The Florida Keys reef tract: Resilience

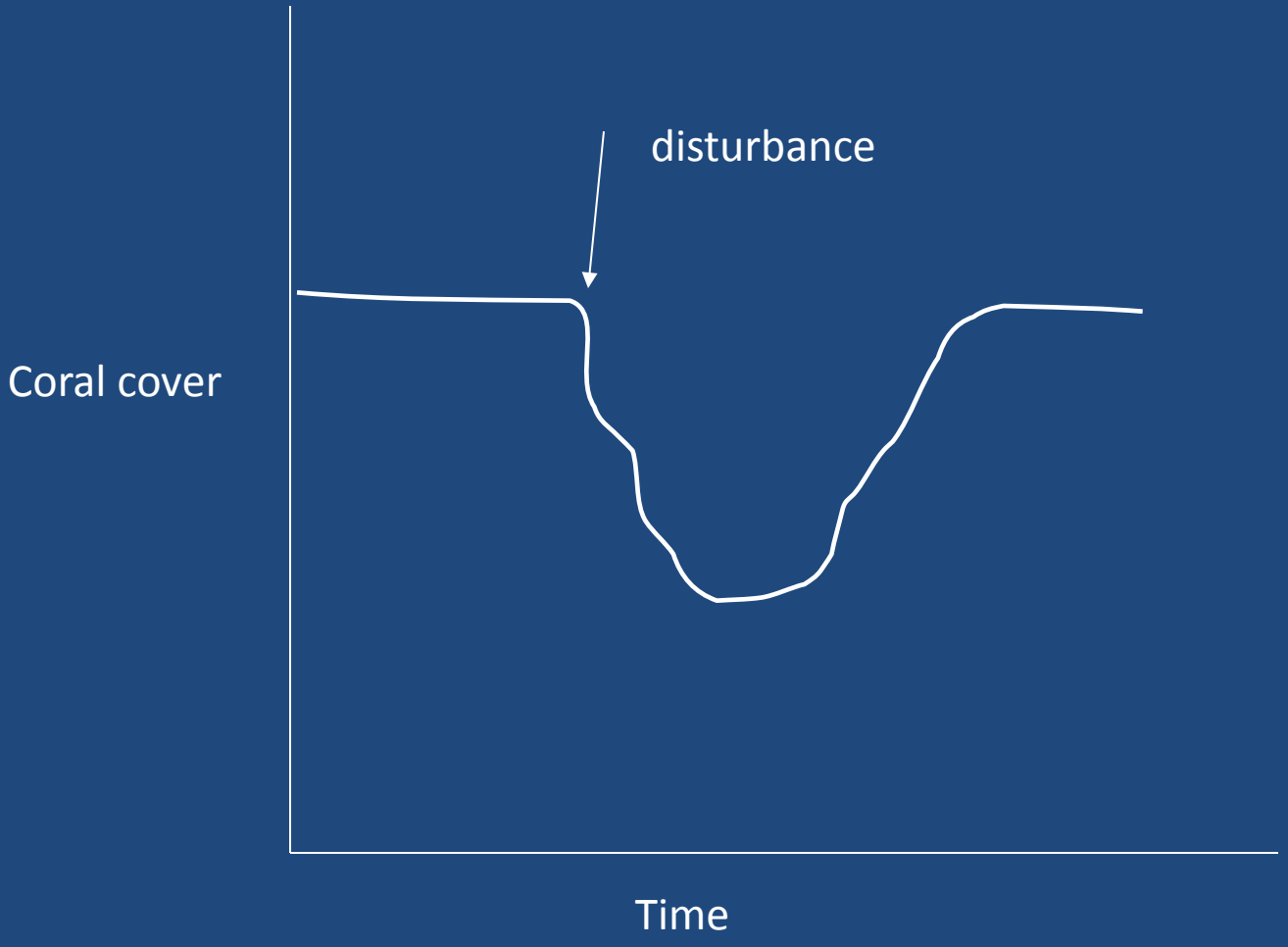
R. van Woesik

April 4, 2013

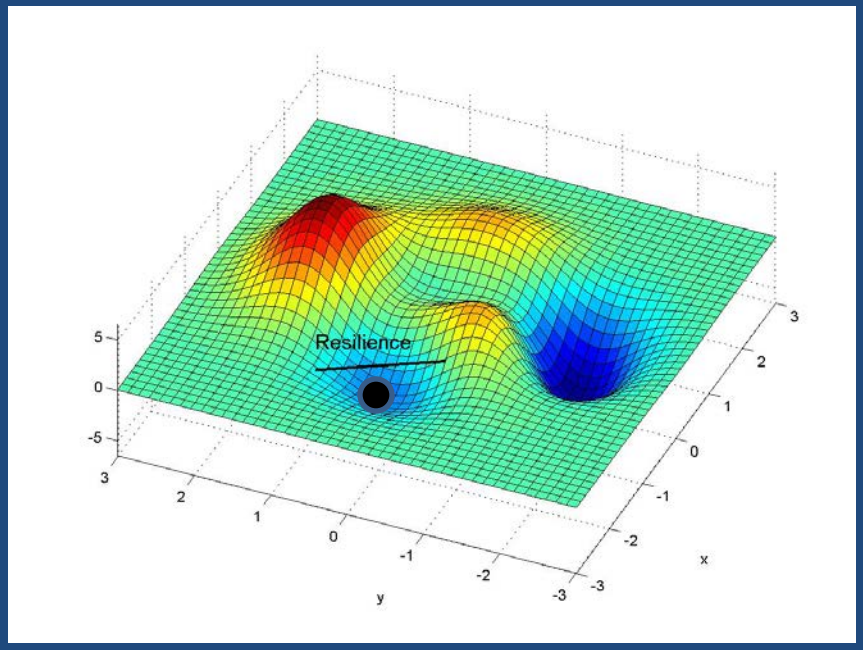
Resilience is:

an ability to recover from or adjust easily to misfortune or change

(Merriam-Webster).

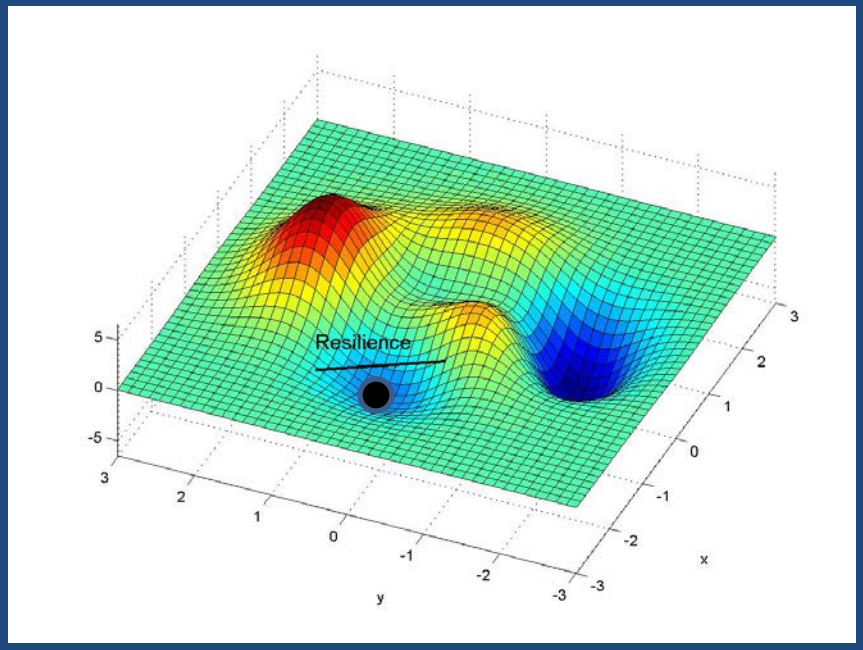


van Woesik et al. (in prep.)



The rationale is resilience

van Woesik et al. (in prep.)



The rationale is resilience

Increase reef ***resilience***: where resilience is the capacity of a system to absorb disturbances by maintaining key functions and processes to resist changing into a different reef phase.

Research Questions

1) What is the status of the Florida Keys?

2) Is the protection within the Florida Keys National Marine Sanctuary consistent with the biological state of the reefs?

3) Can we manage the Florida Keys to increase their resilience?

Research Questions

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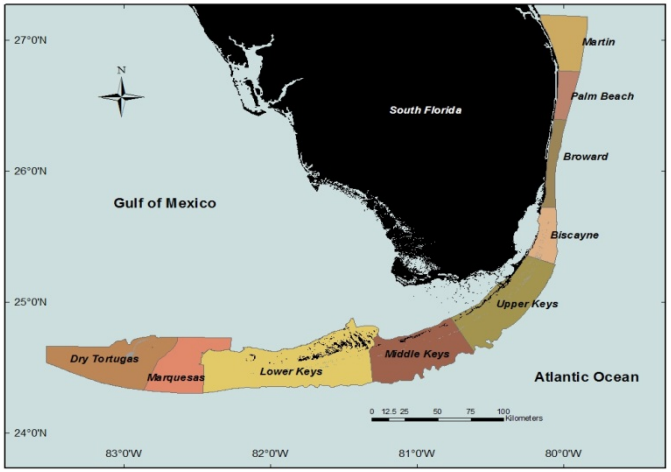
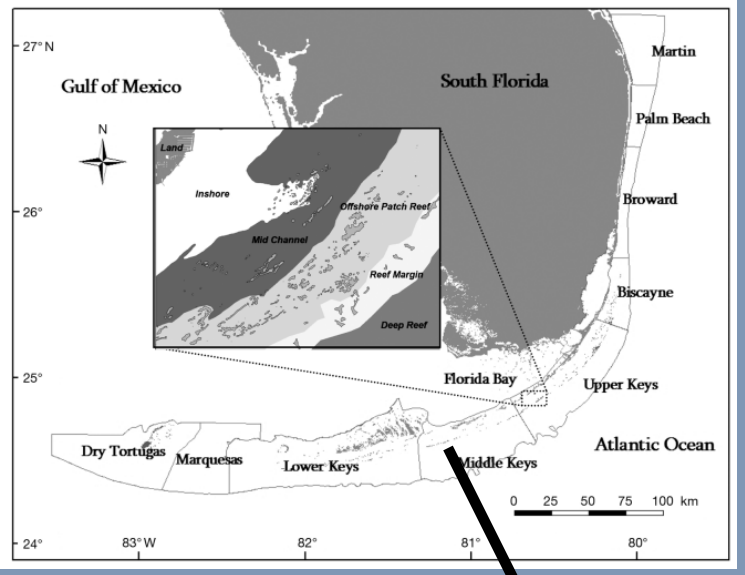
Objectives



(1) Determine the status of the coral assemblages in south Florida.

(2) To what extent are the corals impacted by disturbances events?

Two stage, stratified randomized survey design



Sampling domain

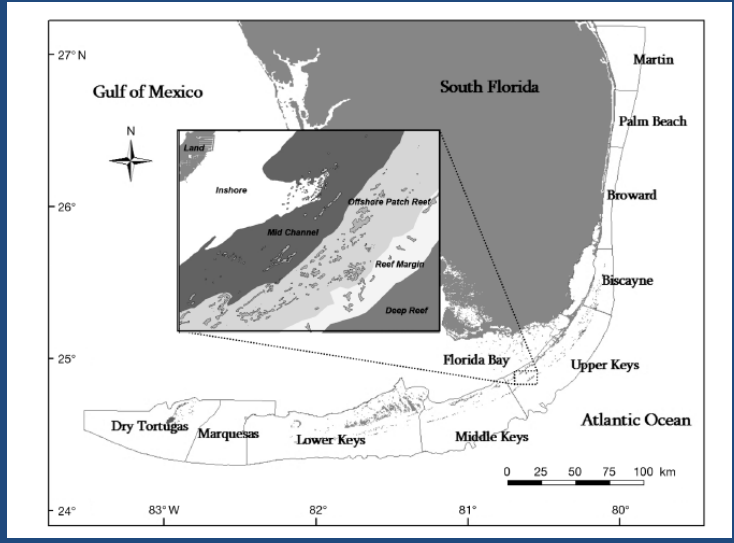
Stratum -
Geographic region & habitat (zone)

Site – first stage primary sampling unit (i)
(200 x 200 m)

Belt transect
10 x 1m - second stage (j) x 2

Ault et al (2005), Bull Mar Sci 76: 595-622; Smith et al. (2011) Environ. Mont. Assessment

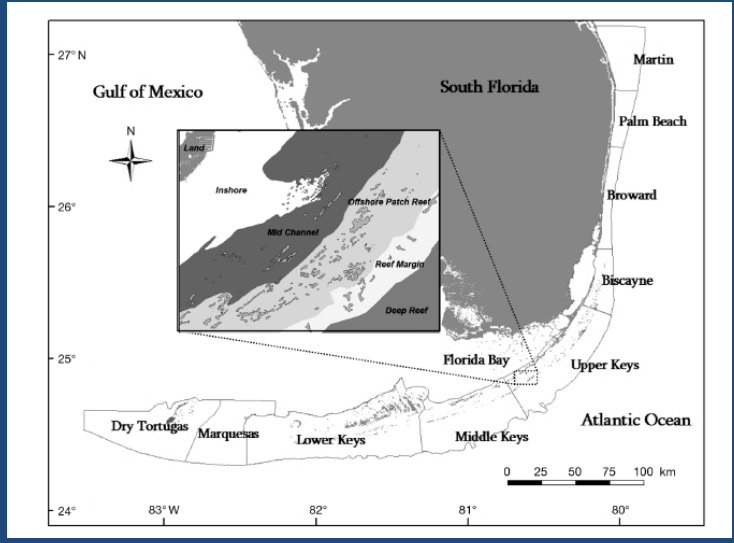
Metrics measured in each site



Within each transect, four main parameters are recorded for each stony coral colony >4cm:

1) Coral species,
2) Percent dead tissue (both recent and old mortality),
3) Colony size (cm),
4) Condition including disease prevalence and bleaching.

