Acropora Species Status and Trends in Dry Tortugas National Park

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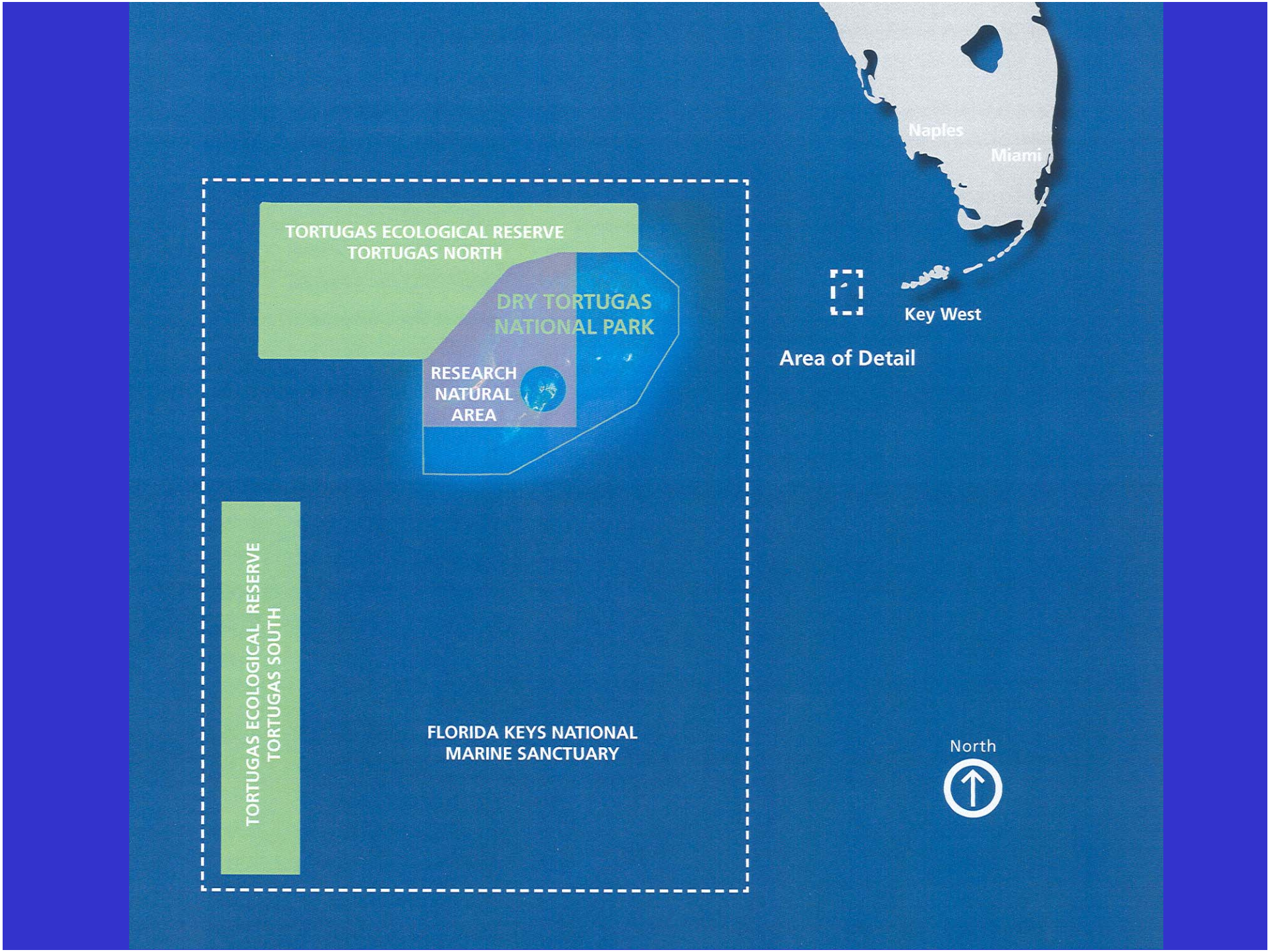
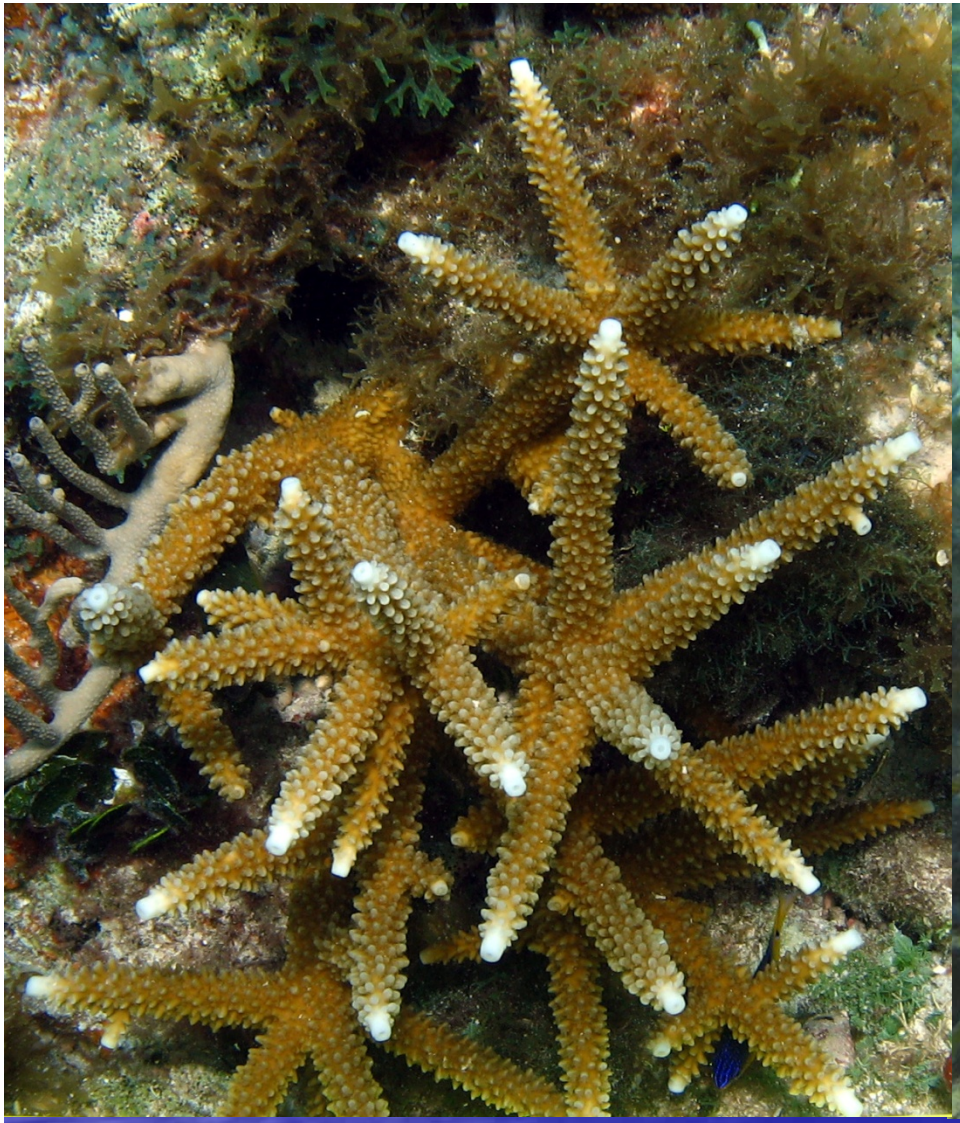

Naples
Miami
Key West
Area of Detail
TORTUGAS ECOLOGICAL RESERVE
TORTUGAS NORTH
DRY TORTUGAS
NATIONAL PARK
RESEARCH
NATURAL
AREA
TORTUGAS ECOLOGICAL RESERVE
TORTUGAS SOUTH
FLORIDA KEYS NATIONAL
MARINE SANCTUARY
North

Dry Tortugas National Park *Acropora* Science and Stewardship Objectives

- **Assess the long term ecological status and trends of *Acropora* species and reefs in the park.**
- **Encourage and support empirical research to better understand the factors affecting *Acropora* (e.g., disease, climate change).**
- **Provide scientific information for more effective park *Acropora* and marine ecosystem stewardship.**
- **Develop, implement, and evaluate conservation and restoration actions.**

***Acropora palmata* (elkhorn coral)**
ESA Threatened Species



Acropora cervicornis
(staghorn coral)
ESA Threatened Species

Acropora prolifera
(fused staghorn coral)
staghorn - elkhorn hybrid

Focus of this Presentation

- **Compare the current spatial distribution and extent of *Acropora* dominated reefs to the last *Acropora* surveys done in 1976 (Davis 1982).**
- **Current status and recent trends of Acropora populations in DTNP: *A. palmata*, *A. prolifera*, and *A. cervicornis*.**

Methods

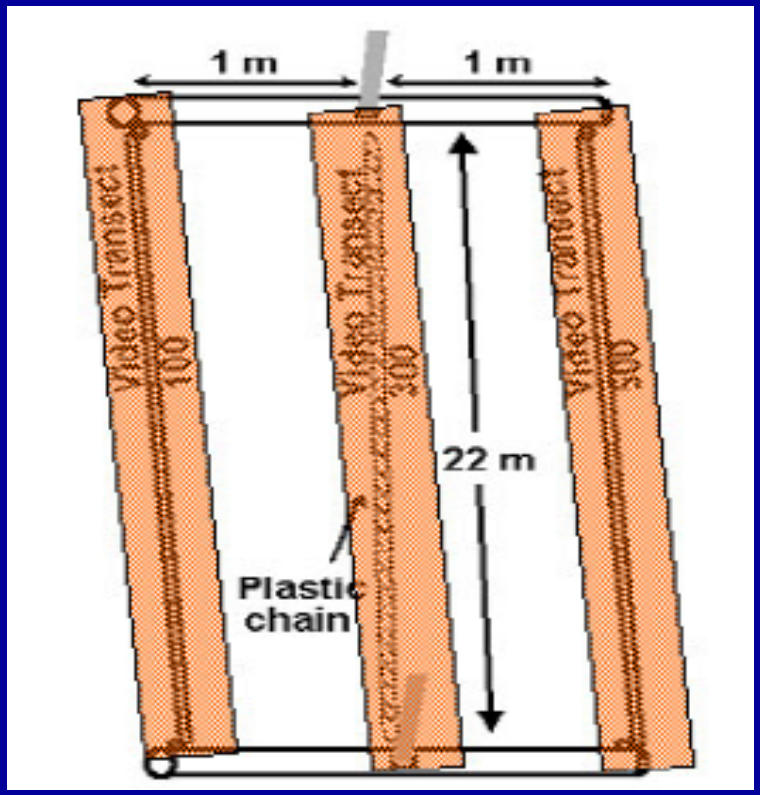
Acropora Spatial Distribution and Extent

- Re-survey areas indentified in 1976 as *Acropora* dominated reefs.
- Snorkeling with underwater scooter and GPS. Record survey tract, *Acropora* colony location, number of colonies, and colony size and condition/health (e.g., % live tissue, disease). [Similar to method developed by Williams and Miller, NMFS/NOAA.]
- In deeper water (>8m), paired SCUBA divers with scooters. A boat follows the divers recording their tract using boat GPS.

