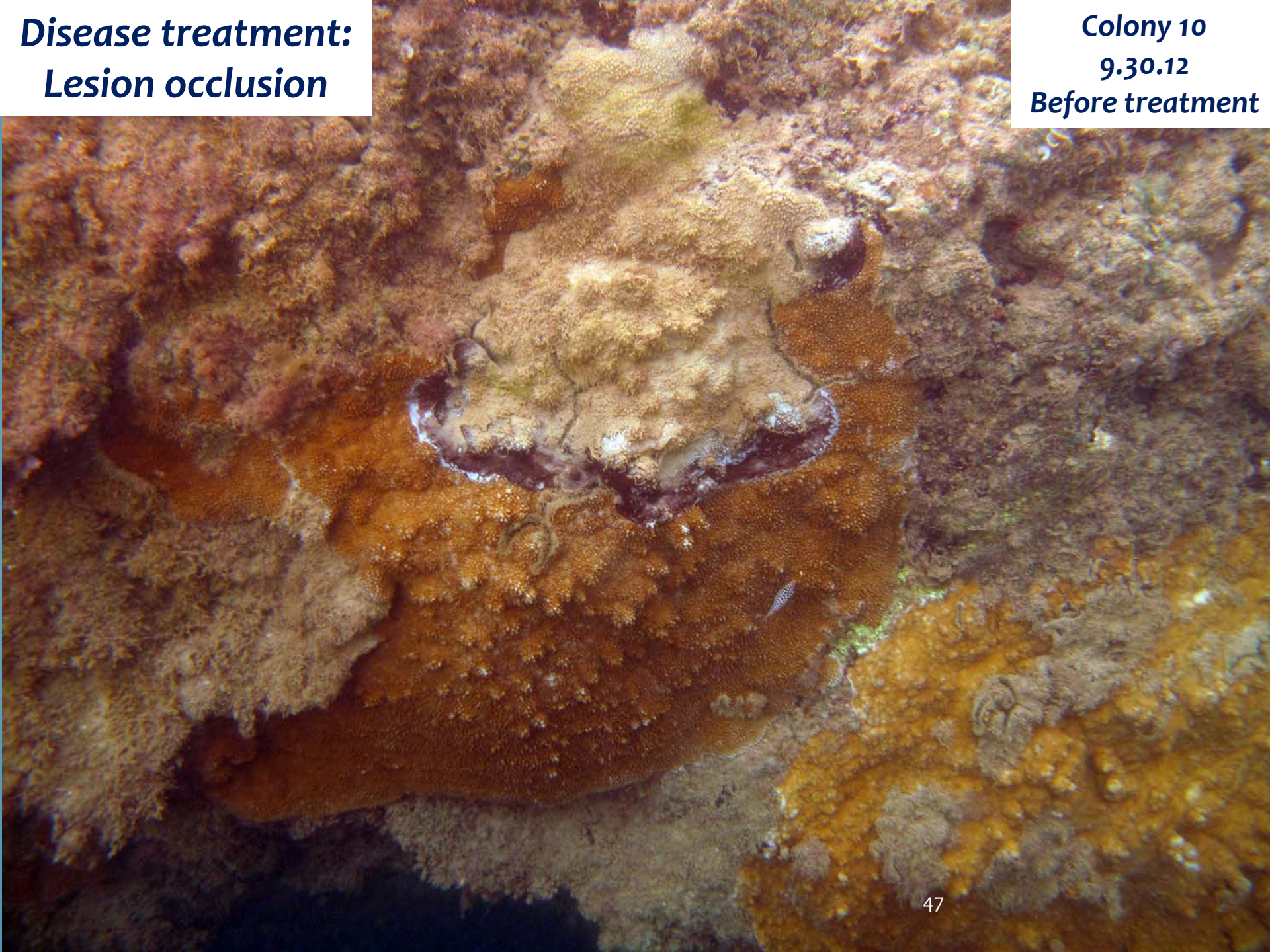
Runyon unpublished data

Disease virulence in the field


Colony 13
11.28.12
untreated


Colony 13
5.29.13
untreated

Disease treatment: Lesion occlusion