Metrics measured in each site



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1) Coral species,
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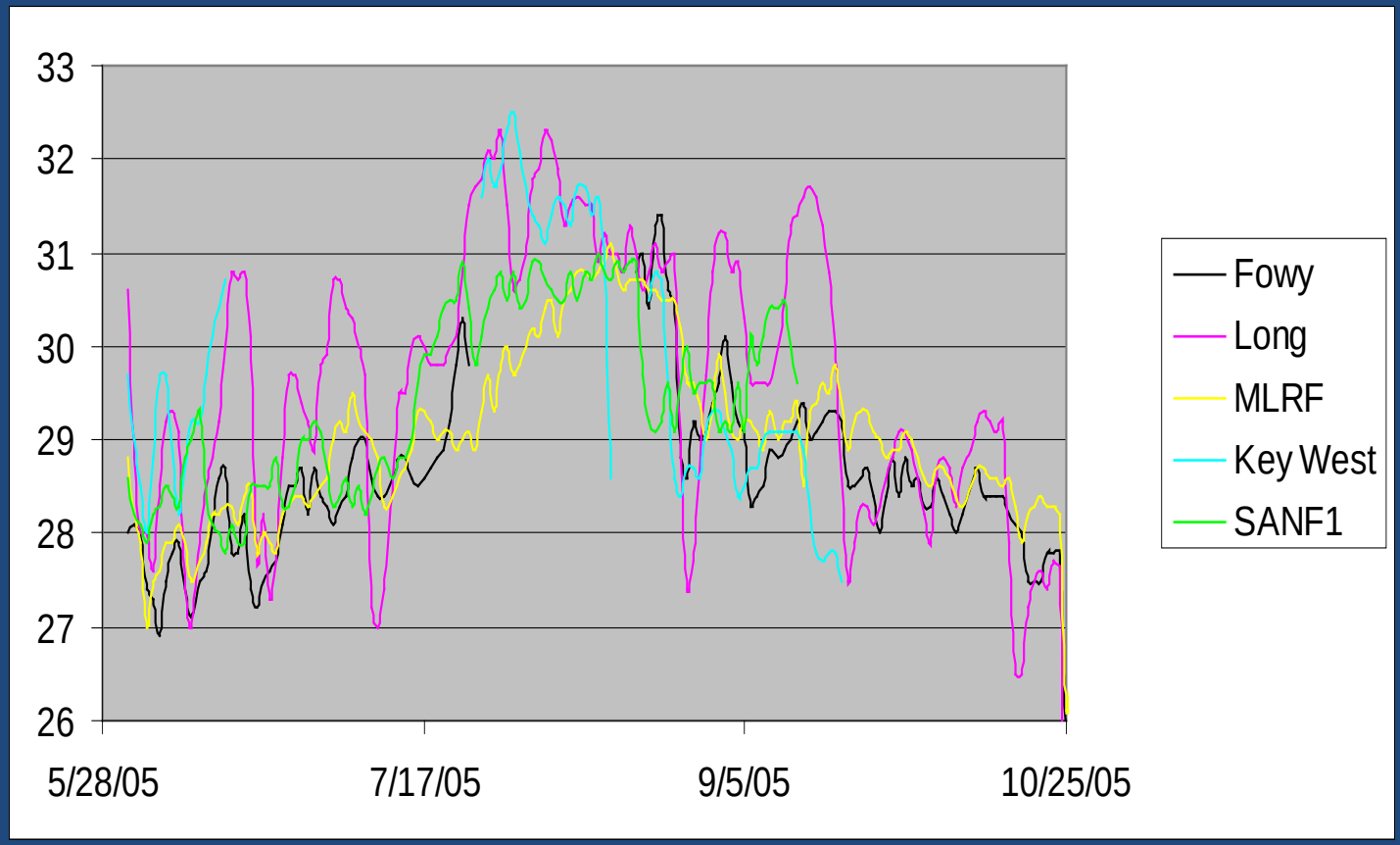
4) Condition including disease prevalence and bleaching.

This approach provides detailed information on the coral populations' size-frequency distributions, coral cover, and bleaching prevalence… . to better understand and identify resilient areas.


33
32
31
30
29
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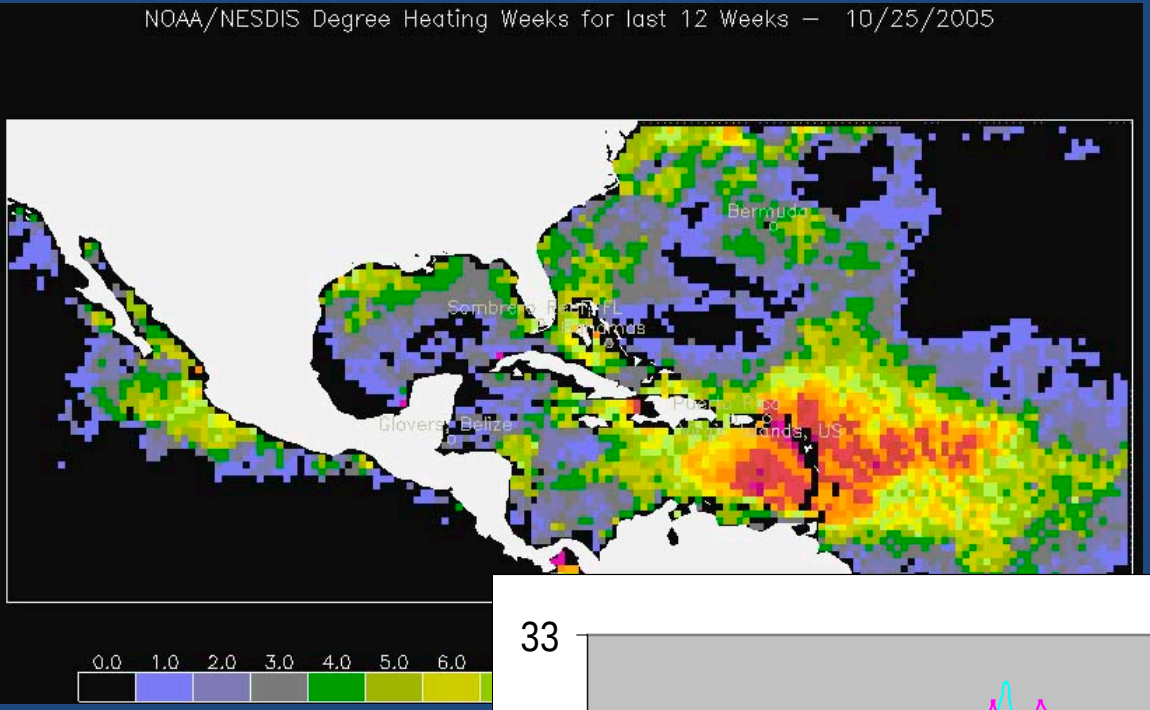
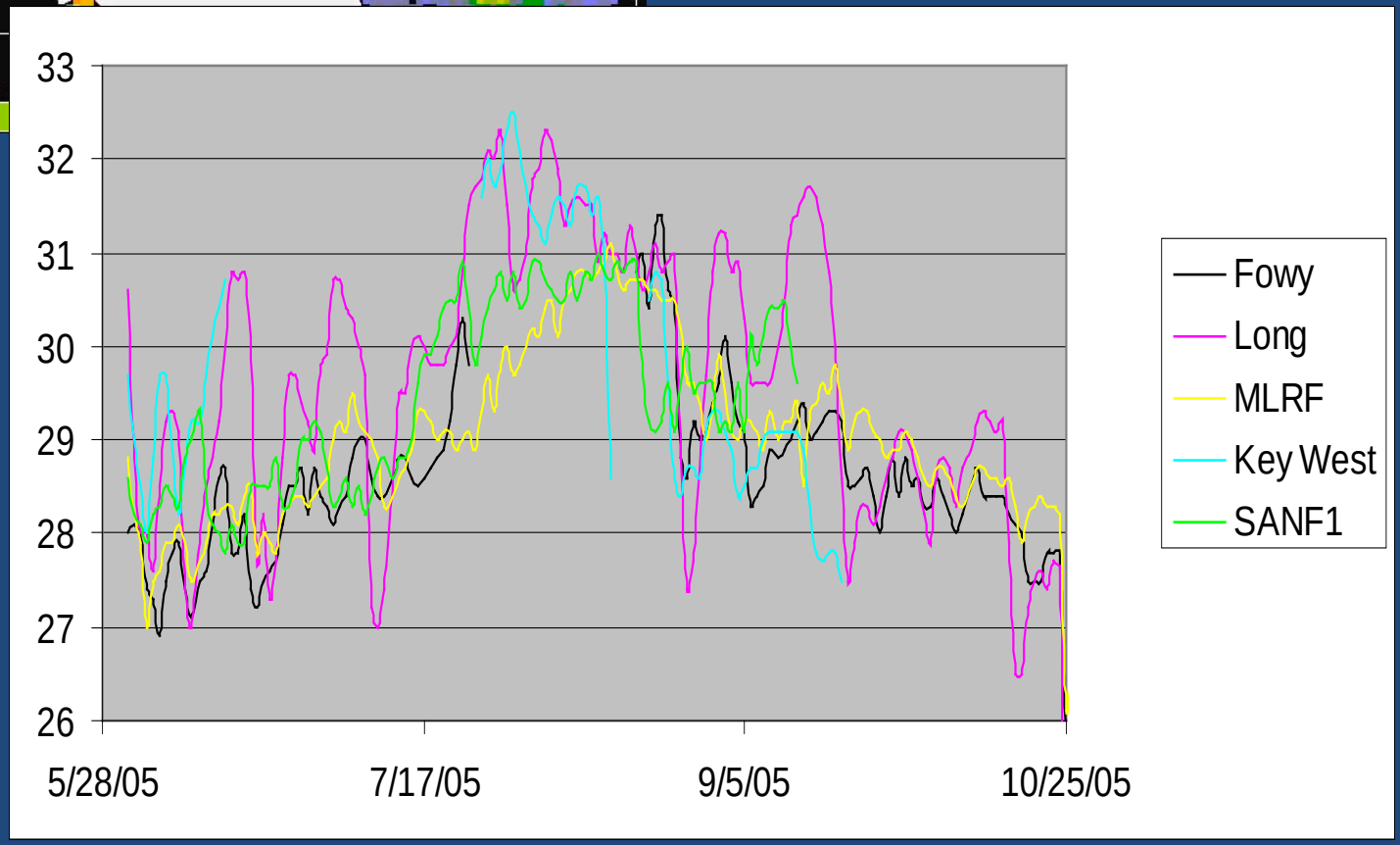
27
26
5/28/05
7/17/05
9/5/05
10/25/05
Fowy
Long
MLRF
Key West
SANF1


NOAA/NESDIS Degree Heating Weeks for last 12 Weeks – 10/25/2005
Bermuda
Belize
0.0 1.0 2.0 3.0 4.0 5.0 6.0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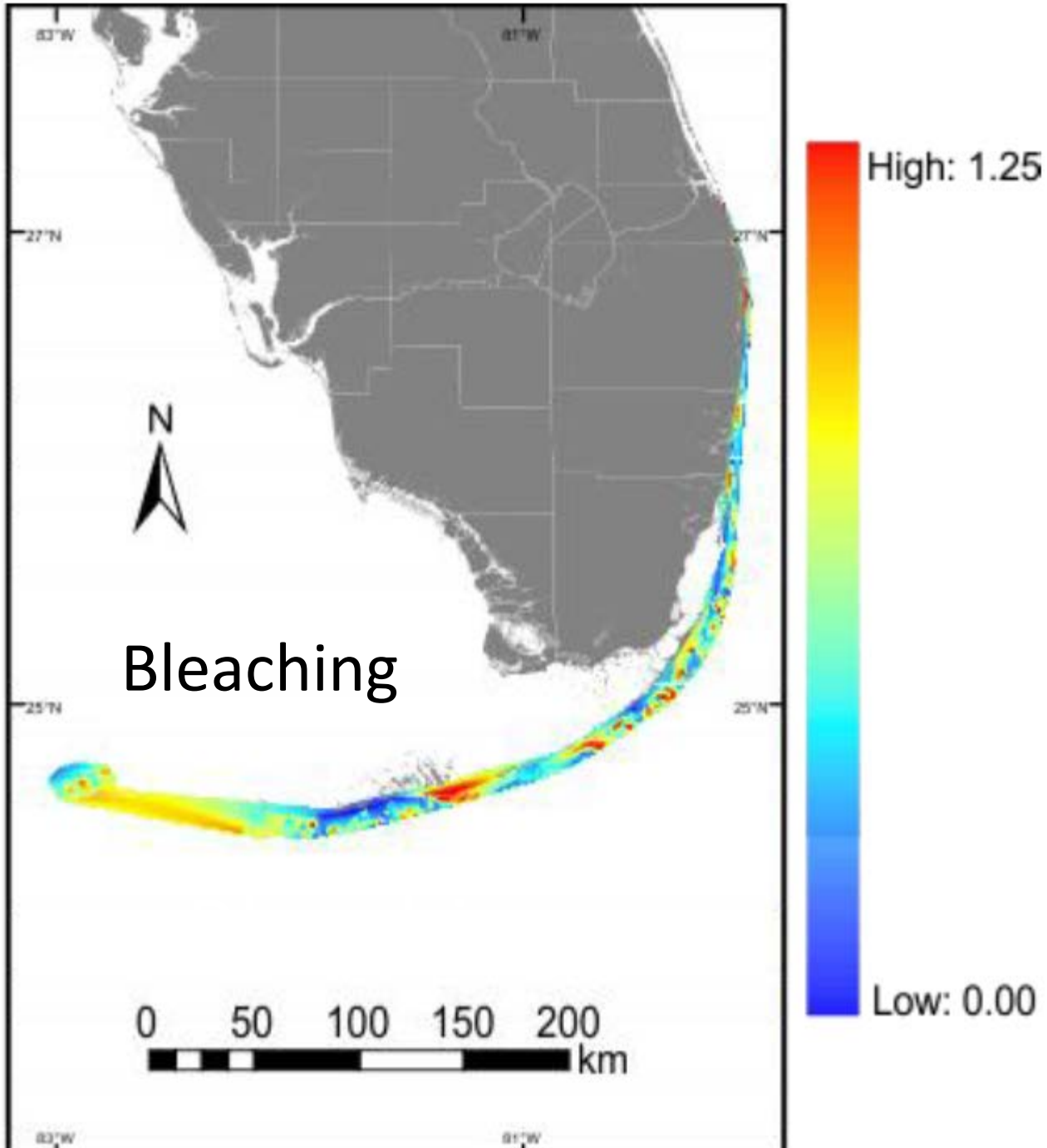
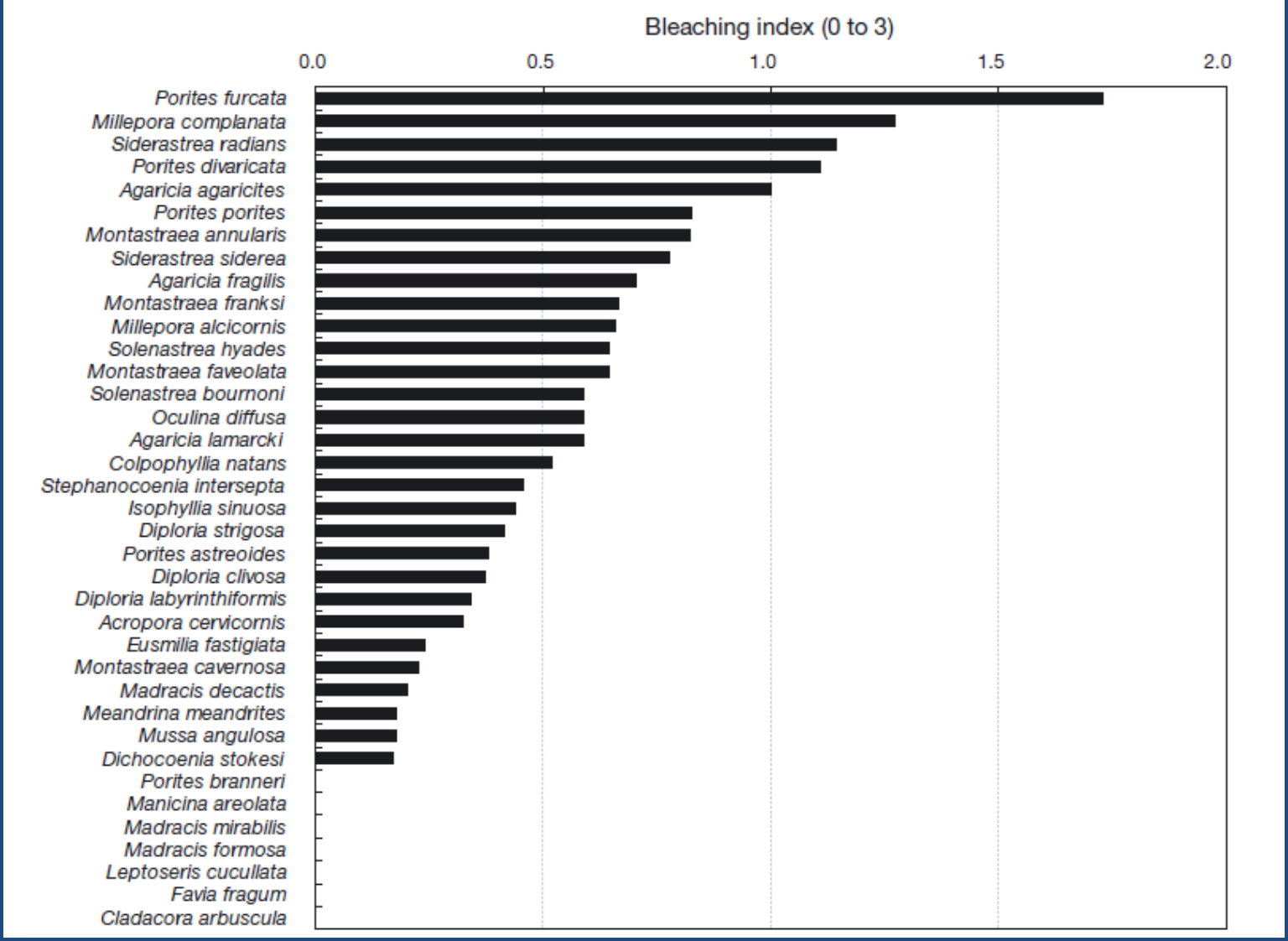
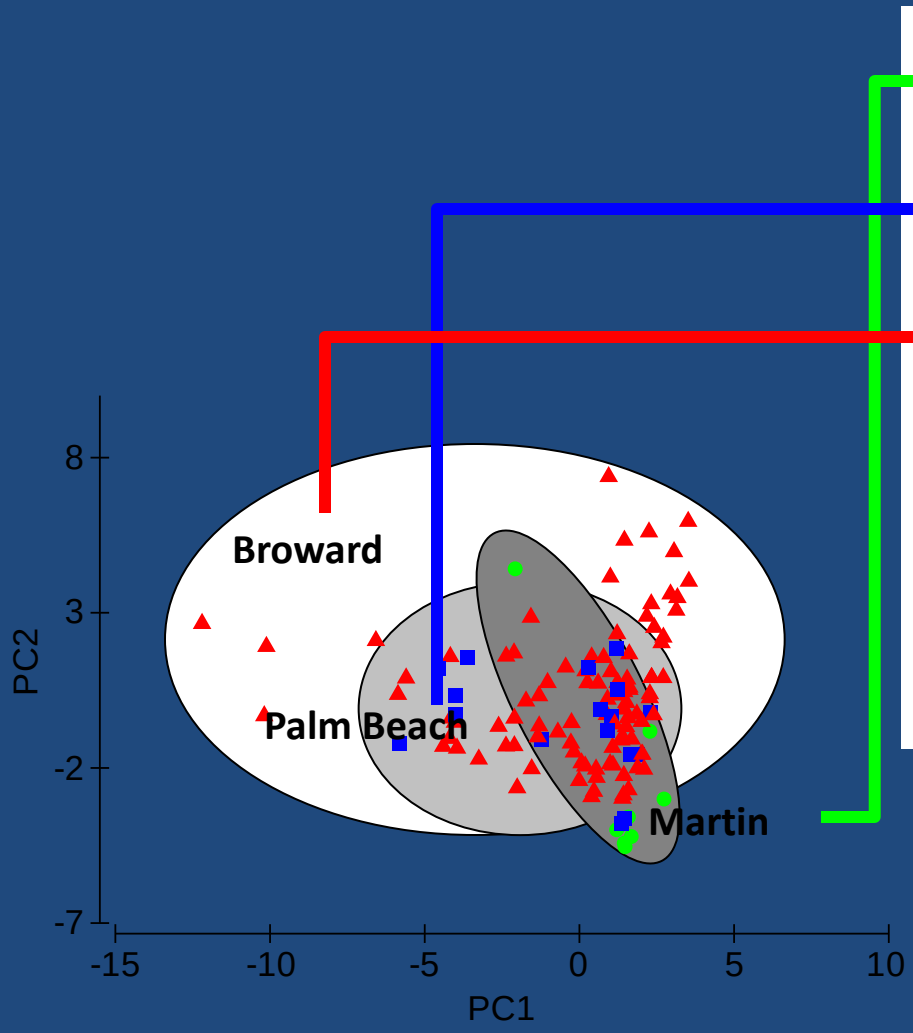