Methods

Coral Percent Cover: FWRI CREMP Videography

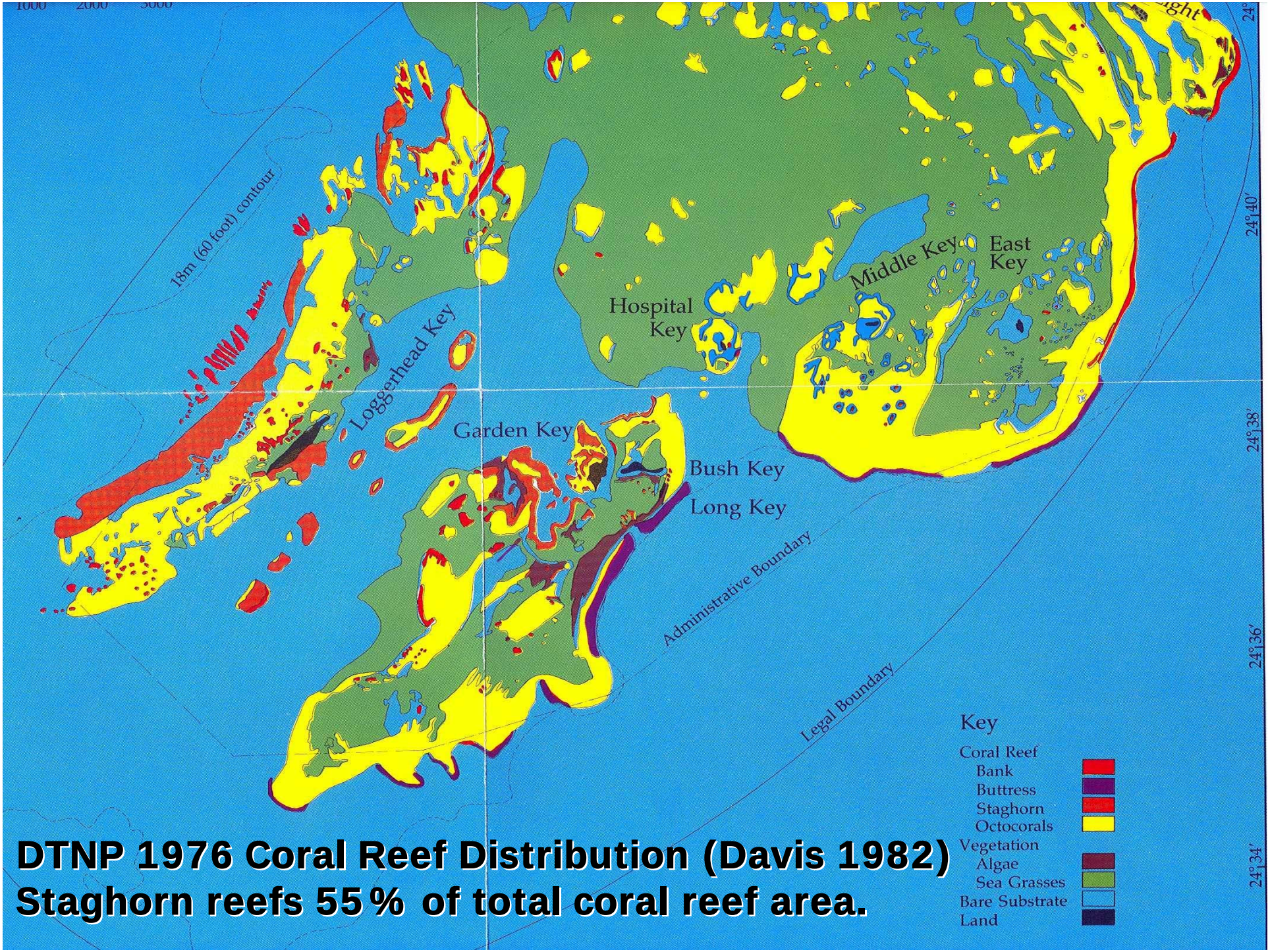
Three fixed continuous video transects per fixed station (replicate). Randomly selected points are analyzed on each image frame. Average of 2000 random points examined per replicate (station); precision to at least 0.1%.



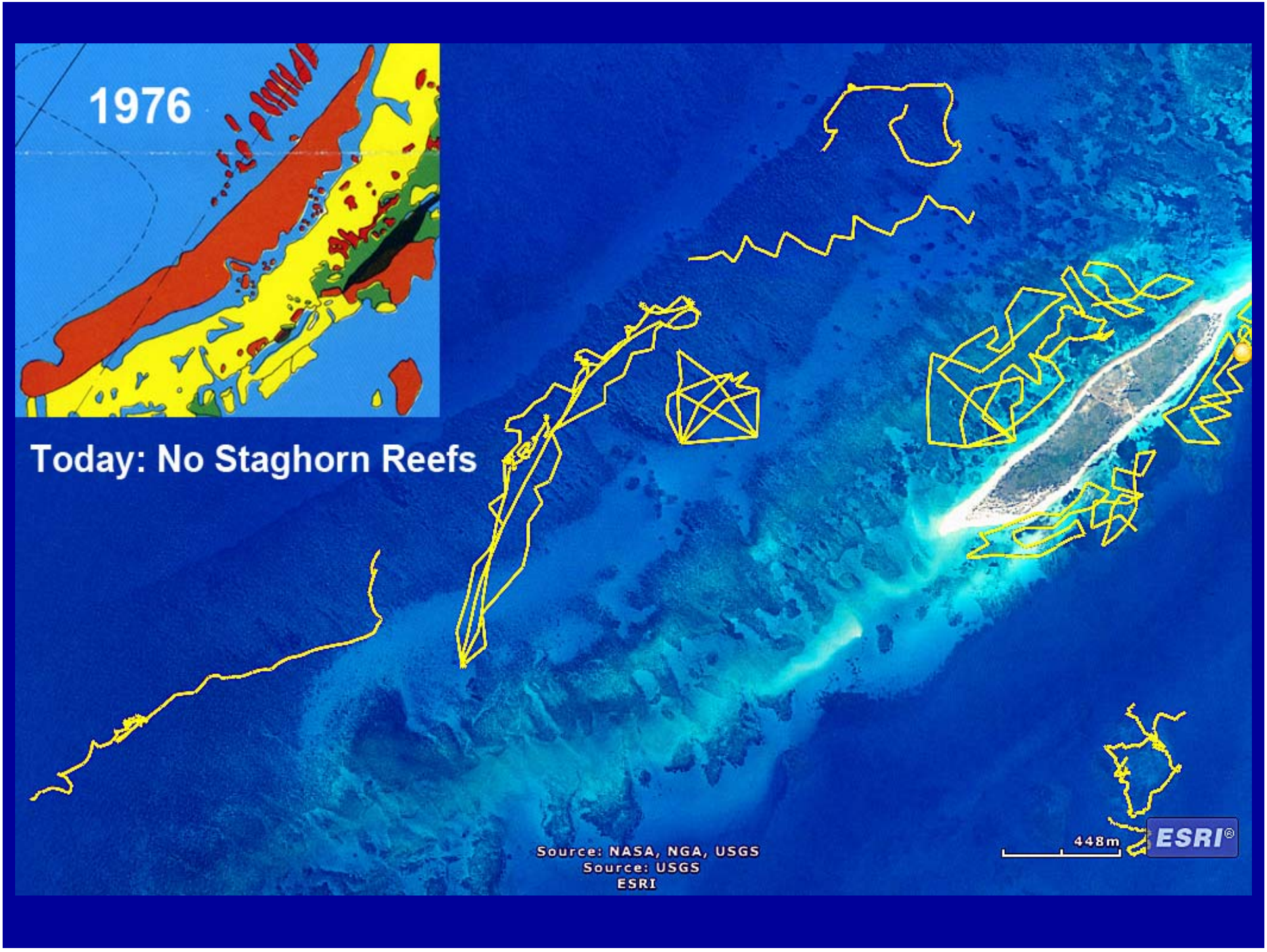
Methods

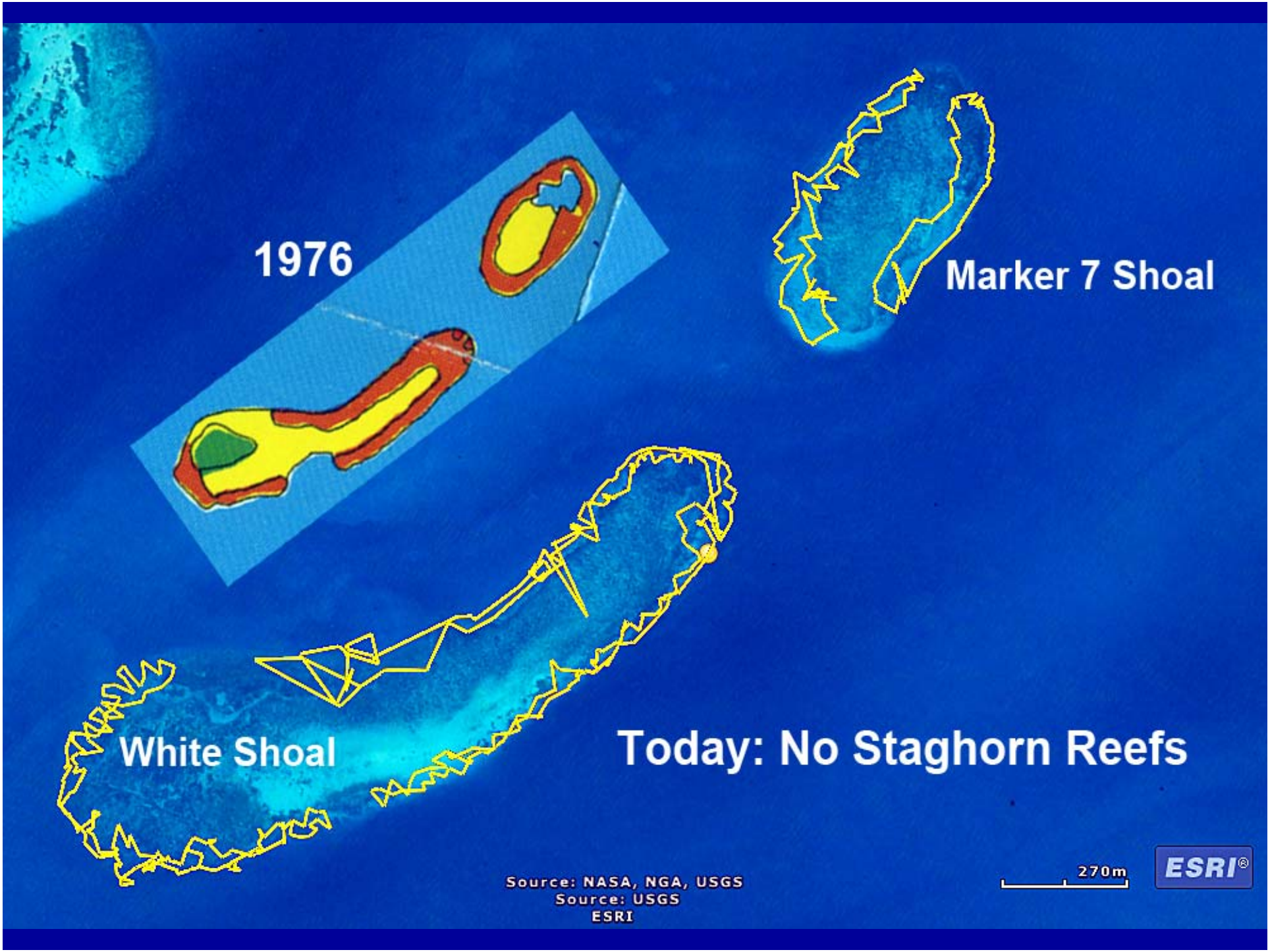
Acropora Disease, Bleaching, and Predation Prevalence