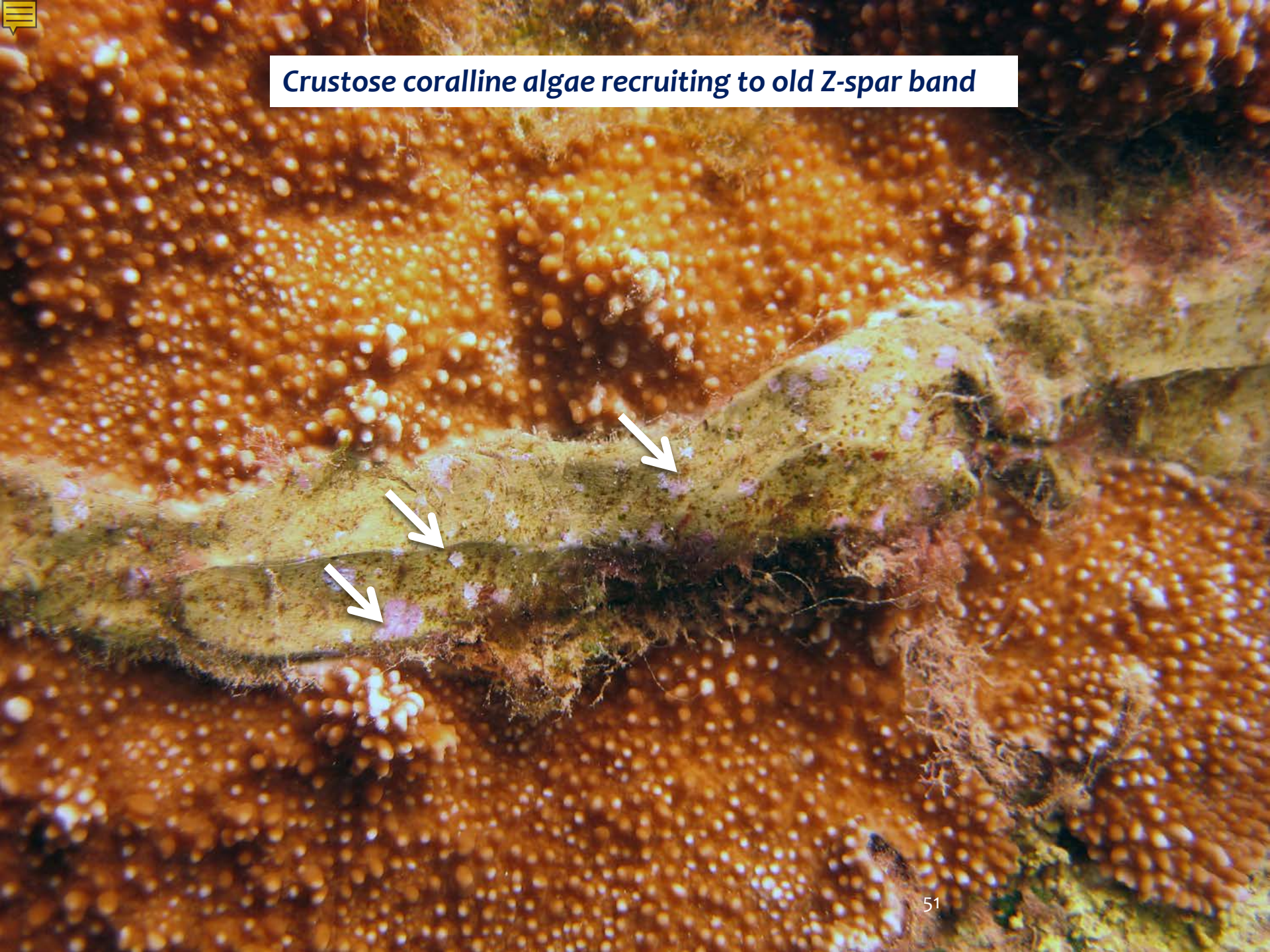


Colony 10
9.30.12
Before treatment

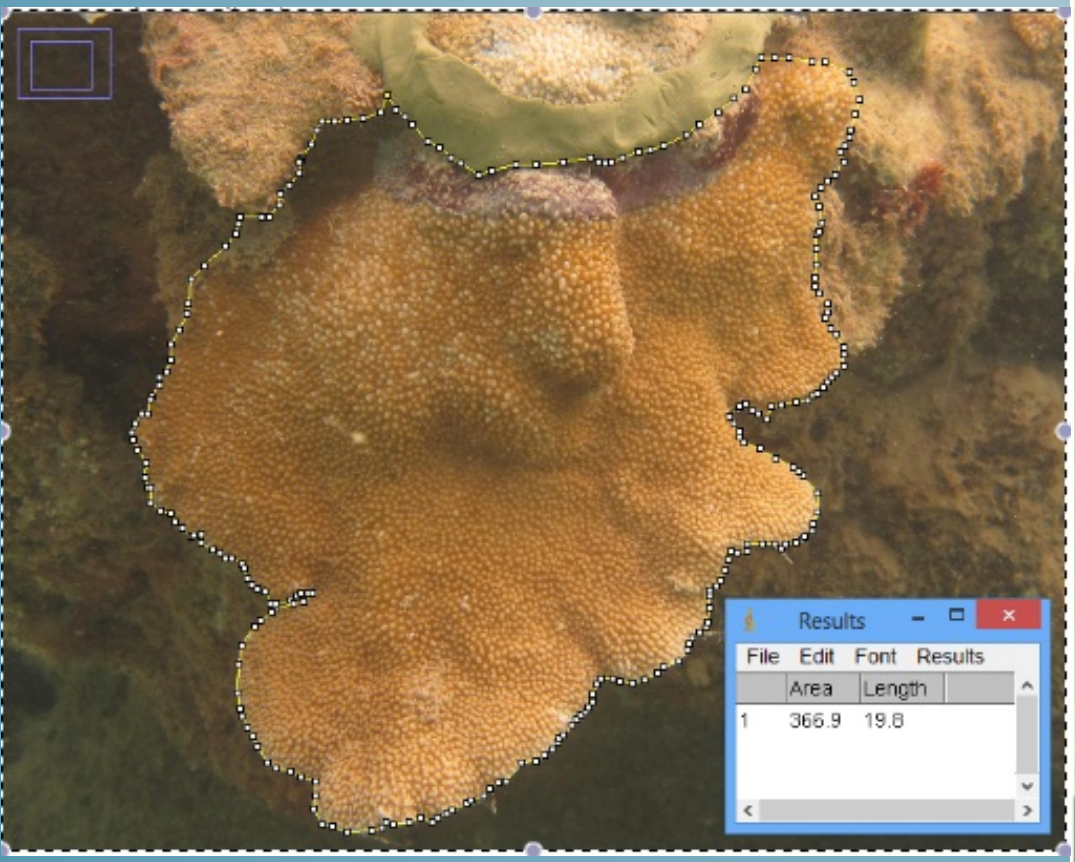

Colony 10
9.30.12
After treatment

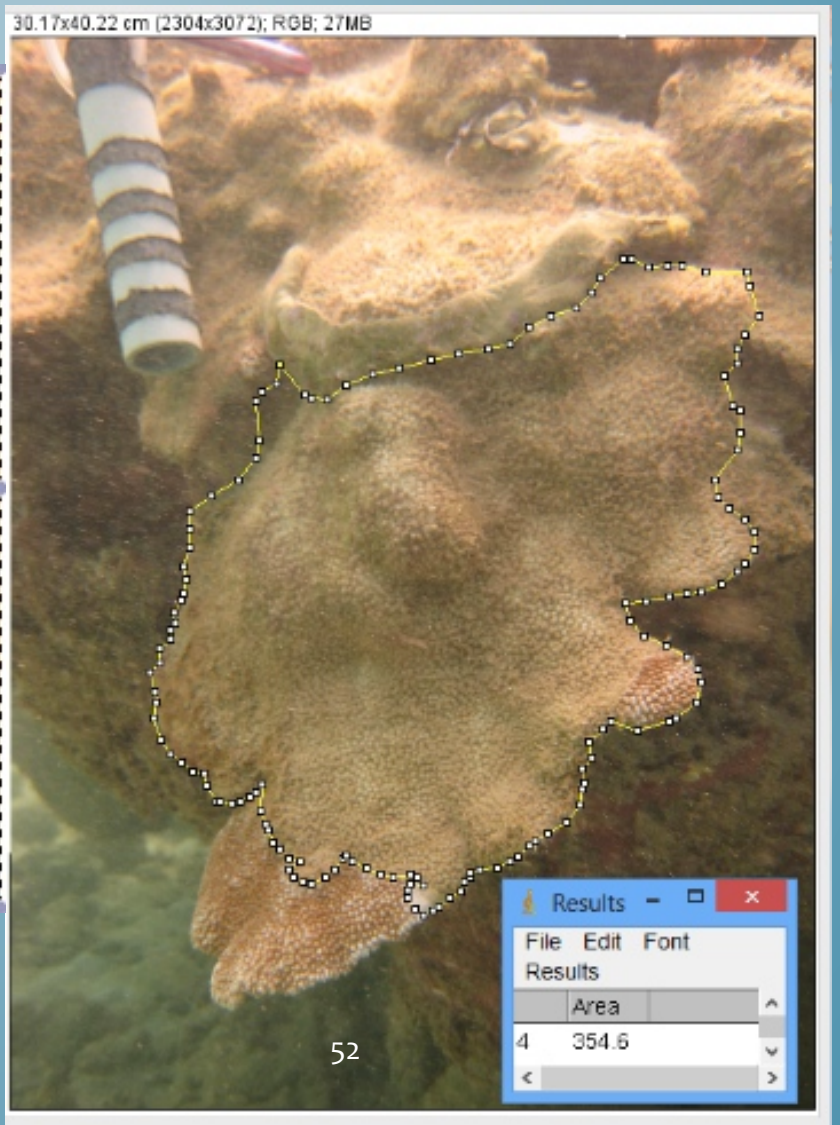

Colony 10
11.28.12


Colony 10