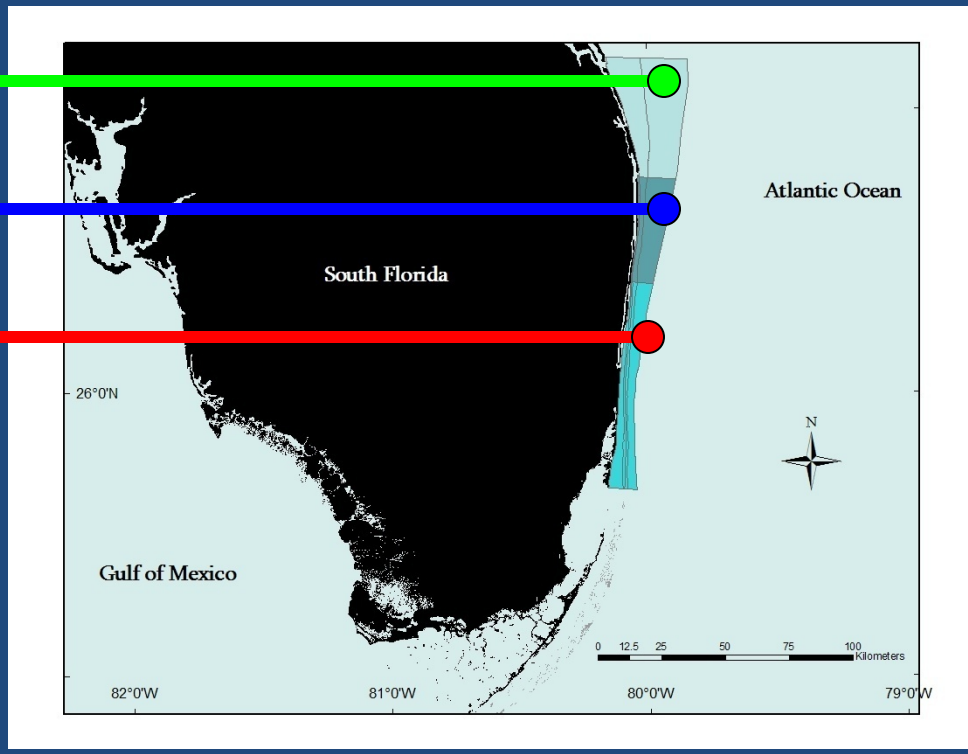
van Woesik
(in prep)

Species variation (38 species)
2005-2012, sites > 1200



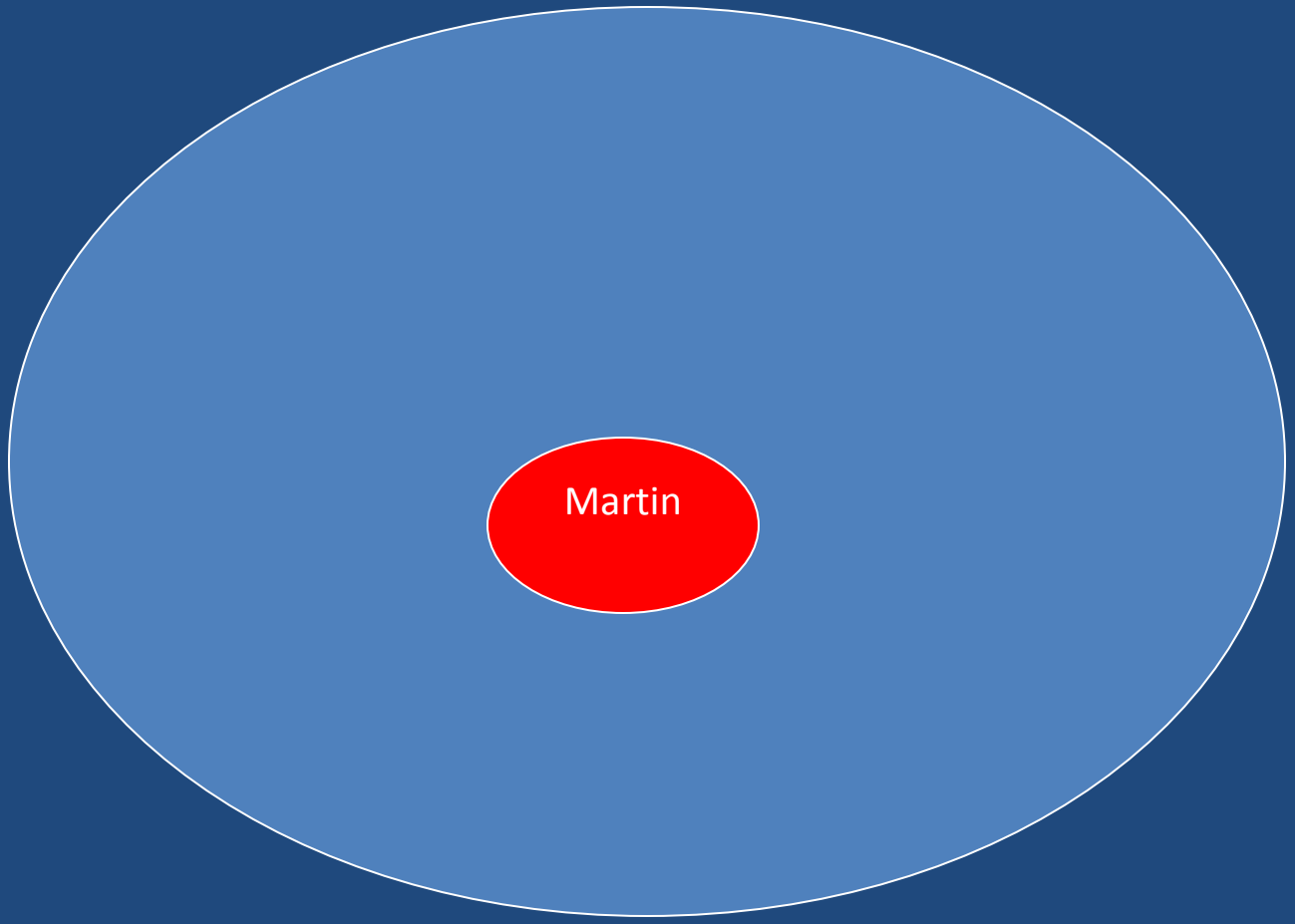
Wagner et al (2010) Marine Ecology Progress Series 408: 65-78