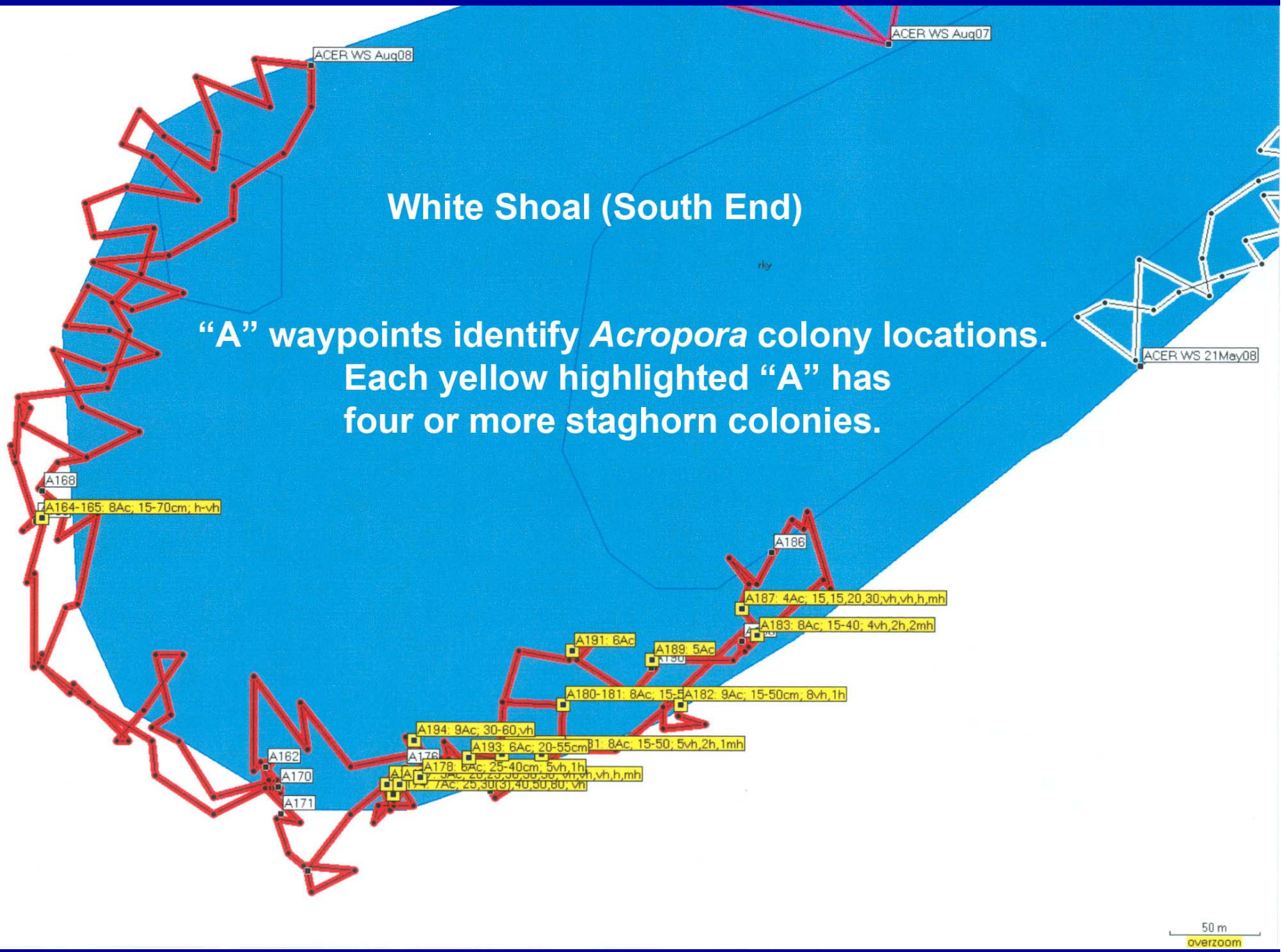
- CREMP Fixed Stations: All colonies ≥10cm 2006-2009, ≥4cm 2010-future, examined in 2x22m fixed belt transect (station). One survey per year.
- "Plot-less" Rapid Assessment: All *Acropora* colonies observed during haphazard swim of entire or most of site are examined. Multiple surveys per year.
- Data presented as percent of colonies examined with disease, etc.



DTNP 1976 Coral Reef Distribution (Davis 1982)
Staghorn reefs 55% of total coral reef area.