May 29, 2013


Crustose coralline algae recruiting to old Z-spar band

Ongoing digital analysis to measure amount of tissue loss





Disease Virulence & Treatment

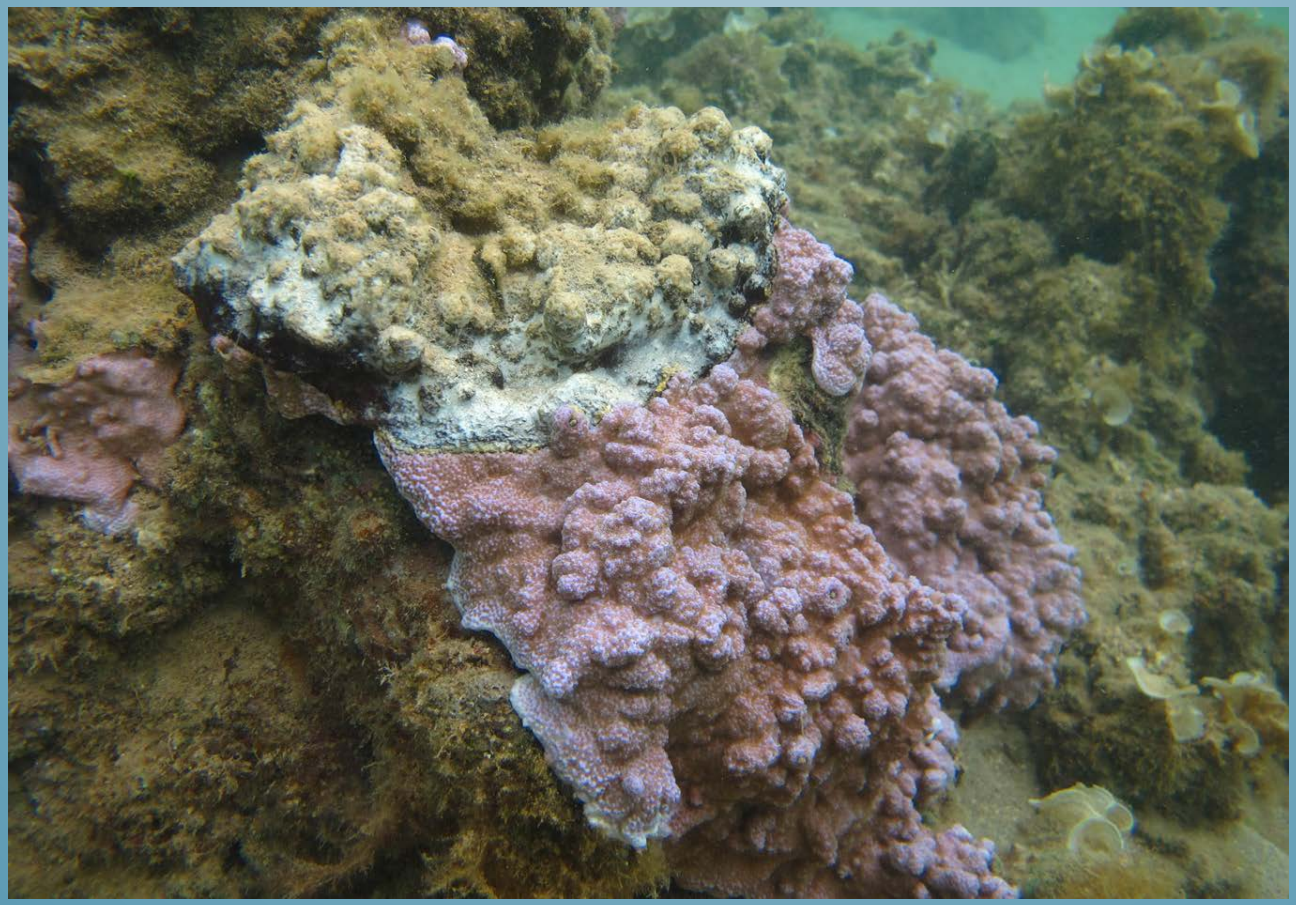