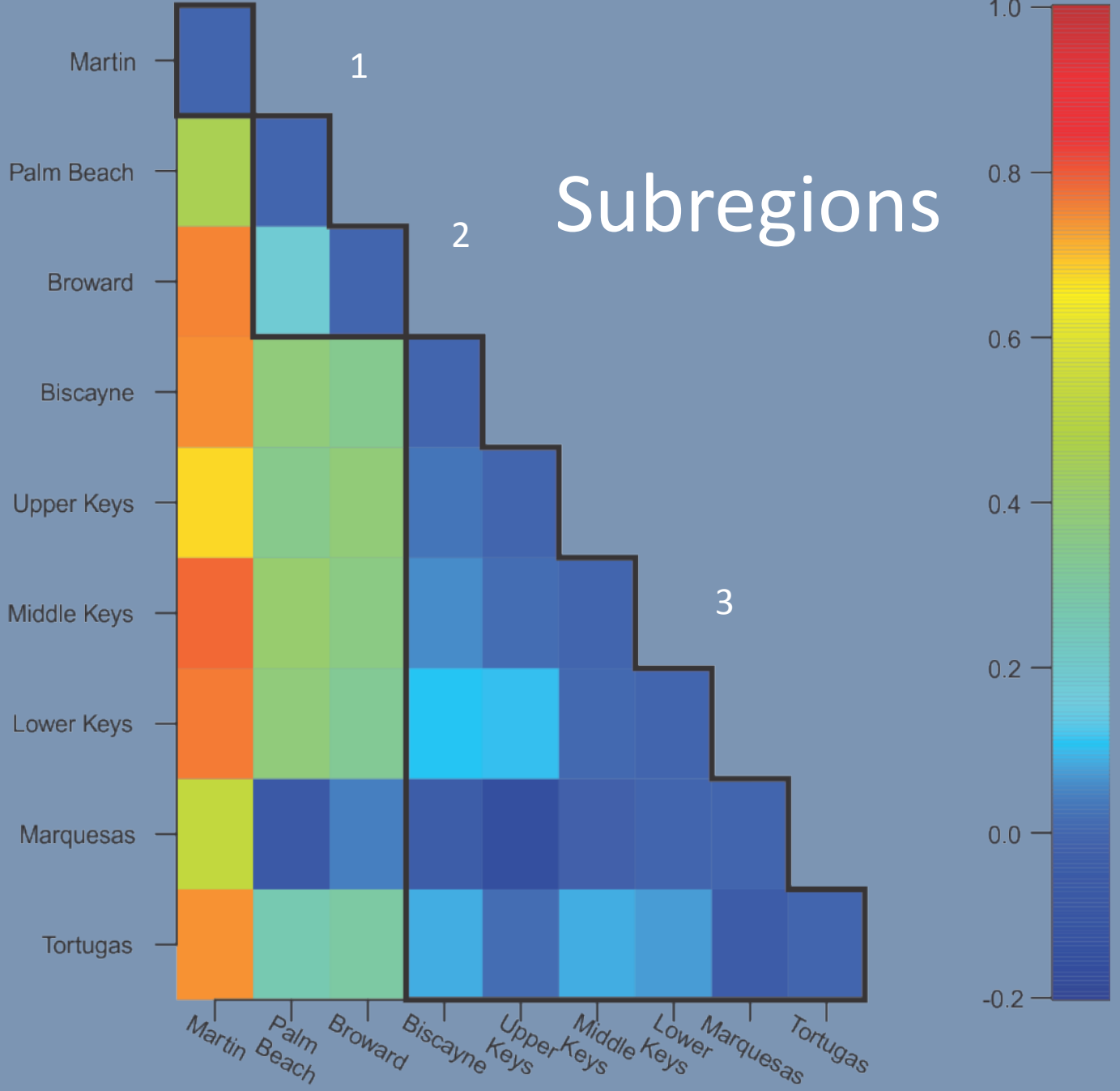




Wagner, Kramer, van Woesik 2010 MEPS 408: 65-78

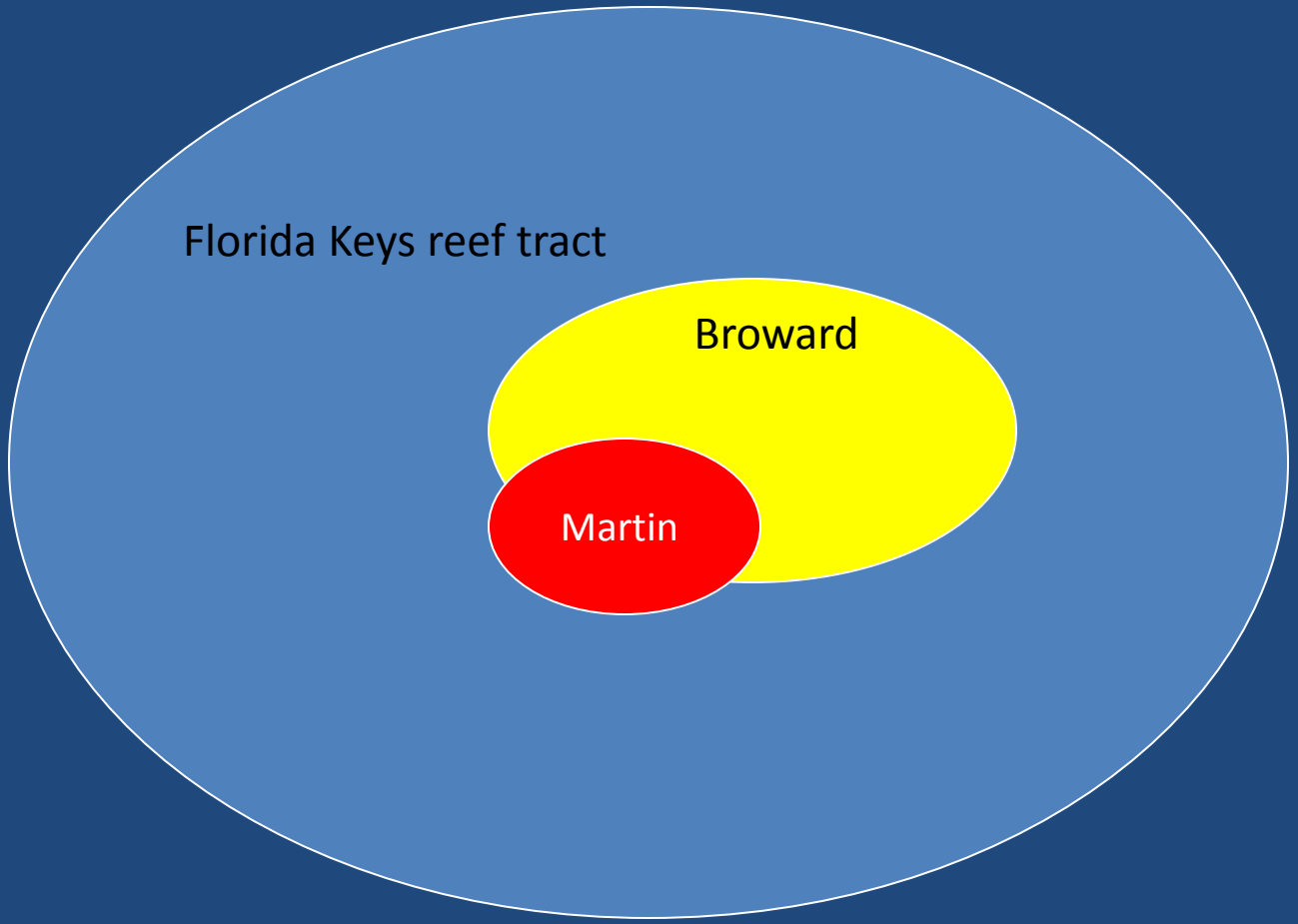
Hierarchically nested



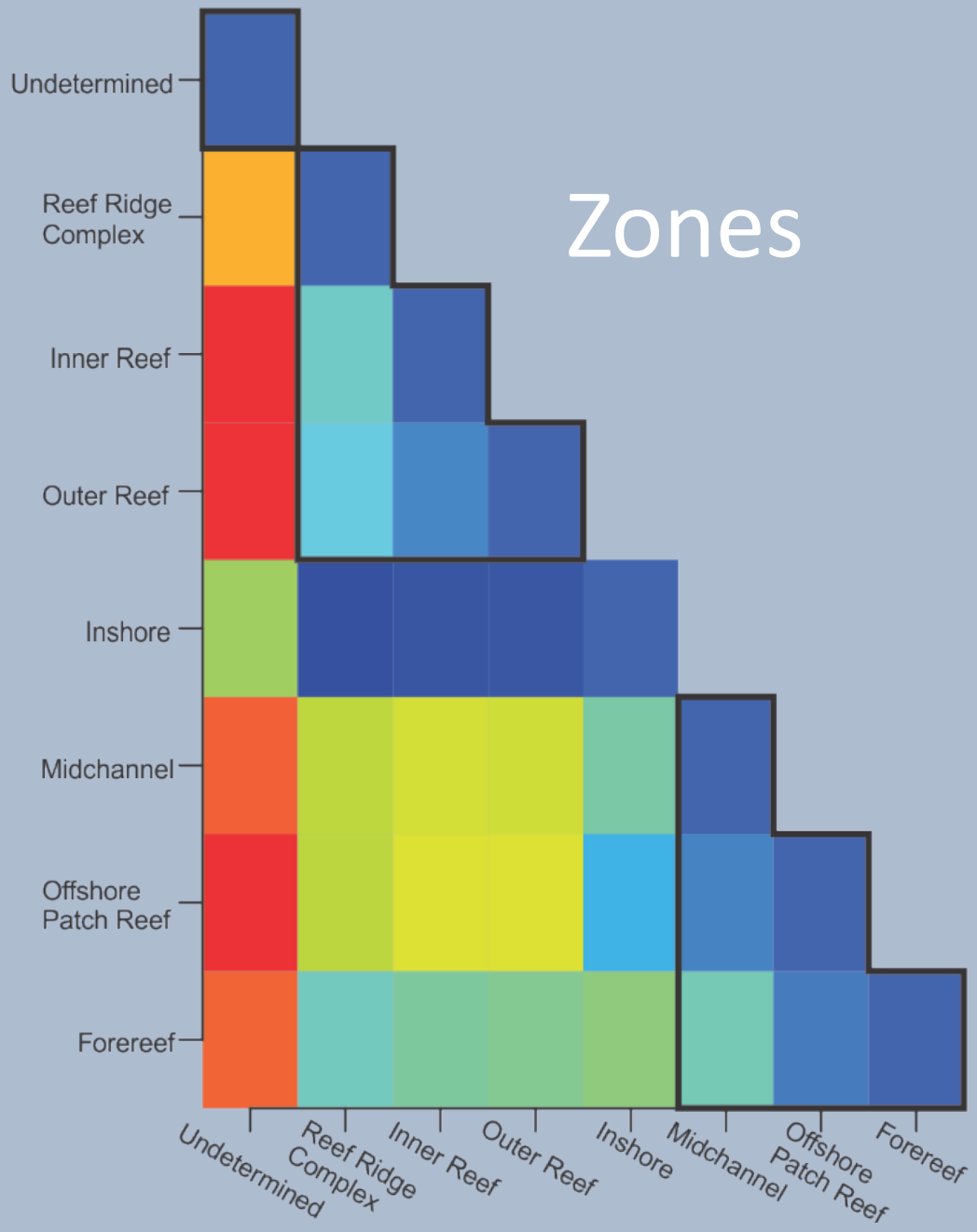


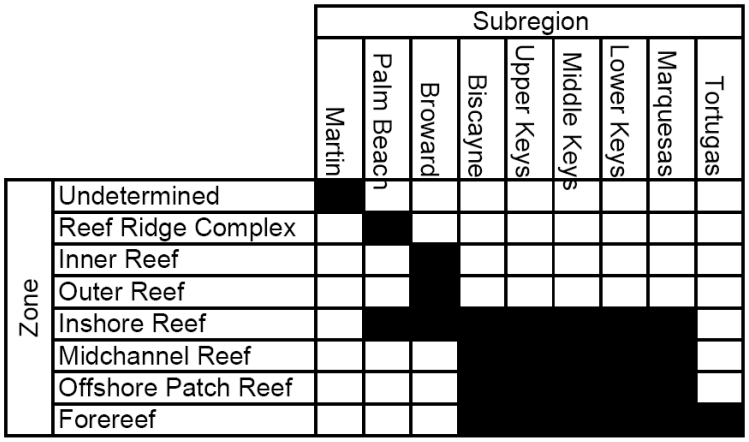
Burman, Aronson, van Woesik (2012) *Marine Ecology Progress Series 467: 89-96*

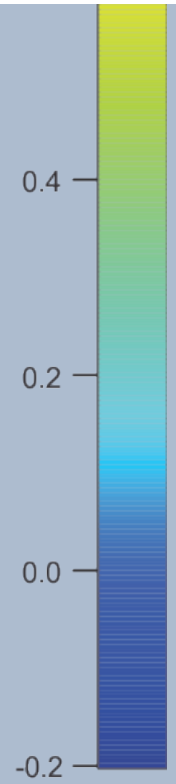
Region – species pool



Zones







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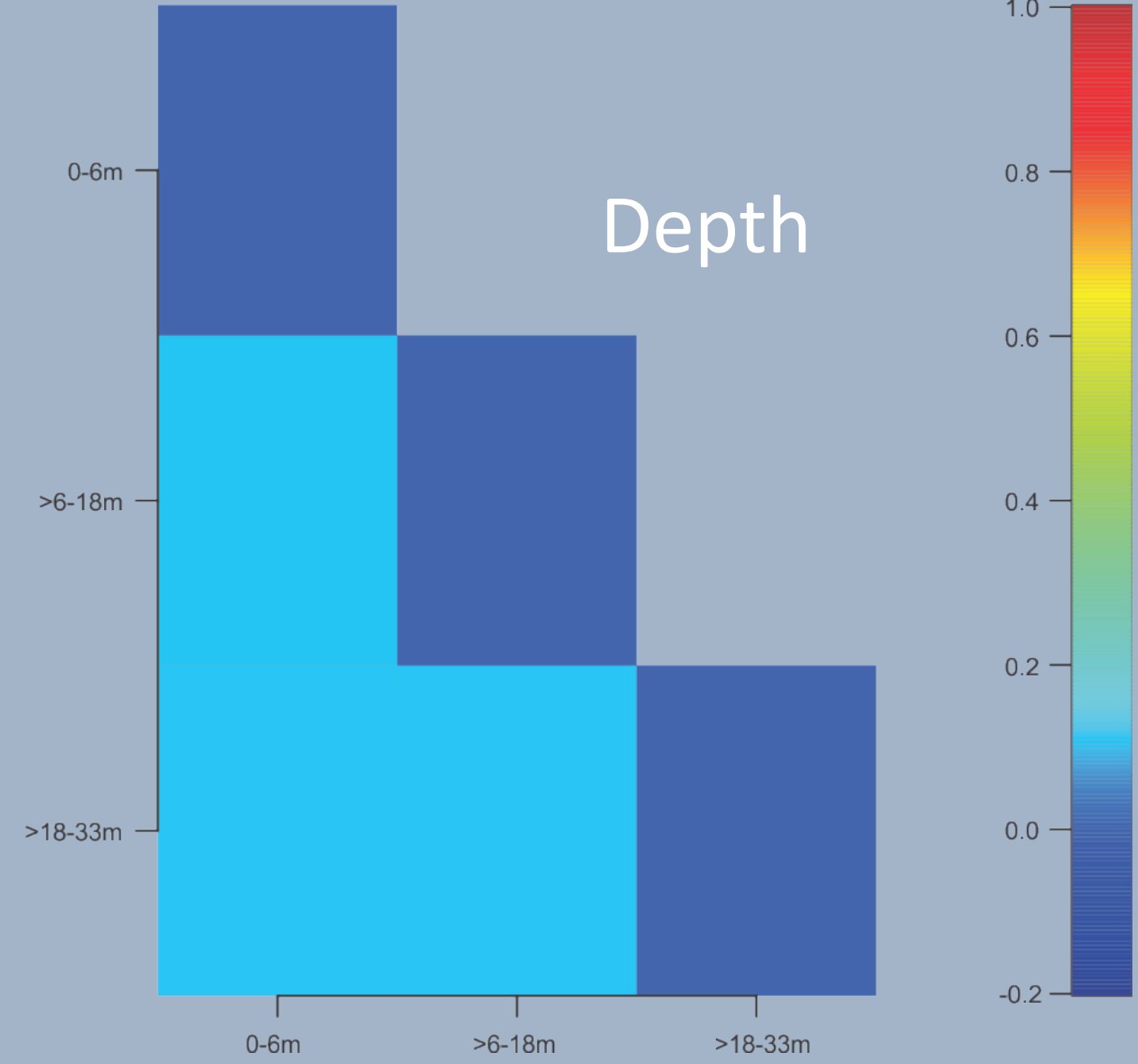

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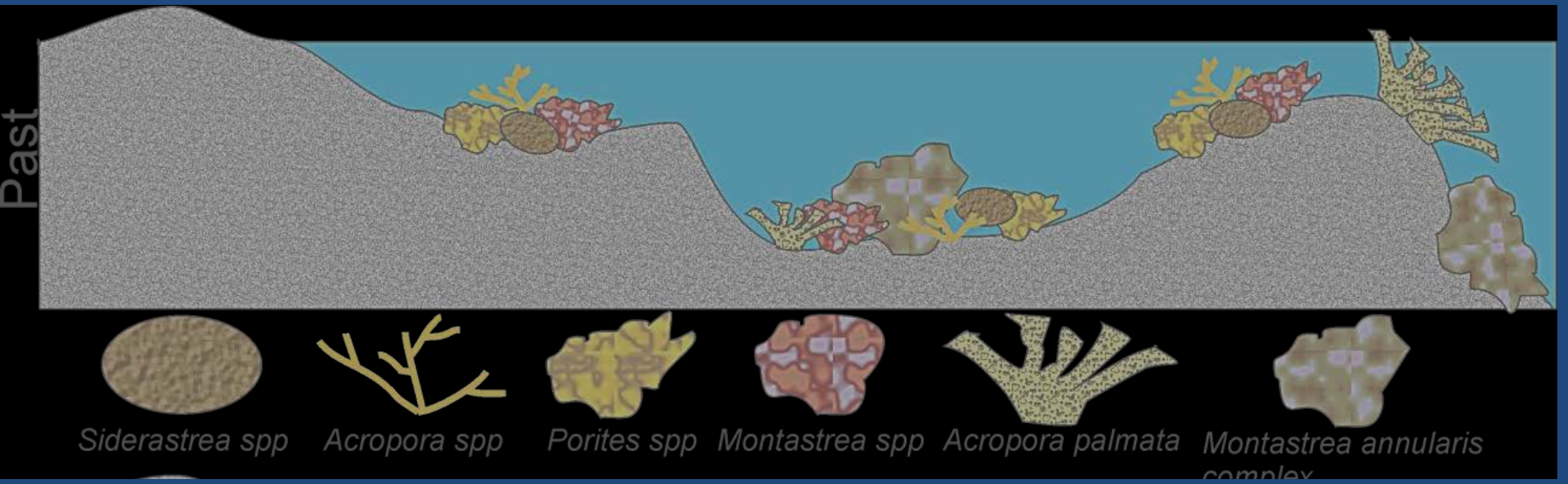
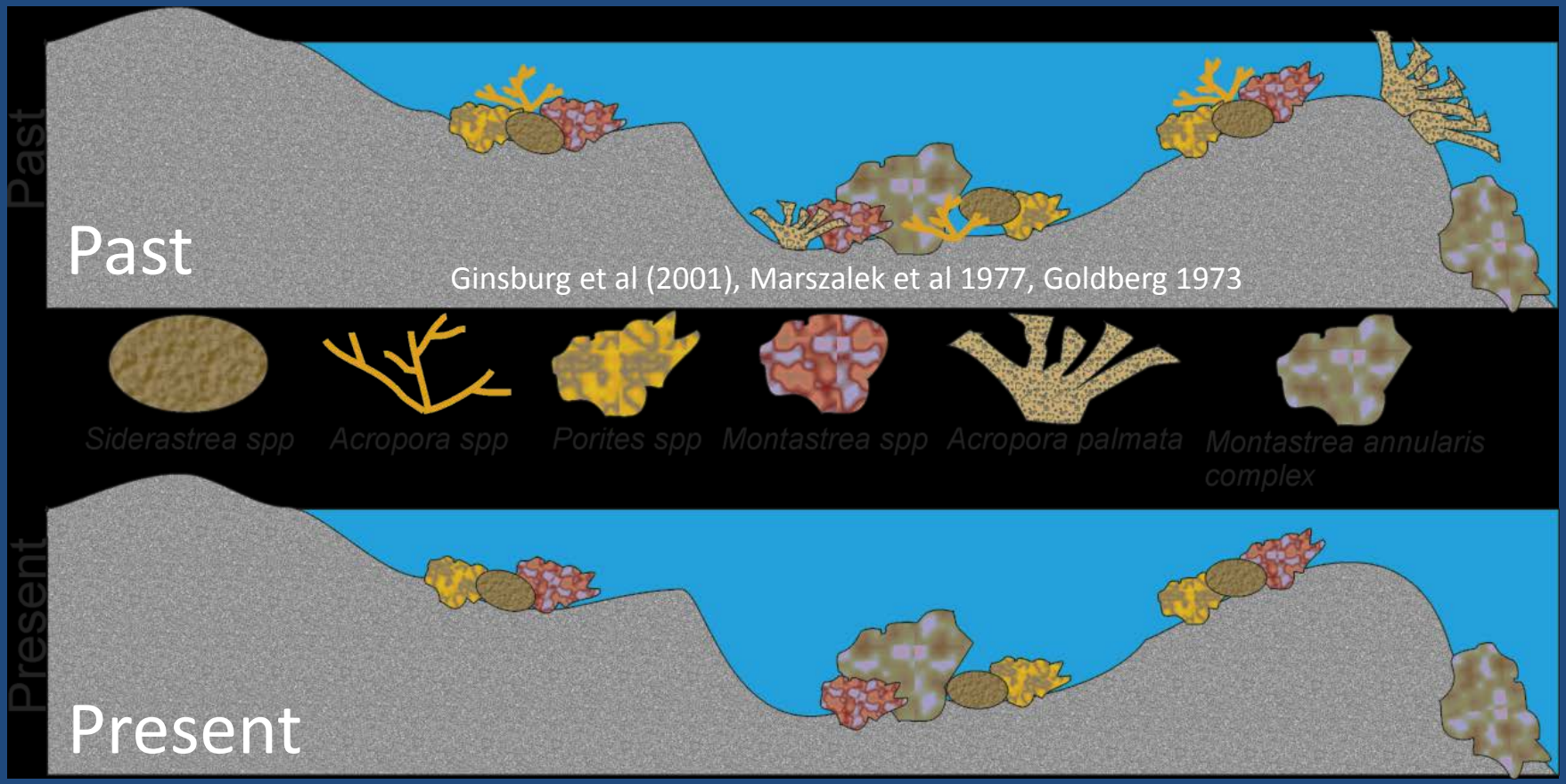