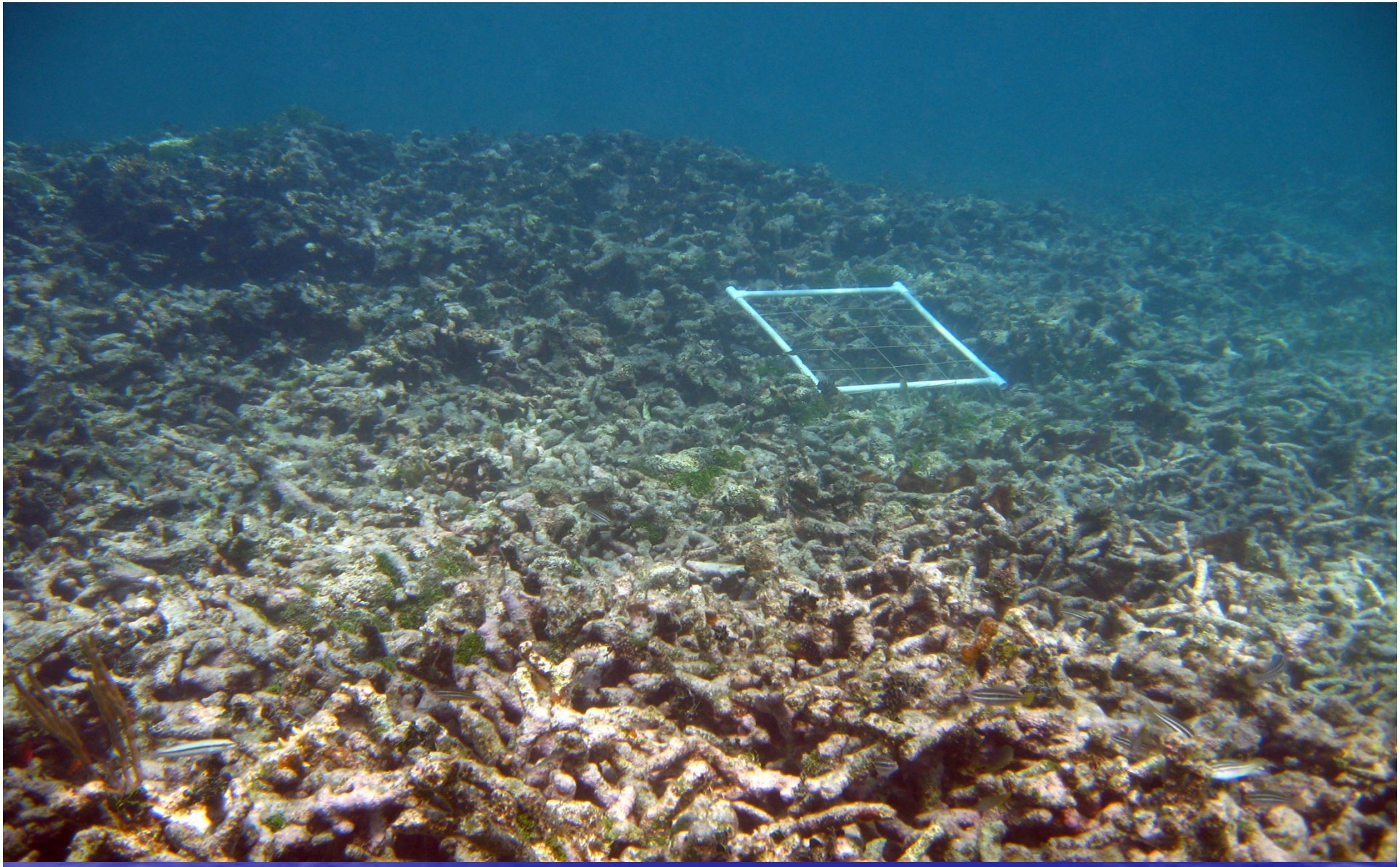

1976
Today: No Staghorn Reefs
Source: NASA, NGA, USGS
Source: USGS
ESRI
448m
ESRI®


1976
Marker 7 Shoal
White Shoal
Today: No Staghorn Reefs
Source: NASA, NGA, USGS
Source: USGS
ESRI
270m
ESRI®

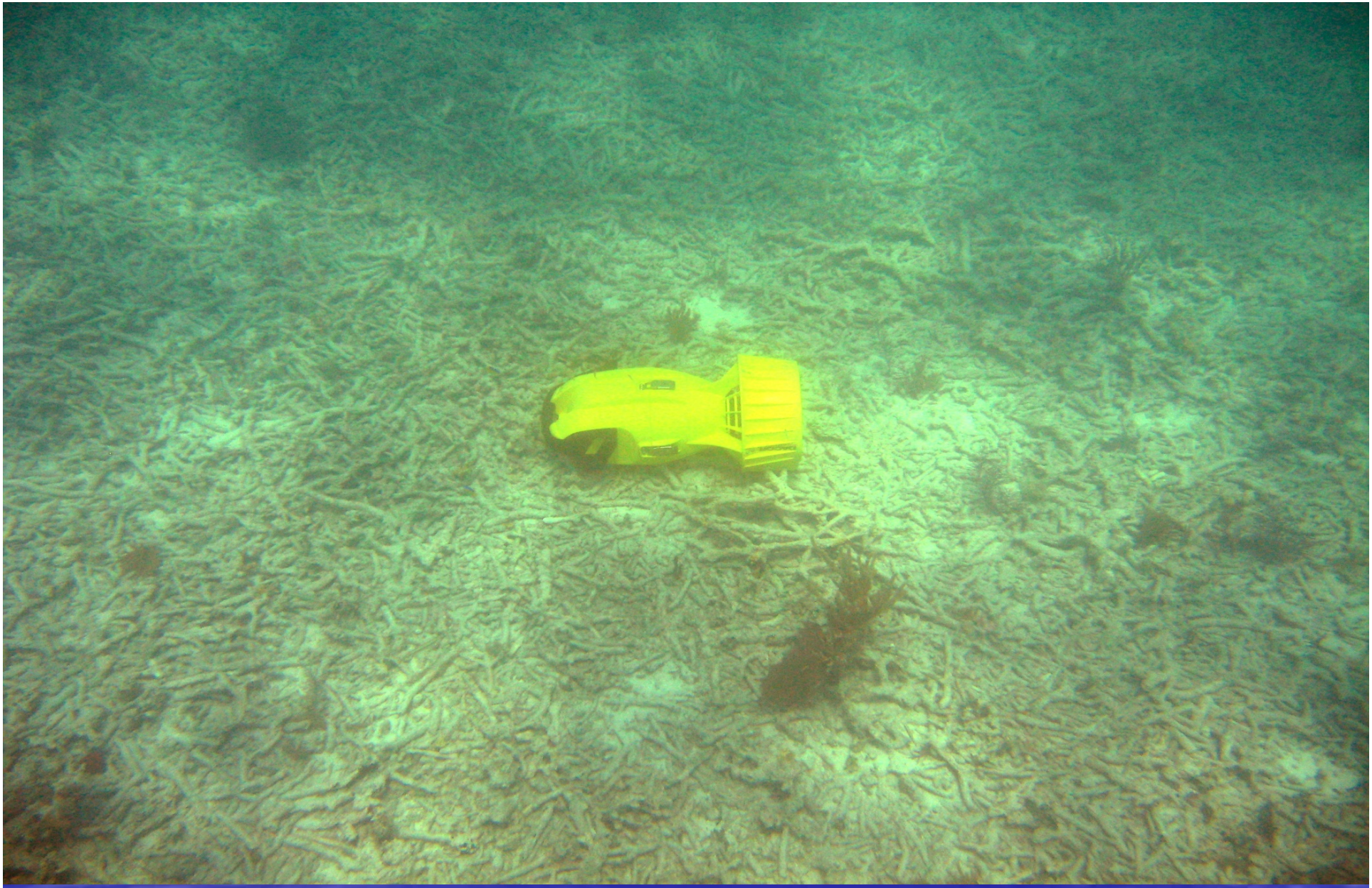

White Shoal (South End)
"A" waypoints identify *Acropora* colony locations.
Each yellow highlighted "A" has
four or more staghorn colonies.
ACER WS Aug08
ACER WS Aug07
ACER WS 21May08
A168
A164-165: 8Ac; 15-70cm; h-vh
A186
A187: 4Ac; 15,15,20,30;vh,vh,h,mh
A183: 8Ac; 15-40; 4vh,2h,2mh
A191: 6Ac
A189: 5Ac
A180-181: 8Ac; 15-5
A182: 9Ac; 15-50cm; 8vh,1h
A194: 9Ac; 30-60;vh
A193: 6Ac; 20-55cm
A176
A178: 5Ac; 25-40cm; 5vh,1h
A162
A170
A171
50 m
overzoom

1976: *Acropora cervicornis* reef west of Loggerhead Key.

[Photo by Gary Davis, NPS]



Today: *Acropora cervicornis* rubble pile west of Loggerhead Key



2008: *A. cervicornis* rubble field, White Shoal.

Dry Tortugas National Park
Acropora Spatial Extent

	1881 (Agassiz 1883)	1976 (Davis 1982)	1993 (Jaap and Sargent 1993)	2009 (Morrison et al, in prep)
Total *Acropora*	461 ha	478 ha	-----	<1 ha
A. cervicornis/ *A. prolifera*	417 ha	478 ha	-----	0.54 ha
A. palmata	44 ha	0.06 ha	0.14 ha	0.11 ha

>99% decrease in *A. cervicornis* 1976-2008


Coral Special Protection Zone (No Access)
A. palmata Patch
A. prolifera Patch
400 m
Image © 2010 DigitalGlobe
Image USDA Farm Service Agency
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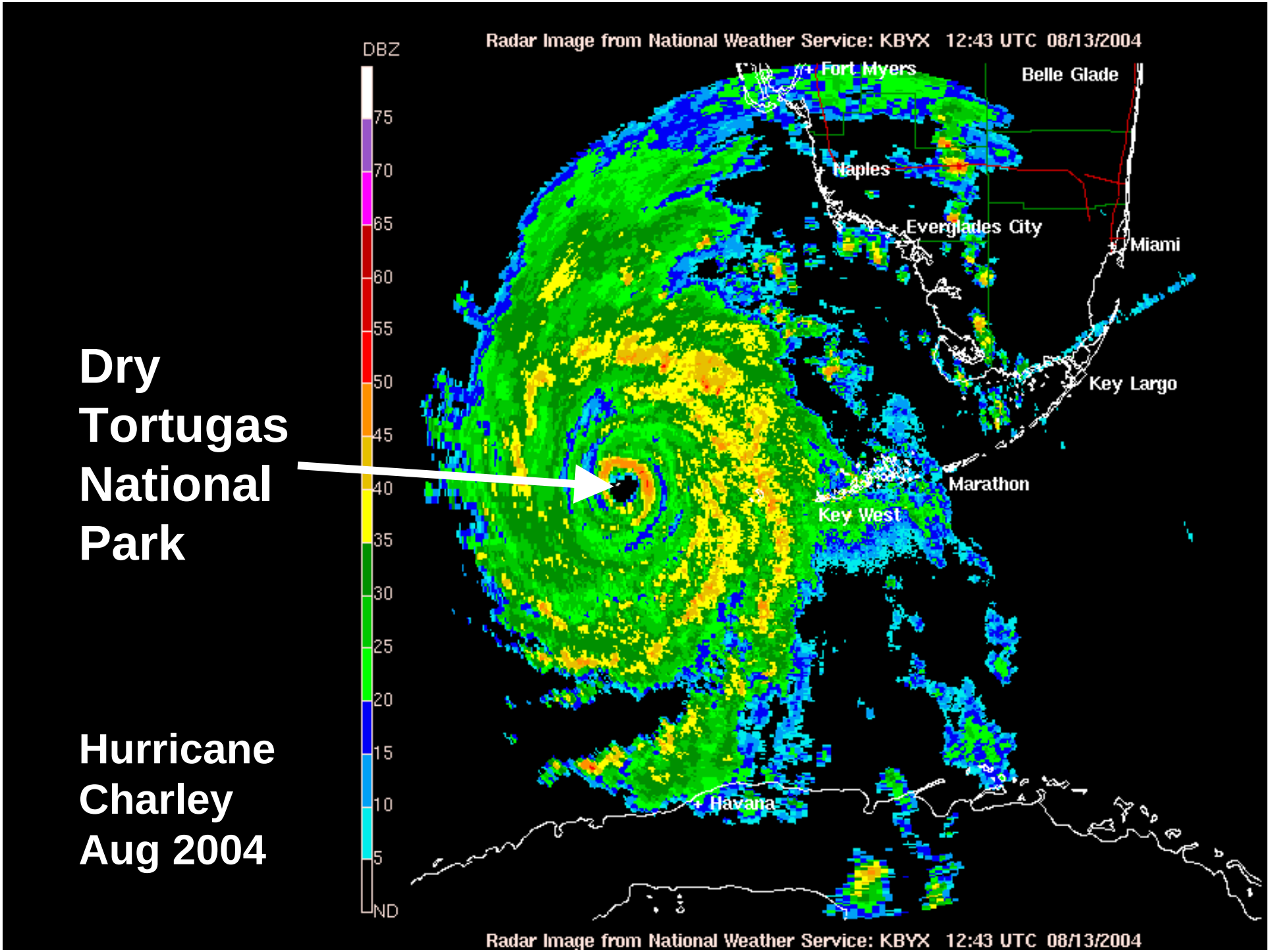
Loggerhead Key *A. cervicornis* patch reef one year prior to Hurricane Charley.

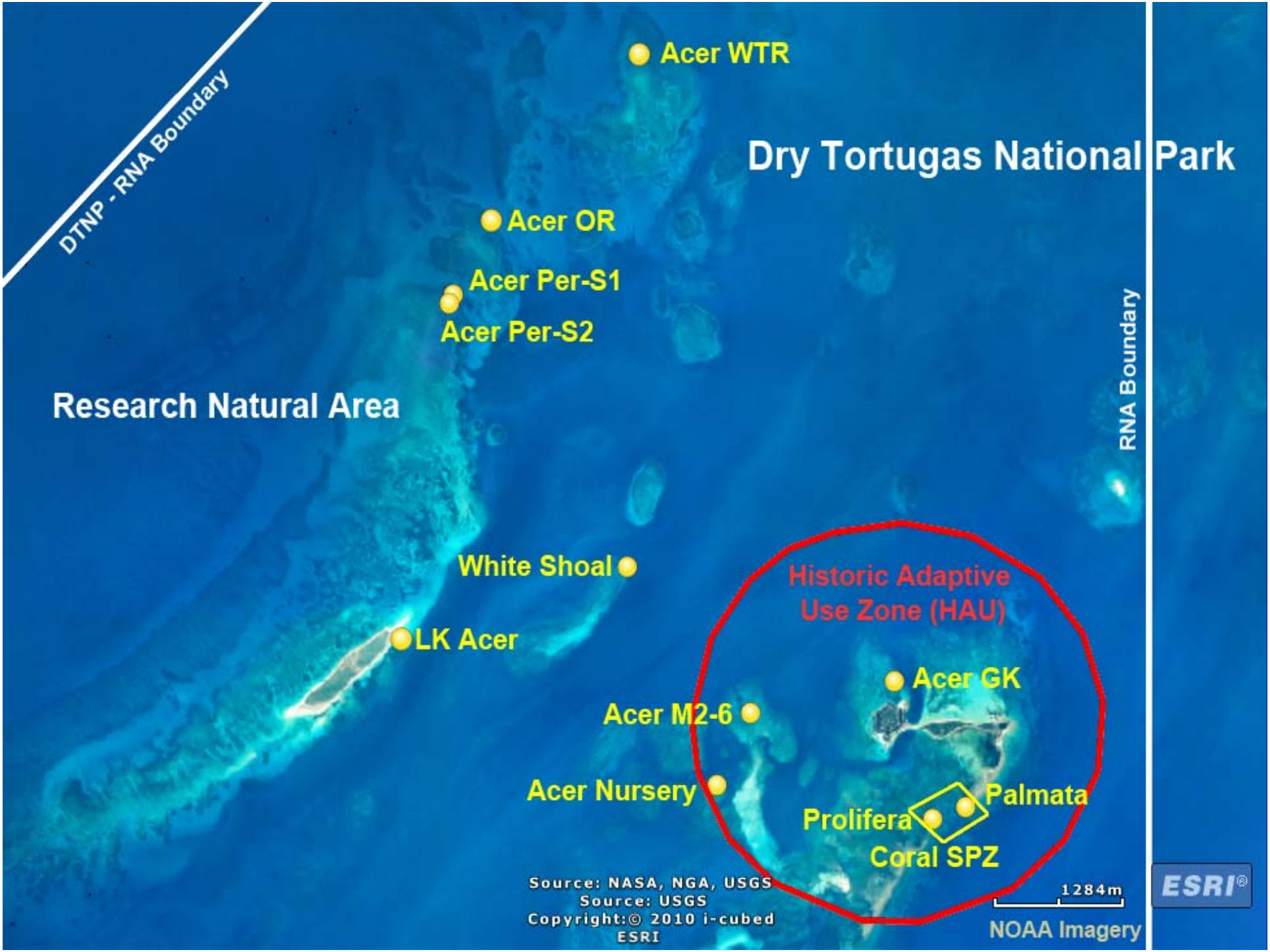
[Photo by Dana Williams, NOAA]