Untreated colonies (n=8)

- *Case fatality rate =25%*
- *Morbidity rate of colonies =100%*
- *Avg. amount of tissue loss/colony=65.9%*
- *Range=12.8%-100%*

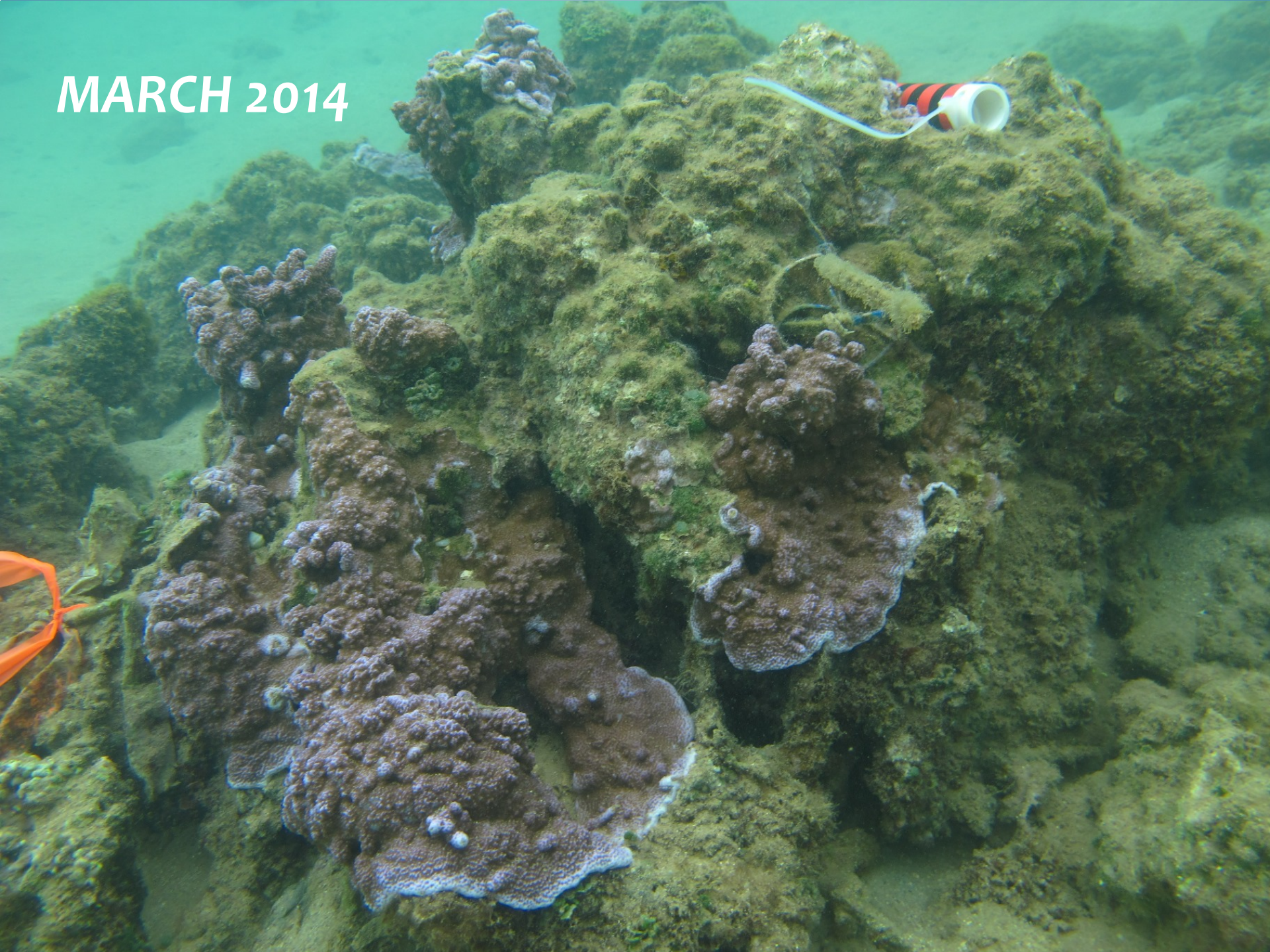
Treated colonies (n=8)