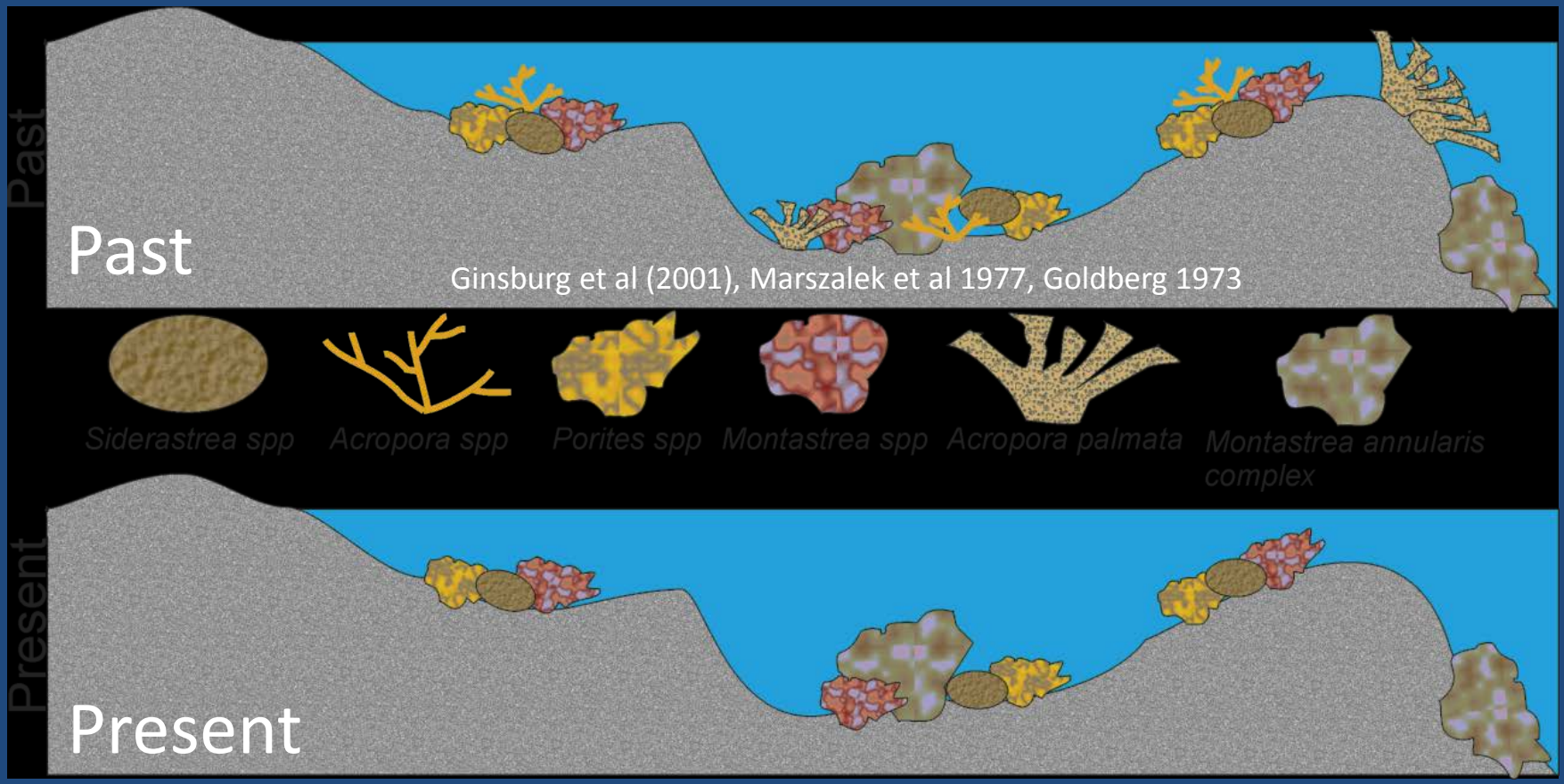
Burman, Aronson, van Woesik (2012) *Marine Ecology Progress Series 467: 89-96*



Decreases in *Acropora palmata* and *Acropora cervicornis* have homogenized zones

Burman, Aronson, van Woesik (2012) *Marine Ecology Progress Series 467: 89-96*

Thermal stress has differentially favored coral species with wide thermal tolerance (eurythermal species)



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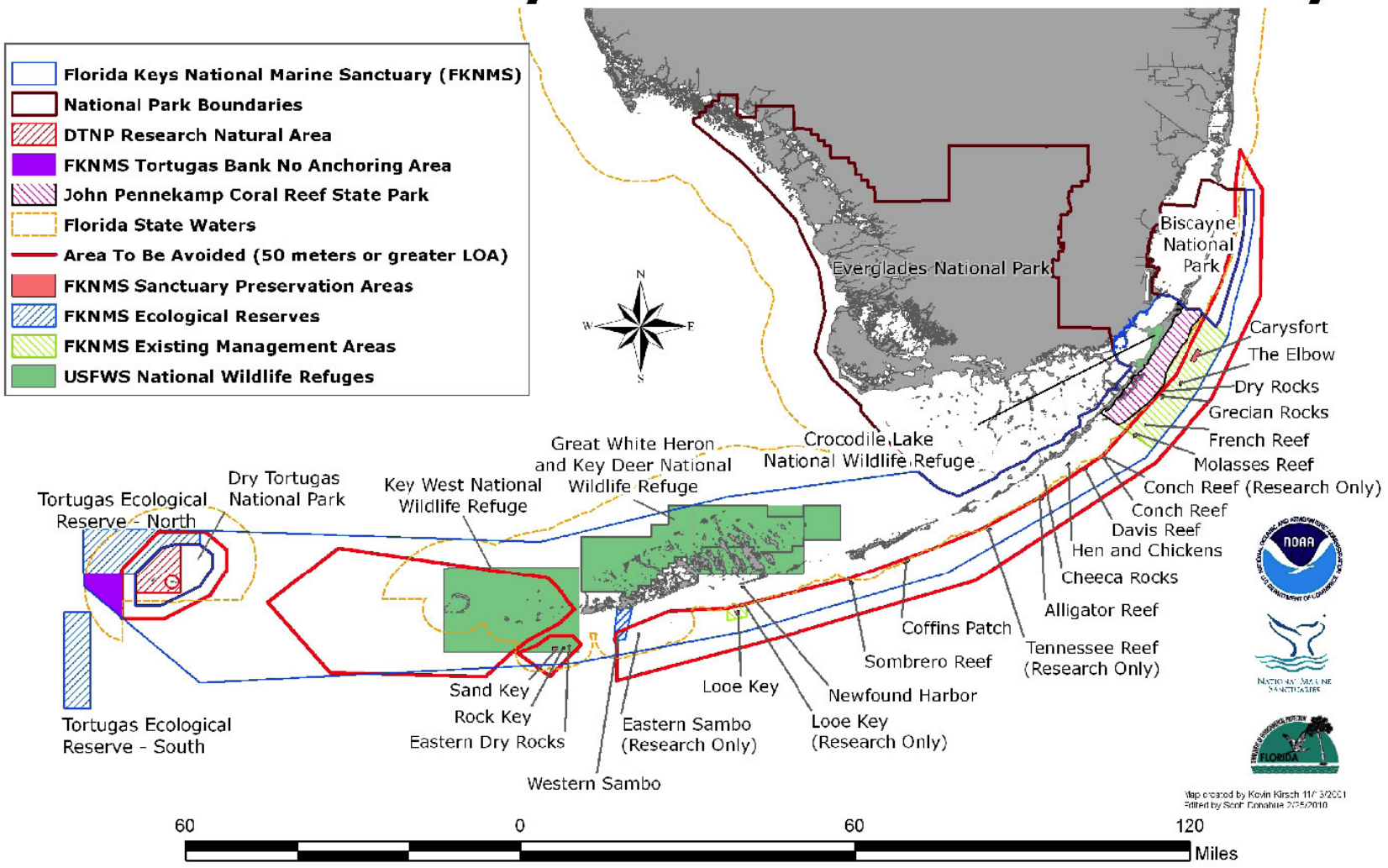
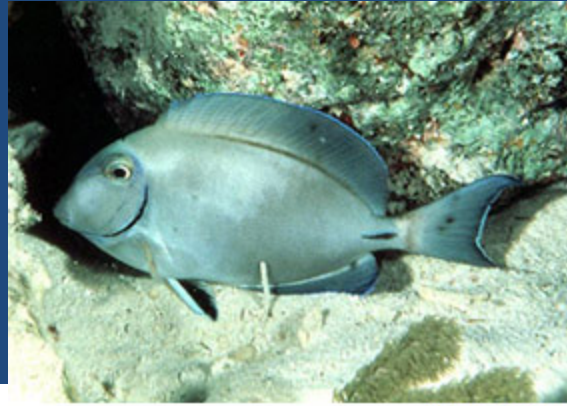
The Florida Keys National Marine Sanctuary was set up, in part, to ensure the sustainable use of the Florida Keys by "***achieving a balance between comprehensive resource protection and multiple, compatible uses of those resources***" [Page 5]…

•Florida Keys National Marine Sanctuary (1996) Final Management Plan/Environmental Impact Statement, Volume I, The Management Plan, I

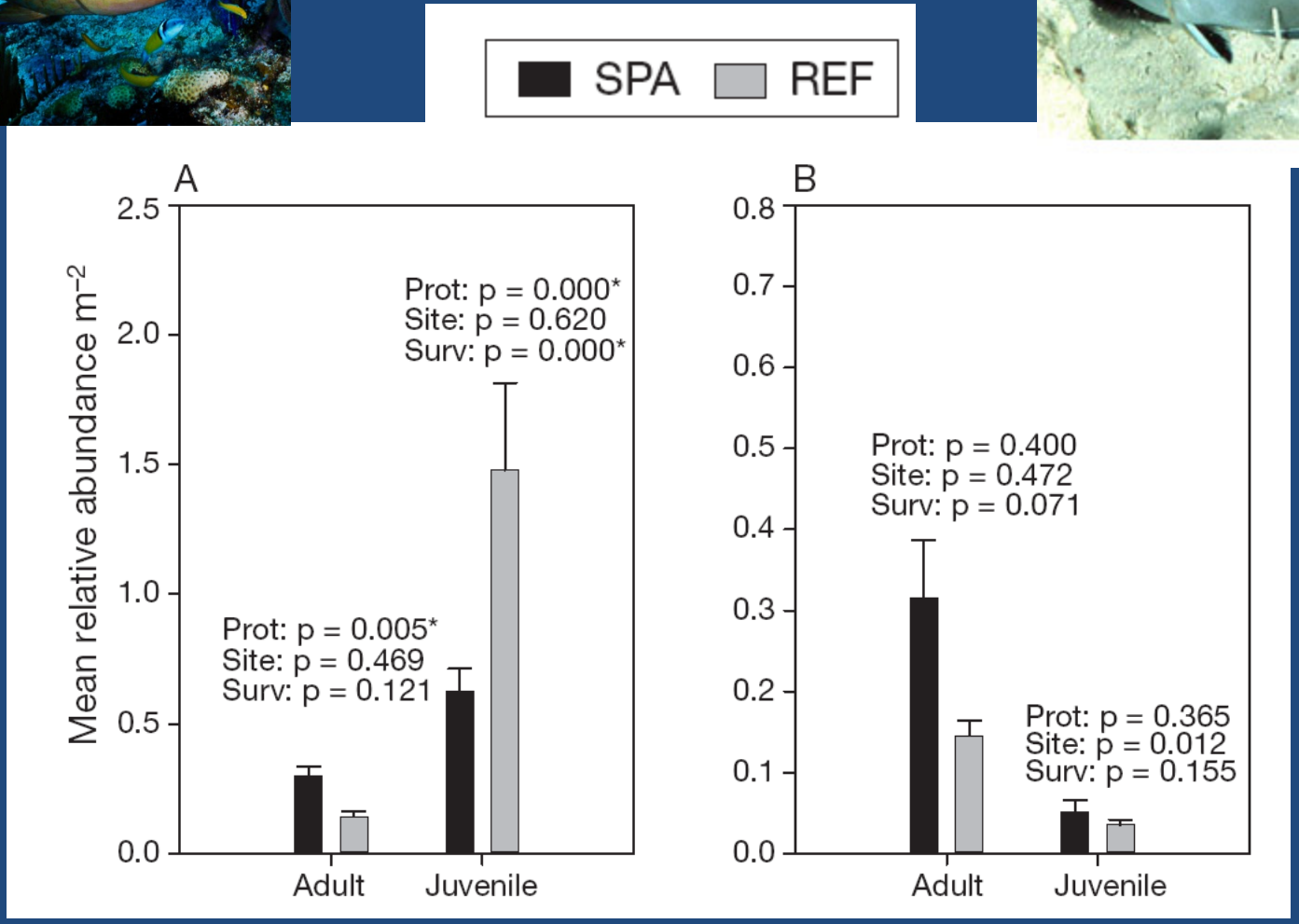
NOAA's Florida Keys National Marine Sanctuary