Dry Tortugas National Park
Hurricane Charley Aug 2004
Radar Image from National Weather Service: KBYX 12:43 UTC 08/13/2004
DBZ
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
ND
Fort Myers
Belle Glade
Naples
Everglades City
Miami
Key Largo
Marathon
Key West
Havana
Radar Image from National Weather Service: KBYX 12:43 UTC 08/13/2004

Loggerhead Key *Acropora cervicornis* patch reef about one year after Hurricane Charley (24 Jul 05).

Proximate Causes of *Acropora* Loss

- 1977 Hypothermic (cold water) event.
  - 90% staghorn loss due to hypothermic stress caused by cold front and cold water mass.
- Mid 1980's to 2003: Disease occurrences.
  - 1995-2000: Multiple significant disease events.
  - 2003: Major disease outbreak affected all *Acropora* spp. *A. prolifera* estimated 90% mass mortality.
- 2004-2005: Five hurricanes affected DTNP in 14 months, unprecedented in 130 year history of Tortugas science.
- 2009-2010: Substantial localized staghorn white band disease outbreaks.


Acer WTR
DTNP - RNA Boundary
Dry Tortugas National Park
Acer OR
Acer Per-S1
Acer Per-S2
Research Natural Area
RNA Boundary
White Shoal
Historic Adaptive
Use Zone (HAU)
LK Acer
Acer GK
Acer M2-6
Acer Nursery
Palmata
Prolifera
Coral SPZ
Source: NASA, NGA, USGS
Source: USGS
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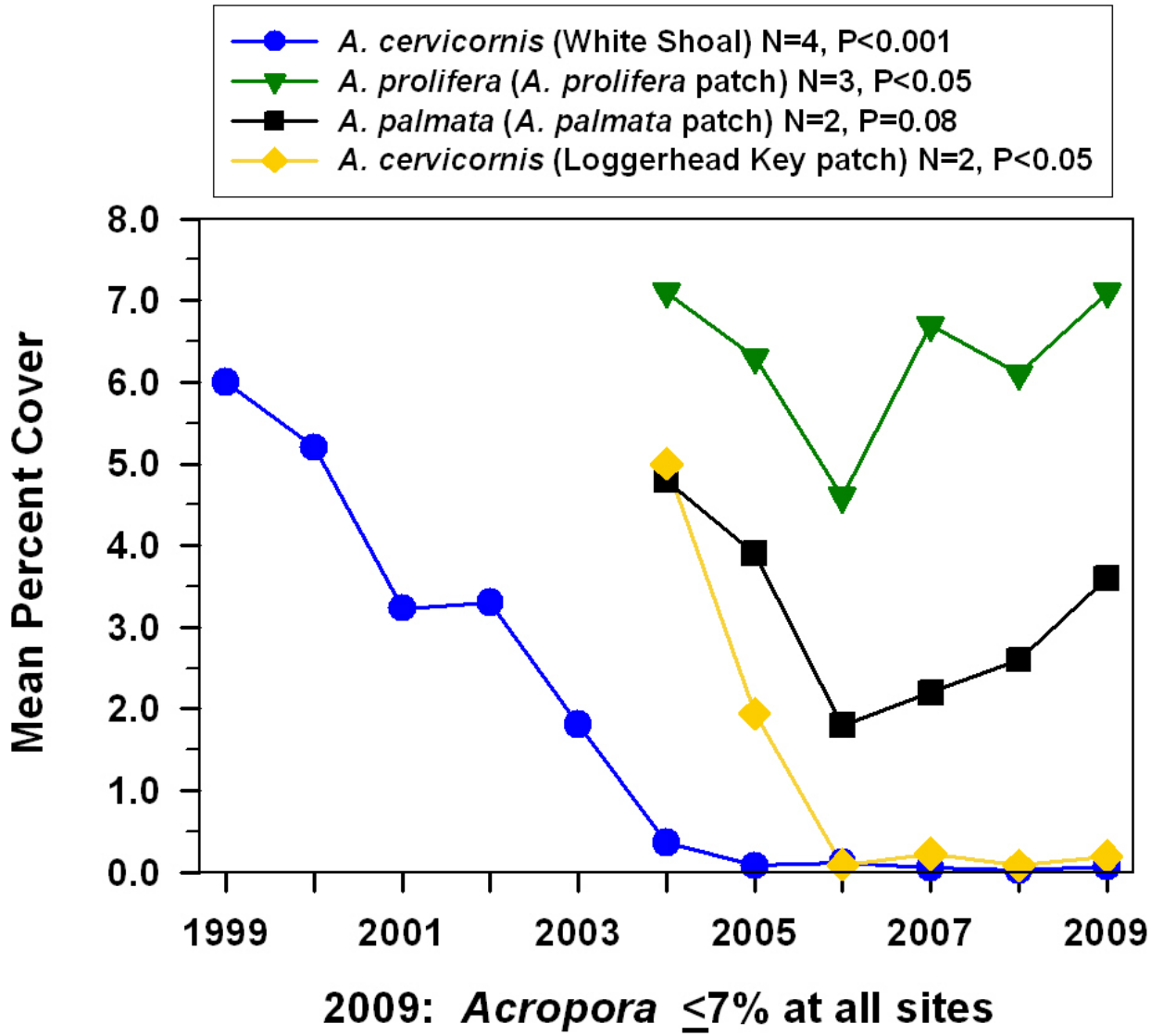
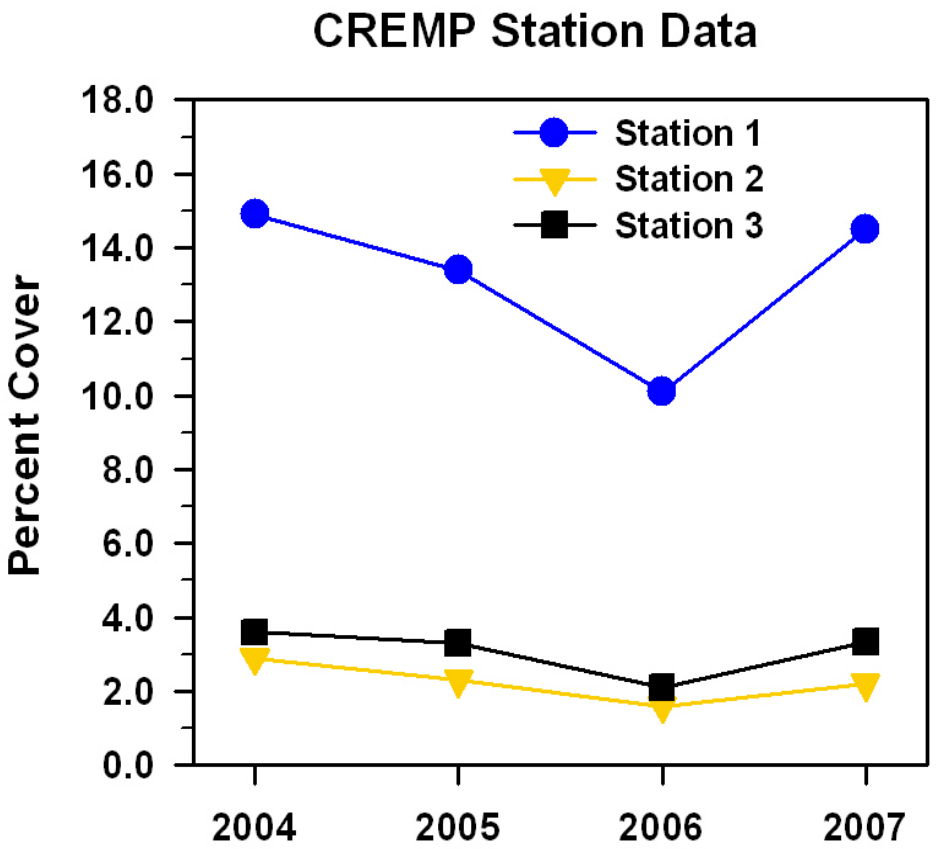
DTNP *Acropora* CREMP Sites: *Acropora* Cover