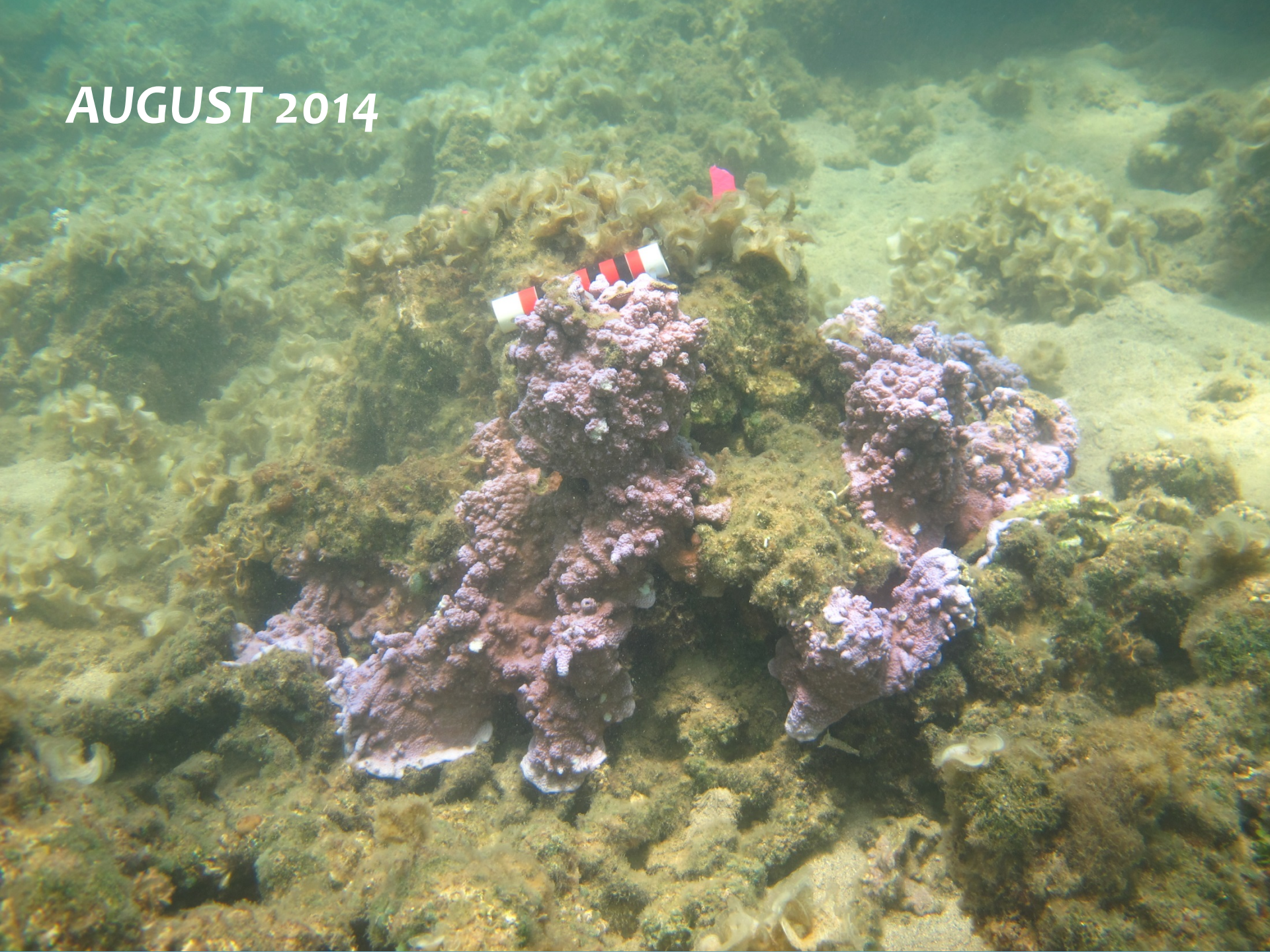
- *Case fatality rate =0%*
- *Morbidity rate of colonies= 50%*
- *Avg. amount of tissue loss/colony=4.4%*
- *Range=0%-35.4%*