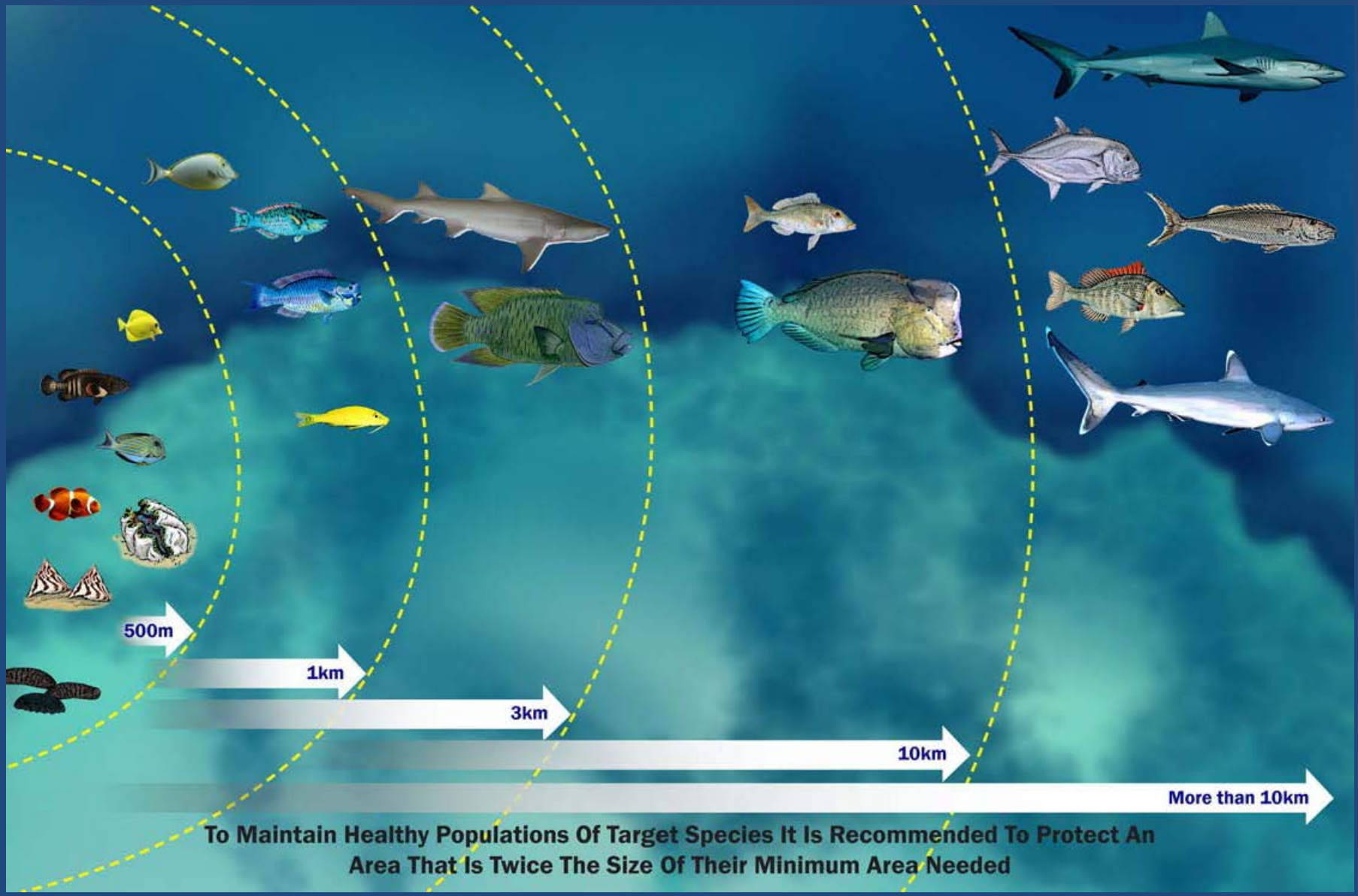
Fishes ….



© J.E. Randall



Kramer & Heck (2007) Marine Ecology Progress Series *349: 111–123*



Green et al 2013

Re-examining Protection

1) Reefs with the highest densities of corals
2) Reefs with the lowest per-colony bleaching intensity
3) Reefs with the lowest disease prevalence

Methods

1) Interpolate: coral abundance, coral bleaching, coral disease

2) Categorize reefs into the high, medium, and low: coral colony densities, bleaching history, disease history

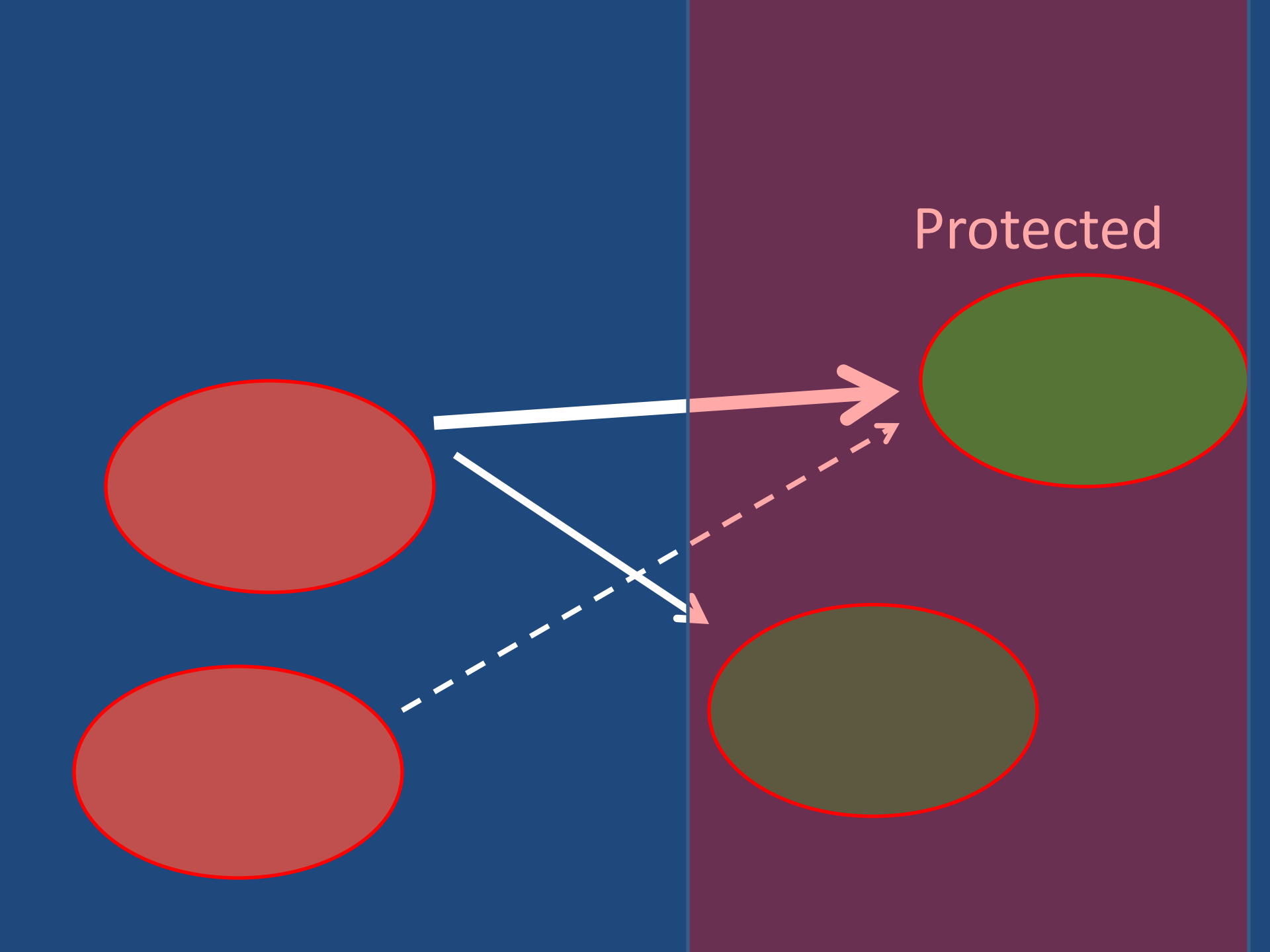
3) Select the ‘best’ reefs

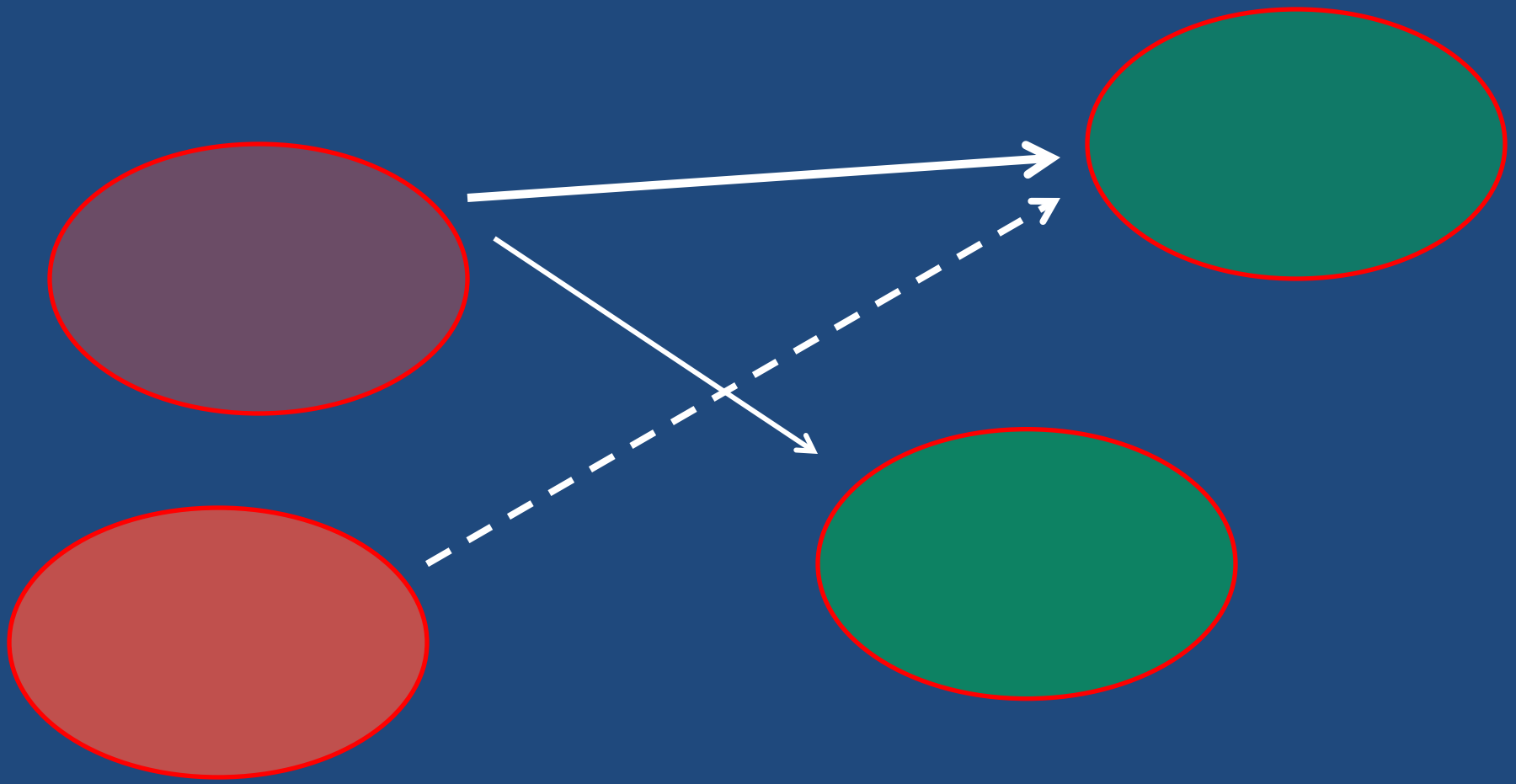
ID	Name	Priority
0	South Carysfort	≤0
1	The Elbow	0
2	Dry Rocks	0
3	Grecian Rocks	1
4	French Reef	<0
5	Molasses Reef	<0
6	Conch Reef	≤0
7	Conch Reef*	≤0
8	Hen and Chickens	<0
9	Davis Reef	0
10	Cheeca Rocks	<0
11	Alligator Reef	<0
12	Tennessee Reef*	1
13	Coffins Patch	0-1
14	Sombrero Key	0
15	Newfound Harbour Key	<0
16	Looe Key*	1
17	Western Sambos	<0
18	Looe Key	≤1
19	Eastern Sambos*	≤0
20	Eastern Dry Rocks	0
21	Sand Key	0
22	Rock Key	<0