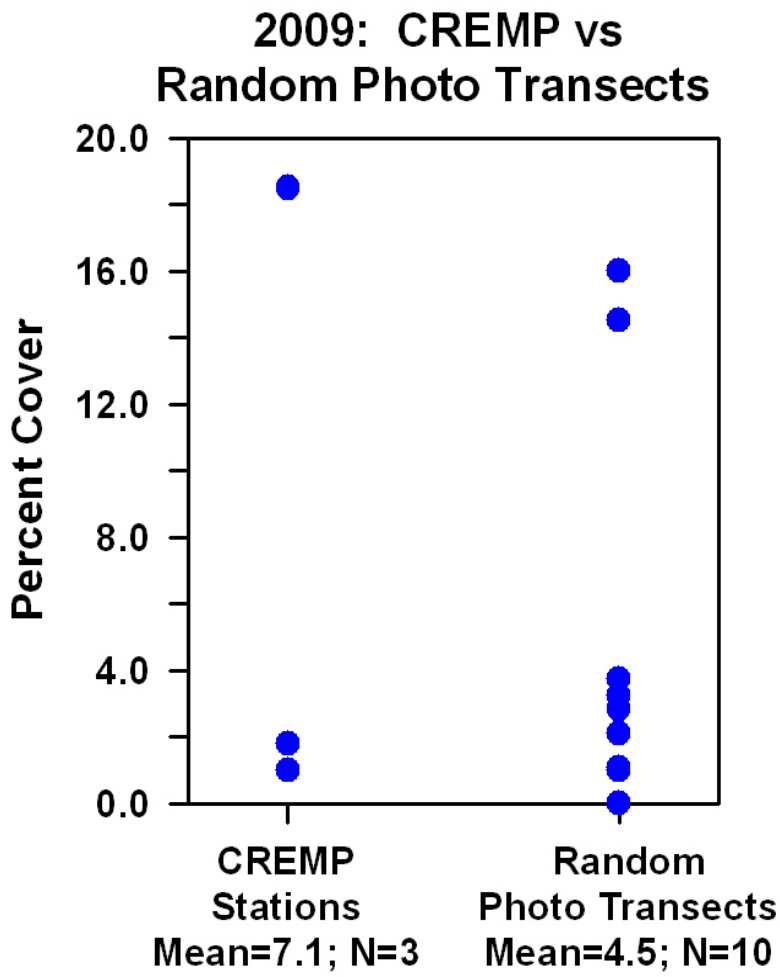


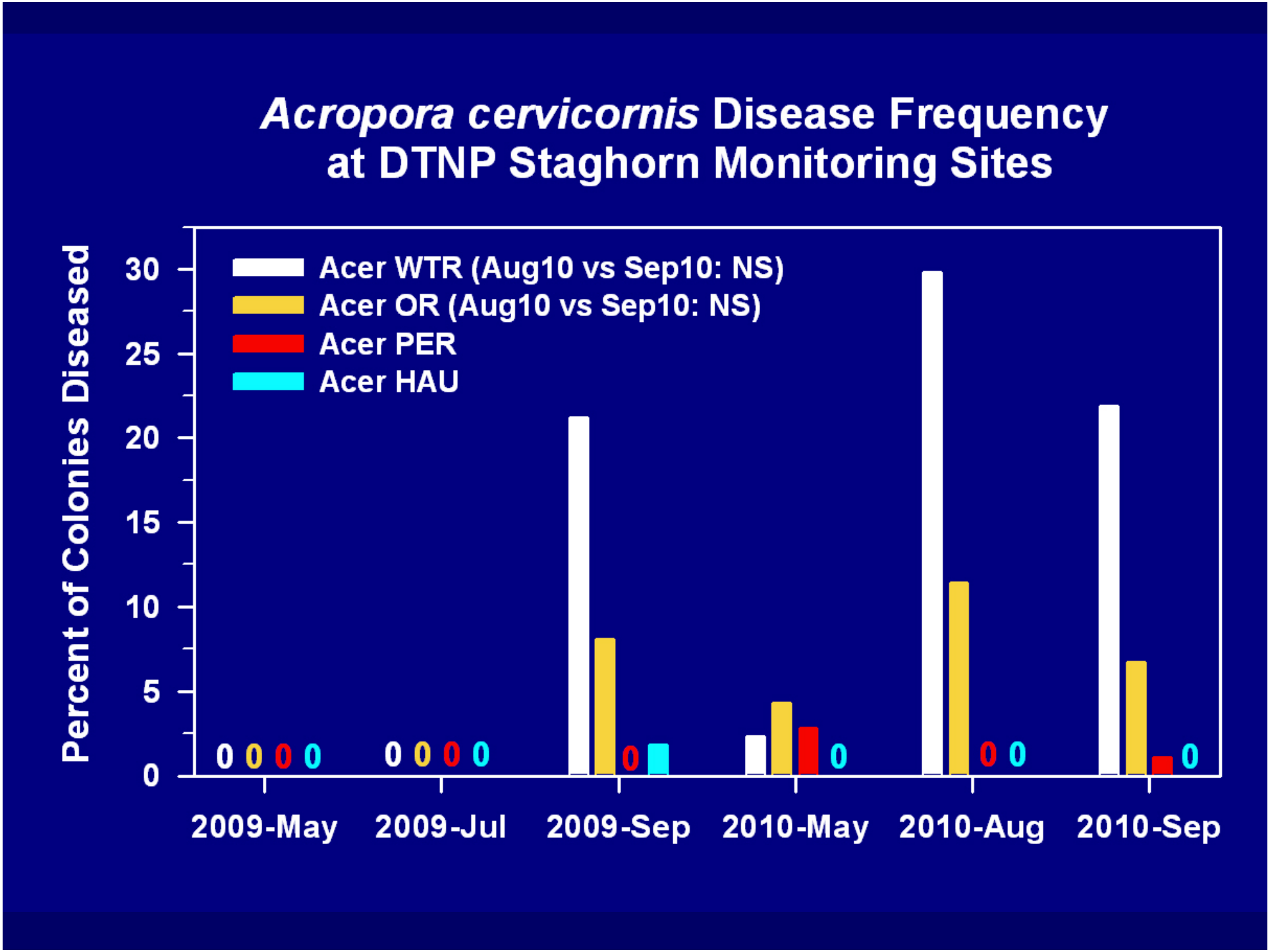
2009: *Acropora* ≤7% at all sites

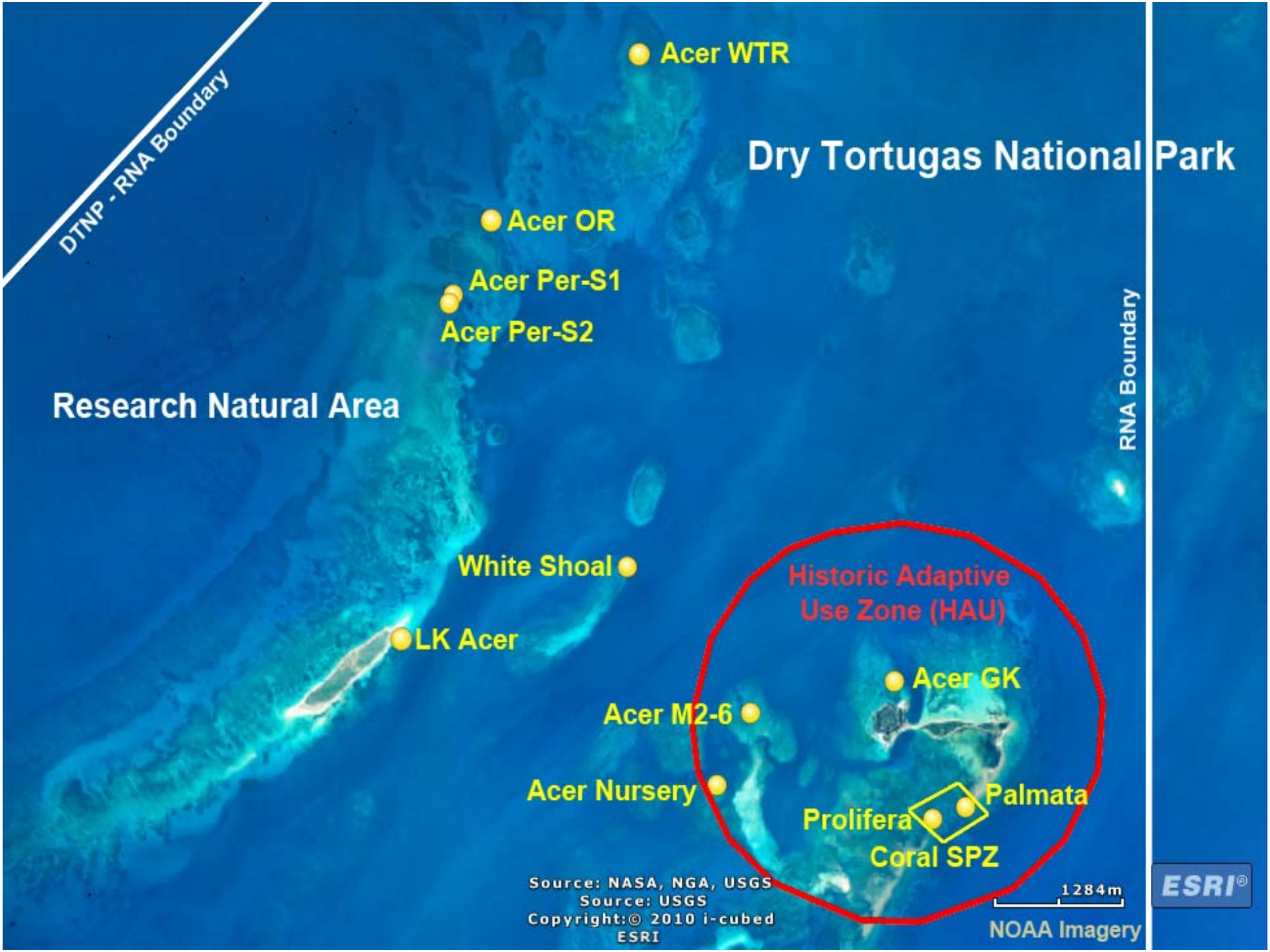
DTNP *Acropora prolifera* Patch: Percent Cover



RM ANOVA on transformed data:
F=17.06; df=3,11; P=0.002
Pairwise Multiple Comparisons (P<0.05):
2004=2005>2006<2007
2007=2004=2005 (recovery)




Acropora cervicornis Disease Frequency
at DTNP Staghorn Monitoring Sites
Percent of Colonies Diseased
30
25
20
15
10
5
0
Acer WTR (Aug10 vs Sep10: NS)
Acer OR (Aug10 vs Sep10: NS)
Acer PER
Acer HAU
0 0 0 0
0 0 0 0
0
0
0 0
0
0 0
2009-May
2009-Jul
2009-Sep
2010-May
2010-Aug
2010-Sep