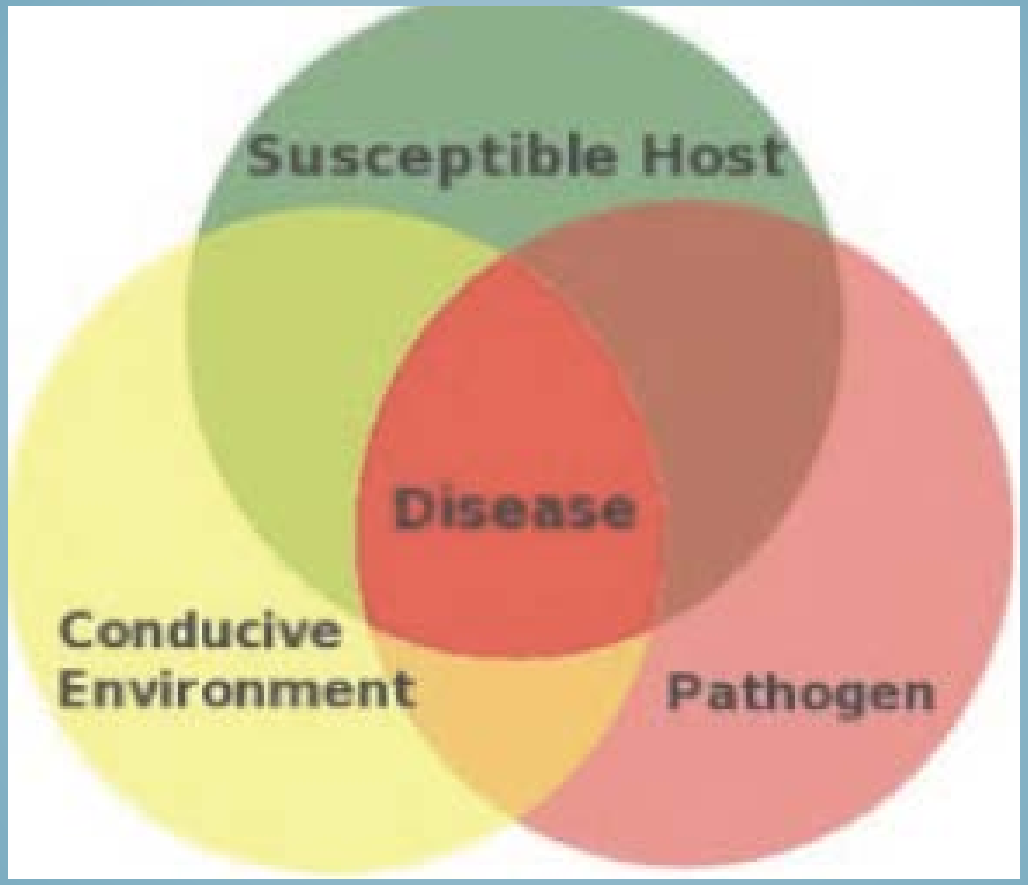
- *Ongoing monitoring of colonies to further understand virulence*
  - *Seasonal difference*
  - *Difference between species*




JULY 2013

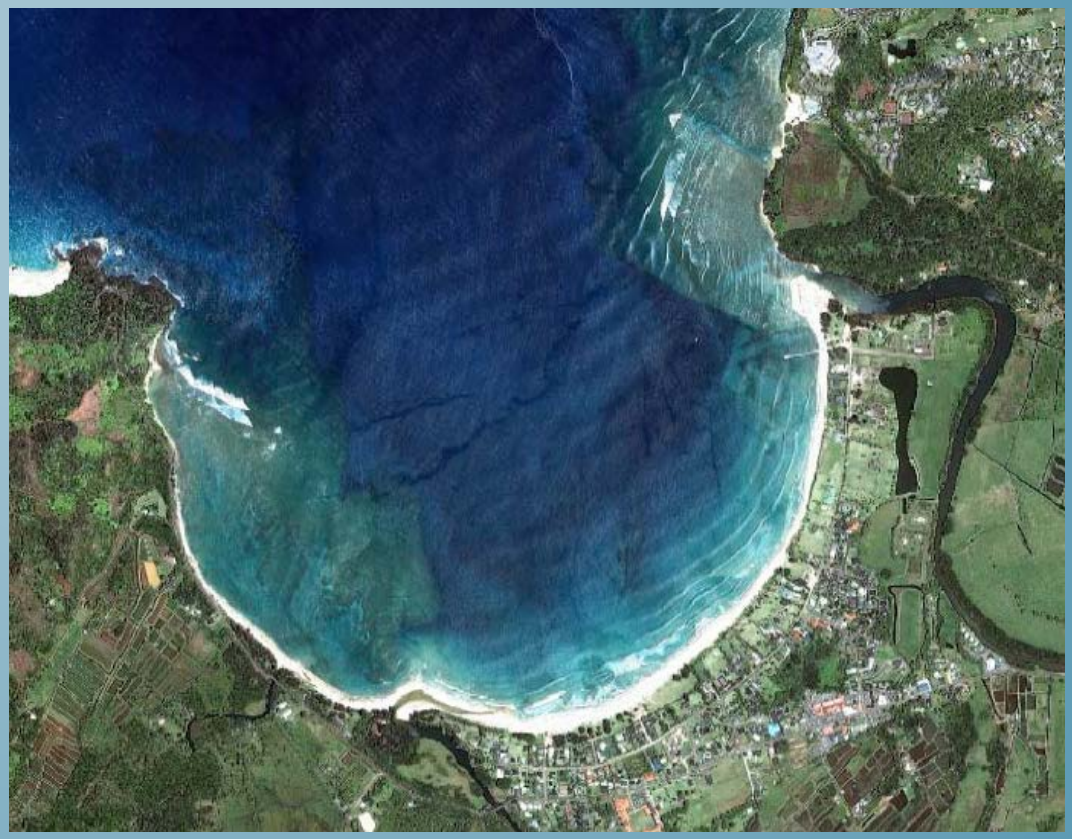

MARCH 2014


AUGUST 2014


Susceptible Host
Disease
Conducive
Environment
Pathogen

CONDUCIVE ENVIRONMENT?