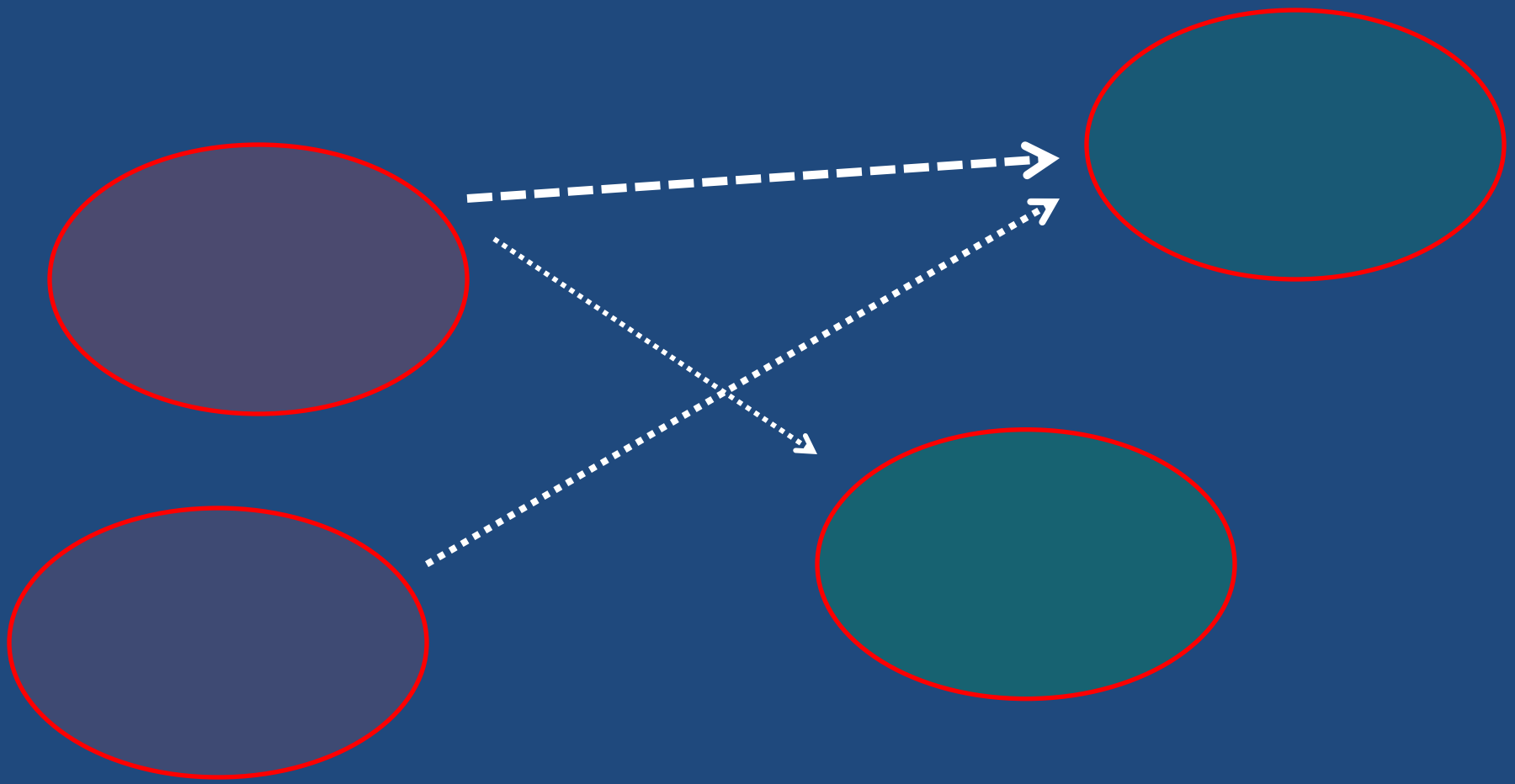
* Denotes research only area

van Woesik & Burman 2012

Reef Condition	Number of MPAs
≤0	18
1	5

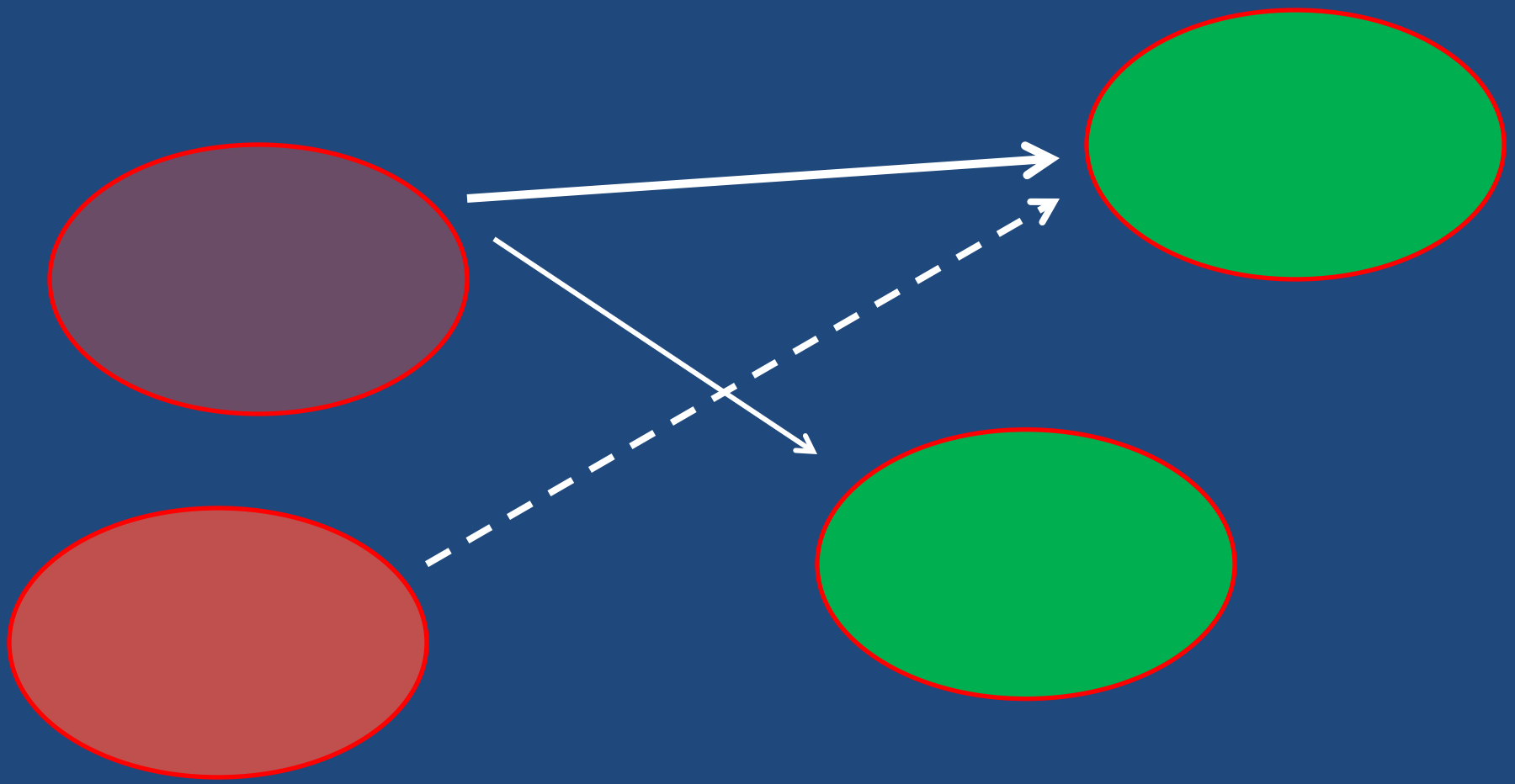

Protected

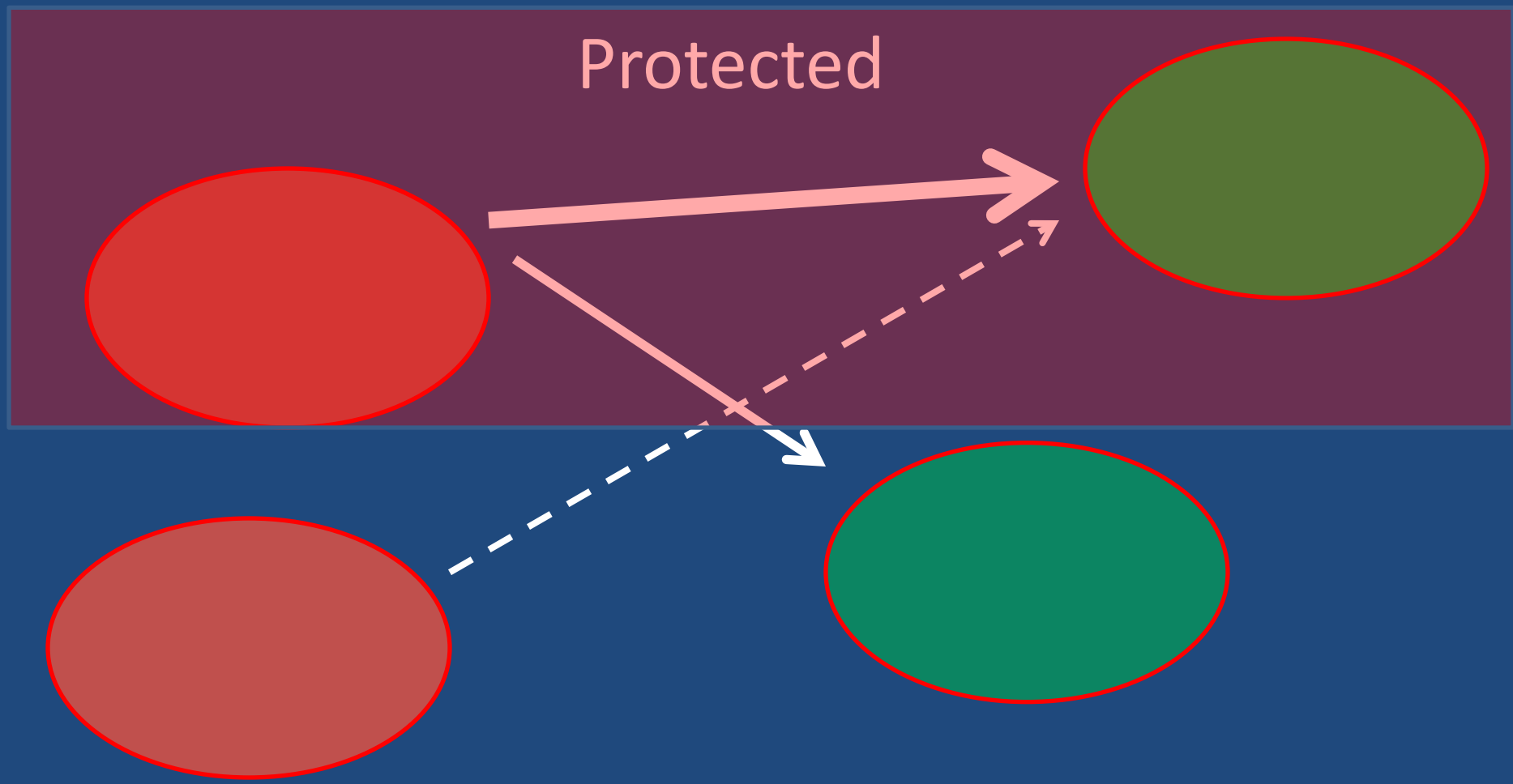




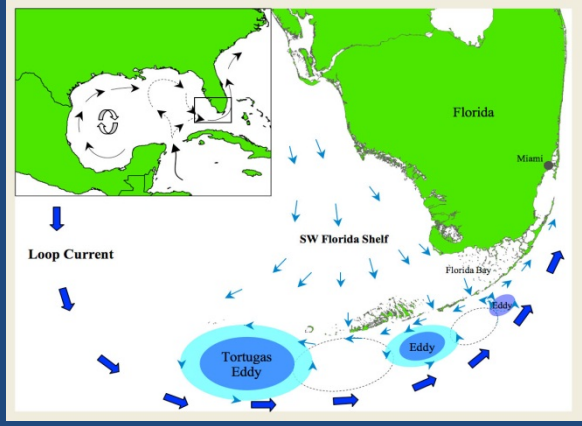
Not so good times

Sources & sinks dilemma



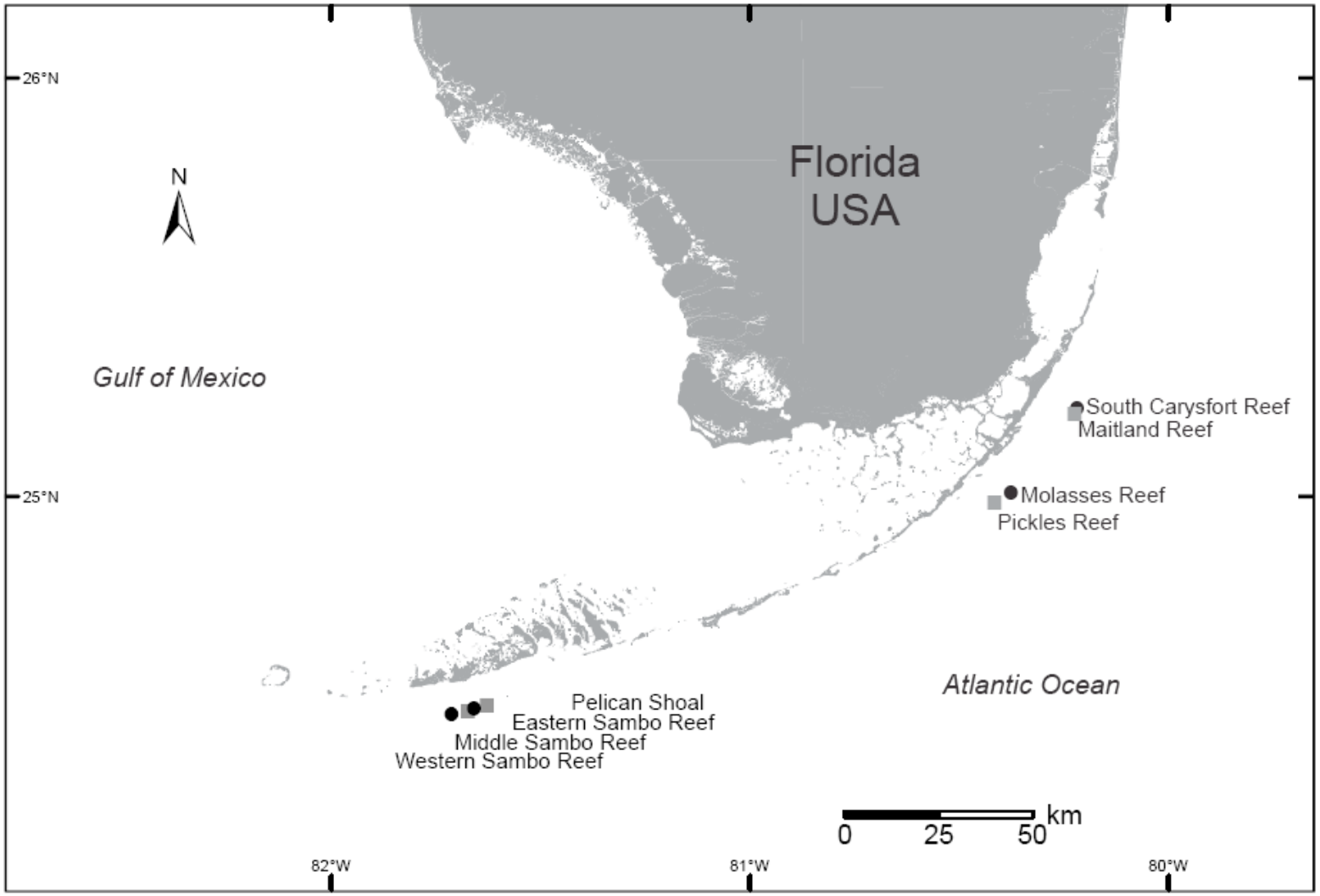

Protected
Good times

Florida Keys National Marine Sanctuary (1996) Final Management Plan/Environmental Impact Statement, Volume I, The Management Plan, National Oceanic and Atmospheric Administration, pp 342.



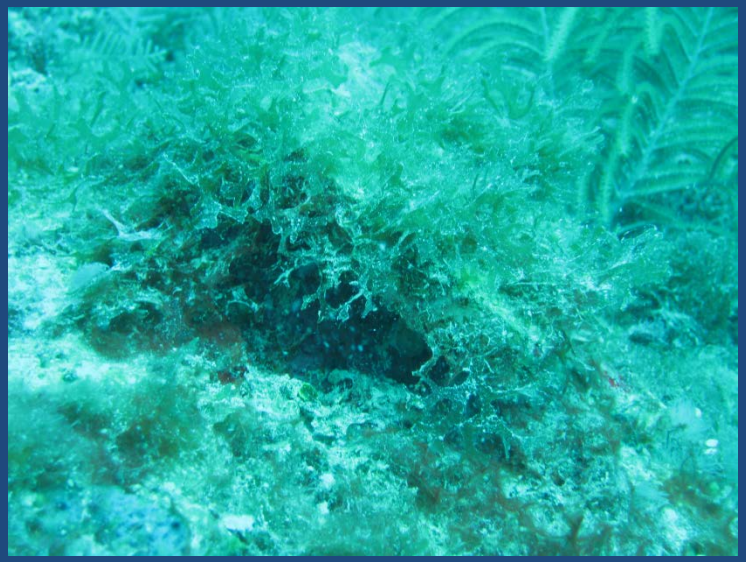
Although the Florida Keys National Marine Sanctuary was set up, in part, to ensure the sustainable use of the Florida Keys by "achieving a balance between comprehensive resource protection and multiple, compatible uses of those resources" [Page 5], ***the placement of the no-take reserves was not independent of oceanographic setting.***

Scott, Aronson, van Woesik (manuscript)



Fished reefs are represented by grey boxes and unfished reefs are represented by dark circles.