Acer WTR
DTNP - RNA Boundary
Dry Tortugas National Park
Acer OR
Acer Per-S1
Acer Per-S2
Research Natural Area
RNA Boundary
White Shoal
Historic Adaptive
Use Zone (HAU)
LK Acer
Acer GK
Acer M2-6
Acer Nursery
Palmata
Prolifera
Coral SPZ
Source: NASA, NGA, USGS
Source: USGS
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1284m
NOAA Imagery
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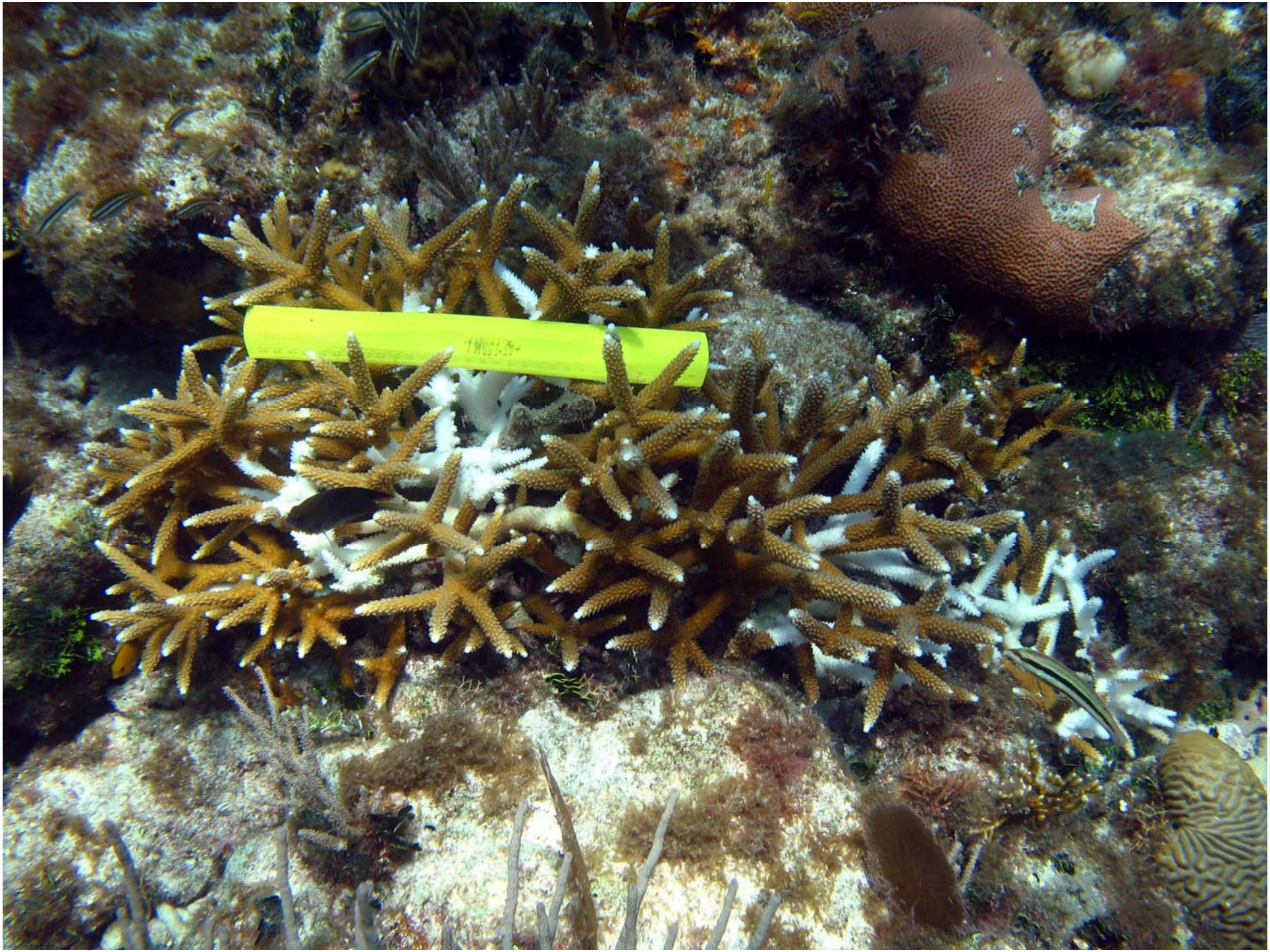
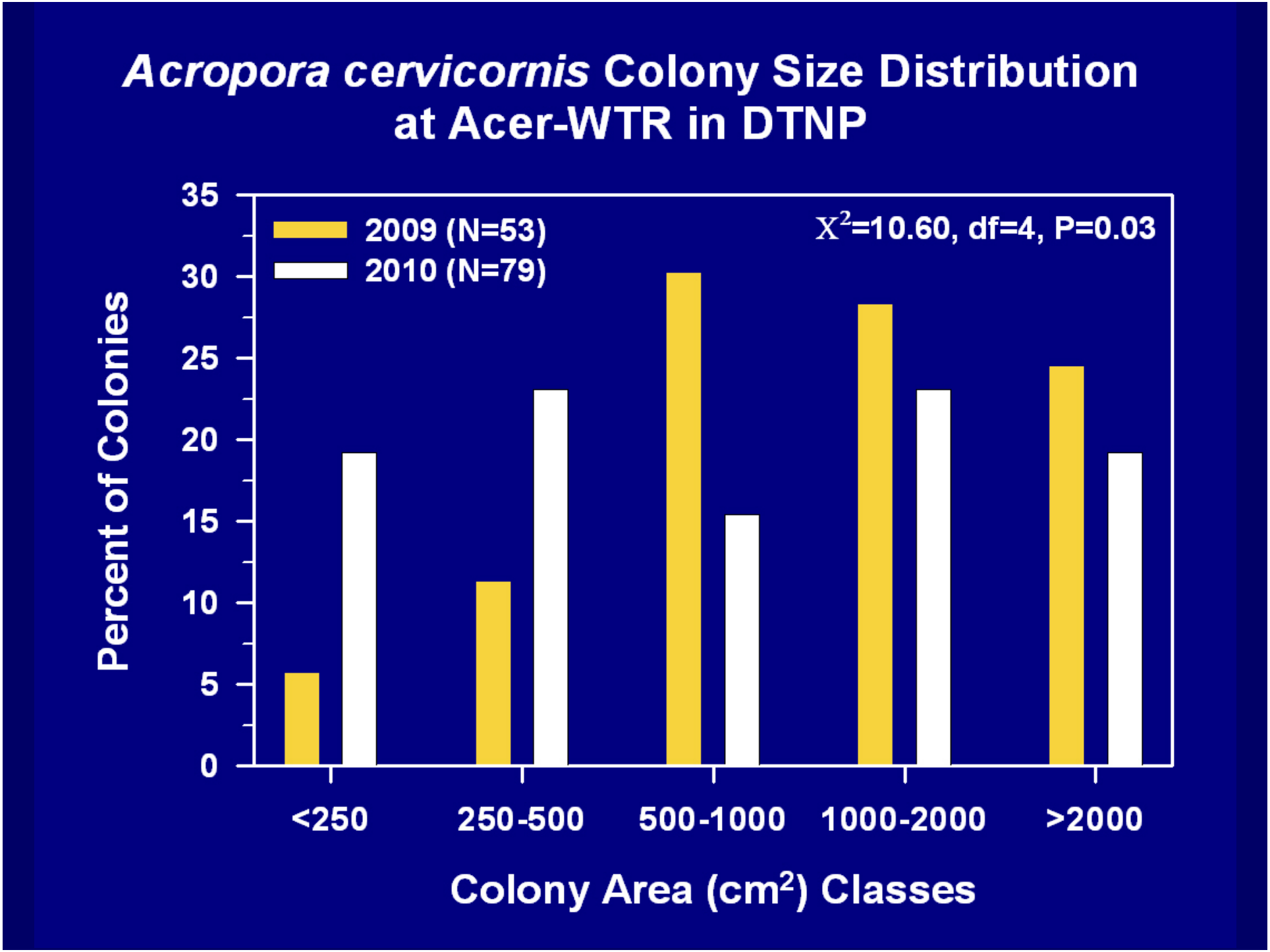
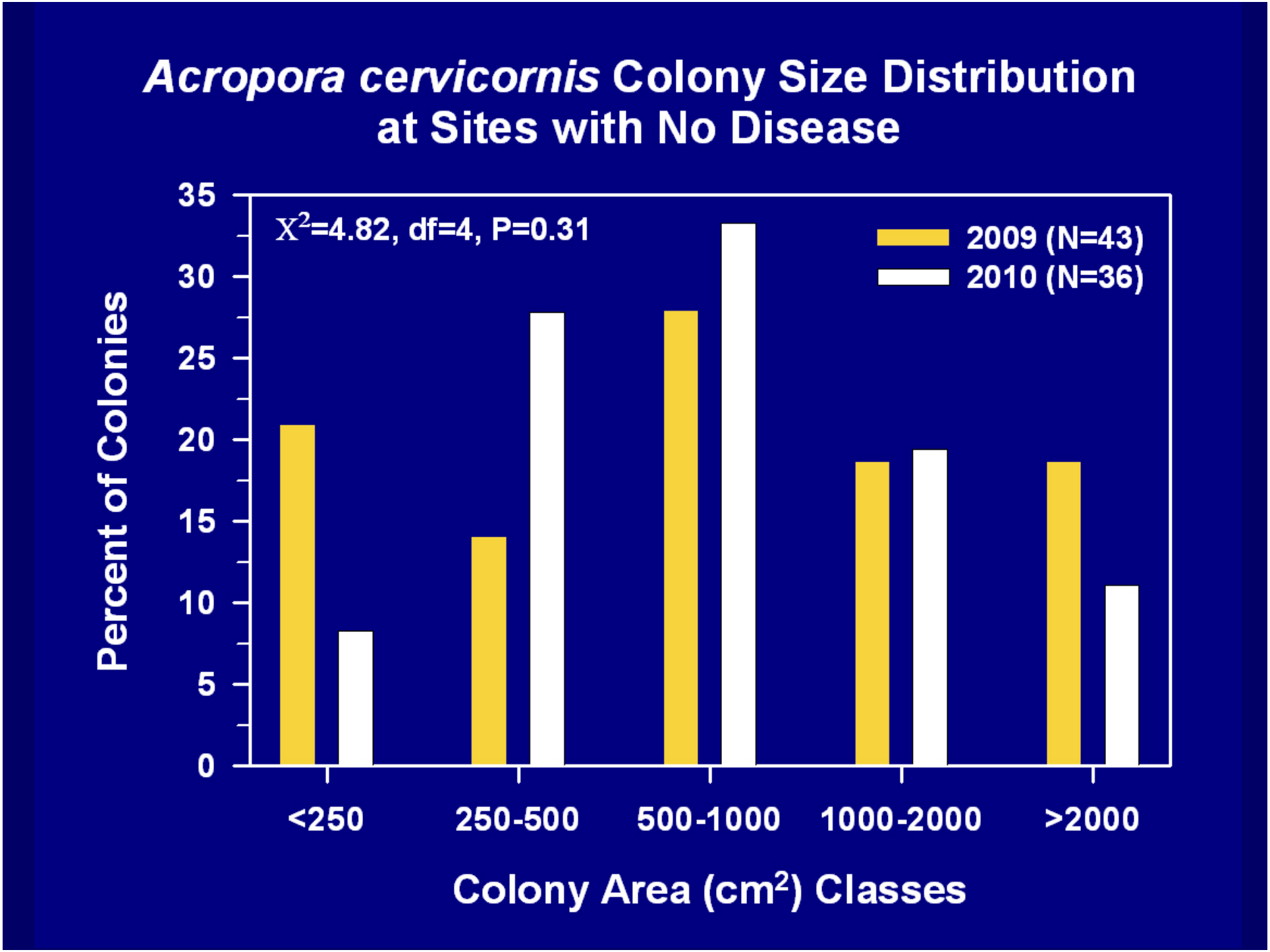
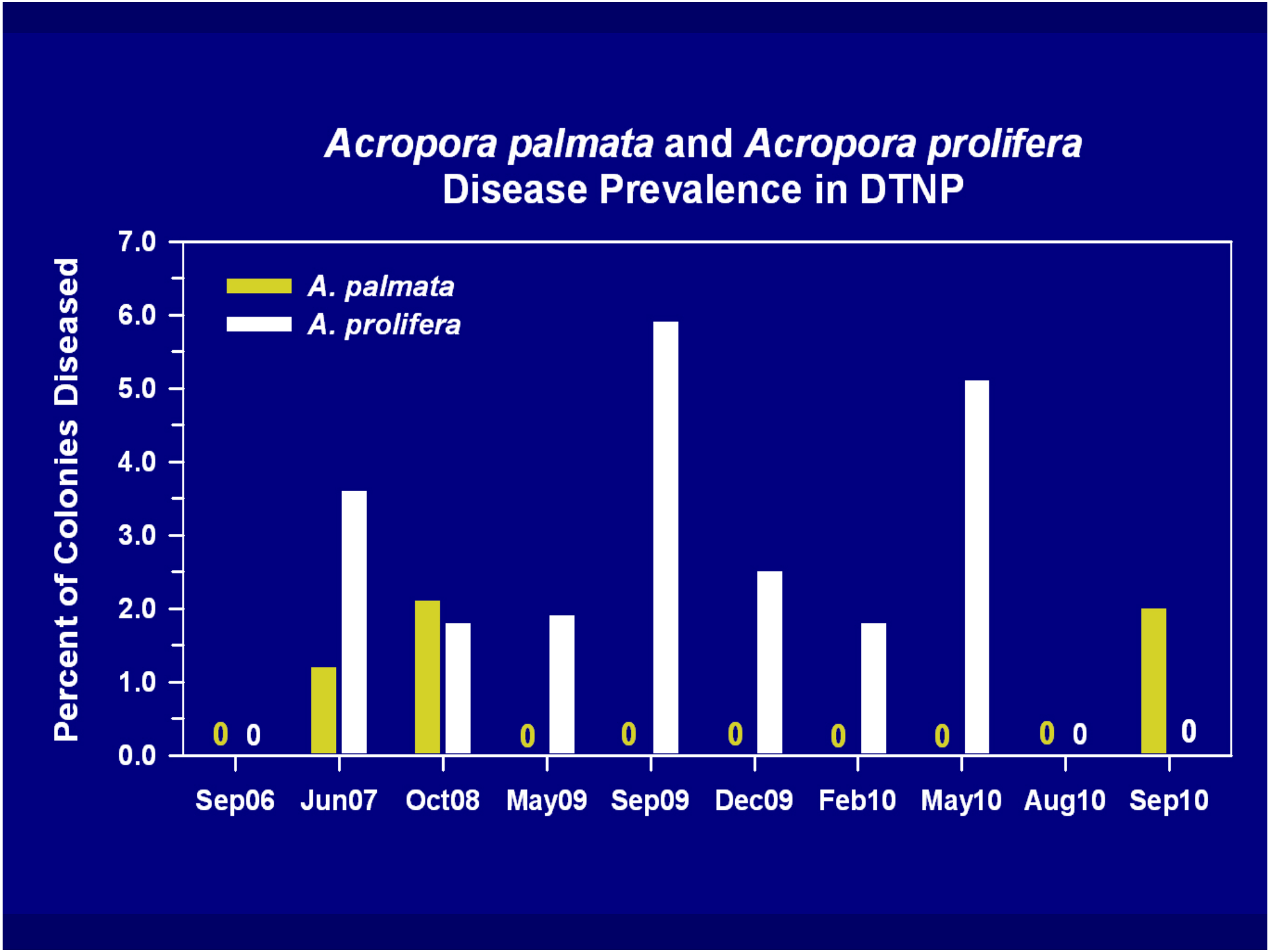
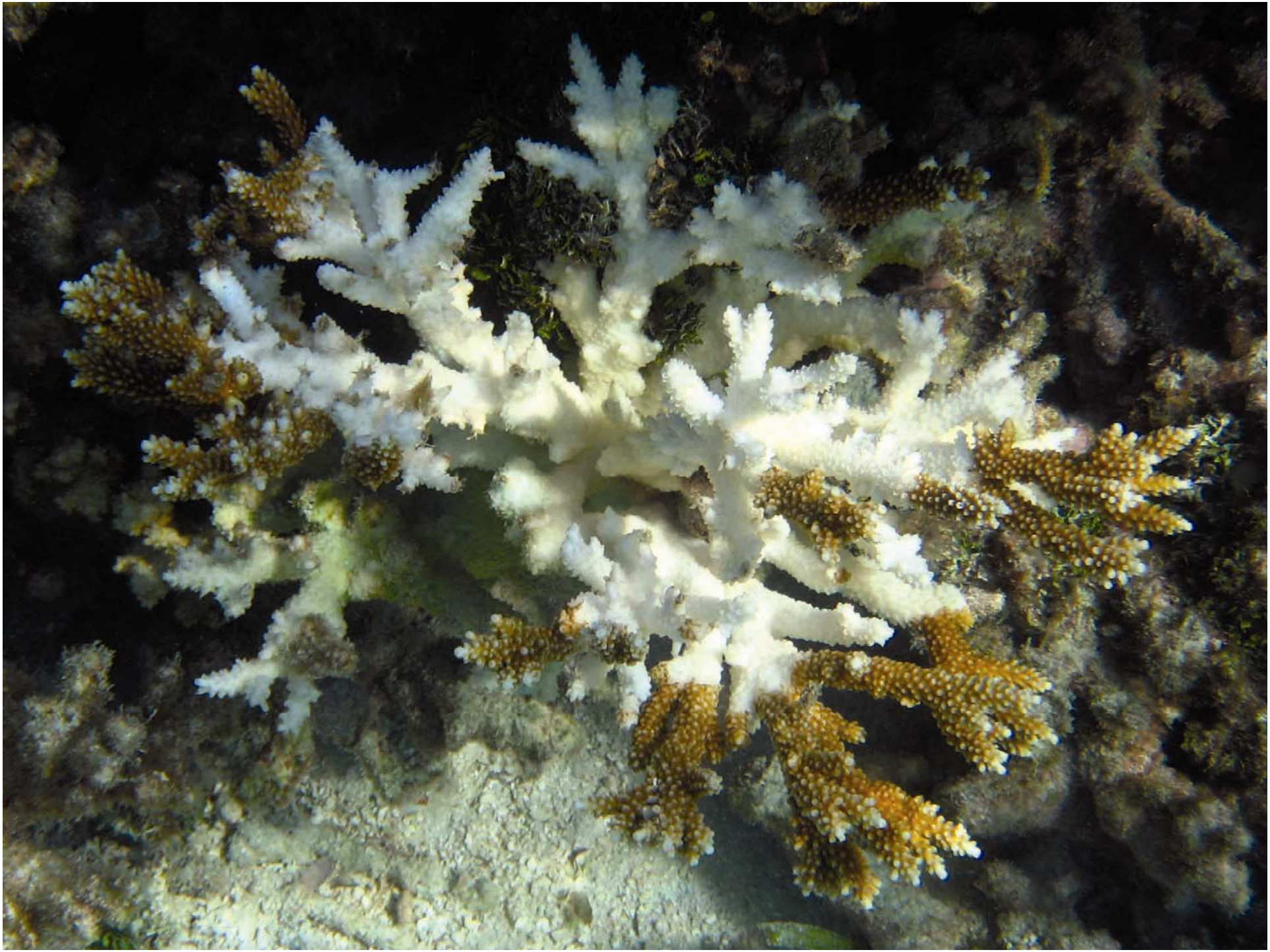