- *Mapping environmental factors*
  - *Total Suspended Solids*
  - *Sediment Sampling*
  - *Water Temperature*
  - *Water Quality Data*
  - *Rainfall*
  - *Hydrology Data*
- *Aquaria Studies to manipulate environmental factors*

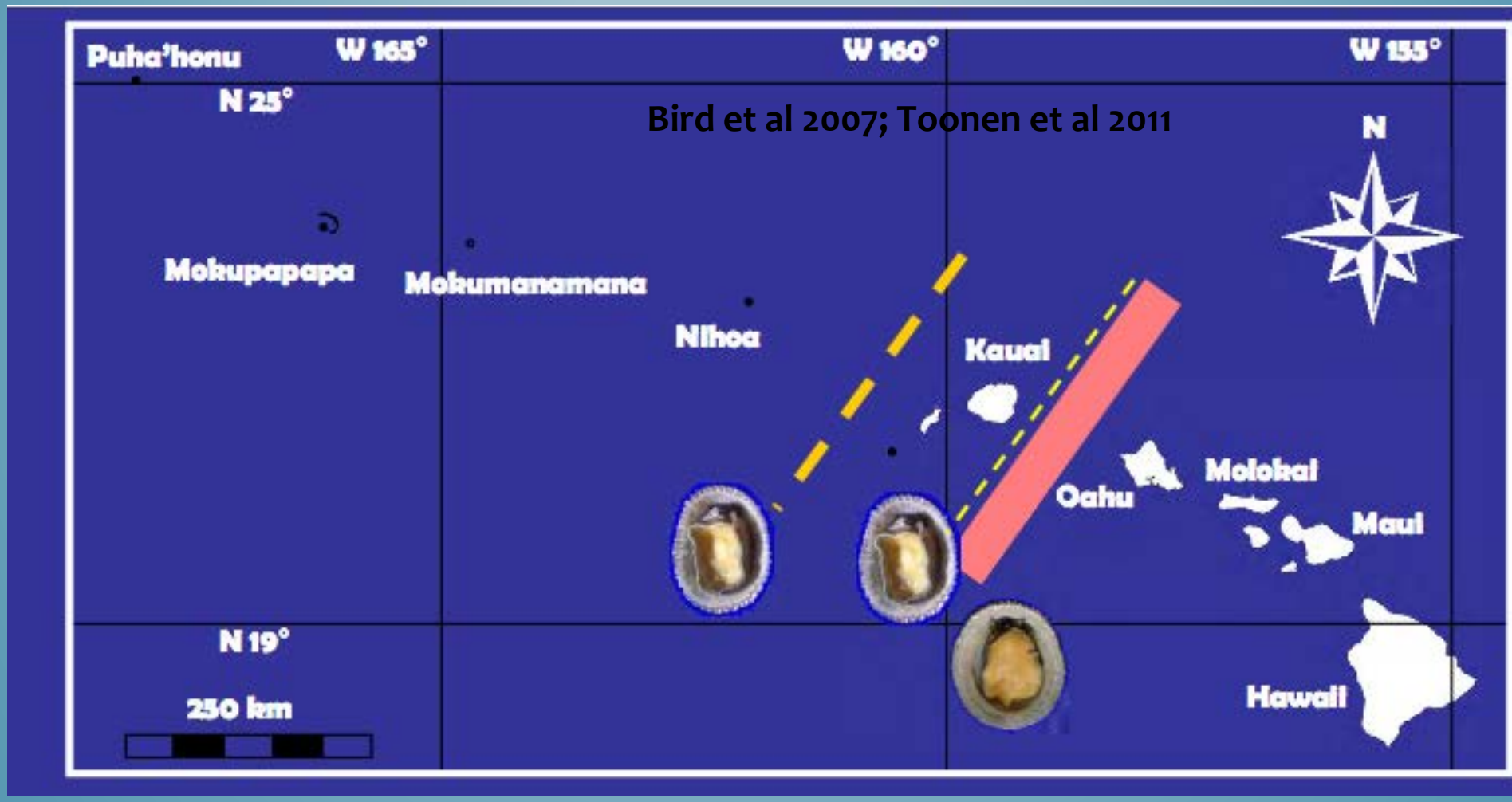


PATHOGEN?

- *Aquaria Studies to study behavior and transmission*

SUSCEPTIBLE HOST?

- *Genetic susceptibility to disease?*



- *Aquaria Studies to better understand environmental factors causing host to be more susceptible*