Coral recruitment study (2011)



- Protection-stratified approach
- Depth-stratified approach
- Location-stratified approach
  - Multiple tiles (n=10) were installed at 3 depths at each site (n=8)

Scott, Aronson, van Woesik (manuscript)

Methods

- Tile Installation: 240 tiles (10cm by 10cm by 1.5 cm unglazed, terracotta tiles where attached to the substrate (n=10 at each depth)
- Tiles arranged to match reef contour
- Tiles installed May 9- May 17, 2011 (n=240)

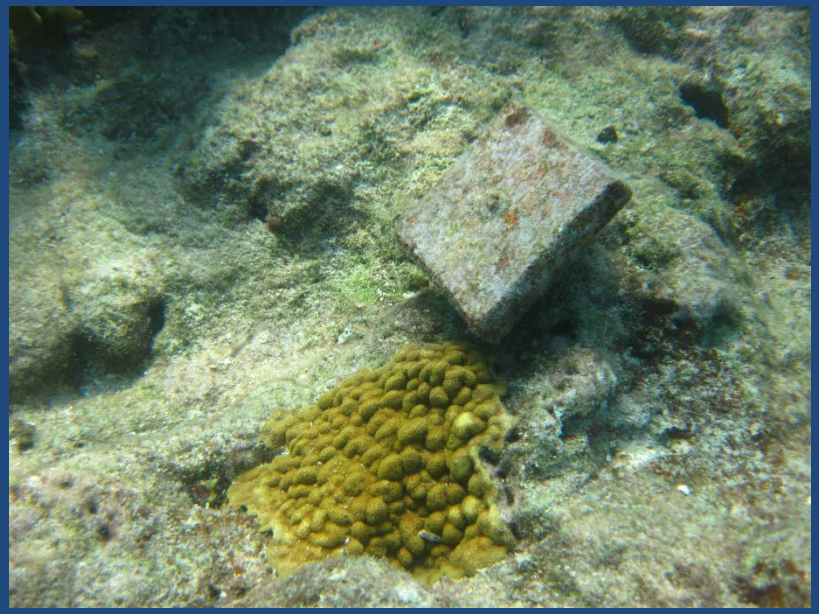
Using a pneumatic drill attached to a SCUBA tank, a small hole was bored into non-living carbonate framework

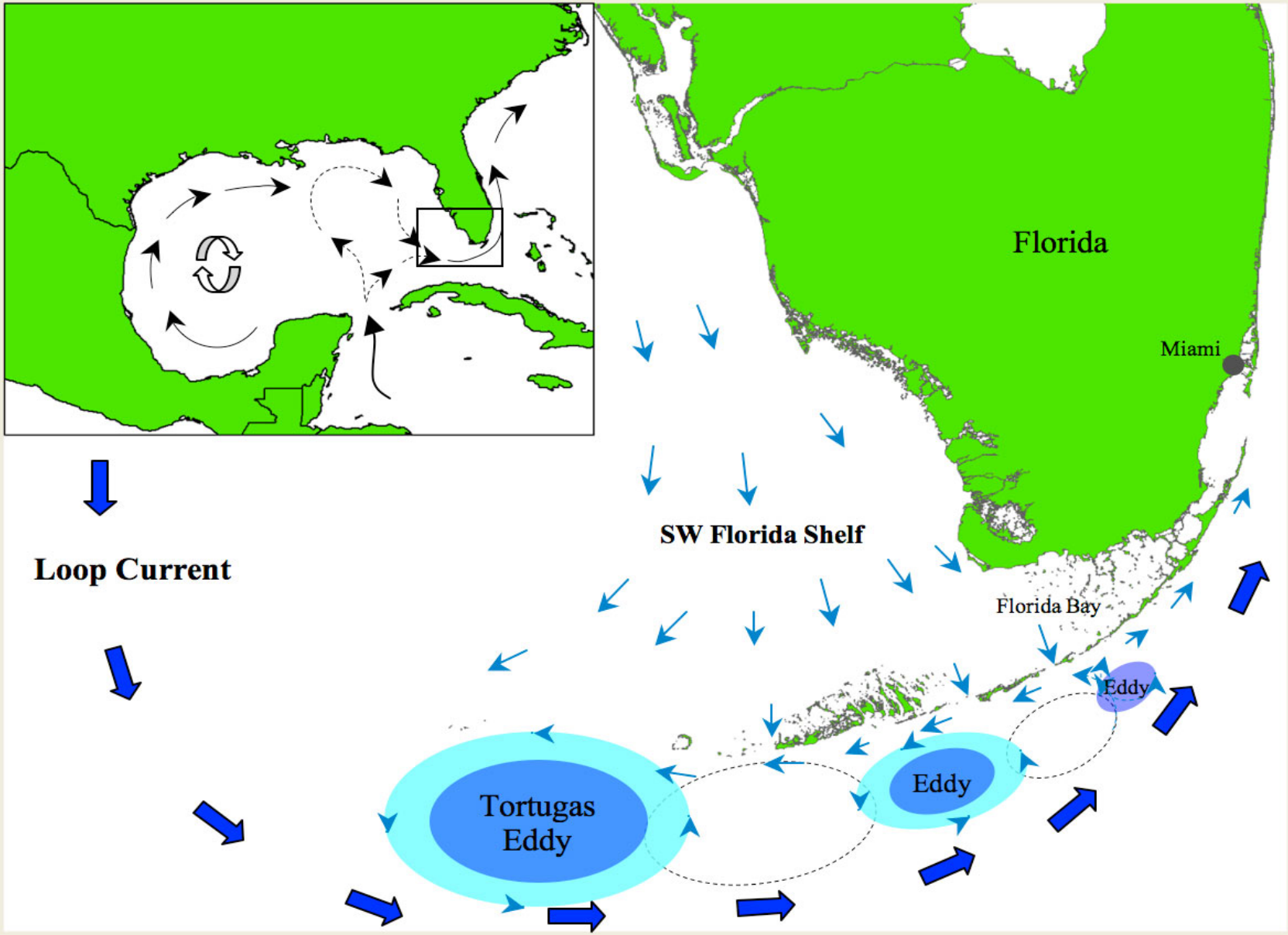
Installation was considered successful when the tile did not spin or move

Methods: Field

Tiles retrieved September 23- September 27, 2011

– 133-141 day soak period




Florida
Miami
Loop Current
SW Florida Shelf
Florida Bay
Eddy
Eddy
Tortugas
Eddy

Research Questions

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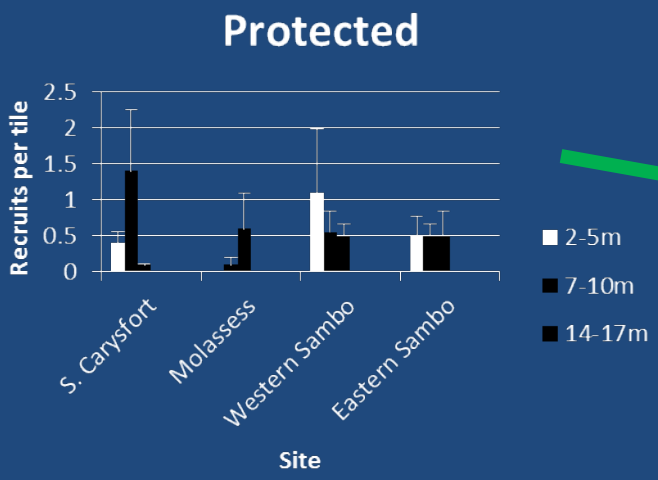
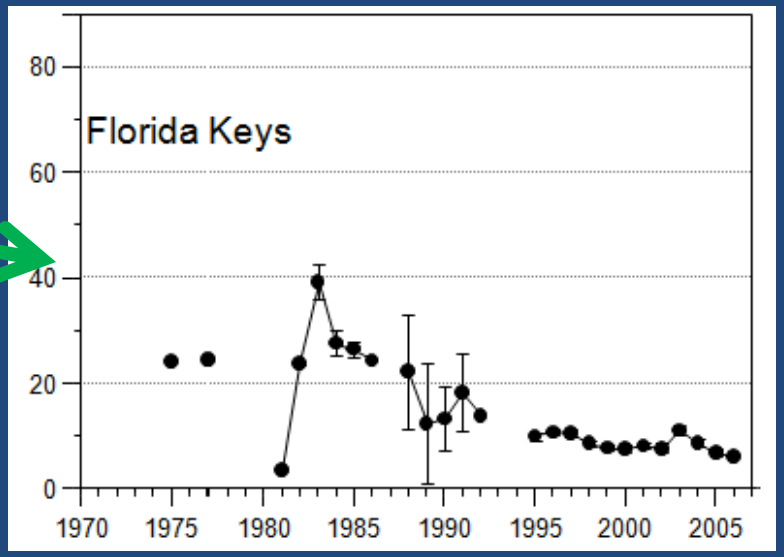
Mismatch

Good recruitment (this study)



Low coral cover in the Florida Keys

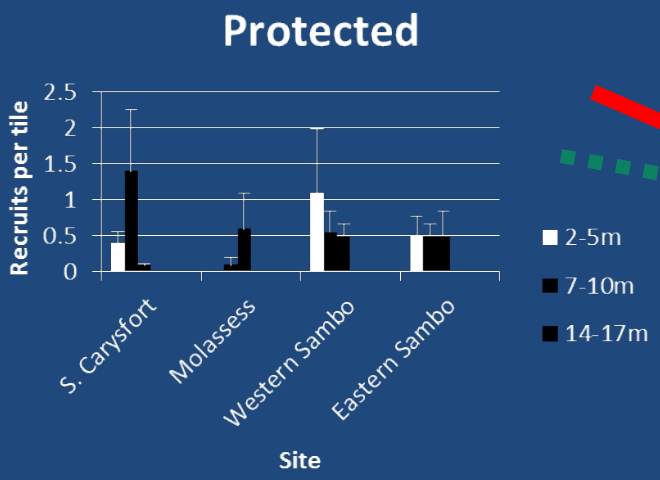


Schutte et al (2010) Mar Ecol Prog Ser 402: 115–122

High mortality:

corals are recruiting but not surviving

Good recruitment (this study)



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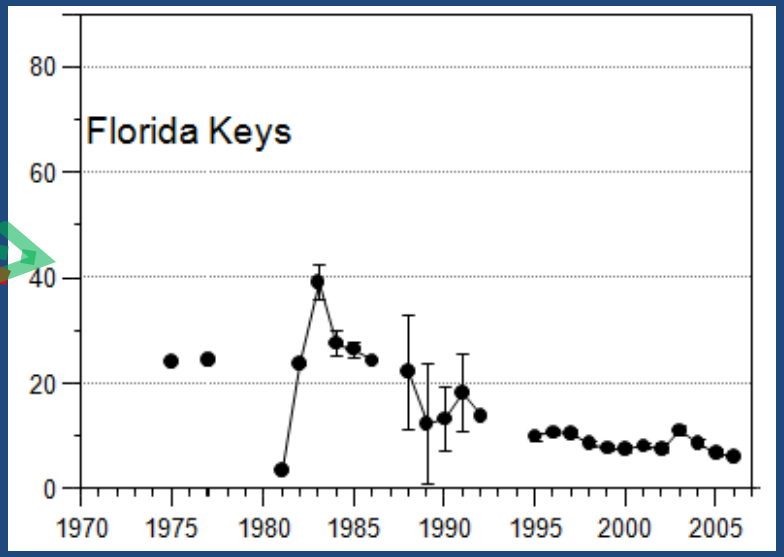
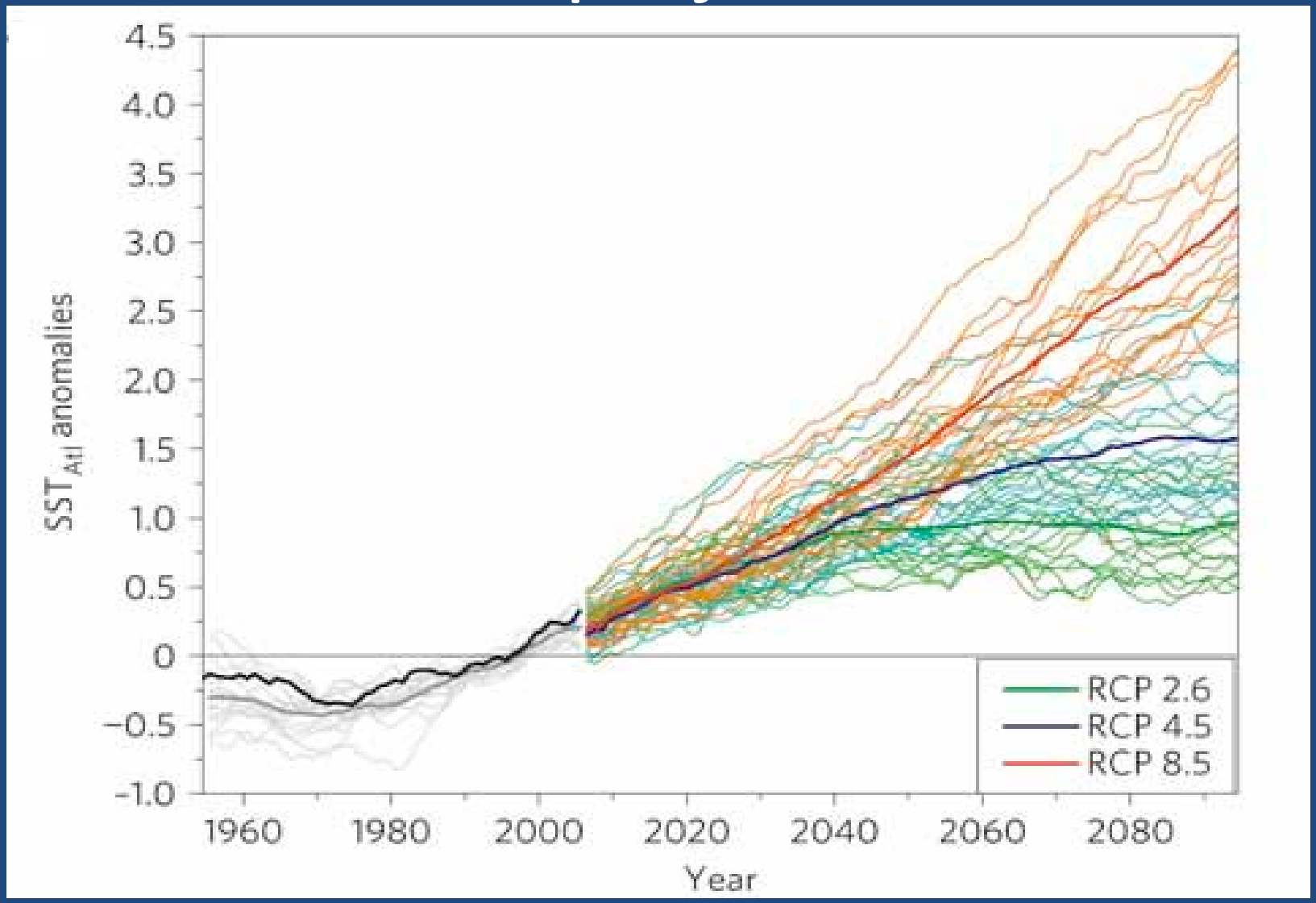


Schutte et al (2010) Mar Ecol Prog Ser 402: 115–122

Global projections



Villanni & Vecchi (2012) Nature Climate Change 2: 604-607

Considerations

Principle 1: Prohibit destructive activities throughout the management area.

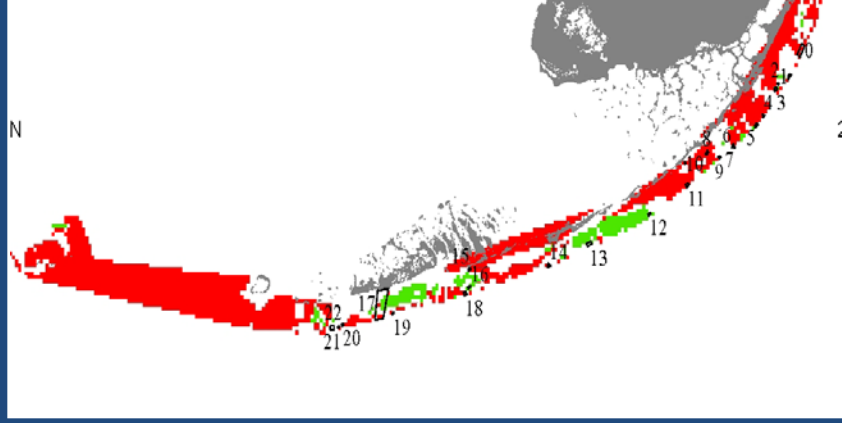
Principle 2: Represent 20-40% of each habitat within marine reserves.

Principle 3: Replicate protection of habitats within marine reserves.

Principle 4: Ensure marine reserves include critical habitats.

Citation: Green, A., White, A., Kilarski, S. (Eds.) 2013. Designing marine protected area networks to achieve fisheries, biodiversity, and climate change objectives in tropical ecosystems: A practitioner guide. The Nature Conservancy, and the USAID Coral Triangle Support Partnership, Cebu City, Philippines. viii + 35 pp.

Conclusions



1) Thermal stress has differentially favored coral species with wide thermal tolerance (eurythermal species);

2) The system has become more homogenous and more stable.

3) To retain resilience, protect the best reefs and those with the potential to recover.

4) Special areas worthy of protection:
Middle Keys: Tennessee Reef to Sombrero Reef;
Lower Keys: Looe Key to Western Sambo