Acropora cervicornis Colony Size Distribution at Acer-WTR in DTNP
2009 (N=53)
2010 (N=79)
X^2=10.60, df=4, P=0.03
Percent of Colonies
35
30
25
20
15
10
5
0
<250
250-500
500-1000
1000-2000
>2000
Colony Area (cm^2) Classes


Acropora cervicornis Colony Size Distribution at Sites with No Disease
X^2=4.82, df=4, P=0.31
2009 (N=43)
2010 (N=36)
Percent of Colonies
35
30
25
20
15
10
5
0
<250
250-500
500-1000
1000-2000
>2000
Colony Area (cm^2) Classes


Acropora palmata and *Acropora prolifera*
Disease Prevalence in DTNP
Percent of Colonies Diseased
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
A. palmata
A. prolifera
0 0
0
0
0
0
0
0 0
0
Sep06
Jun07
Oct08
May09
Sep09
Dec09
Feb10
May10
Aug10
Sep10



Summary/Conclusions

- **>99% loss of DTNP staghorn reefs since 1976 (>50% loss of park coral reefs).**
- **Only two known *Acropora* reefs in DTNP.**
- ***Acropora* species live cover ≤7% on remaining reefs.**
- **1977 cold water event caused 90% mass mortality of staghorn.**
- **More recent *Acropora* loss due to multiple major disease occurrences.**

Summary/Conclusions

- **2004-2005 hurricanes caused *Acropora* decline; but *A. prolifera* and *A. palmata* recovering.**
- **2010 cold water event had no observed effects on DTNP *Acropora*.**
- **Staghorn white band disease outbreaks in 2009 and 2010.**
- **Coral decline is the most significant and challenging DTNP resource stewardship issue.**

Additional *Acropora* Science Actions

- ***Acropora*** **population demographics and colony fate tracking by FWRI and UGA (DTNP and NOAA funded).**
- ***Acropora*** **disease research by USGS and UGA (NPS and USGS funded).**
- **Shallow and deeper water benthic surveys using remote video (ATRIS) by USGS.**
- **Major USGS coral reef research program in DTNP focusing on climate change and disease.**

Acropora Stewardship Actions

- **Installed more effective waste treatment facilities. Ferry visitors required to use restrooms on ferries. Less viral and bacterial contamination (Griffin et al). Nearby *Acropora* disease frequency decreased.**
- **Created no access Coral Special Protection Zone to protect *Acropora* reefs from anthropogenic physical impacts.**
- ***Acropora* restoration project with The Nature Conservancy.**
- **NPS working other agencies/partners and through U.S. Coral Reef Task Force to address regional and global causes of coral decline.**

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- U.S. Environmental Protection Agency (FKNMS Water Quality Protection Program)
- National Oceanic and Atmospheric Administration, Florida Keys National Marine Sanctuary (FKNMS Water Quality Protection Program)