KAUA'I MANAGEMENT RESPONSE TEAM

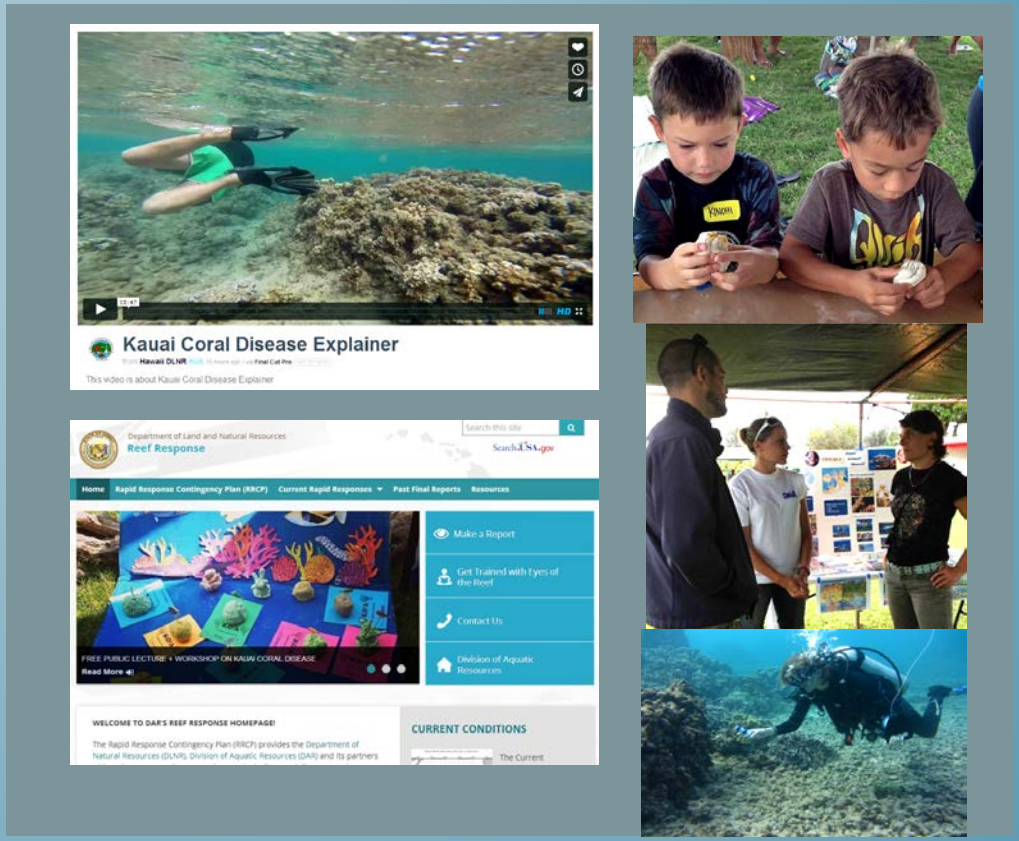
- *Officially convened at the beginning of 2014*
- *Responsibilities include:*
  - *Review incoming data*
  - *Communicate findings to the public*
  - *Assess effective management options to mitigate impact and/or promote recovery*
- *Current Members:*
  - *Department of Land and Natural Resources (DLNR)*
  - *DLNR- Division of Aquatic Resources*
  - *U.S. Geologic Survey (USGS)*
  - *Hawaii Institute of Marine Biology (HIMB)*
  - *University of Hawaii –School of Ocean and Earth Science Technology*
  - *Environmental Protection Agency*
  - *National Oceanic and Atmospheric Association (NOAA)*
  - *Eyes of the Reef (EOR)*

KAUA'I MANAGEMENT RESPONSE TEAM

- ***Current Goal***
  - *Identify narrow set of factors that are driving the coral disease outbreak and effective management actions that can be taken.*
- ***Tasks essential to achieving goal:***
  1. *Biomarker research to identify key stressors on a molecular level*
  2. *Black Band Disease pathogen field study*
  3. *Source water and sediment testing*
  4. *Community outreach and participation*
  5. *Coordination of the Kauai coral disease Response Team*

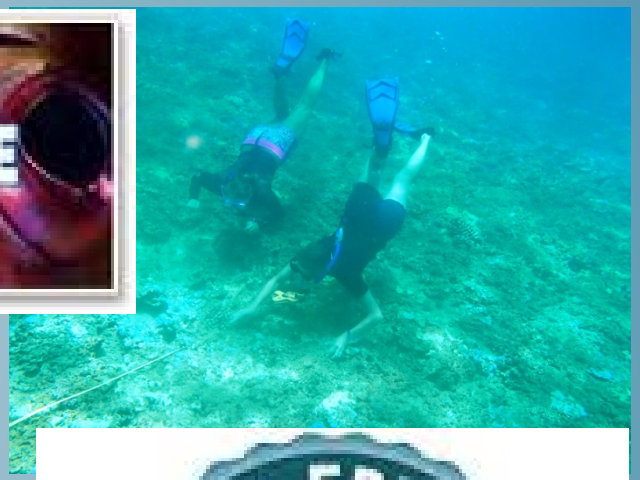
KAUA'I MANAGEMENT RESPONSE TEAM OUTREACH EFFORT

- *2014 outreach launch:*
  - *Reef Response website*
  - *Kauai coral disease video*
  - *Outreach through DAR Education Specialist, EOR coordinator*



WHAT WE ALL CAN DO?

1. *Get wet!*
2. *Use fertilizer wisely.*
3. *Water smart outdoors.*
4. *Be an informed consumer.*
5. *Learn about your wastewater & sewage system.*
6. *Practice good coral reef etiquette.*
7. *Practice pono fishing.*
8. *Support local conservation efforts.*
9. *Lend a hand!*
10. *Keep informed.*
    dlnr.hawaii.gov/reefresponse/




MAHALO!
UNIVERSITY OF HAWAI'I
KAUA'I
COMMUNITY COLLEGE
Hawaii Division of Aquatic Resources
HAWAII INSTITUTE OF MARINE BIOLOGY
COCONUT ISLAND, OAHU
Department of Land and Natural Resources
State of Hawaii
SCHOOL OF OCEAN AND EARTH
SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA
USGS
EYES
OF THE
REEF
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE